Chemistry of Life
Chapter 3

Matter and Substances
Section 3-1

Atoms

Key Idea: All matter is made up of atoms. An atom has a positively charges core surrounded by a negatively charged region.

- An atom is the smallest unit of matter that cannot be broken down by chemical means.
- An element is a substance made up of atoms that have the same number of protons.

Atomic Structure

- The nucleus of an atom is made up of positively charged protons and uncharged neutrons.
- Negatively charged electrons have very little mass and move around the nucleus in a large region called the electron cloud.

Elements

- Atoms of an element may have different numbers of neutrons. These atoms are called isotopes of elements.

Reading Check:

What is a proton?

A positively charged particle that is part of the nucleus of an atom.

Chemical Bonds

Key Idea: Chemical bonds form between groups of atoms because most atoms become stable when they have eight electrons in the valence shell.

Covalent Bonding

- A covalent bond is atoms sharing valence electrons.
- A molecule is a group of atoms held together by covalent bonds.

Ionic Bonding

- An ionic bond is the attractive force between oppositely charged ions.
- An ion is an atom or group of atoms that has an electric charge because it has gained or lost electrons.

Reading Check:

What is a chemical bond?

The attractive force that holds atoms or ions together.

Polarity

Key Idea: Hydrogen bonding plays an important role in many of the molecules that make up living things.

Solubility

- Polar molecules can dissolve other polar molecules and ionic compounds.
- Nonpolar substances, such as oil, grease, and wax, do not dissolve well in water.

Hydrogen Bonds

- A hydrogen bond is the attraction of the negative pole to other nearby molecules.
- It is stronger than attractions between other molecules, but not as strong as covalent bonds.

Reading Check:

Why does salt dissolve in water?

The H atoms in water attract the chloride ions in salt. The O atoms attract the sodium ions in salt.

Water and Solutions
Section 3-2

Properties of Water

Key Idea: Most of the unique properties of water result because water molecules form hydrogen bonds with each other.

- Cohesion is the attraction of particles of the same substance, such as water.
- Adhesion is the attraction between particles of different substances .

Properties of Water

- Water can absorb a large amount of heat without changing temperature.
- This property can help organisms maintain a constant internal temperature.

Solutions

Key Idea: In solutions, some substances change the balance of these ions.

- A solution is a mixture in which ions or molecules of one or more substances are evenly distributed in another substance.
- An acid is a compound that forms extra hydronium ions when dissolved in water.
- A base is a compound that forms extra hydroxide ions when dissolved in water.
- pH is a measure of how acidic or basic a solution is.
- A buffer is a substance that reacts to prevent pH changes in a solution.

Acids and Bases

- When acids and bases are mixed, the extra hydronium and hydroxide ions react to form water.

pH and Buffers

- Each one-point increase in pH represents a 10-fold decrease in hydronium ion concentration.
- Pure water has a pH of 7. Acidic solutions have a pH below 7, and basic solutions have a pH above 7.

Carbon Compounds
Section 3-3

Building Blocks of Cells

Key Idea: Large, complex biomolecules are built from a few smaller, simpler, repeating units arranged in an extremely precise way.

Carbon Compounds

- The basic unit of most biomolecules contain atoms of carbon.
- Carbon atoms can form covalent bonds with as many as four other atoms.

Reading Check:

What element is the basis of biomolecules?

Carbon

Carbohydrates

Key Idea: Cells use carbohydrates for sources of energy, structural materials, and cellular identification.

- A carbohydrate is a class of molecules that includes sugars, starches, and fiber; contains carbon, hydrogen, and oxygen.
- A lipid is a fat molecule or a molecule that has similar properties, including waxes and steroids.

Energy Supply

- Carbohydrates are a major source of energy for many organisms, including humans.

Structural Support

- *Chitin* and *cellulose* are complex carbohydrates that provide support.
- Chitin is found in the shells of insects and the cell walls of mushrooms. Cellulose is found in the cell walls of plants.

Cell Recognition

- In a complex organism, cells recognize neighboring cells by the short, branched chains of varying sugar units on their outer surface.

Reading Check:

What is the basic unit of a carbohydrate?

a sugar

The word vary means to make a minor or partial change in.

Lipids

Key Idea: The main functions of lipids include storing energy and controlling water molecules.

Energy Stores

- The main purpose of fats is to store energy.
- Fats can store energy even more efficiently than carbohydrates.

Water Barriers

- The cell's boundary is made of phospholipids. The structure of cell membranes depends on how this molecule interacts with water.

Proteins

Key Idea: Proteins are chains of amino acids that twist and fold into certain shapes that determine what the proteins do.

- A protein is an organic compound that is made of one or more chains of amino acids and that is a principle component of all cells.
- An amino acid is a compound of a class of simple organic compounds that contain a carboxyl and an amino group and that combine to form proteins

Amino Acids

- Units of amino acids can form links called *peptide bonds*.
- Twenty different amino acids are found in proteins.

Levels of Structure

- Primary Structure = amino acid arrangement
- Secondary Structure = interactions of the various side groups may form coils and folds
- Tertiary Structure = overall shape of a single chain of amino acids
- Quaternary Structure = overall shape that results from combining the chains to form proteins.

Reading Check:

What is a protein's primary structure?

The order of amino acids

Nucleic Acids

Key Idea: Nucleic acids store and transmit hereditary information.

- A nucleic acid is an organic compound, either DNA or RNA, whose molecules are made up of one or two chains of nucleotides and carry genetic information.
- A nucleotide is an organic compound that consists of a sugar, a phosphate, and a nitrogenous base.
- DNA is deoxyribose acid, the material that contains the information that determines inherited characteristics.

- RNA is ribonucleic acid, a natural polymer that is present in all living cells and that plays a role in protein synthesis.
- ATP is adenosine triphosphate, an organic molecule that acts as the main energy source for cell processes.

Hereditary Information

- DNA molecules act as "instructions" for the processes of an organism's life.
- Nucleic acids store and transmit hereditary information.

Energy Carriers

- Cells need a steady supply of ATP to function.

Energy and Metabolism
Section 3-4

Changing Matter

Key Idea: Living things use different chemical reactions to get the energy needed for life processes.

Conservation of Mass

- Matter is neither created nor destroyed in any change. This observation is called the *law of conservation of mass*.

Conservation of Energy

- The ability to move or change matter is called energy.
- Energy exists in many forms and can be converted from one form to another.

Chemical Reactions

Key Idea: Chemical reactions can only occur when the activation energy is available and the correct atoms are aligned.

- Energy is the ability to move or change matter.
- A reactant is a substance that is changed in a chemical reaction
- A product is a new substance that is formed.
- Activation energy is the minimum amount of energy required to start a chemical reaction.

Activation Energy

- To form new bonds, the particles must collide fast enough to overcome the repulsion between their negatively charged electron clouds.

Alignment

- When the reactant particles collide, the correct atoms must be brought close together in the proper orientation.

Reading Check:

What causes particles to repel other particles?

Their negatively charged electron clouds

Biological Reactions

Key Idea: By assisting in necessary biochemical reactions, enzymes help organisms maintain homeostasis.

- An enzyme is a molecule that increases the speed of biochemical reactions.
- An active state is the region where the reaction takes place.
- Substrate is the reactant in reactions catalyzed by enzymes.

Enzymes

- Enzymes hold molecules close together and in the correct orientation. An enzyme lowers the activation energy of a reaction.

Metabolism

- Cells get most of the energy needed for metabolism by breaking down food molecules.

Reading Check:

Why is the shape of an enzyme important?

The shape of the active site determines which reactant will bind to the active site.