



## Cell Biology

### Cell Structure

<b>Cell Membrane</b>	Phospholipid bilayer with embedded proteins; controls the movement of substances in and out of the cell.
<b>Nucleus</b>	Contains DNA, controls cell activities through gene expression.
<b>Mitochondria</b>	Site of cellular respiration; generates ATP.
<b>Endoplasmic Reticulum (ER)</b>	Rough ER (with ribosomes): protein synthesis; Smooth ER: lipid synthesis and detoxification.
<b>Golgi Apparatus</b>	Processes and packages proteins and lipids.
<b>Lysosomes</b>	Contains enzymes for intracellular digestion.

### Cellular Processes

<b>Diffusion</b>	Movement of molecules from an area of high concentration to an area of low concentration.
<b>Osmosis</b>	Movement of water across a semipermeable membrane from an area of high water potential to an area of low water potential.
<b>Active Transport</b>	Movement of molecules against a concentration gradient, requiring energy (ATP).
<b>Endocytosis</b>	Cellular uptake of large molecules or particles by engulfing them in vesicles.
<b>Exocytosis</b>	Cellular secretion of large molecules by fusion of vesicles with the plasma membrane.
<b>Cellular Respiration</b>	Process by which cells break down glucose to produce ATP. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$
<b>Photosynthesis</b>	Process by which plants convert light energy into chemical energy. $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

### Cell Communication

Cells communicate through chemical signals.
<b>Types of Signals:</b>
<ul style="list-style-type: none"> <li><b>Autocrine:</b> Affect the cell that produces them.</li> <li><b>Paracrine:</b> Affect nearby cells.</li> <li><b>Endocrine:</b> Travel through the bloodstream to distant target cells.</li> <li><b>Direct Contact:</b> Communication through gap junctions.</li> </ul>
<b>Signal Transduction:</b> Process by which a cell converts one kind of signal or stimulus into another.
<b>Receptor Proteins:</b> Proteins that bind to specific signaling molecules and initiate a response.

## Genetics

### Basic Genetic Terms

<b>Gene</b>	A unit of heredity; a sequence of DNA that encodes a protein or RNA molecule.
<b>Allele</b>	A variant form of a gene.
<b>Genotype</b>	The genetic makeup of an organism.
<b>Phenotype</b>	The observable characteristics of an organism.
<b>Homozygous</b>	Having two identical alleles for a gene.
<b>Heterozygous</b>	Having two different alleles for a gene.
<b>Dominant</b>	An allele that masks the effect of another allele.
<b>Recessive</b>	An allele whose effect is masked by a dominant allele.

### DNA and RNA

<b>DNA</b>	Deoxyribonucleic acid; the genetic material containing instructions for cell function.
<b>RNA</b>	Ribonucleic acid; involved in protein synthesis. Types include mRNA, tRNA, and rRNA.
<b>Transcription</b>	Process by which RNA is synthesized from a DNA template.
<b>Translation</b>	Process by which proteins are synthesized from mRNA.
<b>Codon</b>	A sequence of three nucleotides that codes for a specific amino acid.
<b>Central Dogma</b>	DNA → RNA → Protein

### Mendelian Genetics

<b>Law of Segregation:</b> Allele pairs separate during gamete formation.
<b>Law of Independent Assortment:</b> Genes for different traits assort independently during gamete formation.
<b>Punnett Square:</b> Diagram used to predict the genotypes and phenotypes of offspring.
<i>Example:</i> Monohybrid cross of two heterozygous parents (Aa x Aa) yields:
<ul style="list-style-type: none"> <li>1 AA (25%)</li> <li>2 Aa (50%)</li> <li>1 aa (25%)</li> </ul>

## Ecology

## Basic Ecological Terms

<b>Ecosystem</b>	A community of living organisms (biotic) and their physical environment (abiotic) interacting as a system.
<b>Habitat</b>	The natural environment where an organism lives.
<b>Niche</b>	The role and position a species has in its environment; how it meets its needs for food and shelter, how it survives, and how it reproduces.
<b>Population</b>	A group of individuals of the same species living in the same area.
<b>Community</b>	An interacting group of various species in a common location.
<b>Biome</b>	A large naturally occurring community of flora and fauna occupying a major habitat, e.g., forest or tundra.

## Biochemistry

### Macromolecules

<b>Carbohydrates</b>	Provide energy and structural support. Monosaccharides, disaccharides, and polysaccharides.
<b>Lipids</b>	Store energy, form cell membranes, and act as hormones. Fats, oils, phospholipids, and steroids.
<b>Proteins</b>	Perform a wide range of functions, including enzymes, structural components, and transport. Amino acids are the building blocks.
<b>Nucleic Acids</b>	Store and transmit genetic information. DNA and RNA.

## Energy Flow

<b>Producers</b>	Organisms that produce their own food through photosynthesis or chemosynthesis.
<b>Consumers</b>	Organisms that obtain energy by consuming other organisms. (Herbivores, Carnivores, Omnivores).
<b>Decomposers</b>	Organisms that break down dead organic matter.
<b>Food Chain</b>	A linear sequence of organisms through which nutrients and energy pass as one organism eats another.
<b>Food Web</b>	A network of interconnected food chains.
<b>Trophic Level</b>	Each step in a food chain or food web.
<b>Energy Pyramid</b>	Graphical representation of energy flow through trophic levels.

### Enzymes

<b>Enzyme</b>	A biological catalyst that speeds up chemical reactions by lowering the activation energy.
<b>Substrate</b>	The reactant on which an enzyme acts.
<b>Active Site</b>	The region of an enzyme where the substrate binds.
<b>Cofactor</b>	A non-protein chemical compound or metallic ion that is required for an enzyme's activity.
<b>Inhibitor</b>	A substance that decreases the activity of an enzyme. (Competitive and Non-competitive).

## Biogeochemical Cycles

The cycling of essential elements (e.g., carbon, nitrogen, water, phosphorus) through the biotic and abiotic components of ecosystems.
<b>Carbon Cycle:</b> Photosynthesis, respiration, decomposition, and combustion.
<b>Nitrogen Cycle:</b> Nitrogen fixation, nitrification, denitrification, and assimilation.
<b>Water Cycle:</b> Evaporation, transpiration, condensation, precipitation, and runoff.

### Important Concepts

<b>pH:</b> A measure of the acidity or alkalinity of a solution.
<b>Buffers:</b> Substances that resist changes in pH.
<b>ATP (Adenosine Triphosphate):</b> The main energy currency of the cell.