

Unit 1: Chemistry of Life

- **Water's unique properties:**
 - **Cohesion:** Water molecules stick to each other
 - **Adhesion:** Water molecules stick to other surfaces
 - **Surface tension:** Allows insects to walk on water
- **Hydrolysis breaks bonds;** dehydration synthesis forms bonds
- **Nucleic acids:** DNA and RNA, composed of nucleotides
Nucleotides: made of a sugar, phosphate group, and nitrogenous base
- **Proteins:** Comprised of amino acids; structure determines function
- **Carbohydrates:** Sugars that store energy
- **Lipids:** Nonpolar molecules, found in cell membranes, vary in saturation

Additional Notes:

Unit 2: Cell Structure & Function

- **Key organelles:**
 - **Ribosomes:** Protein synthesis
 - **Endoplasmic Reticulum (ER):** Detoxification and lipid production
 - **Golgi Apparatus:** Modifies and packages proteins
 - **Mitochondria:** ATP production, powerhouse of the cell
 - **Lysosomes:** Enzyme digestion
- **Cytoskeleton:** Provides structural support and aids in cell movement
- **Phospholipid bilayer:** Selective permeability for nutrients and waste
- **High surface area:** Enhances transport efficiency
- **Active transport:** Moves substances against concentration gradient using ATP
- **Endosymbiotic theory:** Origins of mitochondria and chloroplasts

Additional Notes:

Unit 3: Cellular Energetics

- **Enzymes:** Lower activation energy, speed up reactions
 - **Active site:** Where substrate binds
 - **Factors affecting enzyme activity:** pH, temperature, concentration
 - **Competitive inhibitors:** Block active site
 - **Noncompetitive inhibitors:** Change enzyme shape
- **Photosynthesis:**
 - Light reactions produce ATP and NADPH
 - Calvin cycle uses ATP and NADPH to synthesize glucose
- **Cellular Respiration:**
 - **Aerobic respiration:** Requires oxygen, produces ATP
 - **Anaerobic respiration:** Does not require oxygen, less efficient
 - **Main steps:** Glycolysis, Krebs cycle, Electron Transport Chain

Additional Notes:

Unit 4: Cell Communication & Cell Cycle

- **Types of signaling:**
 - **Paracrine:** Nearby cells
 - **Endocrine:** Distant cells via bloodstream
 - **Autocrine:** Same cell
- **Signal transduction pathway:** Reception, transduction, response
 - **Reception:** Ligand binds to receptor
 - **Transduction:** Signal is relayed and amplified
 - **Response:** Cellular response, such as gene expression
- **Feedback mechanisms:**
 - **Negative feedback:** Reduces stimulus (e.g., insulin regulation)
 - **Positive feedback:** Amplifies stimulus (e.g., childbirth)
- **Cell cycle stages:** Interphase (G1, S, G2), Mitosis, Cytokinesis
 - **Mitosis:** Division of nucleus, produces identical daughter cells

Additional Notes:

Unit 5: Heredity.

- **Meiosis:**
 - **Meiosis I:** Homologous chromosomes separate
 - **Meiosis II:** Sister chromatids separate
 - Results in four genetically unique haploid cells
- **Genetic variation:**
 - **Crossing over:** Exchange of genetic material between homologous chromosomes
 - **Independent assortment:** Random distribution of chromosomes
- **Pedigree analysis:** Tracking inheritance patterns
- **Environmental influences:** Can affect gene expression (e.g., temperature influencing fur color)
- **Genetic disorders:** Result from mutations or chromosomal abnormalities

Additional Notes:

Unit 6: Gene Expression & Regulation

- **DNA replication:** Semi-conservative process, 5' to 3' direction
 - **Key enzymes:** Helicase (unwinds DNA), DNA polymerase (builds new strand), Ligase (joins fragments)
- **Transcription:** DNA to mRNA
 - **Processing:** Addition of 5' cap, poly-A tail, and splicing of introns
- **Translation:** mRNA to protein
 - **Ribosomes** read mRNA, tRNA brings amino acids
- **Gene regulation:**
 - **Transcription factors:** Proteins that control gene expression
 - **Operons:** Found in prokaryotes, regulate gene clusters
- **Mutations:** Changes in DNA sequence, can be beneficial, neutral, or harmful
- **Biotechnology tools:**
 - **Gel electrophoresis:** Separates DNA fragments
 - **PCR: Amplifies DNA**
 - **Bacterial transformation:** Introduces new genes into bacteria

Additional Notes:

Unit 7: Natural Selection

- **Evolution:** Change in allele frequencies over time
- **Natural selection:** Process where organisms better adapted to their environment tend to survive and reproduce
- **Genetic drift:** Random changes in allele frequencies
- **Hardy-Weinberg equilibrium:** Describes a non-evolving population
- **Phylogenetic trees:** Show evolutionary relationships
- **Extinction:** Leads to new niches and opportunities for survivors
- **Population dynamics:** Study of how populations change over time

Additional Notes:

Unit 8: Ecology.

- **Homeostasis:** Maintenance of a stable internal environment
 - **Net energy gain/loss:** Affects an organism's survival
- **Endotherms vs. Ectotherms:**
 - **Endotherms:** Regulate body temperature internally
 - **Ectotherms:** Depend on external sources for body heat
- **Adaptations:** Traits that improve survival and reproduction
- **Biodiversity:** Variety of life, important for ecosystem resilience
- **Ecological relationships:** Commensalism: One benefits, other is unaffected
 - **Commensalism:** One benefits, other is unaffected
 - **Mutualism:** Both benefit
 - **Parasitism:** One benefits, other is harmed
 - **Predation:** Predator and prey interactions
 - **Competition:** Organisms vie for the same resources
- **Energy transfer:** Only about 10% of energy is transferred to the next trophic level in an energy pyramid

Additional Notes: