EXAM REVIEW

HESI A2 Cheat Sheet

BIOLOGY

Water and Molecules

Water is a polar inorganic compound that is at room temperature a tasteless and odorless liquid, nearly colorless with a hint of blue.

- Formula: H2O
- Density: 997 kg/m³
- Boiling point: 212°F (100°C)
- Molecular mass: 18.01528 g/mol
- Melting point: 32°F (0°C)
- Pure water (solely hydrogen and oxygen atoms), is neither acidic nor basic. It has a neutral pH of 7.
- Water expands by 9% when it freezes.
- Water is able to dissolve other polar molecules and ions, such as sugars and salts. However, nonpolar molecules like oils lack partial positive or partial negative charges, so they are not attracted to water molecules. This is why nonpolar substances like oil remain separate when added to water.
- Water molecules have strong cohesive forces (responsible for surface tension) due to their ability to form hydrogen bonds with one another.
- Water has adhesive properties that allow it to stick to substances other than itself.
- Water is less dense as a solid than as a liquid. As water freezes, the molecules form a crystalline structure that spaces the molecules further apart than in liquid water.

Molecular polarity

Nonpolar molecules - Symmetric: carbon dioxide (CO_2), benzene (C_6H_6), methane (CH_4), ethylene (C_2H_4).

- molecules with four or fewer total electron groups around the central atom; the *bonded atoms are identical* and there are no unshared electrons on the central atom

Polar molecules - Asymmetric: water (H_2O), ammonia (NH_3), sulfur dioxide (SO_2), ethanol (C_2H_6O).

- a molecule in which one end of the molecule is slightly positive, while the other end is slightly negative
- containing *lone pairs of electrons on a central atom* or having atoms with different electronegativities bonded

Properties of polar molecules:

- higher melting points than nonpolar molecules
- higher boiling points than nonpolar molecules
- more soluble in water (dissolve better) than nonpolar molecules
- lower vapor pressures than nonpolar molecules

Intramolecular forces - The covalent bonds that hold atoms together in molecules and polyatomic ions.

Intermolecular forces - Hold molecules together in a liquid or solid; generally much weaker than covalent bonds.

- determine bulk properties such as the melting points of solids and the boiling points of liquids

Types of intermolecular interactions:

- Dipole-dipole interactions: arise from the electrostatic interactions of the positive and negative ends of molecules with permanent dipole moments.
- London dispersion forces: due to the formation of instantaneous dipole moments in polar or nonpolar molecules as a result of short-lived fluctuations of electron charge distribution, which in turn cause the temporary formation of an induced dipole in adjacent molecules.
- Hydrogen bonds: especially strong dipole–dipole interactions between molecules that have hydrogen bonded to a highly electronegative atom, such as O, N, or F.

Metabolism

Metabolic Pathways:

- **Catabolism** - The degradation of complex molecules into simpler ones, releasing the chemical energy stored in the bonds of those molecules; releases energy.

! Cellular respiration is a form of catabolism. It represents the set of metabolic reactions and processes that take place in the cells of organisms to convert biochemical energy from nutrients into adenosine triphosphate (ATP).

Cellular respiration formula: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O +$ Energy (ATP)

- **Anabolism** - Synthesizing compounds from simpler substances required by the cells; requires and stores energy.

Enzymes - A protein that facilitates or catalyzes chemical reactions within metabolic pathways.

Cell Basics

Cellular reproduction - Cell Division

Prokaryotes - *binary fission* - 3 stages

1. **DNA replication** - Results in two identical chromosomes, meaning that each daughter cell will have its own chromosome.
2. **Chromosome Segregation** - The two chromosomes separate, and move to opposite poles of the cell.
3. **Separation** - A new plasma membrane starts growing into the center of the cell, and the cytoplasm splits apart, forming two daughter cells.

Eukaryotes - 2 stages

- Mitosis - The nuclear membrane breaks down and later reforms. The chromosomes are also sorted and separated to ensure that each daughter cell receives a diploid number (2 sets) of chromosomes.
  - ***Prophase:*** chromatin condenses into chromosomes, and the nuclear envelope, or membrane, breaks down.
  - ***Metaphase:*** spindle fibers attach to the centromere of each pair of sister chromatids. The sister chromatids line up at the equator, or center, of the cell.
  - ***Anaphase:*** sister chromatids separate and the centromeres divide. At the end of anaphase, each pole of the cell has a complete set of chromosomes.

	▸ ***Telophase:*** the chromosomes begin to uncoil and form chromatin. ▸ **Cytokinesis** - The division of the cytoplasm in eukaryotic cells, resulting in two genetically identical daughter cells.
Photosynthesis	**Equation:** $6CO_2 + 6H_2O$ + light energy $\rightarrow C_6H_{12}O_6 + 6O_2$ **Autotroph** - An organism that is capable of photosynthesis. **Heterotroph** - An organism that is not capable of photosynthesis. ▸ In all autotrophic eukaryotes, photosynthesis takes place **inside an organelle called a chloroplast.** ▸ In plants, photosynthesis takes place primarily in leaves. ▸ It occurs not on the surface layers of the leaf, but rather **in a middle layer called the mesophyll** (which contains chloroplast-containing cells). ▸ The entire process of photosynthesis **begins through** a pigment embedded in the thylakoid membrane, called **chlorophyll**.
Genetics	**Mendel's laws of Inheritance:** **Dominance:** hybrid offspring will only inherit the dominant trait in the phenotype. ▸ *suppressed alleles = recessive traits* ▸ *alleles that determine the trait = dominant traits* **Segregation:** allele pairs segregate during the formation of gamete and re-unite randomly during fertilization. ▸ *allele pairs segregate during the formation of the gamete and reunite randomly during fertilization* **Independent Assortment:** a pair of traits segregates independently of another pair during gamete formation. ▸ *as the individual hereditary factors assort independently, different traits get equal opportunity to occur together*
DNA	The **building blocks of DNA** are nucleotides, made up of: ▸ a nitrogenous base ▸ deoxyribose (5-carbon sugar) ▸ phosphate group ▸ Within the double-helix structure of DNA, the two strands that make up the double helix are **complementary and anti-parallel in nature**. ▸ **Deoxyribose sugars and phosphates** form the backbone of the structure, and the nitrogenous bases are stacked inside. ▸ During cell division, **each daughter cell receives a copy of the DNA** by a process known as DNA replication. **DNA replication:** the two strands of the double helix separate during replication, and each strand serves as a template from which the new complementary strand is copied.