Levels of Biological Organization

Introduction to Biology (1.1)

Life begins at this Level

Levels of Biological Organization

- There are many different levels of organization that are important for biology
  - Each level consists of a specific ordered arrangement of parts from the lower levels
  - Each level has important properties not contained in lower levels
  - Different forces affect biology at each of the different levels
  - For example,
    - Specific molecules are made of specific arrangement of atoms
      - It must have phospholipids in its membrane
      - It must have DNA connected in long linear chains to store genetic information
      - It must have proteins in the membrane to let molecules pass through
    - An organ is made of specific arrangement of tissues
      - The outside of the heart has epithelia tissue to serve as a barrier
      - A bulk of the heart is made of muscle.
      - Different chambers of the heart are connected by connective tissue

Atomic Structure

- An atom is the smallest unit of matter that can be isolated from purely chemical means
- Atoms are composed of 3 subatomic particles:
  - Proton has positive (+) charge
  - Electron has negative (-) charge
  - Neutron lacks electrical charge
- The center of an atom is the nucleus which contains the protons and neutrons. Electrons orbit the nucleus chaotically in regions called electron shells
- Atoms with different configurations of subatomic particles have different chemical properties.
- Each different configuration is a different element. Examples: hydrogen, oxygen, carbon, etc.

Elements

- Most of the human body is made of water (73%)
  - Water molecules are composed of 2 hydrogens and 1 oxygen (H₂O)
- Most of the mass of the human body comes from oxygen atoms, followed by carbon and then hydrogen
**Molecules**

- Atoms can be combined and joined by chemical bonds to form molecules.
- One type of chemical bond involves sharing electrons.
- Water is composed of 3 atoms but only 2 different elements.

- In water, oxygen shares one of its red electrons with a hydrogen, the hydrogen shares its white electron with oxygen, they now share two electrons forming a chemical bond.
- Oxygen forms a chemical bond with two hydrogens to make 1 water molecule with formula \( H_2O \).

**Biological Macromolecules**

- Most of a cell (other than water) and therefore most of an organism is made of molecules that fall into 1 of 4 categories.
  - **Proteins** (orange in figure)
  - **Carbohydrates** (yellow)
  - **Lipids** (blue)
  - **Nucleic acids** (red and black)

  - DNA and RNA are both nucleic acids.
  - We call these biological molecules "macromolecules" because they are large molecules made of smaller building-block type molecules.

**Biological Molecules**

- **Carbohydrate** such as starch and sugars serve as quick acting sources of energy and cell markers.
- **Lipids** such as fats, oils also function as energy storage but store more energy per gram than sugar but take longer to extract the energy.
  - A very important characteristic of lipids is that they repel and do not interact with water.
  - Phospholipids are important lipids of biological membranes.

- **Proteins** are much of the biological machinery that give cells their function.
  - Enzymes break molecules down or build them up.
  - Other proteins are structural or move things.

- **Nucleic acids** store information.
  - DNA stores genetic information, RNA copies genetic information and delivers it to ribosomes to make proteins.

**Human Bodies Contain Over 100 Different Cell Types**

- There are many different cell types in the human body.
- Each cell type has a different function.
- Each cell's function is determined by the molecules it is made of.

  - Muscle cells contain many fibrous proteins that pull on other proteins to shorten during contraction and producing force.
  - Adipose cells aren't very active compared to many others and mainly function to store large quantities of fat for long term energy storage and to insulate the body.
  - Red blood cells are almost entirely filled with the protein hemoglobin. Hemoglobin absorbs oxygen which is how we transport oxygen in our blood.
Cells of the same type and function are organized into tissues.

Different tissues are assembled in particular ways to produce different organs. Each organ is a structure that has a unique function.

Different organs working together to perform the major functions of the body are called organ systems.

An organism is a structure made from one or more cells that can live and reproduce independently.