Chemistry of Life

Matter

- Matter
  - Has weight and occupies space
  - Usually can feel, taste or see it
- Three states of matter
  1. Solid
  2. Liquid
  3. Gas

Composition of Matter

- Element
  - Building block of matter
- Most common elements
  - C - carbon
  - H - hydrogen
  - O - oxygen
  - N - nitrogen
Composition of Matter

- Atom
  - Smallest part of an element

The Chemical Composition of Living Matter

1. Organic compounds
   - Compounds containing carbon
   - Examples
     - Carbohydrates, lipids, proteins and nucleic acids

2. Inorganic compounds
   - Compounds lacking carbon. Smaller, simpler
   - Examples
     - Water, salts, acids, and bases
Inorganic Compounds

Salts
- Compounds that separate (dissociate) into charged particles (ions) when dissolved in water.
- Examples
  - Calcium, phosphorus, sodium, potassium, iron

Inorganic Compounds

Acid
A substance that can release hydrogen ions (H⁺)

Example

\[
\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^- \\
\text{(hydrochloric acid)} \quad \text{(hydrogen ion)} \quad \text{(anion)}
\]
Inorganic Compounds

Base

A substance that can accept hydrogen ions

Example

\[ \text{NaOH} \rightarrow \text{Na}^+ + \text{OH}^- \]

(sodium hydroxide) (cation) (hydroxyl ion)

Dissociation — Addition of NaOH

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Acid-Base Concentrations

Measured by:

pH

A measure of the concentration of hydrogen ions.
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Dissociation of Water Molecules

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**pH Scale**

Water dissociates:

\[ H_2O \rightarrow H^+ + OH^- \]

- Water
- Hydrogen ion
- Hydroxyl ion

7 = neutral pH \( (H^+ = OH^-) \) pure water

Range of pH scale: 0 - 14

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**pH Scale**

Increasing concentration of hydrogen ions \([H^+]\)

Increasing concentration of hydroxyl ions \([OH^-]\)
Regulating Acid-Base Concentrations

Buffers
A substance(s) that help stabilize the pH of a solution.

Example
Maintaining blood pH between 7.35 - 7.45

Organic Compounds

1. Carbohydrates
   - Sugars and starches
2. Lipids
   - Neutral fats, phospholipids and steroids
3. Proteins
4. Nucleic Acids
   - DNA and RNA
Carbohydrates

- **Monosaccharides**
  - Structural unit or basic building block
  - Simple sugars
  - Examples: glucose, fructose, deoxyribose

- **Disaccharides**
  - Double sugars
  - Examples: sucrose, maltose, lactose

- **Polysaccharides**
  - Long, branching chains of simple sugars
  - Examples: starch and glycogen

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**Glucose Structure**

\[ C_6H_{12}O_6 \]

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**Condensation Synthesis and Hydrolysis of Maltose**

Condensation synthesis

\[ \text{glucose} \quad \text{glucose} \rightarrow \text{maltose} \]

Hydrolysis

\[ \text{maltose} + \text{H}_2\text{O} \rightarrow \text{glucose} + \text{glucose} \]
Lipids

1. **Neutral fats (triglycerides)**
   - Building blocks: fatty acids and glycerol
   - Found in fat deposits (skin and around organs)
   - Protects and insulates body organs
   - Major source of stored energy in body

2. **Phospholipids**
   - Found in cell membranes

3. **Steroids**
   - Cholesterol, vitamin D, sex hormones
Proteins

- Building blocks: amino acids
- Amino acids join together in chains - form large, complex molecules
- Sequence of amino acids in chain determines the structure and function of the protein
- Examples: enzymes, antibodies, hormones
Synthesis and Hydrolysis of a Peptide (Basic Equation)

Condensation synthesis

amino acid + amino acid \rightarrow dipeptide + water

Hydrolysis

Primary Structure of Protein

Secondary Structure of Protein

hydrogen bond
Enzymes

- Proteins that increase the rate of a chemical reaction (catalyze) without becoming part of the product or being changed itself.
- Each enzyme controls one specific chemical reaction.
- Recognized by suffix -ase
Nucleic Acids

- Function: making protein
- Building blocks: nucleotides
- Major kinds
  - DNA (deoxyribonucleic acid)
    - Double stranded - spiral staircase-like structure
    - Makes exact copies of itself
    - Provides instructions for making protein
  - RNA (ribonucleic acid)
    - Single strand
    - Carries out instructions from DNA to make protein

Nucleotide with Purine Base

Nucleotide with Pyrimidine Base
Adenosine Triphosphate (ATP)

- A modified nucleotide
- Function:
  - provides chemical energy used by all body cells.
- Energy released from ATP
  - Used to transport certain molecules across cell membranes
  - Causes proteins in muscle cells to shorten
  - Used to drive energy-absorbing reactions
The End