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Medical Biochemistry and Molecular Biology

INTRODUCTION

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What is Biochemistry?

- Biochemistry is the application of chemistry to the study of biological processes at the cellular and molecular level.

- It deals with integration of chemistry, physiology and biology to study living systems by:
  
  A. Studying the structure and behavior of the complex molecules found in biological material and
  
  B. the ways these molecules interact to form cells, tissues and whole organism
Principles of Biochemistry

- **Cells** (basic structural units of living organisms) are highly organized and constant source of energy is required to maintain the healthy state.

- All organisms use the same **type of molecules**: carbohydrates, proteins, lipids & nucleic acids.

- Instructions for growth, reproduction and developments for each organism is **encoded in their DNA**
Cells

- Basic building blocks of life
- Smallest living unit of an organism
- Grow, reproduce, use energy, adapt, respond to their environment
- Many cannot be seen with the naked eye
- A cell may be an entire organism or it may be one of billions of cells that make up the organism
Biomolecules – Structure

- **Building block**
  - Simple sugar
  - Amino acid
  - Nucleotide
  - Fatty acid

- **Macromolecule**
  - Polysaccharide
  - Protein (peptide)
  - RNA or DNA
  - Lipid

Anabolic → Catabolic
About 60-90 percent of an organism is water. Water is used in most reactions in the body. Water is called the universal solvent.
Life needs 3 things:

(1) ENERGY, which it must know how to:

- Extract
- Transform
- Utilize
Life needs (2) SIMPLE MOLECULES, which it must know how to:

- Convert
- Polymerize
- Degrade
Life needs (3) Biochemical Reactions

- **Metabolism**: total sum of the chemical reaction happening in a living organism (highly coordinated and purposeful activity)
  - a. **Anabolism** - energy requiring biosynthetic pathways
  - b. **Catabolism** - degradation of fuel molecules and the production of energy for cellular function

- All reactions are catalyzed by enzymes

- The primary functions of metabolism are:
  - a. Production & utilization of energy
  - b. Synthesis of molecules needed for cell structure and functioning (i.e. proteins, nucleic acids, lipids, & CHO)
  - c. Removal of waste products
Functional groups

- A **functional group** is an atom or a group of atoms with characteristic chemical and physical properties. It is the reactive part of a molecule.
- Organic compounds having only C—C and C—H bonds are called **Hydrocarbons**.
Alcohols

- Members of the alcohol family contain a **hydroxyl group**.
- The **hydroxyl group** comprises an oxygen with one single bond to a hydrogen and another single bond to one of the hydrocarbon chain.
Primary Alcohol
-CH₂OH

Secondary Alcohol
-CHOH

Tertiary Alcohol
-COH
Carboxylic Acids

**Carboxylic acids**

- Members of the carboxylic acid family contain a **carboxylic acid group**
- The carboxylic acid group comprises a hydroxyl group connected to a carbonyl group:

\[
\begin{align*}
\text{carbonyl group} & \quad + \quad \text{hydroxyl group} \\
\text{carboxylic acid group}
\end{align*}
\]
Chemically, esters can be synthesized by reacting a carboxylic acid with and alcohol:

\[
\text{carboxylic acid} + \text{alcohol} \rightarrow \text{ester} + \text{water}
\]
Carbonyl group

- **Carbonyl group**: group composed of carbon + oxygen atom with double bond.

- Includes:
  1. Aldehyde
  2. Ketone
ALDEHYDE

CARBONYL GROUP

KETONE
Amino & Imino groups

Amino group: \(* \quad \text{—} \quad \text{NH}_2\)

Imino group: \(* \quad \quad \equiv \quad \text{NH}\)
Food & Nutrients

- **Foods** contain nutrients and are derived from plant or animal sources

- **Nutrients** are used by the body to provide energy and to support growth, maintenance and repair of body tissues
Importance of nutrients

Nutrients- components of food:

1) Provide energy
2) Provide structural materials
3) Provide regulatory agents that support cell growth, maintenance, and repair of tissues
4) reduce the risk of certain diseases
Classes of Nutrients

- Macronutrients:
  - Needed in relatively large amount
  - In grams
  - Includes:
    - Carbohydrate
    - Lipid
    - Protein
    - Water

- Micronutrients:
  - Needed in relatively trace amount
  - In μg or ng
  - Includes
    - Vitamins
    - Minerals
Participation of nutrients in Body Composition

Carbohydrates
Proteins
Vitamins
Minerals
Fat
Water
Carbohydrates
Proteins
Vitamins
Minerals
Fat
Water
GREAT THANKS

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