Identification of Biomolecules

Course instructor: Jibril H. Yusuf PhD.

E-mail: jibril.habib@tiu.edu.iq

Assistant: Ms. Lavan Ali

Course: **General Biology I** (MA 101)

Fall Semester (2025)

Week 2

Date 23-12-2025

Outline

- What are Biomolecules?
- Composition of Biomolecules
- Major Classes of Biomolecules
- Additional Biomolecules
- Qualitative Analysis of Major Biomolecules
- Materials and Reagents
- Procedure

Objectives

❖By the end of this lecture, students should be able to:

1. Identify different classes of biomolecules using chemical tests.

2. Understand the principle behind each biochemical test.

3. Interpret color changes and record observations accurately.

❑ What are Biomolecules?

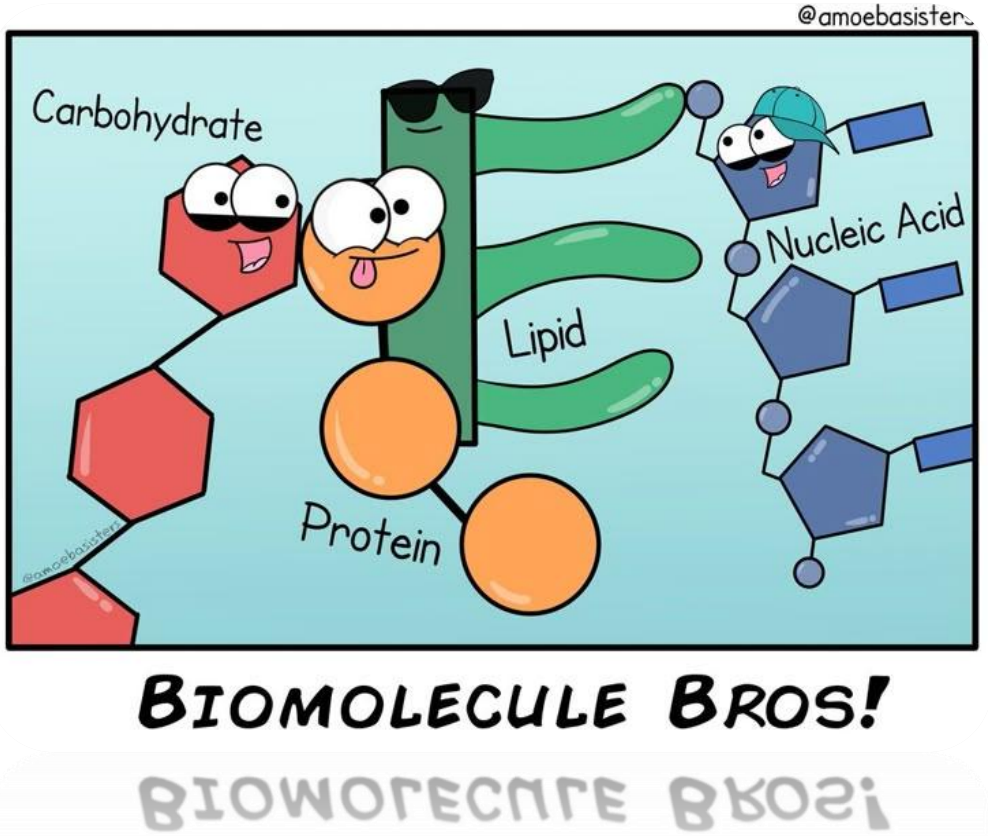
➢Are organic molecules found in living organisms that are essential for structure, function, and regulation of life processes.

❖ Key Points:

✓ **Mostly carbon-based (organic)**

✓ **Synthesized by living cells**

✓ **Involved in metabolism, energy, growth, and regulation**



❑ Composition of Biomolecules

- Biomolecules are primarily composed of just **6 elements**, with carbon (C) as the central element:

1) Carbon (C).
2) Hydrogen (H).
3) Oxygen (O).
4) Nitrogen (N).
5) Phosphorus (P).
6) Sulfur (S).

❖ Major Classes of Biomolecules:

1. Carbohydrates

➢ **Elements:** C, H, O

- **Functions:**
  - ✓ Primary source of energy
  - ✓ Structural components (cellulose, chitin)

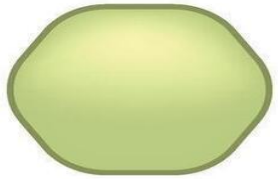
➢ **Examples:** Glucose, starch, glycogen

❖ Major Classes of Biomolecules:

Carbohydrates

Monosaccharide

Glucose
Fructose
Galactose



Single Sugar Molecule

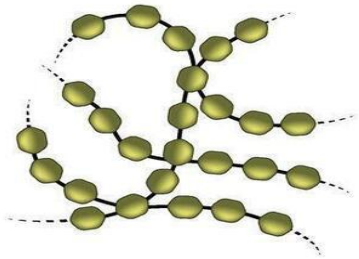
Disaccharide

Maltose
Sucrose
Lactose

Two Sugar Molecules Linked

Polysaccharide

Starch
Glycogen
Cellulose



Many Sugar Molecules Linked

2. Lipids: Hydrophobic (water-insoluble)

➢ **Elements:** C, H, O, P, N

- **Functions:**

  ✓ Energy storage.
  ✓ Cell membrane structure
  ✓ Protection and insulation

➢**Examples:** Fats, oils, phospholipids, steroids

3. Proteins: Made of amino acids linked by peptide bonds

➢ **Elements:** C, H, O, N

- **Functions:**

  ✓ Enzymes.
  ✓ Structural support.
  ✓ Transport and defense.

➢ **Examples:** Hemoglobin, enzymes, antibodies

4. Nucleic Acids:

- **Elements:** C, H, O, N, P.
- **Functions:**
  - ✓ Store and transmit genetic information.
- **Examples:** Examples: DNA, RNA

5. Additional Biomolecules:

- **Vitamins:–** Regulate metabolic reactions.
- **Minerals:–** Inorganic elements essential for physiological processes
- **ATP:–** Energy currency of the cell
- **Secondary metabolites:**– Defense and ecological roles

❖ Importance of Biomolecules in Life Processes:

- Biomolecules are involved in:

➢ Energy production (ATP, carbohydrates, lipids)

➢ Growth and repair (proteins)

➢ Genetic control (DNA, RNA)

➢ Physiological processes such as nerve activity, muscle contraction, and metabolism.

❖ Identification of Biomolecules:

- **Aim:** To identify the presence of major biomolecules: Carbohydrates, proteins, and lipids; in given biological samples using standard biochemical tests.

➢ Materials

- ✓ Test tubes and test tube rack
- ✓ Dropper / pipette
- ✓ Water bath
- ✓ Distilled water

Reagents:

- Benedict's reagent
- Iodine solution
- Biuret reagent/Ethanol
- Sudan III or Sudan IV

Samples:

- Glucose solution
- Starch solution
- Egg albumin (protein solution)
- Vegetable oil or milk

Experiment 1: Test for Reducing Sugars (Benedict's Test):

- Aim: To detect the presence of reducing sugars in a given food sample using Benedict's reagent.

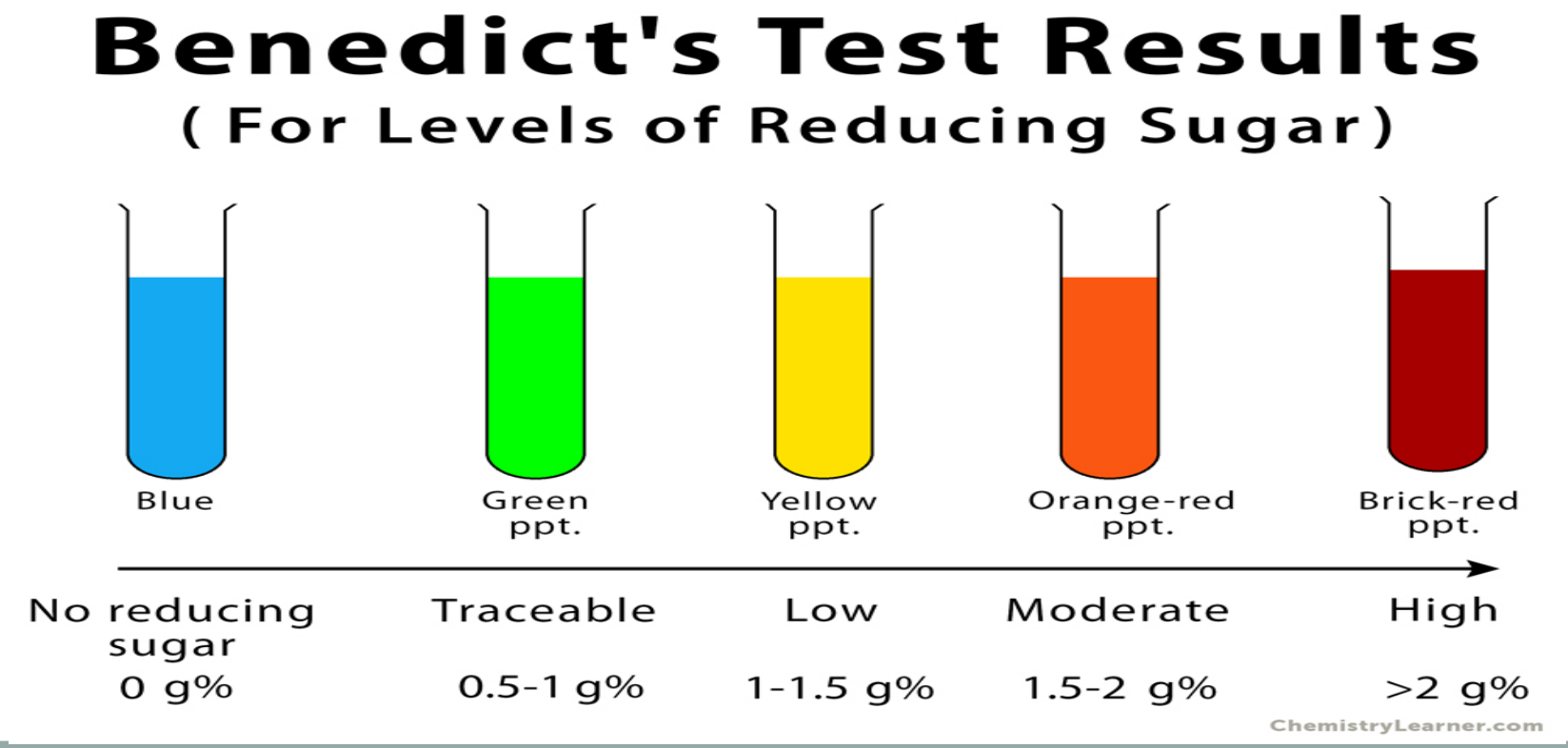
- **Principle:**
- Reducing sugars (e.g., glucose) reduce copper(II) ions in Benedict's reagent to copper(I) oxide, producing a color change.

Procedure:

1. Take **2 ml of the test sample** in a clean test tube.
2. Add **2 ml of Benedict's reagent** to the test tube.
3. Mix gently.
4. Heat the mixture in a boiling water bath for 2–5 minutes.
5. Observe the color change and record the result.

Observation and Results:

- Blue → Green / Yellow / Orange / Brick-red precipitate.
- Presence of reducing sugar is confirmed.



Starch Test

Starch contains amylose, which has **a helical structure. Iodine molecules** become trapped inside this helix, producing **a blue-black complex**. Simple sugars lack this structure and therefore do not give a positive reaction.

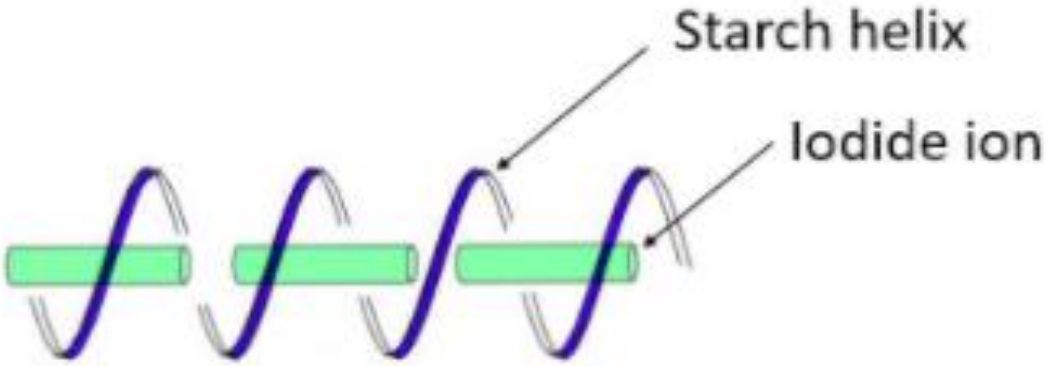


Fig.- Starch-iodine complex

Reagents and Materials

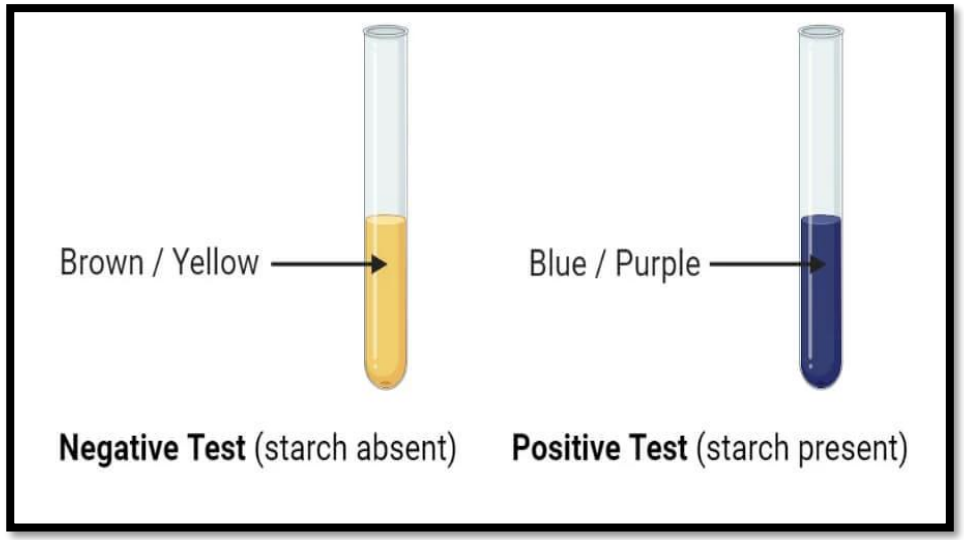
- Iodine solution (iodine-potassium iodide)
- Test tubes
- Dropper
- Samples: **Starch solution or Potato extract**
- Micropipette or dropper
- Micropipette tips

Procedure

- Label clean test tubes according to the samples.
- Add 2 ml of each sample solution into the respective test tube.
- Add 2-3 drops of iodine solution to each tube.
- Mix gently & Observe the color change immediately and record the result.

Expected Observation

- **Blue-black color: Starch present**
- **Yellow-brown color: Starch absent**



Experiment 2: Test for Proteins (Biuret Test):

- Aim: To detect the presence of proteins in a given sample using the Biuret test.

- **Principle:**
- The Biuret test is based on the reaction between peptide bonds in proteins and copper (Cu^{2+}) ions in an alkaline medium.

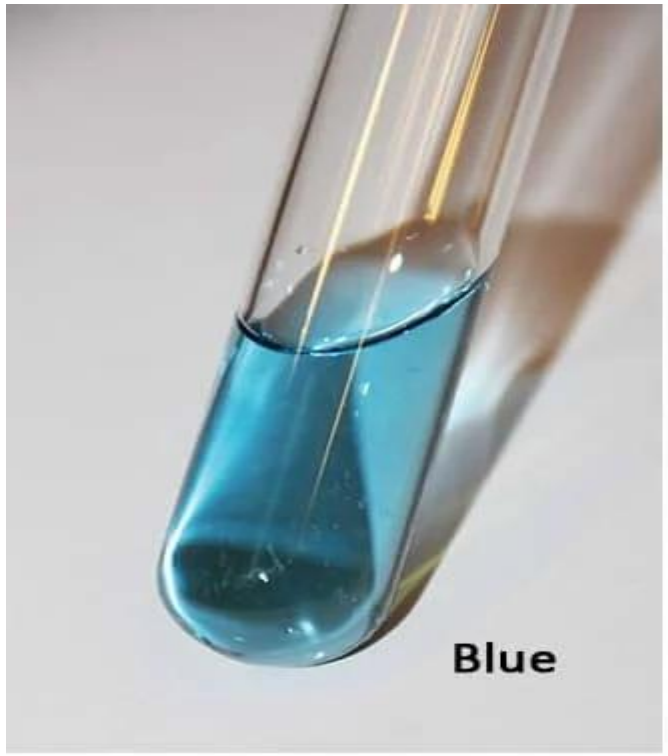
- When proteins are present, copper ions form a violet or purple-colored complex with the peptide bonds.

Procedure:

1. Take 2 ml of the test sample in a clean test tube.
2. Add 2 ml of Biuret reagent.
3. Mix gently by shaking the test tube.
4. Heating is not required.
5. Observe the color change and record the result.

Observation and Results:

- Blue → Violet / Purple color.
- Presence of protein is confirmed.



Negative biuret test

Positive biuret test

Experiment 3: Test for Lipids (Sudan III Test):

- Aim: To detect the presence of lipids (fats and oils) in a given sample using the Sudan III test.

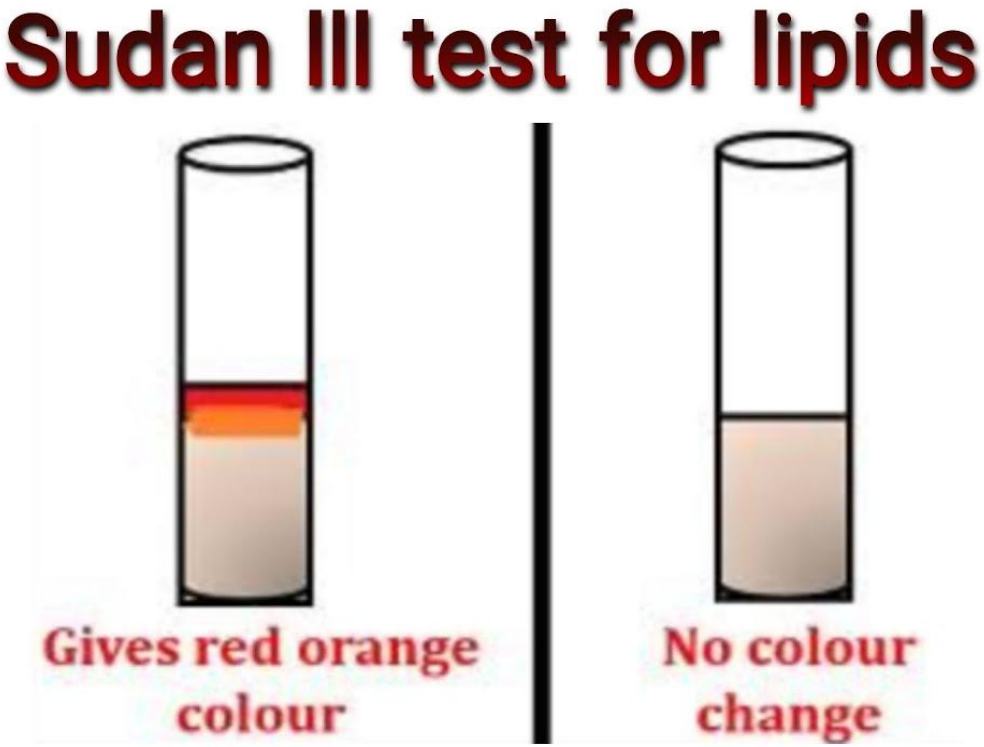
- **Principle:**
- Sudan III is a fat-soluble dye. When added to a sample containing lipids, the dye dissolves in the lipid droplets and stains them red or orange.

Procedure:

1. Take 2 ml of the test sample in a clean test tube.
2. Add 2–3 drops of Sudan III solution.
3. Shake gently and allow to stand for 1–2 minutes.
4. Observe the color change and record the result.

Observation and Results:

- Formation of red/orange-stained oil layer.
- Presence of lipids is confirmed.



References

1. Campbell, N.A. et al. (2020). Biology (12th ed.). Pearson Education.
2. Mader, S.S. (2022). Biology (14th ed.). McGraw-Hill Education.
3. Raven, P.H., Johnson, G.B. et al. (2021). Biology (12th ed.). McGraw-Hill
4. Principles of Biology

Thanks