

Biochemical Tests for Carbohydrates, Proteins, and Lipids Lab Report

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Biochemical Tests

Biochemical tests are a fundamental part of biological and biochemical laboratory work, as they are used to detect and confirm the presence of key biomolecules such as carbohydrates, proteins, and lipids in different samples. These macromolecules play essential roles in living organisms, including energy storage, structural support, and metabolic regulation. In this laboratory exercise, the presence of carbohydrates (starch, reducing sugars, and non-reducing sugars), proteins, and lipids is investigated using standard qualitative chemical tests. Each test relies on a specific chemical reaction that produces a visible color change or physical change, allowing the identification of the substance present in the sample.

Carbohydrates are first analyzed in this experiment, and three different types are tested: starch, reducing sugars (such as glucose), and non-reducing sugars (such as sucrose). These different forms of carbohydrates vary in structure and chemical reactivity, which is why different tests are required for their identification.

The first test is the iodine test for starch. This test is commonly used to detect the presence of polysaccharides, particularly starch, in a given sample. In this procedure, a few drops of iodine solution, which appears brownish-orange in color, are added to a test tube containing the sample suspected of containing starch. When starch is present, the solution changes color from brownish-orange to a distinctive bluish-black color. This color change occurs due to the interaction between iodine molecules and the helical structure of amylose, a component of starch, forming a complex that absorbs light differently. If starch is absent, no color change occurs, and the solution remains brownish-orange.

The second test is the Benedict's test for reducing sugars, such as glucose. Reducing sugars are carbohydrates that have a free aldehyde or ketone group capable of reducing metal ions in solution. In this test, Benedict's reagent is added to two separate test tubes, one containing distilled water (as a control) and the other containing a glucose solution. Both test tubes are then heated in a water bath. The control test tube containing distilled water remains blue, indicating no reaction. However, the glucose solution undergoes a series of color changes depending on the concentration of reducing sugar present. It may change from blue to green, yellow, orange, and finally brick red. A greenish color indicates a low concentration of reducing sugars, while a brick-red precipitate indicates a high concentration. This reaction occurs because reducing sugars convert copper(II) sulfate in Benedict's solution into insoluble copper(I) oxide during heating.

The third carbohydrate test is for non-reducing sugars, such as sucrose. Non-reducing sugars do not react directly with Benedict's solution because they lack a free aldehyde or ketone group. Therefore, a two-step process is required. First, a sample of sucrose is tested with Benedict's solution, and no color change is observed, confirming that it is a non-reducing sugar. Next, acid hydrolysis is performed by adding dilute acid to the sucrose solution and heating it to approximately 100°C while monitoring the temperature using a thermometer. This process breaks down sucrose into its constituent monosaccharides, glucose and fructose. After hydrolysis, the solution is cooled and neutralized using an alkali to ensure proper reaction conditions for the next step. Finally, Benedict's test is performed again. This time, a positive result is obtained, indicated by a brick-red precipitate, confirming the presence of reducing sugars formed after hydrolysis.

After carbohydrates, the experiment continues with the protein test using Biuret reagent. Proteins are essential biomolecules composed of amino acids linked by peptide bonds. The Biuret test detects these peptide bonds. In this procedure, a few drops of Biuret solution are added to a sample containing albumin, which is a common protein found in egg white. Initially, the Biuret reagent is blue in color. When proteins are present, the solution changes from blue to a lilac or purplish color. This color change confirms the presence of peptide bonds in the sample, indicating that proteins are present. The intensity of the purple coloration is directly proportional to the amount of protein in the sample.

Finally, the lipid test (emulsion test) is conducted to detect fats and oils. Lipids are non-polar molecules that do not dissolve in water but dissolve in organic solvents such as ethanol. In this test, the lipid sample (oil) is first mixed with ethanol and shaken thoroughly to dissolve the lipid content. After this, distilled water is added to the mixture, and the solution is shaken again. A milky white emulsion forms if lipids are present. This occurs because lipids are initially dissolved in ethanol, but when water is added, they become insoluble and disperse as tiny droplets, forming a cloudy emulsion. If no lipids are present, the solution remains clear.

In conclusion, biochemical tests provide a simple and effective method for identifying major biological molecules based on observable chemical reactions. The iodine test is used for detecting starch, Benedict's test is used for reducing sugars, acid hydrolysis followed by Benedict's test is used for non-reducing sugars, the Biuret test is used for proteins, and the emulsion test is used for lipids. Each of these tests relies on specific biochemical principles that allow clear identification of macromolecules in unknown samples. These tests are widely used in biological and medical laboratories, as well as in food science, to analyze the composition of different substances. (OpenStax, 2026; Nuffield Foundation, n.d.; Royal Society of Chemistry, n.d.)

References

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