

# Chemicals of Life



## Introduction

Several tests have been developed by biologists to determine the presence of different major chemical compounds found in cells. Allow students to use these tests to determine the major chemicals of life in four unknown samples.

## Concepts

- Biochemistry
- Chemical nature of living cells

## Background

The fundamental chemical components of cells may be grouped into four basic categories—carbohydrates, proteins, lipids, and nucleic acids. Other chemicals such as water, salts and minerals are also present and vital to living cells. Characteristic tests to identify each of the four major classes of biological molecules are described below.

Polysaccharides such as starch are detected by mixing 12 drops of an unknown with 2–4 drops of iodine solution. The solution will turn from a yellow-brown color to a dark purple if starch is present.

The presence of proteins may be determined by mixing 12 drops of an unknown solution with 5–10 drops of biuret test solution. The solution will turn from a light blue to purple if proteins are present.

To determine if lipids are present, mix 12 drops of an unknown with 5 drops of Sudan III and mix vigorously. The solution will turn a pale yellow color if no lipid is present. If the unknown is a lipid, two layers will form. The top layer containing the lipid will be a pale pink-orange color.

Determine whether nucleic acids are present by mixing 6 drops of an unknown with 12 drops of diphenylamine. Place in a hot water bath for 10–20 minutes. The solution will turn purple in color if DNA is present and green if RNA is present.

## Materials

Unknown A, 42 drops	Beaker, 250-mL
Unknown B, 42 drops	Graduated cylinder, 100-mL
Unknown C, 42 drops	Hot water bath
Unknown D, 42 drops	Labels
Unknown E, 42 drops	Marker
Biuret test solution, 25–50 drops	Microcentrifuge tubes, 5
Diphenylamine DNA test solution, 60 drops	Pipets, disposable
Iodine solution, 10–20 drops	Stirring rod
Sudan III solution, 25 drops	Weighing dish or paper
Balance, 0.1-g precision	

## Safety Precautions

*Diphenylamine DNA test solution is a flammable liquid. It causes severe skin burns and eye damage and is toxic if inhaled. Avoid breathing mist, vapors or spray. Iodine solution is an eye and skin irritant. Biuret test solution is corrosive to body tissues. Sudan III solution is alcohol based and is flammable, harmful if swallowed, causes skin and serious eye irritation, and may cause respiratory irritation. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Safety Data Sheets for additional safety, handling and disposal information.*

## Procedure

### Part A. Preparation of Unknowns

1. Prepare each of the unknown solutions according to the following recipes. Increase or decrease quantities in proportion according to class size.

Unknown A — Distilled water only.

Unknown B — Mix 1 g of gelatin into 100 mL of hot distilled water.

Unknown C — Mix 1 g of soluble starch into 100 mL of hot distilled water.

Unknown D — Mix vegetable or mineral oil with an equal volume of water.

Unknown E — Mix 1 g of DNA into 200 mL of distilled water.

### Part B. Testing for Carbohydrates, Protein, Lipid, and Nucleic Acid.

1. Label five microcentrifuge tubes A–E, respectively.
2. Add 12 drops of unknown A to microcentrifuge tube A, 12 drops of unknown B to microcentrifuge tube B, etc. through tube E.
3. Add 2–4 drops of iodine to each test tube to test for the presence of carbohydrates.
4. Make a chart with the five unknowns labeled vertically and the four tests horizontally across the top. Record results on the chart using a (+) to indicate a positive test and a (–) to indicate a negative test.
5. Remove the unknowns from the tubes and thoroughly clean and rinse the microcentrifuge tubes.
6. Repeat steps 1–5 using appropriate quantities of each unknown and test chemicals to test for proteins, lipids, and nucleic acids following the tests outlined in the *Background* section.

## Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The test solutions from this lab should be collected and grouped by chemical test and then disposed of as follows: carbohydrate/iodine—Flinn Suggested Disposal Method #12a, protein/biuret—Flinn Suggested Disposal Method #10, Sudan III—Flinn Suggested Disposal Method #18a, and nucleic acid/diphenylamine—Flinn Suggested Disposal Method #24a.

## NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

### Disciplinary Core Ideas: High School

HS-LS1 From Molecules to Organisms: Structures and Processes

LS1.A: Structure and Function

LS1.C: Organization for Matter and Energy Flow in Organisms

### Science and Engineering Practices

Planning and carrying out investigations

Analyzing and interpreting data

### Crosscutting Concepts

Cause and effect

Structure and function

## Tips

- Tests can be run on “known” solutions prior to doing the “unknowns” activity. Such action will enhance student’s familiarity of what the different results look like.
- The tubes containing vegetable or mineral oil may be difficult to clean. Save time by using fresh microcentrifuge tubes if available.
- Results should indicate Unknown A is negative for all tests, Unknown B is positive for proteins, Unknown C is positive for carbohydrates, Unknown D is positive for lipids, and unknown E is positive for nucleic acids.

- Although any DNA source may be used, DNA may be purchased from Flinn Scientific, Catalog No. D0025.
- If a positive DNA test is not readily seen, try placing the microcentrifuge tube containing the DNA and diphenylamine solution in a beaker of gently boiling water for 10–20 minutes. A positive (blue or purple color) should be seen during this time. Be sure the tube stays securely fastened. An alternative is to place the DNA and diphenylamine test solution in an open test tube in the boiling water bath.

## Acknowledgment

Special thanks to David Brock, Roland Park Country School, Baltimore, MD, for providing the information for this activity.

## Materials for *Chemicals of Life* are available from Flinn Scientific, Inc.

Catalog No.	Description
FB1435	Chemicals of Life—Super Value Laboratory Kit
B0050	Biuret Test Solution, 100 mL
D0060	Diphenylamine DNA Test Solution, 100 mL
G0037	Gelatin, 150 g
I0036	Iodine Solution, Lugol's, 100 mL
S0122	Starch, Potato, 100 g
S0159	Sudan III Solution, 100 mL
M0064	Mineral oil, 500-mL
FB0002	Microcentrifuge Tubes, pkg of 500

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.