BASF
We create chemistry

Kids' Lab
Creating Fun with Chemistry!

Experiment Guide

Strawberry DNA

Objective

The DNA molecule is common to all plants and animals and contains all the genetic information for an organism. This activity follows basic chemistry techniques to extract DNA from strawberries.

Introduction to Kids' Lab

Welcome to the BASF Kids' Lab. BASF is the world's largest chemical company and run Kids' Lab programs like this all around the world. Can anyone think why? BASF wants children all over the world to understand and enjoy experimenting with chemistry!

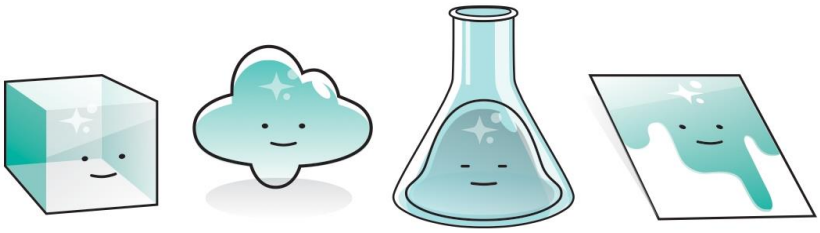
Has anyone heard that word before: Chemistry? What do you think it means?

Chemistry is the science of matter. Have you heard the word "matter" before? What is matter? Matter is anything that takes up space and has a weight here on earth. So basically, matter is a scientific word for stuff.
Chemistry is a science that explores the composition of substances and their properties and reactions. In other words, Chemistry is a science that explores how different stuff behaves.

Matter comes in a few different forms or states: Solids, Liquids and Gases are the most common.

Chemistry is all around us. For example:
Who takes a vitamin? How do vitamins help you? (Grow big and strong, boost immunity) BASF makes chemicals that go into vitamins.
Raise your hand if you play a sport or ride a bike. What should you do to be safe? (Wear a helmet, pads, etc.) What materials make up the helmets that you wear? (Plastics and foam) BASF makes chemicals that go into the plastics and foams in helmets and padding.
Besides helping you grow strong and keeping you safe when you are playing your favorite sport, BASF chemistry keeps farmers crops safe, cleans water for those in need and keeps babies clean and dry.

Let me introduce you to morpH, the face of Kids' Lab. morpH can move through the three states of matter with ease. Is there a substance that you know of, like morph that can easily shift from solid to liquid to gas (and back again)? Water! That's right! You know that water is usually liquid but what happens when you freeze water? Water becomes a solid ice cube. When you boil water, it becomes a gas.



Water is essential for all living things including plants like strawberries.
morpH and I would like you to explore the how to extract DNA from strawberries.

Experiment Introduction

Deoxyribonucleic acid or **DNA** is found in the cells of every living organism. DNA contains all of the genetic information for the organism. The molecules that make up DNA are incredibly small, but we can see it by extracting the DNA and isolating long chains of it.

DNA can be isolated from cells in a process called DNA extraction. In the first step, we need to disrupt or break open the cells by mashing them in an extraction solution. In our experiment, our extraction solution contains water, soap and salt. The soap contains sodium laurel sulfate, which breaks up fats and proteins within the cells. During the DNA extraction, the soap pulls apart the fats (lipids) and proteins that make up the membranes surrounding the cell and nucleus. Once these membranes are broken apart, the DNA is released from the cell. The salt helps break down cellular components further but also removes proteins that protect DNA molecules. The DNA and other molecules dissolve in the extraction solution as you break open the cells.

After filtering out the solids and insoluble materials or **residue**, we collect the filtrate. The liquid that passes through the filter and collects in the cup is called the **filtrate.** This filtrate contains all of the molecules and cellular components that dissolved in the extraction solution. When we add the cold alcohol, the DNA precipitates out of the solution because DNA is insoluble in alcohol.

DNA*:* also known as deoxyribonucleic acid. It is a double-stranded molecule that carries the genes of an organism. It is the genetic material in all living cells.

Sodium laurel sulfate*:* an anionic (an anion is a negatively charged atom) detergent and surfactant that is found in soaps, shampoos and toothpastes, among other personal care products.

Lipid*:* a fatty, organic compound which helps store energy and create the structural component of a cell membrane.

Residue: The remains of something after certain procedures such as filtration.

Filtrate: a liquid that has passed through a filter

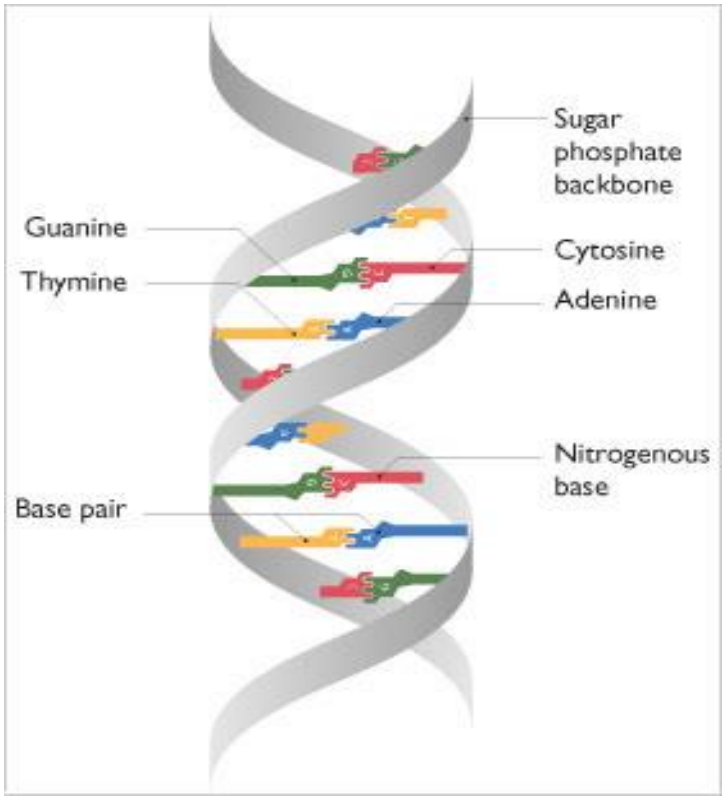
Additional Background Information

DNA is not a single molecule, but rather a series of pairs of molecules joined by hydrogen bonds. Each strand of DNA forms a long chain of chemical blocks called nucleotides, of which there are four types: adenine (A), cytosine (C), guanine (G) and thymine (T). Nucleotides are arranged in two long strands that form a spiral called a double helix. Between the two strands, each base can only pair with one single predetermined other base:

A+T, T+A, C+G and G+C are the only possible combinations. Two nucleotides paired together are called a base pair. If you only have the sequence of nucleotide bases from one strand of DNA, you can easily determine the nucleotide bases that occur on the complementary strand because of this specific base pairing. These bases determine the information available for building and maintaining an organism. No matter what the organism is, these four basic molecules will be in the backbone of the DNA and have the same specific base pairings. The only difference between species is the amount of DNA per cell and the sequence of the nucleotides.

DNA is the hereditary material in humans and all other living organisms. Almost every cell in a person's body has the same exact DNA. Most DNA in your body is located in the cell nucleus. An important property of DNA is that it replicates or makes copies of itself. Each strand of DNA in the double helix can serve as a pattern or template for duplicating the sequence of bases. This is a critical step when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell.

A complete set of genes or genetic material present in DNA is called a *genome*. A gene is a small fragment or short sequence of DNA within the genome of an organism. Genes encode for all kinds of physical properties of an organism such as color, size, shape and longevity. The human genome has over 3 billion base pairs that encode about 20,000 genes. Ninety-nine percent of these genes are the same in all people. Even though different organisms don't look like each other, they still share similar DNA sequences. In fact, humans share DNA sequence that is similar to bacteria, fruit flies and mustard grass!



DNA is a double helix formed by base pairs attached to a sugar-phosphate backbone.

Safety Guidelines

Lab safety is a must! In order to safely explore Chemistry, we need to follow proper lab safety. How do you think we are going to do this? Biologists follow very strict procedures to protect themselves and they include:

- Gloves
- Safety glasses
- Lab aprons or lab coats

Before we get started:

- Be sure everyone including instructors and helpers are wearing safety glasses and gloves. An apron or lab coat are also recommended for this activity.
- Point out any safety features in the classroom (ie. Eyewash or emergency shower; emergency exits).
- Mention housekeeping rules – NO EATING OR DRINKING.
- Mention location of bathrooms.

The Experiment: Extracting DNA from a Strawberry

Each student should start with a strawberry and resealable plastic bag. Depending on the age group, other liquids can be added by adults. Use care handling the isopropyl alcohol.

Materials

- 1 strawberry per student
- Resealable plastic bags, 1 per student
- 2 tablespoons of water
- 1 teaspoon clear dish washing liquid
- ½ teaspoon table salt
- Stirrer or spoon
- Funnel
- Coffee filter
- 2 clean plastic cups
- 15 ml conical tube, test tube, narrow jar or flask
- Measuring tool for tablespoons (1 per instructor)
- Measuring tool for teaspoons (1 per instructor)
- Cold isopropyl alcohol (1 teaspoon per person)
- Eye dropper to dispense alcohol
- Toothpick (or wooden coffee stirrer)-DNA will stick to the wood better

Step 1: Prepare for the experiment
Chill a bottle of rubbing alcohol by placing it in a freezer for 10 minutes and keep it cold in the classroom by placing in a container of ice. Set out materials needed for the experiment at each participant's desk or table.

Step 2: Make your extraction solution
In a cup, add 2 tablespoons of water, 1 teaspoon of soap, and 1/2 teaspoon of table salt. Stir the ingredients in the cup.

If time is limited, a larger quantity of this solution can be made beforehand and added directly to the bag with the strawberry. See simplified procedure:

SIMPLIFIED PROCEDURE (for about 30 participants)
To make one quart of extraction solution, mix the following:

- ½ cup of dish soap
- 1 tablespoon of salt
- Add water up to a quart (about 3 1/2 cups)

Add approximately 2 tablespoons of this extraction solution to each bag with a strawberry and proceed to step 3.

Step 3: Disrupt the strawberry cells
Place a strawberry in a resealable plastic bag. Add the water, soap and salt mixture (extraction solution) from step 2 into the plastic bag with the strawberry. Remove as much air as possible and seal the bag. Gently mash the strawberry in the bag until there are no large pieces. Mashing the contents of the bag against a table is helpful. Try not to shake the bag or create excessive soap bubbles.

Step 4: Filter
Place a coffee filter in a funnel and place it over a new cup. Pour the contents of the bag into the funnel so that the liquid portion filters into the cup and the strawberry solid particles are captured in the filter in the funnel.
Discard the filter and its contents (place back in the plastic bag and discard).

Step 5: Precipitate the DNA
Pour some of the liquid from the cup into a test tube or 15ml conical tube (fill the test tube approximately 3/4 full, up to 14ml). Place the test tube in a cup or test tube rack so it stands upright (you can use the cup you originally used to create the water, salt and soap mixture). Use the eye dropper to add 1 teaspoon of cold isopropyl alcohol to the test tube and close the lid. Do not mix further.

Wait a few seconds and watch as DNA appears at the top of the test tube as a white “cloud.” The DNA will be at the very top of the clear layer of isopropyl alcohol, not where the two layers meet. You should see tiny air bubbles that become trapped between the DNA molecules as it aggregates.

Open the lid and remove the precipitated DNA strands with a toothpick or wooden coffee stirrer. The DNA you observe at this step is actually thousands long DNA strands that are tangled together in a clump.

Summary:

The study of DNA, genes and heredity is called Genetics. DNA contains so much information and scientists try to find out which genes are responsible for certain characteristics or functions. To study genes and how they work, scientists routinely extract DNA from organisms using the same techniques in this experiment. All living things, from bacteria and other microorganisms to plants and humans, contain DNA in their cells. Remember that when you eat a plant or an animal, you are consuming DNA from every cell that you ingest.