BioPharmaceutical Technology Center
INSTITUTE

DNA Extraction from Fruit

Field Trip Background

Purpose Statement

At the BTC Institute, we are committed to enabling students and teachers to get into the molecular science lab, engaging their hands and minds. Our goal is to encourage students to develop a sense of fun and wonder and confidence in themselves as they use scientific principles to explore the world around them.

The goal of the DNA Extraction from Fruit laboratory module is to coach students to participate in scientific inquiry; to undertake the process of science in the context of a hands-on molecular lab.

To prepare students for the experience, it is important for them to review or be introduced to:

- the basics of how a scientific experiment is designed, run and analyzed
- the cellular and molecular concepts of what DNA is, where you'd find DNA in a cell, and why a scientist might want to focus on DNA
- some of the vocabulary associated with the above concepts

Building & Running an Experiment

- **Procedure:** A procedure is a method; a set of instructions that can be followed to obtain a desired outcome.
- **Experiment:** An experiment is a scientific test.

  When a scientist designs an experiment, they will create a procedure. In the DNA Extraction from Fruit field trip, we will use two procedures (Control and Experimental). In the experimental procedure, the scientist will choose one part of the procedure and change it. The part that is changed is called the variable.

- **Variable:** A variable is a single change that a scientist intentionally makes when running and experiment.

  Note that a procedure is <u>not necessarily</u> an experiment…
  Think of a procedure as a recipe. When you make a batch of pancakes, you will follow the recipe (the procedure). If you decide to put blueberries into the batter, or to add an extra egg, each of those changes would be considered a variable. It only becomes an experiment if you make the pancakes both WITH and WITHOUT the change.

- **Control:** A control is an important part of an experiment where you intentionally perform a procedure and leave your variable unaltered.

  By doing the procedure in two different ways, it allows you to say *scientifically* whether the variable had an effect by comparing the pancakes with the change directly to the control pancakes without the change.

Building & Running an Experiment (continued)

- **Observation:** An observation is a detail witnessed and recorded by a scientist when they run an experiment.

  The act of noticing whether your pancakes look or cook differently, or whether the pancakes taste differently WITH the variable relative to the control would be considered an observation. In your kitchen, you might make a note of both the variable and the observation in your cookbook so that you remember the next time you decide to make pancakes. In a laboratory, a scientist must record their observations in a laboratory notebook as a way of documenting that a scientific test (an experiment) was run.

Experimental procedures are the basic building blocks of how science is done. The purpose of scientific experiments is to explain how the world works in some way. The way that a scientist records and analyzes their observations throughout an experiment form the proof that scientists use to explain the world *scientifically*.

Conceptual Background for DNA Extraction

Your students will work to get DNA (that they can see) out of fruit. In pairs, they will run both a Control Procedure and an Experimental Procedure.

Each procedure consists of two essential parts:

Part One: Digestion

Digestion is the process of breaking down tissues and cells.

When your body digests food such as fruit, tissues and cells are broken down to release molecules, like nutrients, so that your body can have access to them.

Digestion in the laboratory works similarly to how it does in your body. Our purpose will be to release the molecules that are otherwise locked away in the tissues and cells of the fruit. In the laboratory, we will use multiple strategies to break down tissues and cells to give us access to the fruit's DNA:

- **Physical & Mechanical:**
  There are many physical things that happen when you eat that aid in digestion. Chewing is important, as is the saliva that moistens things in your mouth. The heat of your body helps the process as does the contraction of the smooth muscles in esophagus, stomach, and intestines.

  We will use our hands to massage a resealable bag to break apart fruit. We will also use warm water so that the heat and moisture can help us as we physically mash up the tissue.

Conceptual Background for DNA Extraction

Part One: Digestion (continued)

- **Enzymes:**
  Enzymes are special protein molecules that do work inside and outside of cells. Some enzymes play a key role in breaking down tissues and cells. Other enzymes help convert the molecules released in digestion into nutrients that your body needs. Nearly every part of your digestive system excretes enzymes that are important. Saliva and stomach juices are important examples.
  We will use meat tenderizer when we digest fruit in the lab. One of the main ingredients of meat tenderizer is an enzyme called a protease that breaks down proteins.

- **Detergents:**
  Another important aspect of digestion that happens inside of you is the breakdown of fats. Your gallbladder excretes bile, which is an important part of how your body breaks down the fats that you eat.

  We will be using household detergents to help us break down fats. We use household detergents to break up grease that may be on our hands, or our clothes, or our dishes. Particularly, the outer cell membranes of plant cells are composed of fats. Using detergents can help us to pop cells open so that we can access the DNA inside.

Part Two: Alcohol Precipitation of DNA

Precipitation is a process where a substance changes from one phase of matter to another, especially when that phase change results in something falling out of something else.

When it rains or snows, water changes phase from a liquid vapor to a liquid or solid and falls out of the air.

There are many kinds of substances that dissolve well in water. Table sugar (sucrose) and table salt (sodium chloride) are good examples. DNA molecules do the same thing. When DNA is in water, it is in an aqueous solution; which means it dissolves into the water.

Scientists have learned a number of chemical tricks to take molecules that are dissolved in water and help them become a solid and to precipitate out of solution:

- **Salt:**
  Salt is a broad term for ionic compound that dissolves well in water. Some types of salt can interfere with the molecular relationship between water and DNA that keeps DNA in an aqueous solution. We will add table salt (sodium chloride) to our fruit digestion to help solidify and precipitate our DNA.

- **Alcohol:**
  Alcohols are liquid chemicals that behave differently than water. Importantly, DNA does not like to dissolve into alcohol. We will use alcohol to help cause the DNA released by the fruit cells to solidify and precipitate. The best alcohol of choice is usually laboratory-grade ethanol (95% or 100%). Ethanol is usually used ice-cold in order to get more DNA to precipitate. Isopropanol can be used, but it can force other salts to precipitate with the DNA. If you do opt for isopropanol, use less and keep it at room temperature.

Approaching the Lab

Finally, here are some important points to help students get into the proper mindset for the activity:

DO:

- **Understand** the steps that you do before you do them. If you have any questions, ask!
- **Focus** on each step as you do it.
- **Observe** what you do in the lab and what happens when you do it.

and:

- **DO NOT** pressure yourself to be perfect.
- **DO NOT** try to get the "right" answer.
- **DO NOT** focus on what others are doing or get competitive with your classmates.