Welcome to Science E!

In this program, your students will simulate animal nerve connections with an electrical current, build a methane gas collection system, create an electromagnet, and so much more.

The 36 experiments in this program will introduce your students to Forces and Interactions, Life Systems and Cycles, Geology, Physics, and Energy. They are designed to teach your students to think like scientists and use real scientific skills and practices.

What do Students Need to Know?

In the past, science instruction focused on teaching students what we already knew about science. However, as technological growth and development exploded in recent years, we realized that simply teaching students what we know now isn't sufficient—it doesn't adequately prepare them for the future. The technology and scientific developments our students will use when they are adults have not been invented yet. So how do we prepare them for what they will need to know when it is still unknown to us?

Instead of only teaching facts and knowledge, our instructional focus needs to shift. In addition to exposure to familiar science topics, such as Physical Science, Life Science, and Earth and Space Science, today's students also need skills and scientific practices that will help them find out what they need to know on their own. They need to become innovators and developers and not just passive consumers of scientific knowledge. By the time your students are ready for further education or to enter the workforce, they need to know how to investigate purposefully, build models, ask useful questions, and be able to report their findings so they can share what they learn with others. They should also be able to develop creative solutions to problems, and build and test their designs to determine how well they work. Once tested, they should be able to improve their designs so they can develop an even better solution. The lessons required to arrive at this destination will need to be hands-on, interactive, and student-driven. They may be a little noisy, and hopefully not too messy, but they will certainly be an adventure like no other.

Introduction

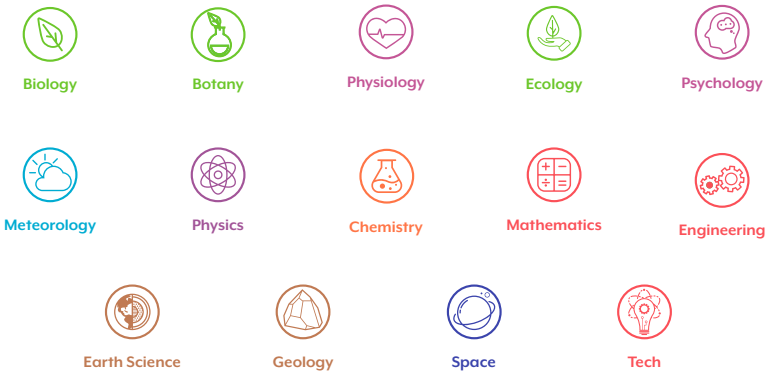
How This Program Works

Through this program, your students will use the Scientific Method to explore their world, not just memorize the steps. Your students will brainstorm solutions to problems, and have space to come up with ways to test them with you. Together, we will begin to prepare them to think for themselves, weigh the claims they encounter around them, and innovate on their own. We will also incorporate key Scientific and Engineering Practices to explore ideas that connect across all subjects, like cause and effect, patterns, structure and function, systems, stability and change, cycles, and more.

In addition to practicing the Scientific Method, you will also begin to teach the process of Engineering Design, in which students investigate a problem they can solve through design. Some lessons will present a challenge or problem which will require your students to design (and build!) a solution, and then they will test their solution's effectiveness in solving the problem. From there, they may also apply what they learned from their tests toward designing an improved solution.

Science E will serve as your roadmap for this year's experiment instruction. We have chosen easy experiments that will fascinate your students and help them begin to develop key scientific skills through exploration. Before you start teaching, take a few minutes to familiarize yourself with this book and the structure of each experiment.

Each lesson begins with an overview of the **Key Concepts**, intended to give you, the instructor, a big-picture view of the goals of the lesson. By the end of the experiment and discussion, your students should have a solid understanding of the lesson's Takeaways (which mirror the Key Concepts), so you know they have mastered the important information. And since each lesson is truly an exploration, your students will often delve into elements of several different scientific disciplines in a single day. You can quickly see which topics you will cover in the icons provided on the Introduction page for each experiment:



Introduction

Let's Get Started

To help you teach with confidence, we recommend you read through each experiment the night before. You may also use this time to gather the supplies noted on the Materials List that you will need to provide. While you will find some experiment supplies around your home, we have collected a number of materials for your convenience in our **Science Supplies Kit**, listed with a K in the Materials List (at the beginning of each experiment). The data charts and templates, listed with a P, follow each experiment and are also included in the **Paper Packet**.

The **Appendix** of this book includes a complete list of the supplies you will need to provide yourself, a list of items in the Science Supplies Kit, and a list of charts and templates in the Paper Packet. You can start collecting the items you need to provide now so they will be ready when you need them.

A few of the experiments require some early preparation, which we'll warn you about in a **Before You Begin** note at the start of the experiment. Be sure to check the next experiment for this note when you wrap up an experiment so you will be fully prepared to teach the next lesson when you intend to.

When you have gathered the supplies and are ready to teach, head to the experiment's **Introduction** and simply start reading to your students. Our provided instruction helps you pique your students' curiosity about each day's topic, and will challenge them to **Make a Prediction** about what they will experience in the experiment. The **Investigate** section offers step-by-step procedures that walk you through the experiment itself, and includes discussion information to help you explain what's happening along the way. Use the questions under **Draw Conclusions** to bring the concepts and observations together, and close with the thoughts under **Takeaway**.

As you have time, enjoy the information under **See the Bigger Picture** which illustrates how the scientific principles discussed in the lesson apply to the world at large. Also, be sure to check out the **Make Connections** section as you work to add more depth and extend conversation about the experiment's topic. We also include **Tips** to help you know what to expect and complete the investigations with as few bumps as possible. If your students still want more, try out the suggestions under **Go Further** for related activities that will help you extend the exploration.

Introduction

Plan for your students to take an active role in setting up the experiment and completing the steps (with your help, of course). Give them room to be curious and ask questions. If we don't address something that comes up as you work by the end of the experiment, make a note to help them find the answer later. The more you can support their curiosity and inquisitiveness, the better you will teach them to think like a scientist. And don't forget—they can help you clean up, too!

We can't wait for you to start this grand adventure with your students, helping them to explore their world while learning to think like scientists and design like engineers. Through this journey, you will prepare them to be an active part of a future that we can't even imagine today.

1 How Does It Taste?

Key Concepts

Animals have **sense cells** which collect and send information from the environment to the brain.

Taste cells send sensory information to the brain about the taste of food.

People can test food to determine its sweetness.

Materials

- How Does It Taste? Experiment Sheet P
- 10 drops iodine K
- eyedropper K
- 1 Tablespoon cornstarch
- water (about ½ cup)
- 1" cube of potato
- 1" cube of carrot
- a small piece of bread
- 1 leaf of lettuce (chopped)
- knife*
- 6 small bowls

P Indicates the item is in the Experiment Paper Packet

K Indicates the item is in the supply kit.

*Ask for an adult for help when using the knife to cut the food samples.

Introduction

The human tongue contains approximately 10,000 taste buds, which hold sense cells. Sense cells send information about the food we eat to our brain. The tongue can detect four main tastes: sweet, salty, sour, and bitter. Scientists have more recently found a fifth taste: *umami*. This Japanese word means "delicious" or "good savory taste" and is found in fish, bacon, mushrooms, and soy sauce. If foods all fit into one of these five categories, it would be easy to understand how we interpret taste. However, even scientists find it difficult to understand the sense of taste. For example, you may not think of a piece of bread as a sweet food, but try holding a piece of bread in your mouth, and you will start to notice a sweet taste. If you focus, you might even sense that the tip of your tongue is doing much of the "tasting." Bread is made up of starch, which is a type of sugar.

Your brain has stored memories from the chemical signals sent by all those taste cells. Sometimes, those are happy memories like a piece of cake or a favorite treat. The next time you see that same food, you are ready to try it again. Our sense of taste also helps us avoid rotten or poisonous foods.

Our taste buds are sensitive to the different chemicals in foods. We can perform tests on foods to identify certain chemicals, just like our taste cells. In this activity, you will test different foods to determine if a food is sweet or starchy by observing how the color changes when foods are mixed with an iodine solution. A **solution** is made in chemistry when you combine two substances.

The iodine solution is red-colored but turns blue when it comes in contact with starch. To test your iodine solution, you will place several drops on a sample of cornstarch. You can use the cornstarch test to compare the

other food samples to see if they also contain starch. Your sweet-sensing taste cells would send this sweet-taste information to your brain.

Make a Prediction

How can you use cornstarch and iodine to determine if a food is sweet (starchy)?

Investigate

Activity 1 - Prepare Sweet Taste Test

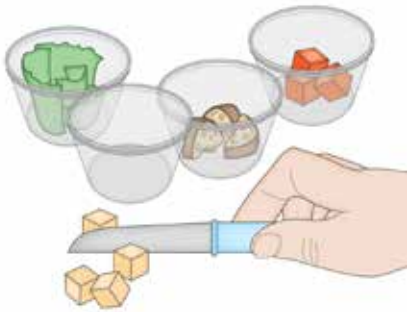
1. To prepare the iodine solution, pour the packet of iodine into a bowl and mix with ½ cup water. Be careful with iodine because it can stain. Use non-staining bowls like glass, or disposable containers.

Tip:

If you do not have these items on hand, use other similar foods you may have in your kitchen.

2. Cut samples of the foods to be tested. Ask an adult for help if needed:

   - 1" cube of potato
   - 1" piece of carrot
   - a small piece of bread
   - a small amount of lettuce



3. Place each food item into a small cup.

4. Add 1 Tablespoons corn-starch to the 5th cup and set it aside.

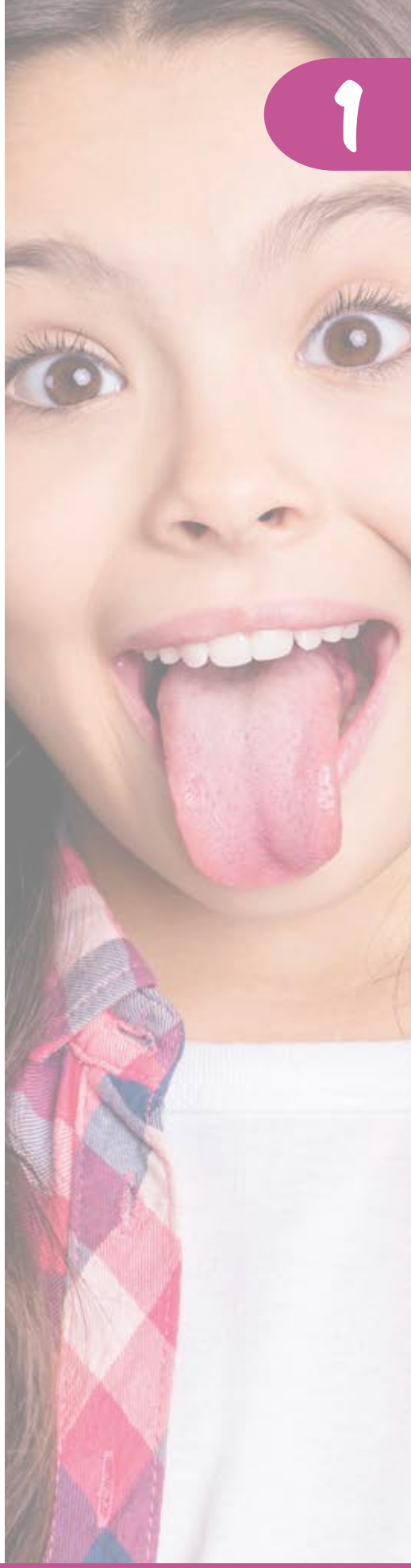
5. Make your iodine-starch test sample by adding 10 to 15 drops of the iodine solution to the cornstarch sample. Observe the color change. Save the cup to compare your food samples during the test.

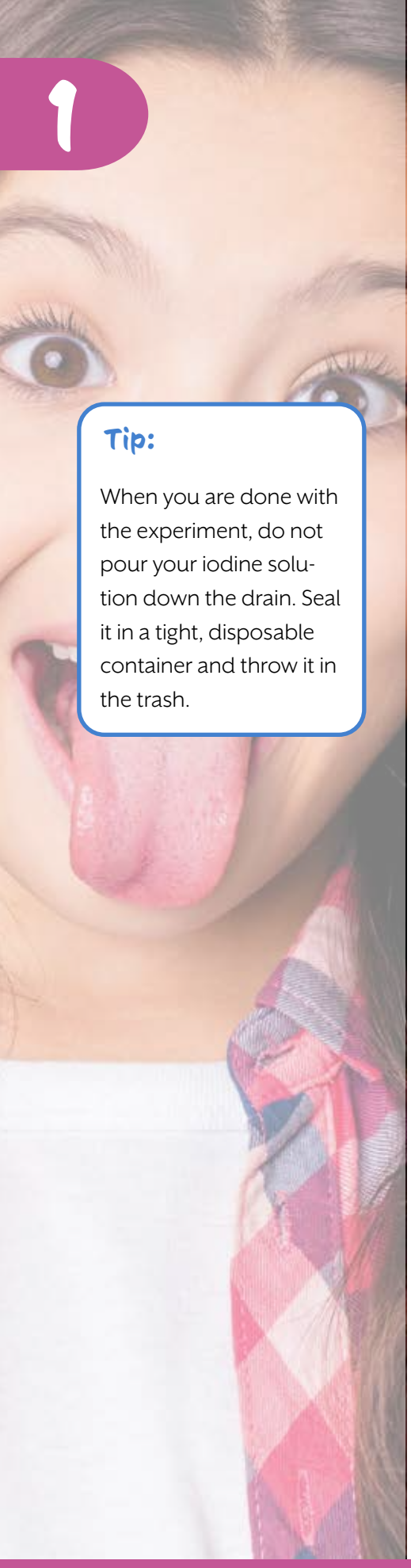
Activity 2 - Testing for Sweetness

Make a prediction: Which of the food samples do you think contain starch?

1. Add 10 to 15 drops of iodine solution you prepared in Activity 1 to each food sample cup.

2. Allow the samples to sit for one minute so that the chemical reaction can occur, and the color change is easy to see.





Tip:

When you are done with the experiment, do not pour your iodine solution down the drain. Seal it in a tight, disposable container and throw it in the trash.

3. Compare each sample with the cornstarch cup. Observe and record any color changes that occur. For each sample, check "yes" or "no" on the **Experiment Sheet** following this experiment. A "yes" answer means the food contains starch, the sample turned blue, and a sweet-taste cell would send that information to the brain. A "no" answer means the food does not contain starch, and a sweet-taste sense cell would not collect information about it.

Bread Reaction – Positive

Lettuce Reaction – Negative

Draw Conclusions

How can you test for starch in food without actually using your taste cells? (Possible: it is possible to test for starch in food by using iodine solution. Iodine solution turns blue when it comes into contact with starch, which is a type of sugar.)

What are the five tastes that can be detected by the human tongue? (Possible: Different kinds of taste cells react when they meet certain chemicals. The human tongue has sweet, sour, bitter, salty, and umami taste sense cells.)

Why are taste cells helpful for an animal's survival? (Possible: Taste cells gather information about the food an animal takes into its mouth. If the food tastes terrible, the animal is not going to eat, so the animal is less likely to eat something poisonous.)

How does the animal's brain react to information from the taste cells? (Possible: The brain receives the information, processes it, and stores it as memories, which means the animal will not eat that same food if it sees it again.)

When you drink a glass of lemonade, which taste cells are most active on your tongue? (Possible: The taste cells for sour tastes are most active when drinking lemonade.)

Takeaway

Animals have **sense cells**, which collect and send information from the environment to the brain. This information is processed, or organized, by the brain and stored as memories. The memories affect how the animal will respond in future situations. What makes each type of taste cells unique is that they only respond when they come in contact with specific chemicals. Your food test was similar to a taste cell because the iodine solution only changed color when it came in contact with one chemical called starch.

Taste buds are filled with a type of sense cell that gives the brain information to help animals make decisions about whether or not to eat something. For example, poisons might taste badly, making an animal less likely to eat an item that could make them sick or kill them.

The human tongue contains **taste cells** that send specific information about foods, such as if it tastes sweet, bitter, salty, sour, or umami to the brain. It is possible to test the reactions of foods to show if they have certain chemicals that make them taste sweet. The test helps model how taste cells work when we eat different foods.

See the Bigger Picture

If you have ever had a stuffy nose or a bad cold, you might have noticed that foods do not seem to have as much taste as when you are feeling healthy. Taste cells are only part of how our brain processes information about the food we eat. Our sense of smell and our sense of taste work together to provide valuable information about food to keep our bodies safe from poisons and unsafe foods.

Make Connections

Starches, the molecules found in potatoes and cornstarch, are a type of carbohydrate. Animals cannot make carbohydrates. Plants containing the green pigment chlorophyll make carbohydrates through photosynthesis. Leaves are specially designed with a large surface area to capture as much light from the sun as possible. As many as 100 chloroplasts are packed into each cell, giving leaves their green color. Cells take in carbon dioxide from the atmosphere, combine it with water and, in the presence of light, convert the molecules into carbohydrates. Plants use the sugar for energy. Any energy that is not used by the plant is converted to starch and stored in the plant.

Go Further

You learned that each of the types of taste cells responds to one of five different tastes – sweet, sour, bitter, salty, or *umami*. Over your life, you might have discovered certain foods that you like or dislike. Did you know that the foods we choose may be hereditary? When something is hereditary, that means it is a characteristic passed along in a family, such as height or eye color. For example, some people enjoy dark chocolate, and others enjoy a steaming plate of broccoli. Research some examples of food choices that might be inherited or passed on in families. Take a survey in your family about favorite foods or not-so-favorite foods.

Taste cells are designed to sense chemicals in food and send the information for processing to our brain, which will use the data to influence our future behavior. Some foods we eat contain artificial flavors, and these chemicals can change the way we choose foods. Artificial flavors can trick our brains into thinking we are eating something healthy when we may not be. Make a list of the foods you eat in a week. How much of the food you ate contains artificial flavors? Perhaps try replacing one artificially flavored food with a healthier choice.

How do your other senses affect taste? A cold or stuffy nose can undoubtedly change the way food tastes, but what about your sense of sight? Ask an adult for permission to gather some healthy and tasty treats with your friends or siblings and try to identify food items while closing your eyes.

How Does It Taste? Experiment Sheet

Starch Reaction / Sweet Taste

Food	Yes	No
Potato		
Carrot		
Bread		
Lettuce		

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