ROI

INDIANA UPLANDS | PROUD PARTNER

Grade 6-8 STEM Challenge

Is It Pure?

Inspired by Trae, a Pharmaceutical Scientist in the Indiana Uplands.

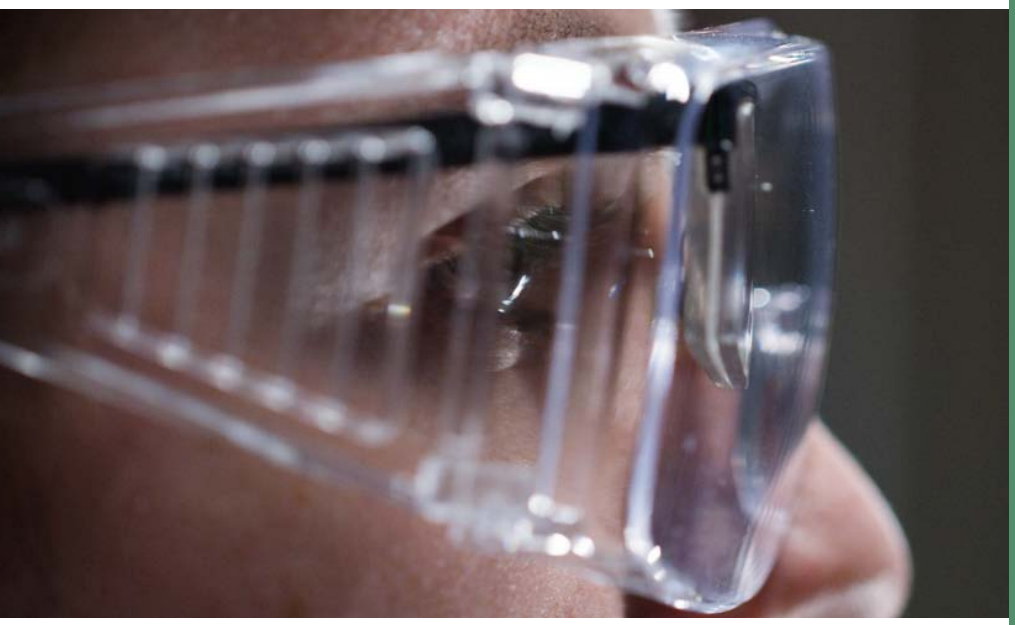
Published by Regional Opportunity Initiatives

GRADE 6-8 STEM CHALLENGE

Is It Pure?

Inspired by Trae, a Pharmaceutical Scientist in the Indiana Uplands.

Students will conduct an investigation to determine if a new product is pure.



CAREER CONNECTION AND LESSON OVERVIEW

Trae is a pharmaceutical scientist at Singota Solutions in Bloomington, Indiana. Singota Solutions manufactures medical compounds and chemicals for other organizations. Trae's job at the lab is to find the best way to manufacture functional products for the client and to ensure that their products are not contaminated. Trae's career focuses heavily on biology, chemistry, and biochemistry, but anyone who conducts scientific research to solve a problem can be called a scientist. Trae pursued this career because he was interested in cells—how they grow, how they behave, and how they can be modified to make things humans need.

In this activity, students will be presented with three samples of a lab product that may be contaminated. Through a scientific investigation, they will determine if the product has been made correctly and is safe for use or if it has been contaminated with chemicals or microbes.

LESSON TIMELINE

DAY 1

- Show the inspiration video, "Trae - Associate Pharmaceutical Scientist" (5 minutes)
- Introduce the activity and challenge (15 minutes)
- Brainstorm ways to tell whether something is alive (30 minutes)

DAY 2

- Lead students through the investigation of substance "54-ND" (40 minutes)
- Discuss and reflect (10 minutes)

Recommended Supplies

For the class:

- Samples of 54-ND labeled A, B, and C
  - Sample A: Sand
  - Sample B: Sand + Dry yeast
  - Sample C: Sand + Crushed effervescent tablet
- Warm tap water
- Sugar packets (no artificial sweeteners)
- Paper towels
- Clear plastic cups or beakers (150ml or 6oz)

For each group (3-4 students)

- Samples A, B, and C in three separate clear containers, labeled
- Warm water
- 1 sugar packet
- Spoon
- Hand lens
- Timer or stopwatch

IN THIS CHALLENGE, STUDENTS WILL:

- Use scientific methods to determine if samples of a lab product are safe to use or contaminated.
- Determine if any contaminants are chemical or biological in nature.

Standards

Science & Engineering Process Standards

SEPS.1 Posing Questions (for science) and defining problems (for engineering)

SEPS.2 Developing and using models and tools

SEPS.4 Analyzing and interpreting data

SEPS.6 Constructing explanations (for science) and designing solutions (for engineering)

SEPS.8 Obtaining, evaluating, and communicating information

Preparing for College and Careers

PCC-2.1 Determine roles, functions, education, and training requirements of various career options within one or more career clusters and pathways

PCC-2.2 Analyze career trends, options and opportunities for employment and entrepreneurial endeavors for selected career clusters and pathways

PCC-2.3 Evaluate selected careers and pathways for education requirements, working conditions, benefits, and opportunities for growth and change

PCC-2.4 Use appropriate technology and resources to research and organize information about careers

6th Grade Science

6.LS.4 Investigate and use data to explain how changes in biotic and abiotic components in a given habitat can be beneficial or detrimental to native plants and animals.

7th Grade Science

7.LS.1 Investigate and observe cells in living organisms and collect evidence showing that living things are made of cells. Compare and provide examples of prokaryotic and eukaryotic organisms. Identify the characteristics of living things.

8th Grade Science

8.LS.10 Gather and synthesize information about how humans alter organisms genetically through a variety of methods.

8.LS.11 Investigate how viruses and bacteria affect the human body.

8.PS.6 Compare and contrast physical change vs. chemical change. Analyze the properties of substances before and after substances interact to determine if a chemical reaction has occurred.

Grade 6-8 Employability Skills

6-8.M.1 Apply new strategies based on lessons learned from feedback.

6-8.WE.3 Complete tasks or activities with some prompting and guidance.

6-8.LS.4 Identify possible career choices and high school course selection using self-assessment (including an appraisal of strengths, interests, and values).

6-8.LS.7 Evaluate decisions and discuss the use of alternatives in decision-making situations.

6-8.LS.12 Use prediction and evaluation skills to develop potential solutions.

Planning and Implementation

IS IT PURE?

Essential Vocabulary

- CHEMICAL REACTION: A process that involves rearrangement of the molecular or ionic structure of a substance, as opposed to a change in physical form
- METABOLISM: The chemical processes that occur within a living thing in order to maintain life. This usually includes breaking down food for energy.
- INSOLUBLE: The inability of a substance to dissolve or break down in a liquid. If something is insoluble in water it will never dissolve—it will just settle out.
- CONTAMINANT: A chemical or biological substance that should not be in a pure product.
- CELLS: The smallest unit of an organism that can be called alive, typically microscopic and consisting of cytoplasm and DNA.

In this challenge, students will:

- Use scientific methods to determine if samples of a lab product are safe to use or contaminated.
- Determine if any contaminants are chemical or biological in nature.

Before Class:

- Read the activity outline sheet and leader notes to become familiar with the activity.
- Mix up the three samples of the lab product, "54-ND." For this experiment, our lab's product will be fine sand. The story for this activity is that 54-ND has been manufactured by the lab but may be contaminated. Students will examine the samples with the hand lens and then add water and a food source (sugar) to the samples to observe the results.

Sample recipes:

A: Sand only (1/4 cup or 50ml for each sample)
B: Sand + dry yeast powder (1/2 of a packet or 1 teaspoon)
C: Sand + crushed effervescent antacid tablets (equivalent of 1 crushed tablet per cup per group

The "Product" samples may be made in larger batches before class and poured into clear, 6 ounce plastic cups. Note: once the tablets have been crushed it's best to keep them in an air-tight bag or container and use the mixture within 24 hours. Longer storage will cause them to react with ambient humidity resulting in clumping and reduced fizz. Pour the samples into individual labeled clear cups immediately before distributing them to the groups.

Guiding Questions

1. How might we tell if a sample might be contaminated?
2. How could we tell if those contaminants were chemical? How could we tell if the contaminant was a living thing, like a microbe?
3. How do pharmaceutical manufacturers ensure that their products are pure?

Day 1

Introduction

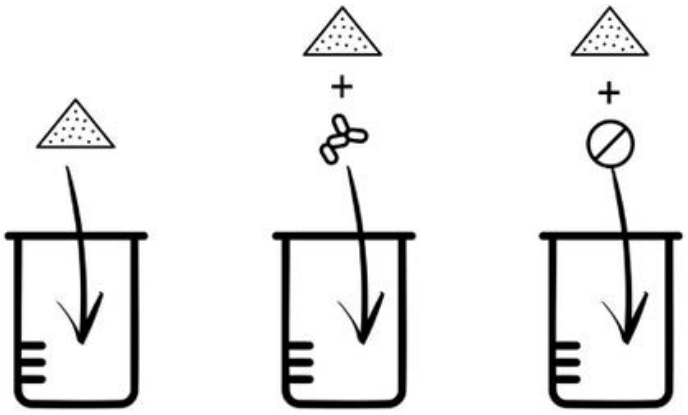
Show students Trae's career shadow video, found at http://www.regionalopportunityinc.org/trae/. Pharmaceutical scientists, like Trae, not only ensure that the correct medical substances are made but also that they're pure enough for use in humans. Many of the materials that Singota manufactures are eventually used in medicines so it is critical that they not contain chemical or biological material that should not be there.

In this activity, students will be working with a new medication, 54-ND. 54-ND is a tan powder that is insoluble in water and should not react when moistened or given a carbon food source, like sugar. Students will examine three different samples of 54-ND and determine if they are contaminated and, if so, whether they are contaminated with a non-living chemical substance or a microbial infection.

The Activity

Students should work in groups of 3-4. Each group should receive three labeled clear cups containing ¼ cup or less of each 54-ND sample. Samples can be labeled in any order, but each group should get a set of the following:

- Sample A: Sand only
- Sample B: Sand + dry active yeast
- Sample C: Sand + crushed effervescent antacid tablet (Alka-Seltzer™ or similar)



Prepare students by introducing the challenge:

> *"You are a scientist working at a pharmaceutical company. Your company has created a new medication, 54-ND, that cures the common cold! 54-ND is a tan colored powder and is safe, non-reactive, and does not dissolve in water. Unfortunately, we think that the product may have become contaminated. Your groups will get three samples of 54-ND and will need to determine if they're contaminated and, if so, with what."*

Write down on the board what the class knows about 54-ND. Prompt to students to brainstorm ways to determine physical and chemical differences between the three samples. How do we know if something is alive? How would we be able to tell if a reaction were chemical or biological? Record these comments on the board and keep them up throughout the investigation.

Day 2

Phsical Analysis

Have students pour a small amount of each sample onto a labeled paper towel and examine it with a hand lens. Have them record their observations in their scientific notebook or on the activity handout. Encourage them to use their senses (except taste) to examine their samples and discuss with their group what they see. Note: Remind them that any material they pour out needs to go back in the correct container! Prompt to record the following on their STUDENT DATA SHEET or in their STEM notebooks:

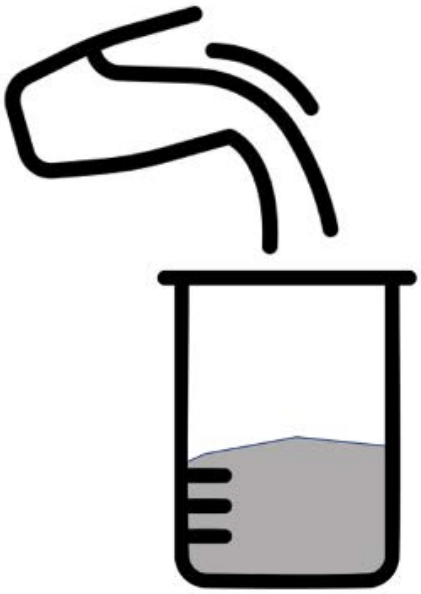
- What does the 54-ND look like up close?
- Do you notice any differences between your three samples?

Chemical Analysis Part 1: Just Add Water

Give students warm water to add to their samples. Ask them what pure 54-ND should do when mixed with water (nothing—it should settle out since it's insoluble and non-reactive.) Have them add a small amount (50ml- enough to cover the sample) of warm water to each cup, stir, and observe the results. Remind them to add water to each cup and record their observations before moving on to the next.

Once all groups have added water and recorded their findings, discuss what they observed. Focus on which samples showed evidence of activity and what type.

- What happened to sample A (sand only)?
  Nothing. It swirled around and then settled out of the water.
- What happened to sample B (sand plus yeast)?
  Not much. Students may see some cloudiness in the water from the yeast dissolving. They may notice that the sample smells a little like bread. Prompt them to think about why bread smells the way it does. They may notice some bubbles but not much.
- What happened to sample C (sand plus effervescent tablet)?
  Fizz! This sample should fizz vigorously when the water is added. However: once the fizzing is complete, additional water should not restart the reaction. Since 54-ND is supposed to be non-reactive with water this sample is probably contaminated.



Prompt students to discuss what this might mean.

- Which samples might be contaminated?
- Do we know for sure if they're contaminated with a chemical or a biological contaminant?
- How could we determine if the contaminant alive, like germs or bacteria or other single-celled organisms?

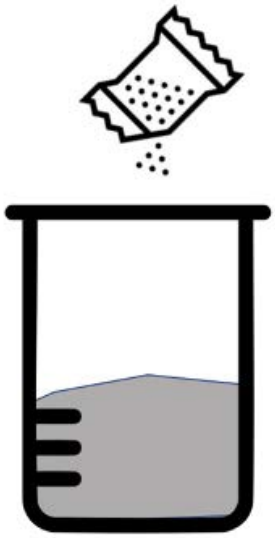
Record students' ideas. If students don't offer the idea of giving the samples food, suggest that we could try adding some sugar to see if something happens.

Chemical Analysis Part 2: Give It a Snack

Provide each group with three packets of sugar and ask them to add one to each sample and stir to dissolve. Let the samples sit for five minutes. Have students record their observations immediately after adding the food source and after five minutes.

Prompt students to consider the following:

- What happened to sample A (sand only)?
  Still nothing, both when the sugar was added and at five minutes. The sugar dissolved but the 54-ND still isn't' reacting. It's probably not contaminated.
- What happened to sample B (sand plus yeast)?
  Not much at first but after five minutes the sample should start to smell strongly of bread and generate bubbles. This reaction will continue for quite a while. This sample is probably contaminated with a microbe.
- What happened to sample C (sand plus effervescent tablet)?
  Nothing this time. The reaction doesn't happen again and it doesn't restart after time passes. Whatever caused the reaction when water was added has run out. This probably IS contaminated, but not with something living.



Discuss and Report

Encourage students to think about what their findings mean.

- Based on your data, what do you think is contaminating each sample?
  - Sample A: This sample behaved we way we expected a pure sample to behave. Our experiments didn't indicate that there was anything wrong with this sample.
  - Sample B: This sample didn't do much when warm water was added aside from smell a little strange. Once we added sugar as a food source, though, it quickly began to smell strongly and create bubbles (but more slowly than sample C.) Since giving this sample food and water was necessary to generate a reaction, it's likely that the contaminant here is some kind of living microbe. We can add additional sugar and it will foam more.
  - Sample C: This sample reacted with water by fizzing and creating foam. We know that the real 54-ND shouldn't do this, so this sample is probably contaminated. It only reacted once with water and adding a food source didn't cause it to react again, so this is most likely a chemical contaminant.
- How can we tell if something is alive? How can we tell if a reaction we see is caused by chemical reactions or living behavior (eating, eliminating, etc)?
  - Chemical reactions tend to run until they are finished and are difficult to restart. Biological reactions can be restarted, in this case by adding more food.

Career Exploration and Extension

Prompt students to think about and research what a career as a pharmaceutical scientist might entail.

- What does a scientist do all day? What does Trae do?
- What kind of training would a student need to become a pharmaceutical scientist? What other types of scientists are there?
- Are jobs like Trae's in high demand? Will more people be hired to develop and manufacture new medicines in the future?
- What kind of education is needed to be a scientist? Where could a student be trained locally for this career? What types of classes are important?

Name: _____

Is It Pure?

Student Data Sheet

Pharmaceutical scientists like Trae have to ensure that the products they make are safe for humans and not contaminated with foreign chemicals or microbes. You have a sample of a new product, 54-ND. 54-ND is a light tan powder that does not dissolve in water and should not chemically react when given food or water.

The Challenge

You have three different samples of 54-ND that need to be tested for contamination. Based on what you know about 54-ND, what could we try to add to see if something is in the sample that shouldn't be?

The Protocol

Physical Analysis

1. Pour a small amount of each sample onto a clean, dry paper towel and examine it with a hand lens. What do you see? Describe your findings below. Remember to include information about the sample's appearance, like color or smell. DO NOT taste your samples! Science uses all of our senses EXCEPT taste!

Sample Name	Physical Observations
A	
B	
C	

Based on your observations and what you know about 54-ND, do you think any of these samples are contaminated? Why or why not?

Name: _____

Chemical Analysis Part 1: Just Add Water!

2. We know 54-ND shouldn't react with water or dissolve. Let's try adding some warm water to each of the samples. Be sure to add the water to each sample one at a time to make sure you don't miss anything important. Once you've added enough water to cover the sample, give it a gentle stir and record what happens immediately and then check the samples again once five minutes have passed.

Sample	Initial Observation	5 Minutes Later
A		
B		
C		

Based on your observations, which samples do you think could be contaminated?

Can you tell if the contaminant is a chemical or some kind of microbe? How could you test to see if the contaminant is alive?

Name: _____

Chemical Analysis Part 2: Give It a Snack!

2. 54-ND shouldn't have any biological contamination, so we shouldn't see any change if we give it a food source. Let's try adding some sugar to each of the samples. Be sure to add the sugar to each sample one at a time to make sure you don't miss anything important. Once you've added sugar to each sample, give it a gentle stir and record what happens immediately, and then check the samples again once five minutes have passed.

Sample	Initial Observation	5 Minutes Later
A		
B		
C		

Based on your second set of observations, which samples do you think could be contaminated now?

Did any of your samples react differently this time? What made the difference?

Name: _____

Reflection

- Based on your findings, which samples do you think are contaminated?

- Do you think any of the samples are contaminated with a living organism? Explain which one(s) and why or why not?

- If you have a sample that seems uncontaminated, how could you be absolutely sure it's pure?

ACKNOWLEDGEMENTS

Activities developed and written for Regional Opportunity Initiatives by

Adrienne Evans Fernandez
Education Specialist

Emily Menkedick
Education Specialist

ROI would like to thank the following members of our Educator Advisory Group for their gracious support and review of this curriculum:

Amy Gordon
Elementary STEM Coordinator
Brown County Schools

Kelly Grimes
7th Grade Science Teacher
Richland-Bean Blossom
Community School Corporation

Alexis Harmon
Academy of Science &
Entrepreneurship Principal
Monroe County
Community School Corporation

Alison Kern
6th Grade Science Teacher
Mitchell Community Schools

Joann Novak
Business & Computer Science Teacher
Monroe County
Community School Corporation

Jean Schick
High School Science Dept Chair (Ret)
Monroe County
Community School Corporation

Katy Sparks
STEM & Computer Science Coach
Monroe County
Community School Corporation

Tara Weisheit
4th Grade Teacher
Washington Community Schools

IMAGE AND CONTENT CREDITS

Images

Stock photography courtesy of Canva.com
Still video images from Trae - Pharmaceutical Scientist
Black and white icon assets courtesy of The Noun Project, including

- Beaker by Cezary Lopacinski from the Noun Project
- sand by Petai Jantrapoon from the Noun Project
- yeast by Christopher T. Howlett from the Noun Project
- pills by Ralf Schmitzer from the Noun Project
- Arrow by kiddo from the Noun Project
- Throw by Nook Fulloption from the Noun Project
- spice by Pham Duy Phuong Hung from the Noun Project

Content

Activity adapted from "Looking For Life," (August 2, 2021.) Retrieved from https://www.jpl.nasa.gov/edu/teach/activity/looking-for-life/

Is It Pure?

Inspired by Trae, a Pharmaceutical Scientist in the Indiana Uplands.

Published by Regional Opportunity Initiatives