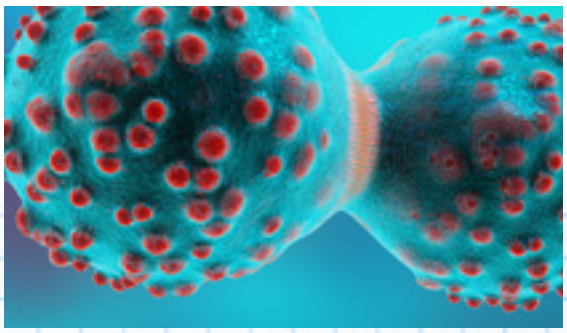
SCIENCE FAIR CENTRAL

Maker Corner Activity



BUILD A SMARTSCOPE!

Grade Level: High School

MAKE. CREATE. EXPLORE.

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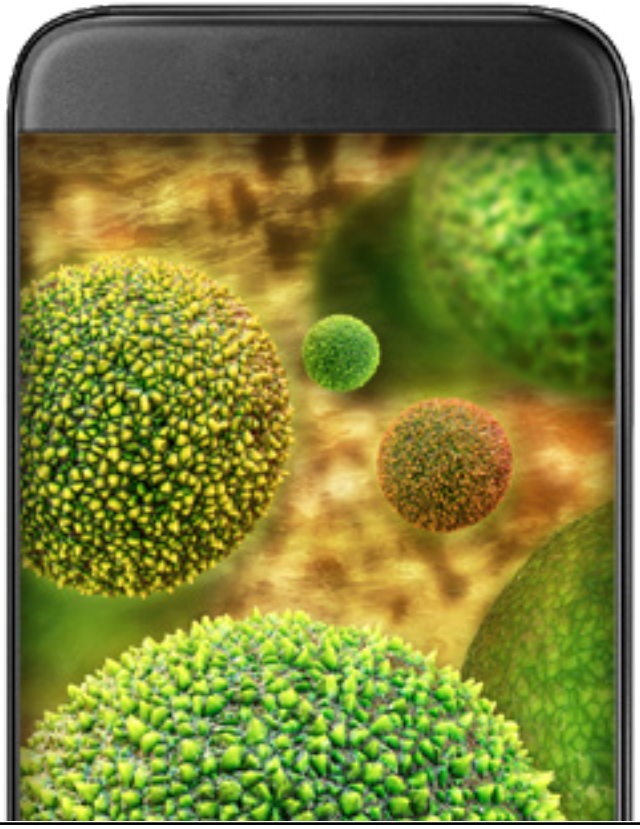
THE HOME DEPOT

Discovery EDUCATION

Your smartphone can become a working microscope!

Overview

Students will work together to design and build a device that will turn their smartphone into a working microscope. This "smartscope" will allow them to view, photograph, and record specimens in the science lab and in the field. They will learn about the invention of the microscope, how microscopes work, and the importance and application of microscopes in the history and future of our world.



This activity focuses on the **Designing Solutions** stages of the Engineering Design Cycle.

Engineering Design Cycle

- Defining the Problem
- **Designing Solutions**
- **Creating or Prototyping**
- Refine or Improve
- Communicating Results

Objectives

Students will be able to:

Discover that microscopes have been an important tool in science and how they have been responsible for many scientific discoveries and technologies that improve the lives of people and the health of our world.

Design, **construct**, and **test** a "smartscope" that will allow them to use their smartphone to magnify, view, and photograph their microscopic discoveries.

Microscopes originally used simple lenses and natural light sources to view things close up.

Materials

- a laptop or iPad for each student
- 5/16” nuts
- 5/16” wingunts
- 5/16” washers
- (4) 1/2” carriage bolts
- plexiglass (pre-cut into square and rectangular pieces no larger than 7x7” and 3x7”)
- plywood (pre-cut into square pieces, roughly 7x7”)
- focus lens from a simple laser pointer (1 per group)*
- small LED flashlight (1 per group)
- power drill
- mounting putty - Loctite 2 oz. Fun Tak Putty (12-pack)
- plastic sheets or slides
- sample of pond water or specimens for viewing *(onion, elodea plants, etc.)*

**Students should extract the lens of the laser pointer by unscrewing the top cap and pushing the lens out with the eraser end of a pencil.*

Have you ever wondered . . .

How a microscope works?

What allows us to see things that are so very small? Early microscopes used simple lenses and natural light sources to view things up close. Yet as technology has advanced, microscopes now use electron beams to look at the surface of things as small as tiny viruses and we even have microscopes that can allow scientists to view atoms!

What have we learned from the invention and use of the microscope?

Believe it or not, there was a time when all we humans knew were the things we could see with our own eyes. As we know now, with the help of a microscope, there are whole world of microbes and microorganisms. By using microscopes, we can see the inner workings of cells and learn about cellular processes that has led to discoveries that have saved countless lives.

Electron beams now allow us to look at things as tiny as viruses.

Make connections!

How does this connect to students?

In a typical science class, students will be introduced to and practice using a microscope, but have they ever thought about how microscopes work and how many discoveries have come from the invention of this important scientific tool? In this lesson, students will understand how lenses, light, and a smartphone can be used to magnify everyday objects. Students will build and test a "smartscope" and can take pictures and videos of living things that are invisible to the naked eye that can be shared with their friends and family, and even make a "smartscope" at home for further exploration of the microscope world around us.

How does this connect to careers?

Microbiologists—study microorganisms such as bacteria, viruses, algae, fungi, and some types of parasites. They try to understand how these organisms live, grow, and interact with their environments.

Nanotechnologists—manipulate matter on the nanoscale (one billionth of a metre), developing new materials and equipment as well as drugs and diagnostic tools. Nanotechnology work involves designing and conducting experiments based around observing nano-scale systems.

Forensic science technicians—aide in criminal investigations by collecting and analyzing evidence. Many technicians specialize in various types of laboratory analysis.

Pathologists—analyze tissue samples under a microscope to determine the presence of cancer of other diseases. They also work on the deceased, helping to discover the cause of death.

How does this connect to our world?

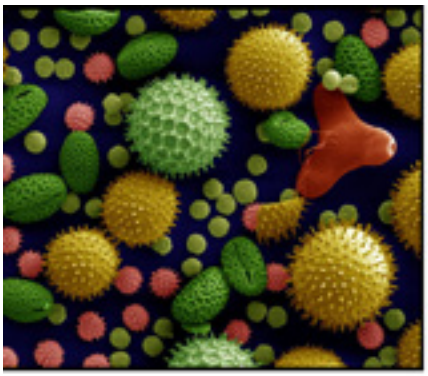
The invention of the microscope in the 17th century opened our eyes to a new world of tiny organisms that were living all around us and in us! From the early discovery of the cell by Robert Hooke, to data gathered in genetics and environmental science, to new discoveries and ideas in the growing field of nanotechnology, the microscope continues to be an essential tool for scientists of all types today. Through building a smartscope, students will learn the basics of how a microscope works and be able to share photos and videos of their discoveries with their scientific community using smartphone technology.

Blueprint for Discovery

Whole Group Activity - 10 minutes

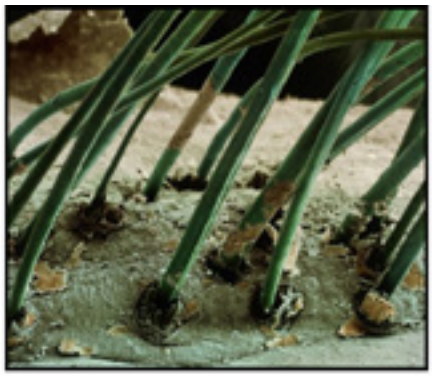
1. Begin the lesson by showing students the following images (either in a projected slideshow, such as PowerPoint or google slides or display them on the front board). As you go through the images, ask students to see if they can identify what they are seeing. Ask students to share their ideas with the class after each image is displayed.

IMAGE A



Pollen from flowers

IMAGE B

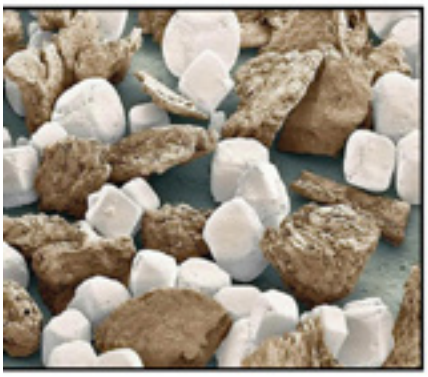


Human eyelash hairs

IMAGE C

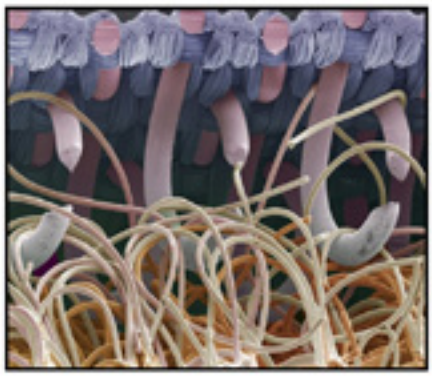
Eyelash mite. Yep, they live in your lashes! Gross!

IMAGE D



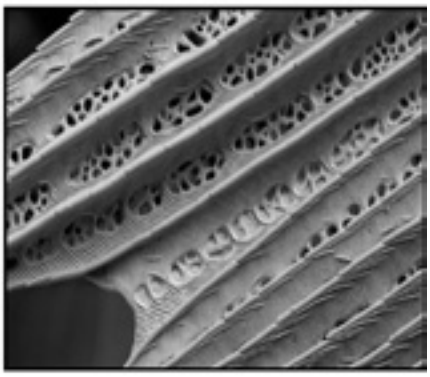
Salt and Pepper

IMAGE E



Velcro

IMAGE F



The wing of a moth

IMAGE H

A bacteriophage virus

2. Ask students to think about how we are able to see all of these amazing images. What important scientific tool has allowed us to view the world in this way?

3. Students should identify that the important tool is the microscope. Explain to students that there was a time in our history when all that we knew about were the things that we could see with the naked eye. How much were we missing? The invention and use of the microscope opened up a whole new world that existed, including the world of cells, microbes, and microorganisms!

4. Show students the following video to help introduce them to the history of the microscope and uses for various types of microscopes in science: https://www.youtube.com/watch?v=Ue-86MDmjns&t=193s

***Extension** - for more on Leeuwenhoek's discoveries, have students watch the following video: https://www.youtube.com/watch?v=ePnbkNVdPio*

Partner Activity - 15 minutes

1. Ask them to take 5 minutes to research on their devices and discuss with the person sitting beside them what important discovery in science is or was only possible because of the use of a microscope.

2. To introduce them to an example of this (and if time allows), show students the following video clip that looks at nanobot technology and human health that uses the microscope: https://www.youtube.com/watch?v=u-RdudALSac

3. To help guide their discussion, create categories on the front board or screen that include: HEALTH/DISEASE, CELLS, EVOLUTION, PHYSICS, FORENSIC SCIENCE, and ENVIRONMENTAL SCIENCE. (Feel free to add any other categories that you want to focus on such as MANUFACTURING, etc.)

4. Have student pairs briefly share their examples with the class and record their answers on the front board or screen in the correct category.

Group Activity - 35 minutes

1. Tell students that although there now are many different types of microscopes, today they will be focusing on light microscopes. Their task will be to get into groups of 3-4 and design and create a microscope that can be used with a smartphone to view, video, and take pictures of the microscopic world!

2. Before they can begin their design, students should review how light microscopes work.

   Have students explore a virtual microscope. Ask students to play close attention to the way that the microscope is set up and to understand the roles that the various parts play. This will help them as they will be designing their own "smartscope" in the next part of the activity. (If the classroom has light microscopes available, teachers may choose to have students use these in place of the virtual microscope.)

3. Show students the materials that have been provided for them. Make sure that groups use the following guidelines as they build their "smartscope:"

   a. Each group must remove and use the lens from a laser pointer. This will act as their second lens (the first one being in their smartphone) to magnify the image they are looking at. These lenses should be lined up perfectly to view specimens.
   b. They should have something in their design that will act as the stage of a light microscope, to hold the specimen on slide in place.
   c. They must design a way to use the light source (small LED flashlight) to illuminate the specimen from below the lenses.
   d. They should have a way to hold the phone steady and still on the smartscope.
   e. Students must follow all safety guidelines for the science lab, including wearing safety glasses and exercising caution when using tools such as drills.

4. Before beginning to build, groups should brainstorm and create a sketch or blueprint of their "smartscope." This can be created on paper or students can use a free online CAD program, such as Tinkercad (https://www.tinkercad.com) or SketchUp (https://www.sketchup.com) on their devices.

5. When students have finished their sketch or blueprint, they should use the materials provided to build their "smartscope" following all safety rules for the lab area.

6. When the building process is completed, the teacher should provide some specimens for the students to test out their "smartscope." Pond water provided excellent specimens for study, as students will likely be able to see movement of microorganisms.

   The teacher may provide an identification sheet for students (https://www.msnucleus.org/watersheds/mission/plankton.pdf) to see if they can identify organisms as they view them.

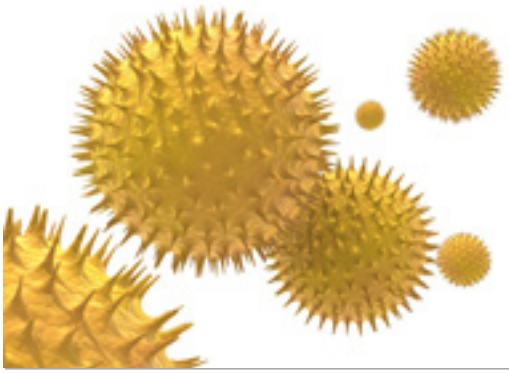
   If pond water is not available, other specimens can be made available to students such as red onion skin, elodea (an aquatic plant available at pet stores), text from a newspaper, or various prepared slides that the teacher may have. Keep in mind that the "smartscope" will only magnify objects 175x, so very small things such as bacteria cells will not be visible.

7. Students should take any time left to view and try out the designs of other groups - how are their designs similar or how could they improve upon their design? How could they create a smartscope that will magnify an image even more? Teacher may choose to have students' complete reflection questions on paper or as a class or individual discussion.

Take Action

As an extension on this lesson, students can perform or design an experiment that will require the use of their smartscope to collect data. Ideas include comparing samples of pond water and use a biodiversity index to help determine which has the best water quality, looking at the effect of saltwater vs. freshwater on osmosis in plant cells, observing the effect of temperature on the respiration of earthworms.

- https://www.biologycorner.com/worksheets/biodiversity.html
- http://sciencenetlinks.com/lessons/plasmolysis-in-elodea-plant-cells/
- http://abt.ucpress.edu/content/49/6/366



National Standards

Science

Next Generation Science Standards

HS-PS3-3
Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-ETS 1-2
Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Technology Education

Next Generation Science Standards and **International Technology and Engineering Educators Association**

ITEEA Standards for Technological Literacy

Standard 1: Students will develop an understanding of the characteristics and scope of technology

J. The nature and development of technological knowledge and processes are functions of the setting

Standard 2: Students will develop an understanding of the core concepts of technology.

CC. New technologies create new processes

Sources

- https://www.sciencelearn.org.nz/resources/496-how-microscopes-magnify
- https://www.extremetech.com/extreme/169673-a-cheap-powerful-digital-microscope-using-your-smartphone-and-an-old-laser-pointer
- https://www.bls.gov/home.htm