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Science Explorations
Teaching Tips, Projects & Science Facts

NEWSLETTERS ARCHIVE

A Closer Look: Microscopes & Magnifiers

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There's nothing quite like a really close up view of something super tiny! Magnification shows us invisible things - amazing details that we simply cannot see without help. The two projects in this issue of *Science Explorations* are designed to be done with a good magnifying glass, although a stereo microscope will add a lot. We've linked three more projects that you can do with a compound microscope, but it's still worthwhile to try them with a magnifier if you don't have one.

Brine Shrimp Pets

Brine shrimp are tiny crustaceans that live in inland bodies of saltwater, such as the Great Salt Lake, but not in the ocean, where they would have too many predators.

Adult brine shrimp, 40x magnification

Brine shrimp eggs remain dormant until the right hatching conditions. These eggs can survive for years when dried and then, when added to salt water, hatch literally overnight! The hatched shrimp larvae are called **nauplii** (singular is "nauplius") and look quite a bit different from adult brine shrimp. A nauplius has only one eye, called a **nauplier eye,** and has an extra pair of antennae with hairlike **setae** for swimming. The nauplii **molt**, or shed their exoskeleton, about 12 hours after hatching. After several more moltings, they reach the adult stage; it only takes about eight days to mature from the time they hatch.

Adult brine shrimp have a pair of compound eyes as well as the nauplier eye. They also have 11 pairs of **phyllopods** or leg-like appendages. The structure of the phyllopods are designed for different functions: some are for swimming and the others are for scraping and filtering algae (the shrimp's primary food source).

Mature brine shrimp might grow to as much as half an inch in length and live for up to three months.

Materials

- Glass hatching tank (wide-mouth quart jar or shallow glass pan at least two inches deep)
- Non-iodized salt (or sea salt mixture)
- Bottled water
- Brine shrimp eggs (you may be able to find these at a pet store)
- Magnifying glass
- Pipet (medicine dropper)
- Petri dishes (optional)

- Microscope (optional)

What to do:

1. Fill the container with one quart of saltwater solution. (To make the solution, mix 1 to1-1/2 teaspoons of sea salt mixture or non-iodized table salt per cup of bottled water.)
2. Sprinkle about 1/16 of a teaspoon of brine shrimp eggs into the dish: you don't need to cover more than one square inch on the surface of the water. Leave the container in a room where bright sunlight can reach it. Your brine shrimp should start hatching in just 24 hours! Look closely and you'll see them vibrating in the water.
3. The shrimp will live 1-3 days without food. To keep them longer, feed them a very tiny amount of yeast - a few grains as needed. You might also need to change the water occasionally, if it gets cloudy. Clean out unhatched eggs from the top of the container with a pipet.
4. To make it easier to study them up close, use a pipet to transfer some of the shrimp with sufficient water into a petri dish. Use a magnifying glass (or stereo microscope) to see them up close. What parts of the brine shrimp can you identify? What are their swimming habits? Eating habits? How do they use their phyllopods? How do they respond to light? Compare the larval stage with the adult stage. Keep track of your observations in a notebook and include sketches of the shrimp.
5. If you have a compound microscope, you can see a specimen at much higher magnification (40-400x). This will allow you to see details like the hairlike setae on the phyllopods. Make a wet mount slide by adding 1-3 drops of water with a brine shrimp onto a concave slide, and placing a slide coverslip over it.

Now that you've seen what brine shrimp look like up close, you can do some experiments to see how they are affected by their environment. To start, test the pH level in the water with pH paper: ideal conditions are a pH of around 8, but no lower than 5 and no higher than 10. To raise the pH level in the tank, add a little bit of baking soda.

You can also try hatching several batches of shrimp at a time, using different hatchery conditions for each batch. Fill 3-4 petri dishes with different solutions: you might use plain tap water, water with a low pH (acidic), and regular salt water to be the control that you can compare the results to. Before you start, hypothesize which solution will have the best results and which will have the worst. Sprinkle a small amount of eggs into each dish. After 24 hours, check on the dishes again. Has anything happened? What are the results after 48 hours? 72 hours? Use a magnifying glass for your observations, and make sketches. Were you right about which solutions would work best and worst? How do you think factors such as temperature (colder or warmer) or more or less light might affect the hatching success rate of the brine shrimp?

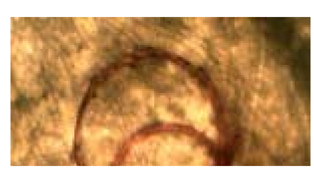
Counterfeit Money

What's to stop people from just making their own money? Copy the design, print your own bill, *voila*! Thankfully, it's not that simple. Take an up close look at money to see why.

Materials

- Money - 1 dollar, 5 dollar, 10 dollar, and 20 dollar bills
- Magnifying glass
- Black light (optional)
- Microscope (optional)

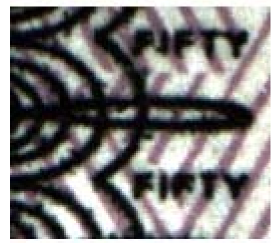
What to do:

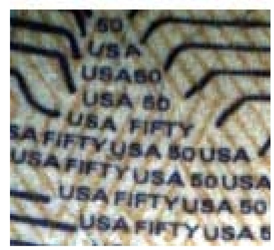


1. First look at a one dollar bill. How many different numbers or number/letter combinations can you find? Can you do some research to find out what each of them represents?
2. Paper money isn't made out of regular paper, which would fall apart too

easily and be destroyed if it got wet. It is made from a mixture of cotton and linen fibers. Not only does this make it durable, but it gives it a distinct feel - experienced people can identify counterfeit money by feel alone! Compare how it feels to how a regular piece of paper feels. Try to find a bill that has a small tear in it. Look at the edge of the tear under magnification to see the fibers (it might help to hold it over a dark background). Compare that to a tear in regular paper.

3. Look closely at a bill with your magnifier. Do you see small red and blue threads? These are added to the paper to make counterfeiting more difficult. With a microscope you'll see that they are mixed in with the smaller paper fibers.





A one dollar bill has a very intricate design, but it isn't valuable enough to need lots of anti-counterfeit features. Now it's time to examine a larger bill, like a ten or twenty. The design of these bill changes over time. If you can, try comparing an older bill with a newer one.

1. Hold the bill up to the light and look in the blank areas. Do you see a picture that you couldn't see before? These are called *watermarks.* They are pictures that are put into the paper when it is made, not printed on the top of it! You should also see a line of text running across the bill that you can only see when you hold it up to the light.
2. Look at the number in the bottom right-hand corner of the "face" side of the bill. Tilt the bill and you'll see the number change colors! Shine a light on the bill from the top and look at the number again under magnification—do you see how the ink is different from the rest of the bill?
3. Take a magnifying glass to the "lines" on the border of the face side of a 10 dollar bill. Did anything surprise you? Look closely at the edges of all the pictures on the bill - can you find any hidden words or phrases?
4. If you have a blacklight, go into a dark room and shine it on the money. Are there any spots that glow?

What's happening?

The people who design money want to make it as hard as possible for counterfeiters to copy. They use all sorts of cool technology to add watermarks, ultraviolet ink, and lots of tiny numbers and text that we can barely see without magnification. People who have the job of spotting counterfeit money have to use careful observation, plus tools like magnifiers and microscopes.

Make a list of all the little details you find on each bill. (Do you see some of the features from the pictures above?) Now that you've found a lot of the details, make a "treasure hunt" for someone else in your family and see how many tiny features they can find!

Here are more great projects to do with magnification. They'll work best with a microscope, but you can still see cool things with a magnifier, if that's all you have:

- Microscope Forensics
- Up Close with Crystals
- Mushrooms & Microscopes

Microscopes in the Workplace

Imagine a guitar the size of a human cell or microscopic artwork hidden on a computer chip! These unlikely things are a reality thanks to microscopes. People use microscopes in a wide variety of fascinating jobs, and sometimes have a little fun on the side! Here are just a few of the fields that use microscopes.

Forensics - Investigators use microscopes to help examine evidence from a crime scene. The criminal may have left behind traces of soil from his shoes, a strand of hair, a thread from his clothing, or a drop of blood. With a microscope, investigators can use these tiny bits of evidence to link a crime to a suspect.

Archeology - Like forensics, archeology tries to discover what happened in the past with small bits of evidence. At an archeological dig, a few preserved fibers can indicate what kind of cloth people wore and how it was made. Preserved grain and pollen suggest what the land was used for and what types of plants grew there. From fragments of buildings, pottery, and tools, archaeologists can get some idea of how people from the past lived, and sometimes a close-up examination of bones will even indicate how they died.

Medicine - Microscopes are used in hospitals to help diagnose illnesses. If you have a bad sore throat, for example, the doctor might swab your throat and send the sample to the lab. There medical technicians will test it and examine it with a microscope to see if you have a bacterial infection like strep throat. Microscopes are also used in some types of surgery that require precise work on small blood vessels and nerves.

Electronics - Computers keep getting smaller and smaller, thanks to amazing miniature electronic circuits called microchips. Microscopes are used in the production of computer chips. And if you look at a chip with a microscope, you might find that the engineers who designed it had some fun doodling on it! Check out some microscope pictures of computer chip artwork at the Silicon Zoo.

Nanotechnology - This field of science explores how to build things out of individual atoms and molecules! Using very specialized microscopes, scientists can actually rearrange atoms to create mini machines that are only nanometers long. (A nanometer is one billionth of a meter!) For practice, scientists working in nanotechnology have built a microscopic guitar that can be played using laser beams and machines that are dwarfed by nearly-microscopic bugs.

There are many different kinds of microscopes to meet the needs of all these different fields. The kind that you use in science class is called an *optical microscope* and it uses visible light to look at thing magnified. Many industries use something called an *electron microscope,* which sends a beam of electrons to the specimen instead of a beam of light. This type of microscope is very expensive and difficult to use, but it can magnify things up to a million times! The pictures it produces are black and white, but scientists will often add color later to help the details stand out.

Science Links

See things magnified thousands of times with this cool virtual scanning electron microscope.

Look at beautiful pictures of microorganisms at the Micropolitan Museum.

Zoom in on incredible electron microscope pictures of everything from dust mites to pollen to viruses.