Name ____

Date ____

1. Draw what you remember is on a penny.

Heads **Tails**

2. Look at a penny for 1 minute. Then draw it again.

Heads **Tails**

3. Use a magnifier to observe a penny. Then draw it again. These circles are bigger because you will need more room for details after observing the penny with a magnifier.

Heads **Tails**

Activity Sheet 2

Name ______________________________

Date ______________________________

Fold

Name of Object	Observable Properties	Sketch

Fold

Activity Sheet 3

Name ____

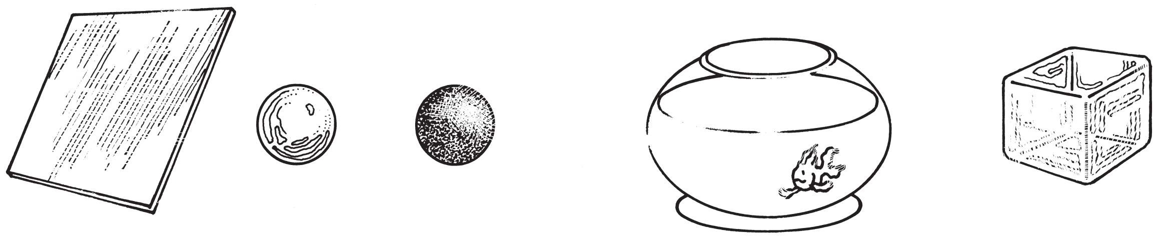
Date ____

Sketch and label the object	Predict: Will this object magnify?	Test: Does this object magnify?	Sketch the underlined word as it looked through the object

What Have You Learned about Lenses? Activity Sheet 4

Name ____

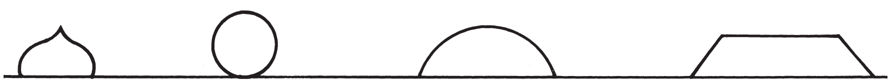
Date ____



A Window | **B** Clear marble | **C** Black marble | **D** Goldfish bowl | **E** Clear cube

1. Look at the objects shown above. Which objects will magnify? Circle the letters of the objects that will magnify.

2. Which of the drawings below looks most like the side view of a water drop on waxed paper? __________



A **B** **C** **D**

3. Name a tool or piece of equipment you may have used or seen at home or at school that has a lens.

   ____

4. Carefully observe the object your teacher has given you. List five properties of that object.

   ______________________________ ______________________________

   ______________________________ ______________________________

   ____

5. Describe a magnifying lens. What can it do? You may use the back of this paper.

Reading Selection

Who Invented the Microscope?

Who invented the microscope?

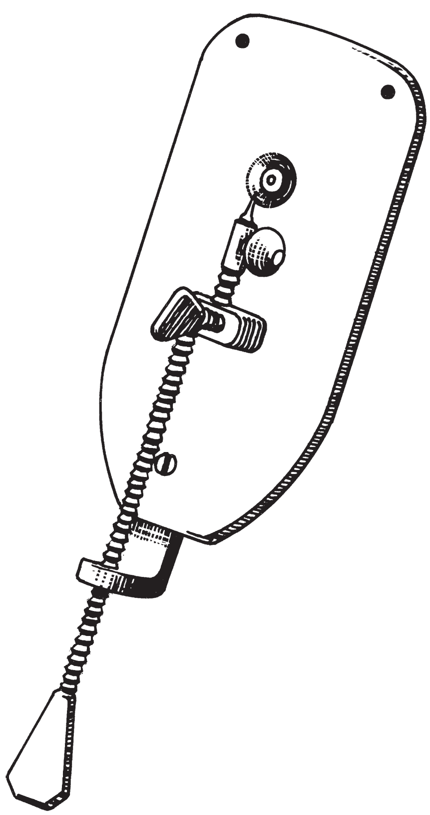
It's hard to say. But we do know that the first person to make and use a lot of microscopes (more than 240 of them in his lifetime) was a Dutchman named Anton Leeuwenhoek.

Leeuwenhoek lived in the 1600s in the Netherlands, and he owned a store full of cloth and pincushions for sale. But the store was never open because Leeuwenhoek preferred to spend his time trying to create pieces of glass that would help him see small things.

After grinding many pieces of glass, trying to create lenses, Leeuwenhoek succeeded in making a microscope. Here's an illustration of what it looked like.

Figure 5-2

One of Leeuwenhoek's microscopes (about actual size)



Most of Leeuwenhoek's microscopes were tiny things, not much larger than 1" × 2". And he had lenses to match—small, polished rock crystal, even a polished grain of sand.

Exciting things were happening all over the world at the time Leeuwenhoek lived. People from the Netherlands and other countries were exploring the seas and new worlds, trading their goods with other cultures. The painters who would become known as the "Dutch Masters" (including Rembrandt and Vermeer) were creating works of art that we instantly recognize today.

More fascinating to Leeuwenhoek than new lands or, possibly, even the new paintings, was what he could see with his simple microscopes, including one-celled plants and animals. He was the first person ever to see these creatures. One of the first times he ever saw bacteria was when he scraped some of the plaque from his teeth and looked at it under his lens. He looked at the blood of mammals and found that they have round blood cells, while other animals—birds, amphibians, and fishes—have oval ones. He was the first to see the *Volvox* (a creature you will have some experience with in a later lesson).

Today, only nine of Leeuwenhoek's microscopes are left. Wouldn't it be interesting to look through one? Do you think you would see different things than you see through the microscopes we have today?

Name ______________________________

Date ______________________________

1. Which of the circles below do you think represents the size of the field of view of your microscope? Put a box around the largest circle you predict you would be able to see all at once in the microscope.

2. Test your prediction. Cut out or rip off the circle at the bottom of the page that matches your prediction. Dampen the paper and put it on a slide. If you can see the whole circle at once, you may have found your field of view. If not, keep trying until you do.

3. Go back to question No. 1 and draw a diamond around the circle that you now know represents the field of view of your microscope.

4. Cut out the metric ruler below and use it to measure the circle that represents your field of view. How big is your field of view?

   ______ mm

5. Select a section of normal lettering (no big headlines or tiny stock market reports) on your piece of newspaper. Draw a circle that represents your field of view. How many letters will you be able to see at once?

   Prediction: ______ letters

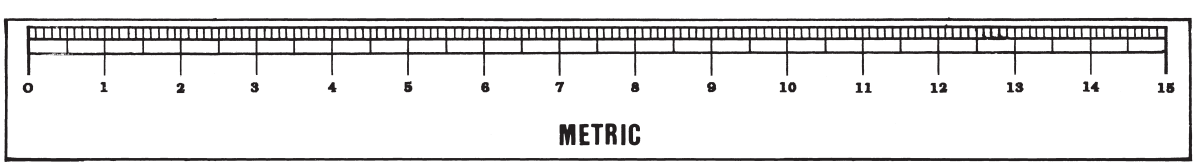
   Actual number seen: ______ letters

6. One way to measure the objects you look at with the microscope is to compare them with something else whose size you already know, like a hair. Pull one hair from your head. Put about one inch of it between two slides and look at it under the microscope. Pay particular attention to how wide the hair is, not how long it is.

7. Use the width of your hair to measure as many of the objects as you can—the microfiche, the screen wire, the burlap, the yarn, and the pencil shavings. The more practice you get training your eye, the better. Ask yourself: Which is wider, my hair or the object? (It will probably be the object in most cases.)

   How many hair-widths wide is:

   Yarn? ______ hair-widths A pencil shaving? ______ hair-widths



Taking a Look with Robert Hooke

Before he became a scientist, Robert Hooke wanted to be a painter. He drew some very accurate, detailed drawings of the objects he observed under his microscope over 300 years ago.

Robert Hooke and Anton Leeuwenhoek lived at about the same time, in the middle of the 1600s. While Leeuwenhoek was busy building microscopes and looking at a great variety of microbes in his little shop in the Netherlands, Hooke was busy doing somewhat the same thing in England.

One of the differences between Leeuwenhoek and Hooke is that Hooke drew what he saw through his microscopes. When he was young, Hooke thought he wanted to paint portraits. But then he went off to school and college, and he became more interested in science. Hooke liked conducting experiments to find out more about the world around us.

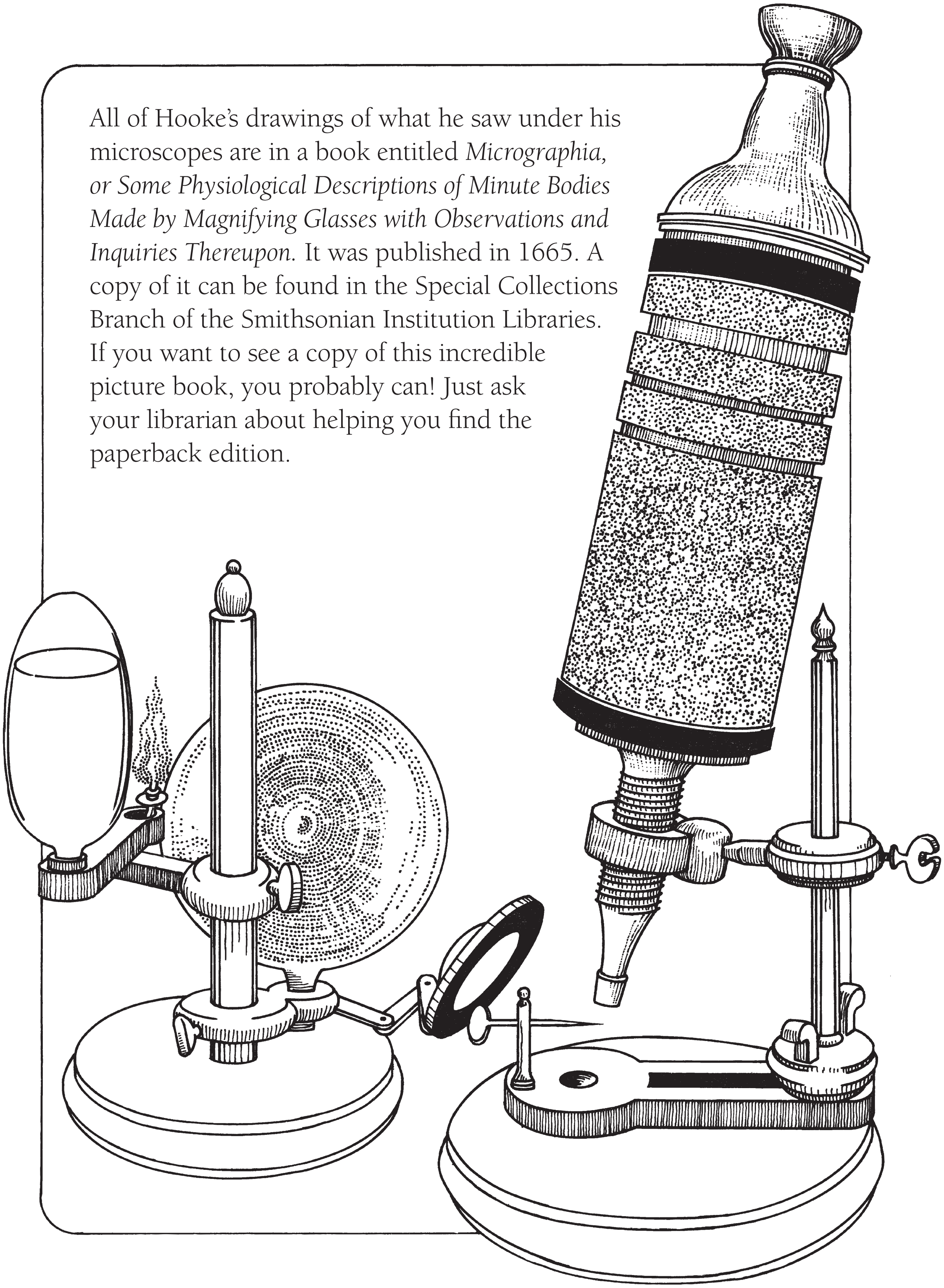
While he was experimenting, Hooke learned a lot about what we call physics. And he invented some tools, such as the barometer, that help us determine what is happening in the physical world. (A barometer detects changes in pressure in the atmosphere, and these changes often indicate whether a storm is coming.) He also was interested in improving microscopes. His original microscope didn't have a lot of magnifying power. Hooke saw that the reason was because the lenses weren't curved enough, so he made his own microscope with a more rounded lens.

But with microscopes Hooke really was more interested in what they could help him see. Using both simple (one lens) and compound (more than one lens) microscopes, he observed and carefully drew pictures of insects and their parts, the point of a needle, the edge of a razor, what he called insects in rainwater (they probably were microbes), snow crystals, and pieces of cork.

Figure 10-2

One of Hooke's microscopes (actual size was about 9 inches tall)

All of Hooke's drawings of what he saw under his microscopes are in a book entitled *Micrographia, or Some Physiological Descriptions of Minute Bodies Made by Magnifying Glasses with Observations and Inquiries Thereupon.* It was published in 1665. A copy of it can be found in the Special Collections Branch of the Smithsonian Institution Libraries. If you want to see a copy of this incredible picture book, you probably can! Just ask your librarian about helping you find the paperback edition.

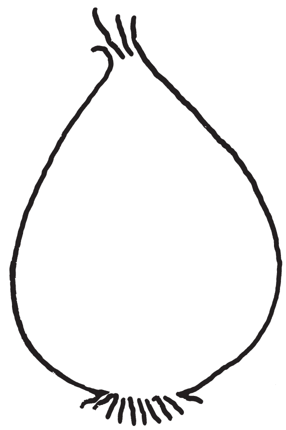


Name ______________________________

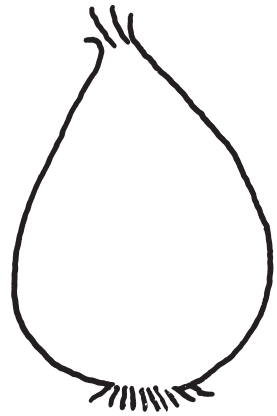
Date ______________________________

Predict | **Observe**

1. Sketch what you *think* you would see if you cut an onion lengthwise from the leaf end to the root end.
2. Sketch what you see when the onion is sliced lengthwise.

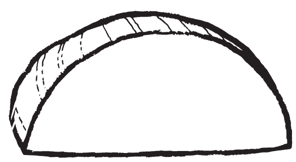


1. I think



2. I see

3. Next sketch what you *think* you would see if you cut one of your onion slices in half across the roundest part.
4. Now sketch what you *see* when the onion is cut through the roundest part.



3. I think

4. I see

5. What do you *think* the onion will look like under the microscope?
6. Now sketch what you *see* under the microscope.

5. I think

6. I see

Reading Selection

Looking at Living Things: Volvox

Commonly found in ponds, **Volvox** is a member of a large group of organisms known as **green algae**. Algae do not have roots, stems, or leaves, but, like green plants, they use light to make their own food by a process known as photosynthesis. Most algae live in the water, but you also may find them on damp surfaces, such as tree trunks, rocks, and soil.

Volvox cells are especially interesting because they live togheter in colonies of 1,000 to 3,000 similar cells, arranged in a hollow sphere. Each individual cell has two **flagella**, or whiplike tails, which work together to propel the colony through the water. The spherical colony of cells is held together by a clear jellylike substance.

Also visible inside the sphere of many of the large colonies are smaller daughter colonies. After the daughter colonies become big enough, they will be released through an opening in the parent colony to become new, independent colonies.

There are advantages to colonial living. For example, because the *Volvox* colony is relatively large (350 to 600 micrometers), the tiny individual *Volvox* cells living in the colony are safe from the many microscopic organisms that feed on other single-celled creatures.

Volvox is one of the beauties of the microscopic world. It is a rich bright green, and the whole globe rotates slowly through the water, reminding one of an ethereal planet in graceful orbit.

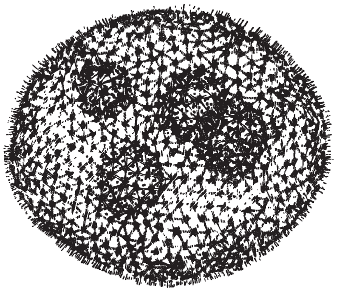


Figure 12-1
***Volvox* colony**

LESSON 13

Reading Selection

Looking at Living Things: Blepharisma

Commonly fond in ponds, **Blepharisma** is a single-celled, pear-shaped creature about 160 micrometers in length. It it unique in its rosy coloration and therefore easy to identify.

Blepharisma's size varies with its nutrition. Ordinarily, its diet consists mainly of bacteria, but if its diet is enriched with other microbes, giant forms of *Blepharisma* may result. These hungry giants will then become cannibals and eat their own kind. Students probably will not witness this drama, but they certainly will notice a great variation in size among the individuals on their slide.

This microbe belongs to a group called **ciliates**. A ciliate's body is covered with short, moveable, hairlike extensions called **cilia**. These cilia act like paddles to move the microbe through the water or to set up currents to force food into its mouthlike opening.

One way that the *Blespharisma* reproduces is by dividing itself in half. This process is called **binary fission**, and it produces two equal twins. There is a good chance that students will see one of these cells in the process of binary fission.

Figure 13-1
***Blepharisma* under the microscope**

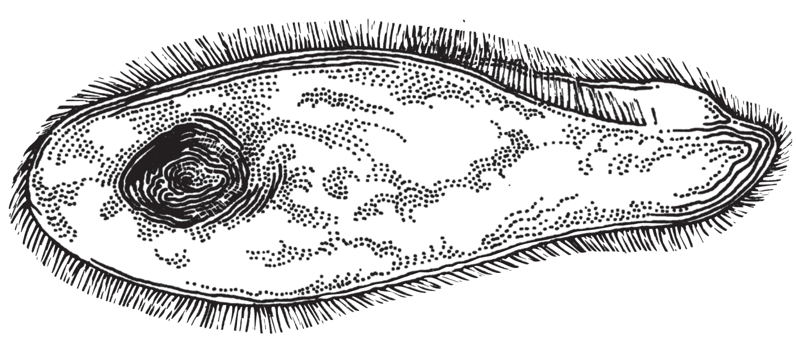
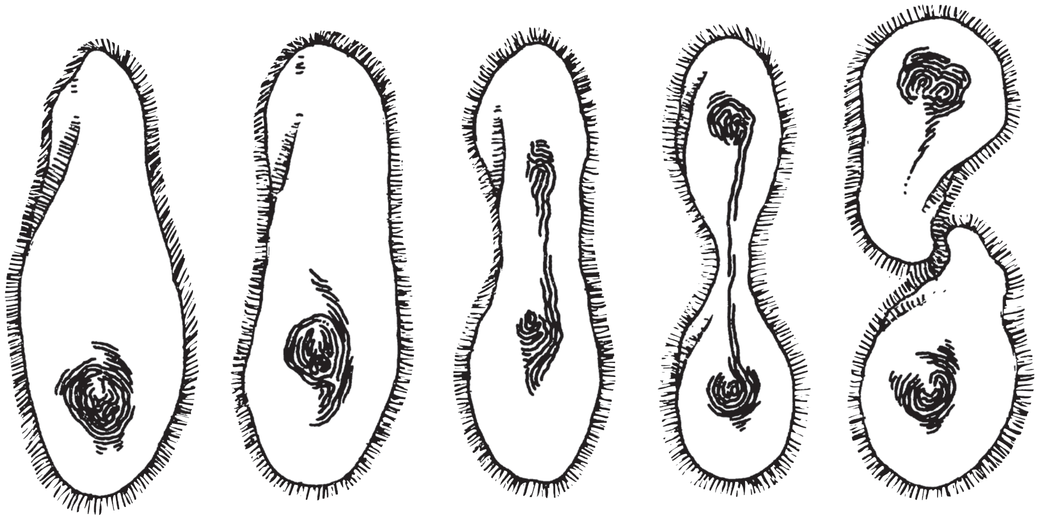


Figure 13-2
Enlarged drawing of *Blepharisma*

Figure 13-3

***Blepharisma* undergoing binary fission**



Reading Selection

Looking at Living Things: Vinegar Eels

The **vinegar eel** is not a fish but, rather, a harmless roundworm about 1.5 to 2 mm long, with point at both ends. Its smooth, slender body is nearly transparent, so it is possible to see its internal organs. Made up of many cells, this creature is large enough to be seen easily with the naked eye in bright light as it moves continuously in its vinegar environment. Few would call vinegar eels beautiful, but they certainly are fascinating.

The vinegar eel has several distinctive features. It is one of the lowest animals to have a digestive tract, complete with mouth and anus. Its method of reproduction is also distinctive. The embryos of the baby vinegar eels develop inside the female's body and are born alive and wiggling. The developing embryos are lined up inside the female's body by age, so you can see all stages of development through the mother's nearly transparent skin, if you have a powerful microscope. Another interesting feature is that the vinegar eel actually spends its entire life in **unpasteurized vinegar**–a very acid environment.

Why haven't you ever noticed vinegar eels shimmering at the edge of your vinegar bottle or swimming in your salad dressing? They simply aren't there, thats why. They live in **unpasteurized** cider vinegar, feeding on bacteria and tiny pieces of apple. But we use **pasteurized** vinegar. Pasteurization is a process of heating to a high temperature to destroy microbes. It produces **sterilized** vinegar, which completely eliminates the possibility of our finding these creatures on our kitchen shelf.

Even though the vinegar eels are quite large compared to *Volox* and *Blepharisma*, they are a challenge to see through the microscope because of their tireless, rapid movement. They have muscles the whole length of their body and move through vinegar with powerful, whiplike motions.

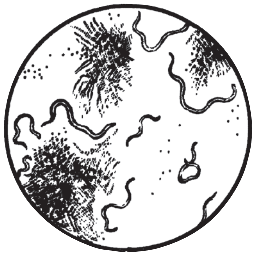
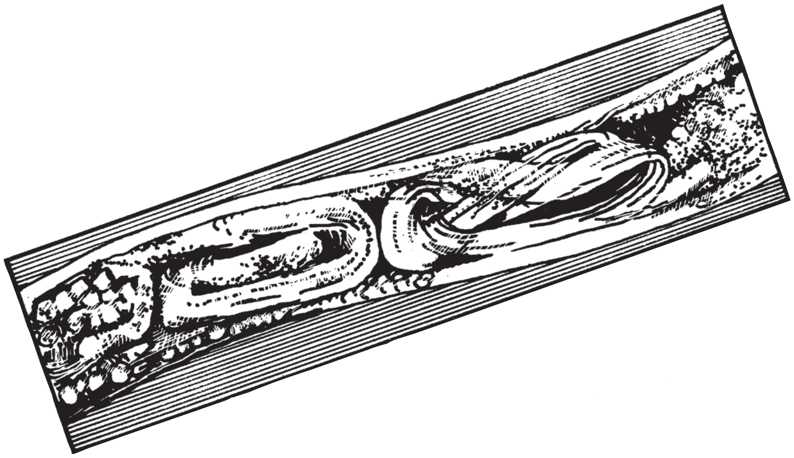


Figure 14-1

Vinegar eels under the microscope

Figure 14-2

Vinegar eel with embryos



Looking at Living Things: Hay and Grass Infusions

Things have changed in the infusion jars. If all has gone well, the hay and grass have begun to **decompose,** the water has changed to an amber brown color, a film of scum floats on the surface, and there is a definite odor when you lift the lid.

What's happening? During the first few days, **bacteria** were responsible for the changes. Most bacteria are one-celled microbes, too small to see with our classroom microscopes. They were probably on the grass, on the jar, or on your hands when you set up the infusions. Some bacteria are harmful to humans and cause disease. Others are useful and are responsible for **decomposition,** the decay of organic material (such as the hay and grass in your infusions). Think of what a mess the world would be if nothing ever decomposed!

Soon after the bacteria began to grow and multiply, slightly larger single-celled organisms appeared and began to feed on the bacteria. These larger organisms probably were also on the blades of grass or hay but in a dried-out, resting state. When conditions became favorable—when they reached water—they broke out of the protective coverings that had prevented them from drying out. Then these microbes began to feed on the bacteria and grow and multiply, too. Since there are thousands of different kinds of microscopic creatures, it is not possible to predict which ones landed in your particular infusions. So be prepared for anything. For the teacher's background information, some possible organisms are illustrated in Figure 15-1.

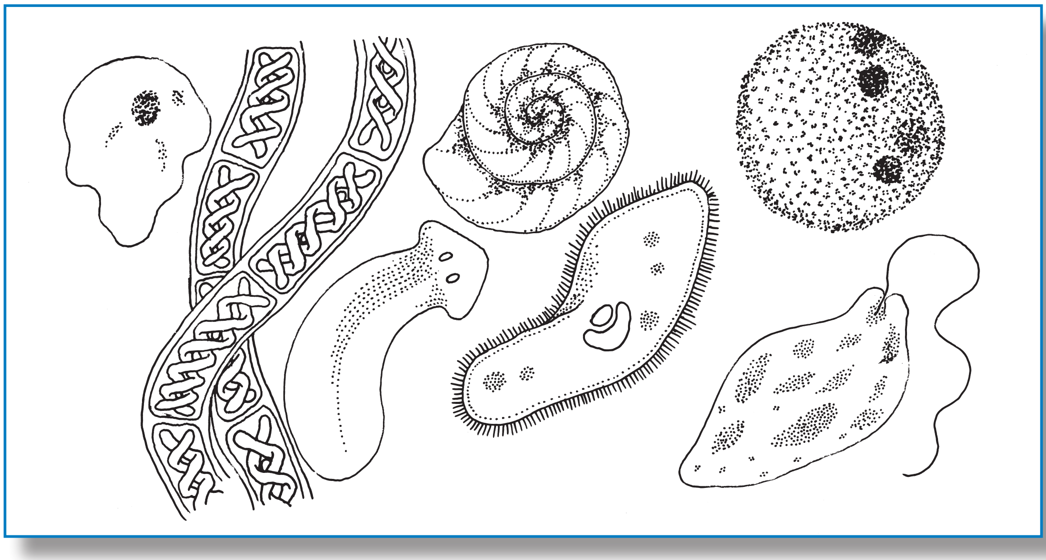


Figure 15-1

Some microbes you might see