# How to Use the
# GILBERT MICROSCOPE

**pp 58- 77**

# CHAPTER 15

## Fundamental Units of Living Organisms

The cell is the fundamental unit of living organisms. Hooke in 1665 examined some thin sections of cork and found that it was formed of small open spaces which he called cells, because they resembled somewhat the cells of the monasteries.

### EXPERIMENT 114. Cork Cells

Repeat Hooke's discovery by making some thin sections of a cork and examine them for cells with first the low and then the higher powers of your microscope. Are the cells the same size and shape when you make the section lengthwise of the cork as crosswise? Another way to obtain a thin section of cork is to soak off the cork from a cork tipped cigarette and use it.

(For directions for section making see chapter 11).

It was soon discovered that these open spaces in cork were not typical cells. Most cells are full of living and stored materials, but when the cork was formed in the bark of the oak tree the cell contents were used up to make the heavy, waterproof walls of the cork cells and that is why they are empty.

### EXPERIMENT 115. Cells from Celery

The cells in the outer layer of celery make good objects for microscopic study. Insert the end of a small knife into the inside of the celery stalk a very slight distance. Hold the skin of the celery against the knife with your thumb or finger nail and strip the skin off by pulling upward. Place the piece on a clean slide in a drop of water and cover with a cover glass. Examine the edges of the preparation under your microscope until you find a place where the cells seem to be only one layer thick. If your first preparation is too thick to show a single layer of box like cells try again.

The celery cells are not empty but contain a jelly-like material called protoplasm. In the protoplasm you will see a round body which is the nucleus (nuc' le us) or the controlling center of the cell. Within the nucleus you may see another round body, the nucleolus (nu cle' o lus). The protoplasm may contain ganules and in healthy normal cells fills the cell completely. The walls of plant cells are thicker than those of animal cells and usually composed of cellulose. Absorbent cotton is nearly pure cellulose obtained from the seed hairs of the cotton plant.

If the water in the protoplasm is lost the protoplasm shrinks and when this happens in many of the cells of a plant the plant wilts or becomes flabby. By the use of strong chemical solutions it is possible to draw the water out of the protoplasm.

### EXPERIMENT 116. Plasmolysis of a Cell

Dissolve a small amount of sugar in a drop of water. Transfer this to the celery cell preparation and run it under the cover glass by touching the other side with a bit of blotting paper. Watch the cell under the microscope and in a little while you will see the protoplasm begin to shrink away from the cell wall. When this happens run fresh water under the cover glass and see if the protoplasm again swells to the size of the cell. If the shrinking has not been too complete recovery takes place. That is why mother puts the vegetables into water before they are served.

### EXPERIMENT 117. Sugar and Salt Solutions

Try different strengths of sugar solutions and of salt solutions and see how the rate of shrinking is related to the concentration of the solution. If you have some Spirogyra



(chapter 16) it makes a very good subject for these experiments.

The flow of water from the protoplasm into a stronger salt or other chemical solution is called osmossis and the regulation of it by the cell keeps its pressure to proper levels. If the difference between the inside and the outside of the cell is too great the cell cannot properly regulate its own pressure and is killed. Too much chemical fertilizer kills the cells in the plant roots. If cells from plants living in the ocean are put in fresh water the flow of water is into the cell, the protoplasm is more concentrated in these cells, and the cells swell up and burst.

Besides the thicker cell wall plant cells often have green material in their cells. The green is chlorophyll (chlor' o fil) and is used by the plant to trap the energy of sunlight for the process of food making. Because of this pigment plants can make foods out of simple mineral salts, water and carbon dioxide gas. Animals do not have this pigment and must depend on the plants for their food stuffs. Some plants, like the bacteria and molds, lack the pigment and are likewise dependent on other plants for food. The green pigment is usually to be found in certain parts of the cell called chloroplastids (chlor' o plas'tids) rather than being scattered throughout the cell.

### EXPERIMENT 118. Chloroplastids

Scrape off a little of the green material that you see on the south sides of trees or fences with a knife and mount some of it in water on a microscope slide. The green matter is now seen to be made of many plant cells—in fact each cell is a plant, fig. 20. Some may be single and others in pairs or quartets. In each one you will see a horse shoe shaped chloroplastid filled with the green chlorophyl. The rest of the protoplasm has no pigment. Can you see the nucleus in the center of the cell?

We have already looked at some animal cells, but we will now wish to look at them more carefully.

### EXPERIMENT 119. Animal Cells

Make a slide of cells from your mouth, like you did in exp. 44, and note that the animal cells have very thin walls, so thin that it only is a surface of the cell fig. 12A. No chloroplastids are seen. Does the protoplasm look like that you saw in the plant cells?

The fundamental living material or protoplasm is the same in both plant and animal cells and the cell is the fundamental living unit. Some plants and some animals consist of only a single cell, while other plants and animals are composed of many cells of different kinds. We will have to see some of these cells and how they are arranged.

The shape of cells is interesting. When the cells grow freely and are not under any special strain they are made so that the wall has the least amount of material in it. Such cells have fourteen sides of which four are squares and the rest are hexagons, (six sided). Such cells stack together and fill the space closely.

### EXPERIMENT 120. The Form of Soap Bubbles

Fill a drinking glass with soap bubbles and note the shape of the bubbles that touch each other but do not touch the glass. Most of the surfaces are hexagons. The wall of the soap bubble is elastic and tends to shrink until it takes the least size and this least size gives the hexagonal form like that of the cells described in the last paragraph Instead of the form being due to economy as in the plant it is due to the surface tension of the soap bubble.

## EXPERIMENT 121. The Cells of Cucumber

Make a thin section of some of the material just under the rind of a cucumber and note that these cells are hexagonal when you look at them under the microscope. Cut another section at right angles to the first one and see if the cells seem to have the same shape. If you look at a large number of cells you may find that a few of them are squares.

## EXPERIMENT 122. The Cells in Onion

Examine a little of the skin of the inner leaves of an onion bulb to see what shape the cells are. Try other plant tissues.

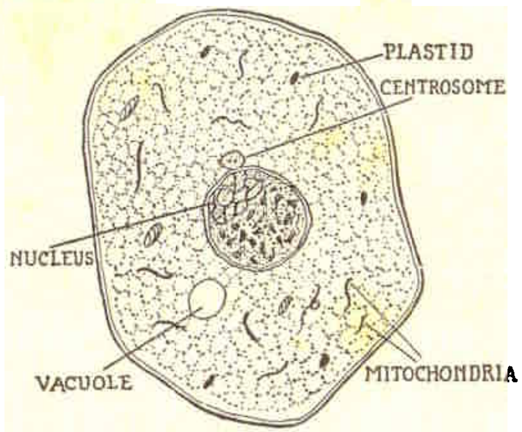



FIG. 18

In determining the shape of a cell we need to see it at different levels by focusing the microscope up and down and getting the shape of it as in fig. 9. The other method is to cut sections and measure them and then do the same at right angles to the first sections. By combining these in a sketch in the notebook a record of the shape of the cell is obtained. When cells do not have hexagonal cross sections we know that more than the least amount of material must have been built into the cell wall and the cell has to spend energy in making and maintaining its wall. We can get some ideas of this by comparing the shapes of different kinds of cells. Many plant cell walls are stiffened with cellulose and the wood is formed by the cellulose being changed into lignin, which is the chemical name for the woody substance. Animal cells also strengthen the cell wall with various materials.

A typical cell consists of protoplasm, the basic living material surrounded by a cell wall or membrane, fig. 18. In the protoplasm is the nucleus which is the controlling center of the cell. A nucleolus may or may not be present. In many plant cells the chlorophyll is found in variously shaped chloroplastids. Other pigments may be present in the protoplasm such as in the colored petals of the flowers. Many cells have stored food in the protoplasm as you saw in experiment No. 68. Some of the single celled organisms have special organelles to correspond with the organs of the many celled organisms which will be examined later.

## EXPERIMENT 123. Oil Stored in Cells

Examine a section of orange peel for stored oil drops in the cells. Test also the flesh of a ripe olive.



## EXPERIMENT 124. Staining Cells

Stain the different cells that you have looked at with thionine and see how much more detail you can make out in the protoplasm.

## EXPERIMENT 125. Staining With Saffranin

Stain the cells with saffranin and compare the results of your observations made with the two stains. The saffranin is a single stain while the thionine is composed of a dye and other chemicals.

## EXPERIMENT 126. Human Red Blood Cells

Examine a drop of blood which you may obtain by pricking your finger with a sterile needle. To sterilize the needle take a sewing needle and heat it until it is red hot. Let it cool without touching anything with the sharp end. The heating kills any bactria that might have been on the needle and which could have infected the puncture. The blood is red because it contains many cells which contain a reddish pigment, haemoglobin, (heem' o glo' bin), but when seen singly under the microscope the cells appear yellow. This pigment is chemically somewhat like the chlorphyl of plants but has iron in it instead of magnesium. It is important because it carries the oxygen from the air we breath into our lungs to the various cells in all parts of our body. Human blood cells have no nuclei; fig. 12E.

## EXPERIMENT 127. Red Blood Cells of a Frog

If you can find a frog or other animal examine some of its blood. The blood cells of most animals do have nuclei.

## EXPERIMENT 128. Cells from Lean Meat

Tease some lean meat, and after you have examined this kind of animal cell stain it with thionine to show the nuclei. Note the cross striations of the muscle cell.

## EXPERIMENT 129. The Fibers in a Nerve

Obtain a piece of a nerve from the butcher and tease the end of it to show that it is made of many fine fibers something like a telephone cable. Stain with thionine. You will not be able to see the nucleus of the cells because they are found in the brain or spinal cord and the nerve trunk is composed of the connecting parts of the nerve cells which go to the muscles.

## EXPERIMENT 130. Plant and Animal Cells

Examine other kinds of animal cells both unstained and stained and compare your observations of plant and animal cells.

# CHAPTER 16

## Unicellular Plants and Animals

NAMES. A great many organisms do not have common names and we are forced to use their scientific names. When we remember that there are well over a million and a half organisms it is not surprising that a good many of the names are long and unusual. Most scientific names are Latin because that language is no longer spoken by any nation and its use therefore avoids any patriotic claims of ownership by a nation. Common names vary with different localities, while the scientific names are passed on by an international committee and belong to only one species of animal. The Indian word for clam is quahaug (quo' hog) and the common clam in a region is often called a quahaug. If you ask for some quahaugs in New England, in the Mississippi Valley or on the Northern Pacific Coast of this country you will be given a different kind of clam in each place. That is why in a manual that is to be used in different states we must use the scientific rather than the common names.

In naming a plant or an animal the discoverer is privileged to give it a name and if no other organism has that name it stands; but if another organism already has the name then the international committee and the discoverer have to give it another name.

The scientist puts the name of the kind of animal or plant first and the specific name last, which is the opposite of the method humans use. We put the given or individual name first and the family name second. Instead of capitalizing all of the names the scientist writes the first name with a capital but not the second. *Homo sapiens* is the scientific name for man and in books the names are usually put into slanted italic letters and in our note books we draw a line under them so that the names are clearly indicated.

There are so many plants and animals that no biologist can know all of them. For our purposes we can recognize a number from our previous knowledge or from the pictures in the manual. If you wish to learn more organisms you may read the books on classification in the appendix of the manual.

In the last chapter the cell was shown to be the fundamental unit of life. Some organisms are composed of only one cell and others are made up of many cells. First we will look at some of the plants and animals made of only one cell. If it is not winter, we will go to the nearest pond and fill a clean jar with a little mud from the surface of the bottom of the pond, some of the decaying leaves, and other material in the pond, a small amount of *living green* plants and the rest water. Let this set in a north window or where it will not be exposed to bright sun and let it settle until the water becomes clear.

After it clears and you look into it you may see some tiny organisms swimming about in it but these are so small that you can barely see them. Catch a few of these in a little of the water with a medicine dropper and put them on a clean slide and gently lower a clean cover glass onto the drop. Do not push the cover glass down or you will crush and kill all of the organisms. Then look at the preparation with the low power objective and later with the higher power objectives. If you study the slide for some time you must add a drop of water to the edge of it to replace that lost by evaporation. If this is not done the animals will be killed. Be sure that the medicine dropper, slides and cover glasses are washed clean, as any chemicals left on them will kill the tiny plants and animals.

You may ask what shall I do if it is winter and there are no unfrozen ponds? Then you make a hay infusion. Boil enough water to nearly fill a pint glass jar and when it is cool put it into the clean glass jar and then put into this a small amount of hay



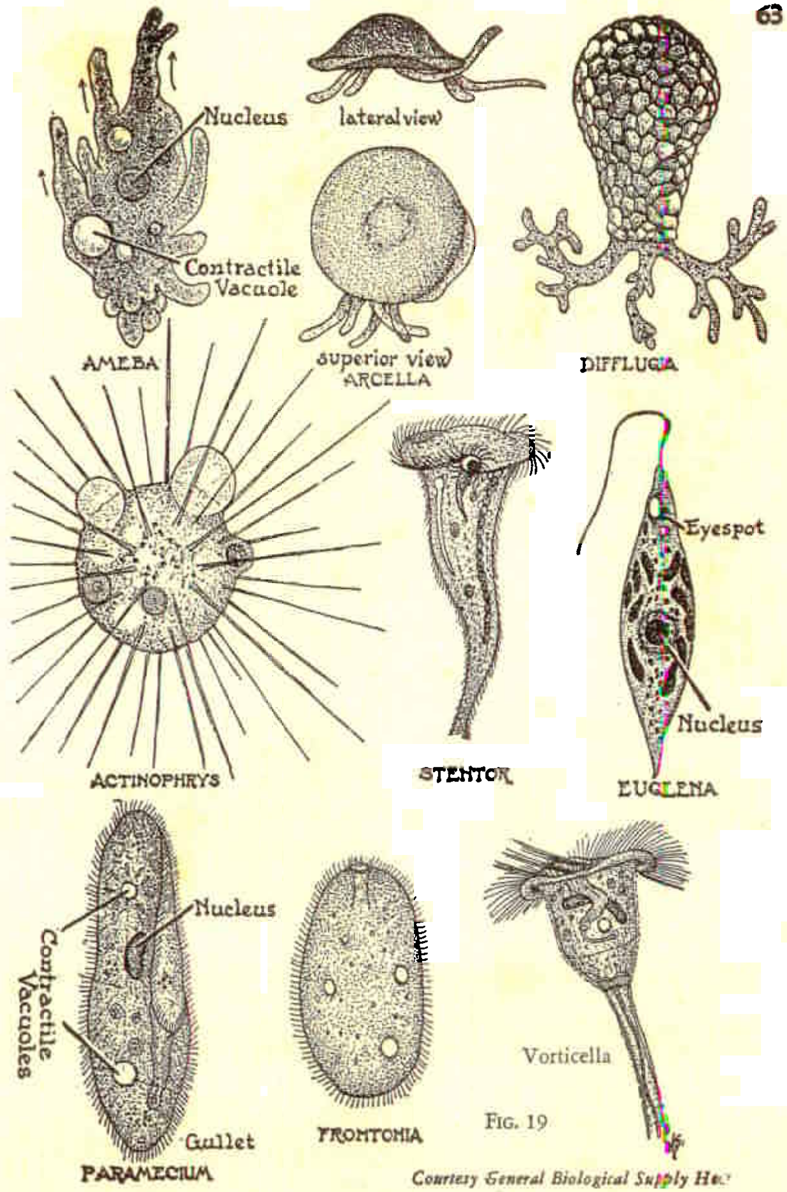



FIG. 19

*Courtesy General Biological Supply Ho.*

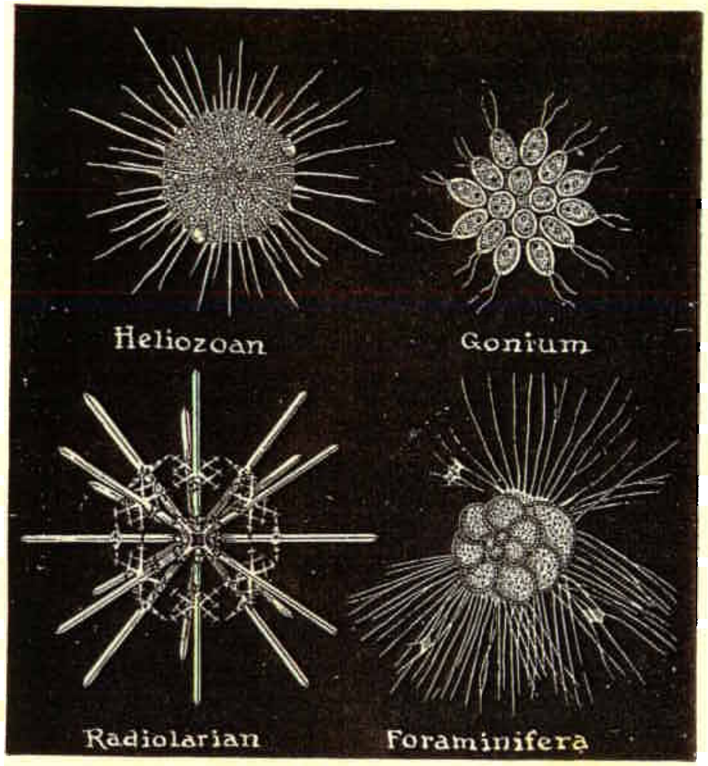



FIG. 19 *Courtesy General Biological Supply House.*

Let it set in a warm room for a few days and you will soon see tiny objects swimming about in it and then you may examine them as described in the last paragraph. In place of the hay you may use a little lettuce leaf or a few wheat kernels. The tiny organisms were present on the hay or grain in a resting form and just needed the water to start living an active life again. You may wish to make several cultures in this manner. One can have subjects to look at with very little trouble anywhere and at any time of the year.

The most common animal in such cultures is apt to be *Paramecium*, fig. 19. It is large for a single celled animal being easily seen as a tiny speck with the naked eye. Under the microscope you will see that one end is pointed and that there is a groove along one side which opens into a mouth. Near either end are the contractile vacuoles which close, or disappear every few minutes, and force the waste materials which collect in them out into the water. The animals swim quite fast and you may have trouble



moving the slide to keep them in view. Take off the cover glass and put a small bit of lens paper onto the drop containing the animals and replace the cover glass. Some of the animals will get into small spaces among the fibers of the paper and when thus trapped are easily watched. Another method for quieting them is to use a little thick gelatin solution which slows up their movement.

## EXPERIMENT 131. The Paramecium

Find a *Paramecium* and notice whether or not it can swim equally well in both directions. Notice the contractile vacuoles. Can you see bits of food passed along the groove into its gullet?

## EXPERIMENT 132. Speed of a Paramecium

Adjust the mirror so that there is enough light to see clearly but not too much and with one of the higher objectives notice the fine hair-like cilia around the animal. These move the animal some-what like oars. How fast does a *Paramecium* swim? You know what the distance across the field of your low power lens is from your notes of experiments 24 and 26. Now if you find out how many seconds it takes the *Paramecium* to swim this far you can then figure how many centimeters it swims per minute. Find out how fast you can run and compare the rate with that of the *Paramecium*. The microscope magnifies distance, but not time.

This animal has an interesting way of defending itself from enemies. Just under its surface are a large number of coiled up, long threads. When danger threatens, these are discharged and penetrate and kill the enemy as they carry a poison.

## EXPERIMENT 133. Defences of a Paramecium

Run a little thionine under the cover glass and as it reaches the animal you will see these spears which are called trichocysts (trick' o sists) extend out from the animal. As they are several times longer than the cilia you can easily distinguish them from the cilia.

Another interesting organism is *Euglena*, fig. 19. If you adjust the light until it is just right you will see that this animal swims by a single, whip-like lash called a flagellum (fla gel' um). It is able to contract its body so that it appears to squirm about. This organism contains green bodies of chlorophyll and can make its own food in the light like a plant, but in the dark it can live like an animal. It represents one of the simplest kinds of life and it is not possible to decide whether it is a plant or an animal.

## EXPERIMENT 134. The Euglena

Find an *Euglena* and determine how fast it can swim. Can you see a little red spot near the base of the flagellum? It is sensitive to light and resembles an eye.

## EXPERIMENT 135. Comparison of the Euglena With the Paramecium

Stain an *Euglena* with thionine and compare its nucleus and other parts with that of the *Paramecium*.

One of the most interesting smaller animals is *Amoeba*, fig. 19. This animal is harder to find as it tends to hide among bits of dirt at the bottom of the dish or in decaying bits of leaves or other vegetable matter on which it feeds. It keeps changing its shape by pushing out foot like processes or pulling them in. It may become nearly round at times. It has a single contractile vacuole and when stained shows the large round nucleus.

## EXPERIMENT 136. The Amoeba

Find an *Amoeba* and make a record of its change in shape by making an outline sketch of it in your notebook every two minutes. How fast does it move? Can you see it roll around some food with one of the foot-like processes? Stain the *Amoeba* with thionine to see its structure.

Chalk comes from the gradual accumulation of the skeletons of small one celled animals called Foraminifera (For' am i nif' er a) at the bottom of the sea. Then as the level of the bottom of the sea raised, the beds of compacted chalk appeared and man could mine the chalk for use.

## EXPERIMENT 137. What Chalk Is Made Of

Scrape off a bit of chalk into some water and examine it under the microscope for skeletons of animals like the Foraminifera, fig. 19. Artificial chalk is made by grinding up calcium carbonate and pressing it together, so if you do not find any animal skeletons you know that your sample of chalk was made artificially.

## EXPERIMENT 138. Foraminifera

If you find *Foraminifera* place some fine scrapings on a slide under a cover glass and add a little vinegar to the edge of the cover glass. As it runs in it will dissolve the calcium carbonate of the skeletons and give off carbon dioxide gas (compare with exp. 109.)

These animals are of commercial importance because their skeletons are also found in the ground. Some of them are found with oil deposits and now the microscopist studies the dirt brought up when new wells are drilled and he can frequently tell from the skeletons of these animals whether or not oil is apt to be found in large quantities.

Fuller's earth or diatomaceous earth (di a to ma' ce us) is used as a polishing medium and to absorb color in purifying liquids. It is composed of skeletons of *Diatoms*, fig. 20. These are plants and when they are living contain green chlorophyl in their protoplasm. The shell is made of two parts which fit together like a pill box. Some are round, others oval or oblong, boat shaped etc. The skeleton is marked with fine lines or pits and some of the markings are so fine that they are used to test the resolving power of the best microscope lenses.

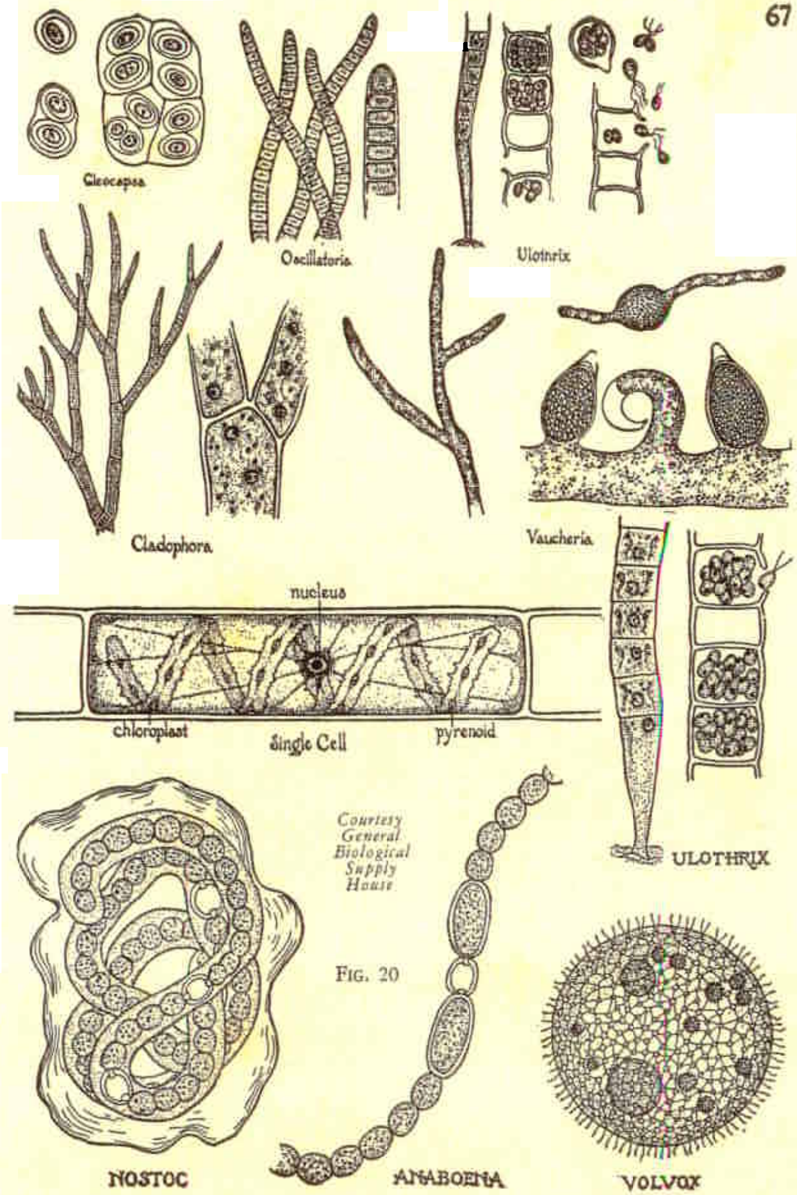

FIG. 20

*Courtesy General Biological Supply House.*

## EXPERIMENT 139. Diatoms

Take a little of the diatomaceous earth that comes with your set and mount it in water and examine with the lower powers of your microscope. Look for unbroken shells and when you find a good one study it with high power.






*Courtesy General Biological Supply House*

FIG. 20

## EXPERIMENT 140. Diatom Skeletons

Test a little diatomaceous earth with acetic acid as you did in exp. 138. The Diatom skeletons do not dissolve in the acid because they are made of silica like glass. This is another method, besides their appearance, of telling them from the *Foraminifera.*

## EXPERIMENT 141. Testing Silver Polish

Rub up a very small amount of your mother's silver polish in a little water and mount under a cover glass and look for diatoms in the polish.

Because these glassy skeletons are hard they are used as an abrasive in polishing materials. They are some times used in poor grades of tooth paste but they should not be used for this purpose because they are so hard that they will injure the enamel on the outside of the teeth.

## EXPERIMENT 142. Testing Tooth Paste Abrasive

Examine a bit of your tooth paste to make certain that it does not have diatoms in it.

## EXPERIMENT 143. Living Diatoms

Look for living diatoms in your cultures from the hay or from the ponds.

When you see some green scum on the surface of a pond be sure to mount a tiny bit of it and look at it with your microscope.

## EXPERIMENT 144. Spirogyra

If it feels slippery to your fingers you will probably find that the filament is made of cells and its *Spirogyra,* fig. 20. The chlorplastid which contains the green coloring matter is wound around the central sap space in the form of a spiral. You may use it for plasmolysis experiments like Nos. 116 and 117.

## EXPERIMENT 145. Oscillatoria

Look for some dark green pond scum, usually on the bottom of a pond, that has simple cells arranged like beads, fig 20. *Oscillatoria.* It is a little harder to find this plant but it is specially interesting as the filaments of cells will move along the slide or one end will wave back and forth. This is one of the simplest plant cells because the nucleus, the pigments and other cell contents are scattered throughout the cell. *Oscillatoria* are sometimes found growing on the damp earth on flower pots in a green house.

## EXPERIMENT 146. Pond Scum

You may find a pond scum like *Anaboena,* fig. 20. Some of these cells seem empty except for a brownish fluid and are breaking cells. If the filament is bent it will break into two filaments at this point and this is one method that they have of increasing their numbers.

## EXPERIMENT 147. Volvox

If you find some *Volvox,* fig. 20, it makes a most interesting object for study. The green round masses may just be seen by the unaided eye, but under the microscope they show a great many green cells held together by a colorless cementing substance. Inside the colony are formed other smaller colonies.



You will see the other plants and animals shown in fig. 19 and 20 and a great many others as well. There are so many of these organisms that some people make the study of them their hobby. They are of great importance to all of us because if certain kinds of them get into our water supplies they may cause it to taste bad. The chemist of the Public Health Department has to examine the water at frequent intervals and if too many of the wrong kind appear proper treatment is necessary.

*Bacteria* are single celled plants which lack green coloring matter or chlorophyll. They are present everywhere and most of the bacteria aid man by breaking up the dead bodies of organisms and adding nitrogen to the soil. Other bacteria sour milk and are important in making butter and cheese. Some bacteria change alcohol into acetic acid. Others make butyl alcohol which is very important in making modern paints and lacquers. Only a few of the bacteria cause diseases.

An easy way to obtain bacteria is to place a small piece of meat about the size of a pea into a half glass of water. The bacteria present on the meat grow rapidly and make the water cloudy. The cloudy water can be examined with the higher powers of your microscope to show the form and motion of the bacteria. There are three kinds, fig. 21.

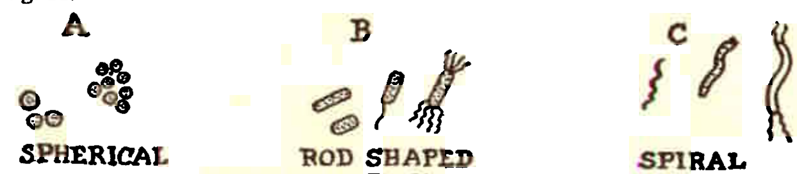



FIG. 21

## EXPERIMENT 148. Round Bacteria

Look for bacteria that are spherical in form like marbles. These are called coccus forms and may be found singly, in chains, in pairs or in irregular masses.

## EXPERIMENT 149. Rod-shaped Bacteria

Look for bacteria that look like very small rods. These are the bacillus kind and some of them have fine hair-like processes which move them along in the liquid.

## EXPERIMENT 150. Spiral Bacteria

The third kind of bacteria according to their shape is the spirellum type which resemble tiny cork screws as they twist along in the meat liquid.

The bacteria decompose the meat juice into bad smelling chemicals so the culture must be kept where it will not annoy other people and destroyed as soon as you are through with it.

It is easier to see bacteria when they are stained. Smear a small drop of the fluid containing bacteria on a clean microscope slide and let it dry. As soon as it is dry pass it through the flame of an alcohol lamp or gas flame three times to warm it slightly and to fix the bacteria to the slide. Then cover the bacteria with either the thionine or the saffranin and let stain for about three minutes. Wash the excess dye off by dipping the slide into a dish of clean water being careful not to rub off the stained bacteria. Let dry and examine with the microscope. If they do not stain well add more dye and heat the slide until the dye steams. After it cools wash as before. To make a permanent preparation add some balsam and a cover glass as you did in Chapter 9.

## EXPERIMENT 151. Bacteria Slide With Thionine

Prepare a permanent slide of bacteria stained with thionine.

## EXPERIMENT 152. Bacteria Slide With Saffranin

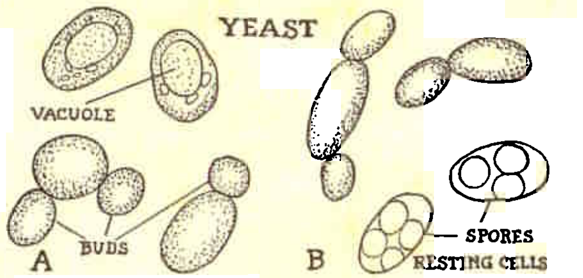



FIG. 22

Make another slide stained with saffranin. Compare the effect of the stains on each kind of bacteria. You can find other harmless bacteria in your hay infusion or in the samples of water from the ponds.

Special methods are necessary to study the disease producing bacteria because they do not grow well in a simple meat infusion and in order to prevent their infecting the microscopist.

Yeast cells are very important in making bread rise, in fermenting alcoholic beverages and in the production of industrial alcohol. The cells may contain a large central vacuole and grains of stored materials, fig 22. The nucleus is diffused and cannot be seen unless the cells are specially stained. They increase in number by forming a bud which gradually grows bigger and when the bud is nearly as large as the mother cell it becomes separated from the mother cell. Sometimes several cells remain touching each other. When they get into a place where they cannot get food easily, yeasts form spores, fig. 22B. The spores are resistant to drying and last until they are blown into a favorable place where they may grow into yeast cells.

## EXPERIMENT 153. Yeast Cells from a Yeast Cake

Take a very tiny piece of a compressed yeast cake, about the size of a period, and rub it into a drop of water, mount under a cover glass and examine with the microscope. The cells are small, about 7-9 micra in diameter, but much larger than bacteria.

## EXPERIMENT 154. Starch in a Compressed Yeast Cake

Add a drop of iodine to the preparation. The starch granules stain blue while the yeast remain colorless or stain slightly brown. The starch was added to keep the cake moist. Can you tell the kind of starch used?

## EXPERIMENT 155. Growing Yeast Plants

Make a slide with a little sugar solution instead of water. Place bits of cover glass at the corners to support the cover glass and seal the edges of the cover glass to prevent the water from evaporating. Watch a bud form and grow up to a mature cell. Use from ten to fifteen times as much water as sugar and very little yeast for best results.

Mold grows on many objects which are left in damp places and the mold plants make interesting subjects for our microscopes. It is easy to obtain the common bread mold by dampening a piece of bread and leaving it exposed to the air. The spores fall on it and grow. When the mold does not appear in a day or so, sprinkle a little dust on the bread. Dust almost always contains mold spores. At first a fine filamentous growth appears on the bread, then some of the filaments grow upward, the ends round and turn dark colored as the spores form in the clubshaped ends.



## EXPERIMENT 156. Bread Mold

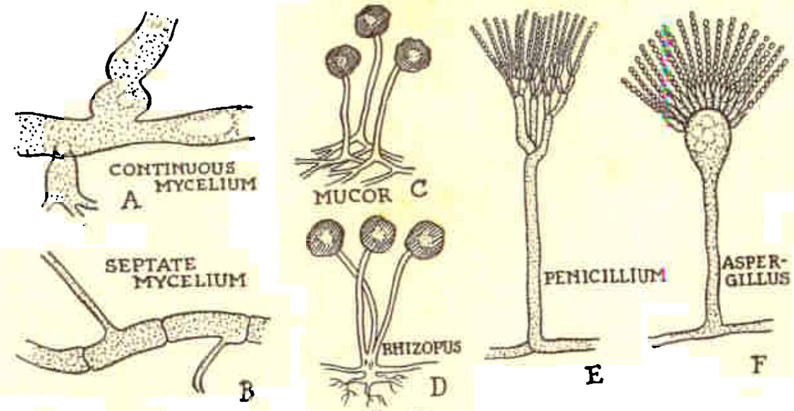



FIG. 23

Pick off a little bread mold with your forceps and examine it in a water mount. The spore bearing heads grow up together and the filaments join one another like those of fig. 23A. A spore finds a suitable place and grows up into a colony. All the protoplasm from this spore is connected without separate cell walls and the many nuclei are scattered throughout the protoplasm, fig. 23D.

The different kinds of molds are distinguished according to whether the filaments are continuous, fig. 23A, or divided as in fig. 23B, also whether the spores form in a club shaped end like the bread mold, fig. 23D or form in chains like those of fig. 23E & F.

## EXPERIMENT 157. Mucor

Look for another common mold Mucor, fig. 23C.

## EXPERIMENT 158. Molds of Fruit and Jelly

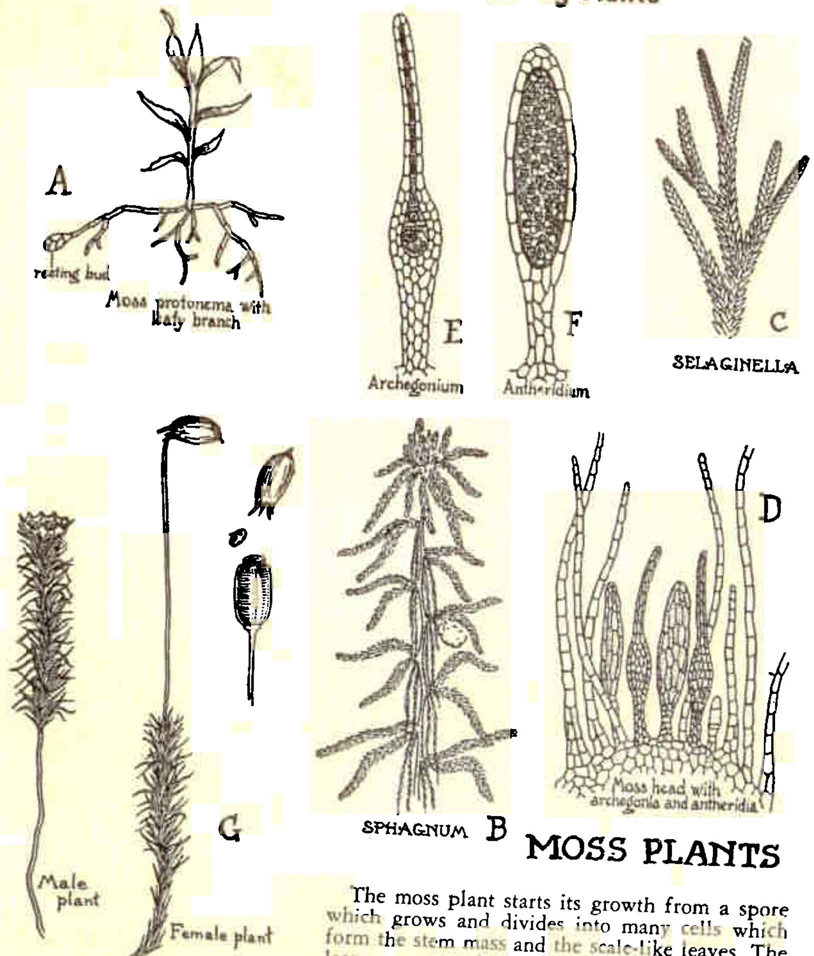
Examine some moldy fruit and jelly for molds with spores in the form of chains, fig. 23E & F. These molds are often bright colored because the spores may be green, orange or brown.

Cells increase their numbers by dividing into two cells, by forming buds, or by forming many spores. When a cell grows large it pinches itself into two either crosswise or lengthwise. Watch for cells in the process of dividing as you examine different preparations.

With the exception of the molds, the cells mentioned in this chapter are considered single celled organisms because the cell is the living unit even though it may be duplicated and the resulting cells form chains or filaments. You may easily find a great many other interesting one celled plants living near you.

# CHAPTER 17

## Mosses, Ferns and Flowering Plants




MOSS PLANTS

POLYTRICHUM

FIG. 24

*Courtesy General Biological Supply House*

The moss plant starts its growth from a spore which grows and divides into many cells which form the stem mass and the scale-like leaves. The leaves are very thin, only one cell thick, and may be examined in a drop of water, fig. 24D. If you separate the leaves at the tip of the plant you may find some conical and club shaped organs like fig. 24E & F. The archegonium (ark' e gon' i um) when ripe contains the female or egg cell and the antheridium (an' ther id" i um) contains the male or sperm cells. In a few kinds of mosses these parts are born on separate plants. The sperm cells break out and swim to the egg cell and join with it to form a new cell, the fertilized egg. This fertilized egg cell then grows into the spore producing plant which gets its nourishment from the original moss plant, fig. 24G. When its growth is complete it forms a club shaped organ in which the spores grow. As the spores become ripe the end of the spore case rises or breaks off and the spores are shaken out so that they form new moss plants.



### EXPERIMENT 159. Moss Plants

Examine a moss plant with your hand lens and then examine the parts of the plant with the microscope. To see the spores you will have to make a thin section of the capsule. You can find moss plants in almost any damp place in the woods or in a park. The spore case is formed at different times of the year for different kinds of mosses and you can usually find at least one kind with spores except during the coldest part of winter.

The ferns are larger plants than the mosses and have a more complex structure. The leaf parts are made of different kinds of cells and you will have to make sections to examine how the stem and leaves are built, fig. 25A. At certain times of the year, frequently in the fall, the spore cases form on the under side of the fronds, fig. 25B. These are built like fig. 25C and make interesting subjects for microscopic study. The spore grows into a heart shaped plant called the prothallium fig. 25D, which produces the egg and sperm cell cases. The prothallium is hard to find but if you look carefully at the base of the plants you may find one. They are small being about 2 to 15 mm. in size. The sperm fertilizes the egg after it swims to it and the fertilized egg grows into a small fern like fig. 25E. This then grows into the large fern.

### EXPERIMENT 160. Ferns

Examine the parts of the fern to see how they are built.

There are a great many kinds of flowering plants including the trees, bushes, grasses, etc., and their parts are so complex that we can only describe a few experiments in this manual. If you wish to learn more about them you may read about them in the botany books listed in the appendix of the manual.

The root is the easiest part for us to start with as the root and the stem are somewhat alike. Place a few wheat seeds in between some sheets of damp soft paper and in a day or so you will see that they have started to grow roots. The very tip of the root has a cap of tough cells to protect it, fig. 26A. Just back of this is the region where the cells are dividing, those back of this region grow in length and as they do so the root becomes longer and thicker. Farther from the tip is a region of root hairs which gather water and food materials from the soil.

### EXPERIMENT 161. Examination of a Root from a Seed

Cut off a root from a seed and examine it with your hand lens and then with the microscope to find the above regions.

Note that the hairs grow out as a part of the cells on the outside of the root, fig. 26B.

### EXPERIMENT 162. Sections of Roots

Make some sections across the different regions of the root. Those at the dividing region will be square in both the cross and the lengthwise sections while those from the growing region will be oblong in lengthwise sections.

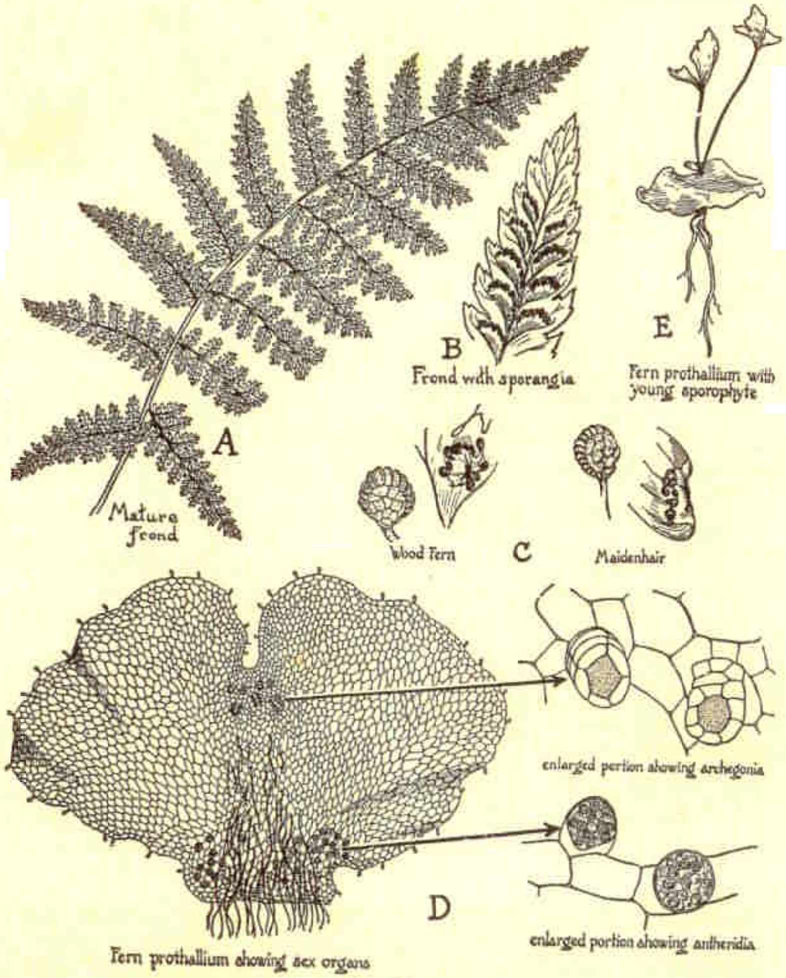



FIG. 25

*Courtesy General Biological Supply House.*

A section in the root hair region will look like fig. 26B. If you stain the root sections with a little thionine the parts will show better. Dilute the thionine until it is light blue colored before putting it on the sections and take them out of the stair before they become too darkly stained.



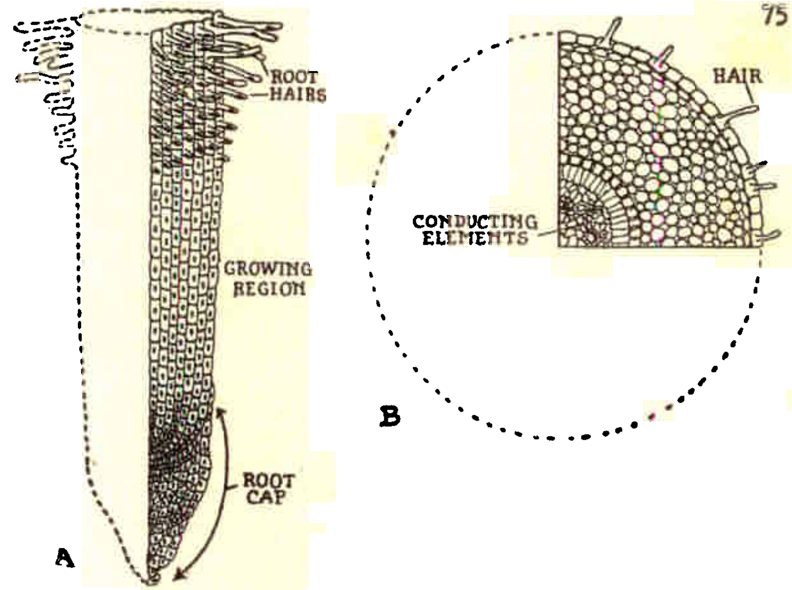
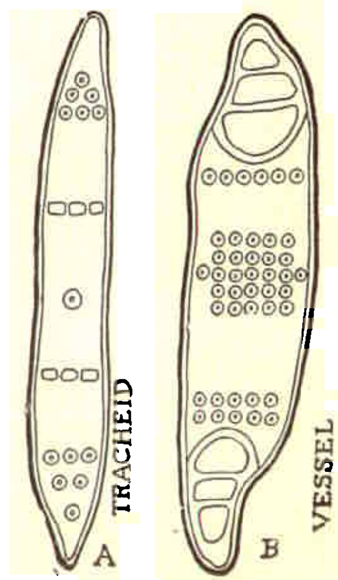
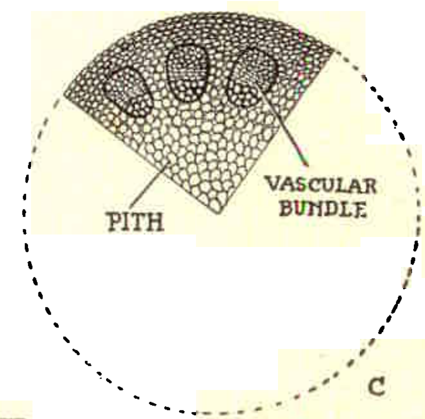



FIG. 26




CROSS SECTION OF GRASS STEM

FIG. 27

The stem of the plant may be made of woody cells as in the trees or may have much softer storage tissue as in the grasses or other soft stemmed plants. It is very difficult to make good sections of woody stems but you can cut the other softer ones like you did in Chapter 11.

## EXPERIMENT 163. Wood Fibers

To see the kinds of cells in wood cut a small slice about 5 mm's square as thin as you can with a sharp razor blade. Place this on a slide and cover with a drop of water. Take your dissecting needles, fig. 3B, and hold the piece with one and pull it apart with the other. Work carefully and gently separate it into as small parts as you can. Look at your preparation after you have put on a cover glass and you will probably see some typical cells like fig. 27. These cells are important in paper making as you will see in Chapter 24. Different stems have slightly different shaped cells and the expert can recognize them. Stain with diluted thionine as you did in the previous experiment.

**The cells form and the cellulose in their walls becomes lignin which is the wood. The hard and the soft woods differ in the kinds of woody cells found in their stems, fig. 27A & B. A grass stem has a layer of strong supporting cells just inside of the stem with a center part largely of storage cells called pith cells.** Among these cells, fig. 27C are bundles of cells which carry the sap to the various parts of the plant. The storage material is used at the time the fruit forms. If you make a drawing of a grass stem in mid-summer and then look at another section later in the year you will see that the pith was used up leaving the stem hollow.

## EXPERIMENT 164. The Structure of a Grass Stem

Cut a section of a grass stem and look at it both before and after staining with diluted thionine. Compare a stem from a plant that has gone to seed with one that is growing.

The leaf is composed of two layers of boundary cells on the top and bottom and many layers of cells in between which have the chlorophyll for making the plant's materials, fig. 28. In addition there are openings, usually on the underside of the leaf, but sometimes on

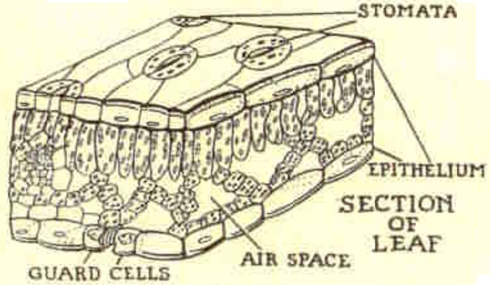



FIG. 28



the pollen grains are shaped differently so that after you learn to know the different kinds you can identify a plant from its pollen. This is important to medicine as pollen causes some sensitive people to sneeze and be very uncomfortable and one may have to identify the troublesome plant from its pollen which may be strained from the air with fine cloth.

Coal is made from pollen that sank into the streams and was changed into the coal by great pressure of the rock sediment formed above it during thousands of years. Peat is coal gradually forming.

## EXPERIMENT 166. The Structure of the Flower

Examine the parts of a flower. The flowers of the grasses are very interesting.

## EXPERIMENT 167. Pollen Grains

Look at different kinds of pollen and make sketches in your notebook to show the differences. If you have a peat bog near by look at a sample of the peaty soil to see what kinds of pollen may be found in it. The methods of chapter 11 may help you.

## EXPERIMENT 168. Pollen Tube Growth

Place some pollen grains into some weak sugar solution and if the concentration is right in about half an hour or so the pollen wall will break and the pollen tube will grow out. If it does not grow try different amounts of sugar. The pollen tube grows into the center part of the flower to the egg cell to fertilize it.

Plant seeds may be studied. It is usually necessary to soak them in water over night to soften the parts so that you may tease them apart with your dissecting needles or cut thin sections of the seed. Some seeds have oily material and others have starchy material. Seeds like the bean contain a small embryo plant which starts to grow when the seed is soaked in water. If you do not have plants around for the above studies you can grow wheat seeds in some damp soil. Bean and pea seeds also sprout easily in damp paper or in damp sawdust.

The starches are very interesting objects and they are also so different in shape and size that with a little observation you can identify a plant from a little of its starch. We have already used the iodine test many times to show whether a substance was starch because the starches turn blue with it. Some of the more common starches are shown in fig. 29.

## EXPERIMENT 169. Starch from Flour

Examine some flour for wheat starch, some ground up rice and the other materials you can find about your house to see how the different kinds of starch look. Stain with iodine.

## EXPERIMENT 170. The Effect of Cooking in Starch

You have already looked at potato starch in Chapter 11. Cook a little potato in a test tube two-thirds full of water and look at the starch grains and you will see how they are swollen and broken. Laundry starch will also show the effect of cooking and you may not find any unswollen grains to show what kind of starch it was. It is often corn starch.