milvay MICRO-PAK

TESTED AND APPROVED milvay SCIENCE LABORATORY EQUIPMENT

MANUAL of EXPERIMENTS

by

TUNIS BAKER, Ph. D.
PROFESSOR OF SCIENCE EDUCATION
STATE TEACHERS COLLEGE, PATERSON, N. J.

CHICAGO APPARATUS CO.
CHICAGO 22, ILLINOIS • MANUFACTURING DIV., POLO, ILL.
MANUFACTURERS OF PRECISE SCIENTIFIC EQUIPMENT SINCE 1908

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TO PARENTS

Although the microscope in this set is designed for the entertainment and education of boys and girls, it is a precision-built instrument that can be used to good advantage by adults as well as children. It is sturdy, well-designed, operates freely, and gives a clear, highly-magnified image. The apparatus supplied with the MILVAY MICRO-PAK is professional, scientific laboratory equipment. Thus accuracy and dependable results are assured. The container is strong, durable, and neatly constructed; there is a convenient place for easy storage of all apparatus and equipment to prevent loss or breakage.

There are no dangerous explosives or poisonous chemicals in the set. Of course, no chemicals should be swallowed or eaten. As long as ordinary household rules of caution are observed, no harm can come to anyone in the regular performance of the experiments included in the set.

All of the experiments in this book have been selected with care; only those that conform to the interests and abilities of children, and that can be performed by them are included. Children differ widely in their ability to follow directions and perform experiments. Therefore, it may be advisable for you to help with a few of them at first, to assure proper results. However, children should be encouraged to do as many as they can by themselves. This will develop self-reliance, powers of observation and reasoning, and skill in handling the microscope and equipment. The directions for performing the experiments are clear, complete, and easy to follow. The type of print is large and adapted to the vision of young boys and girls. The drawings that accompany many of the experiments help to illustrate the parts of plants and animals being observed.

Your boy or girl will enjoy using this MICRO-PAK. Just doing experiments and examining the mysteries of nature under the microscope is a lot of fun. But equally important, the microscope will reveal new and important scientific facts that cannot be learned with the human eye alone. Thus the set is educational as well as entertaining.

TO BOYS AND GIRLS

The MILVAY MICRO-PAK is intended especially for boys and girls who are interested in learning something about the wonderful world in which they live. We live in a world filled with amazing and surprising secrets—secrets that may be revealed to us if we are curious and observing. The wonders of nature are all about us, in the fields, the woods, the ponds, and streams. We find them in our homes, our schools, our gardens. There are the flowers and trees, the birds and insects, and the whole world of tiny plants and animals. All have their own hidden mysteries that are thrilling and exciting to explore. Each season brings new experiences, new opportunities, new and exciting adventures.

Some of the most interesting mysteries of this wonderful world of ours, however, are too small to be seen with the human eye alone. Many of them can only be revealed and understood with the help of a good microscope—a microscope made by skilled and experienced hands. The microscope in your MICRO-PAK is not merely a toy but a scientifically constructed instrument that magnifies an object many times its natural size and produces a clear image as well.

With your microscope, you may develop a hobby that might last a lifetime, and your hobby might eventually lead to a useful and enjoyable career. In this modern age a microscope is a necessity in almost every industry. Whether your microscope is used as a hobby or whether it becomes necessary in your life work, its possibilities are limitless. It can be used in the quiet of your own room, or it can be the means of many happy hours in the company of friends. Whether you live in the city or on a farm, at the seashore or in the mountains, there are always new fields to explore, different specimens to discover, and fresh thrills to enjoy.

This book does not include all the exciting experiences you can have with your microscope. It is merely a guide to suggest the great variety of things in nature that you can examine. For instance, only a few insects are described here. More than 625,000 different kinds of insects have been named and classified by scientists, so you can readily see that the possibilities for the further study of insects alone are unlimited.

Follow directions carefully. If at first you do not find what you are looking for with your microscope, keep trying. It takes practice and patience to use a microscope. After you have tried all the experiments described in this book, look for other things to examine. Take notes and draw pictures of what you see. A good scientist always keeps a record of his discoveries.

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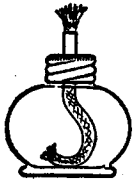
Directions

FOR USING APPARATUS AND EQUIPMENT

Your MICRO-PAK is a complete microscope laboratory containing a generous assortment of apparatus and equipment for examining all kinds of specimens. You will find everything you need for performing many interesting experiments in the neat, metal container. All of the material is professional equipment and accurately constructed, so it is important that you use it correctly. Be sure to read carefully the descriptions given below, before doing any of the experiments. By following these easy instructions you will develop correct habits of observation, and learn how to use the microscope.

ALCOHOL LAMP



The ALCOHOL LAMP is used for heating liquids and chemicals in test tubes or other containers. It is also used for drying out specimens and other objects after they have been placed on glass slides. For fuel, use DENATURED ALCOHOL, which can be obtained at any drugstore. Never fill the lamp more than three-fourths full. After filling the lamp with alcohol, always dry the outside before lighting the wick. When the lamp is not in use, always place the cap over the wick. This prevents the alcohol from evaporating.

COVER GLASS

The COVER GLASS is a thin piece of glass that is usually placed over a specimen after the specimen has been mounted on a plain glass slide and covered with a liquid or stain. The COVER GLASS helps to spread the drop of liquid or stain evenly.

DISSECTING NEEDLE (Straight)

The straight DISSECTING NEEDLE is used for tearing or pulling small specimens apart, for holding specimens, for moving them about, and for puncturing various objects.

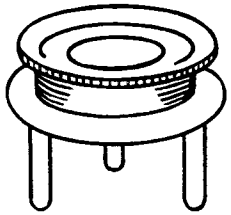
DISSECTING NEEDLE (Bent)

The bent DISSECTING NEEDLE is used in about the same way as the straight needle, except that sometimes a specimen can be handled better with the bent needle. At other times it may be necessary to use two needles at one time.

FORCEPS

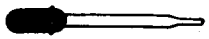
FORCEPS are used for picking up small specimens or other objects, and for holding glass slides in the flame of the Alcohol Lamp.

HAND LENS



The HAND LENS is a magnifying glass that is used for examining objects too large for the microscope. It is usually well to examine most specimens with the Hand Lens before using the microscope, in order to get a general idea of their appearance.

MEDICINE DROPPER



The MEDICINE DROPPER is used for placing drops of water, stains, or other liquids on specimens that have been mounted on glass slides.

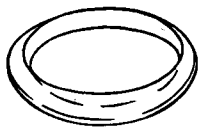
SLIDES (Plain)

The plain GLASS SLIDES are 3x1 inch and are used for examining specimens under the microscope. The specimen is placed on the slide and usually covered with a drop of water or stain, after which it is placed on the stage of the microscope for examination.

SLIDE (Prepared)

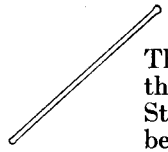
The prepared SLIDE contains a specimen that has been stained and mounted on the glass slide for permanent use. This is a good slide to practice with when you are first learning to use the microscope.

STAINING DISH



The STAINING DISH is used for staining specimens before placing them on a glass slide. The specimen is usually placed in the dish, covered with a stain, and allowed to stand until the solution has had a chance to soak into all parts. The stain is then removed with a medicine dropper and the specimen placed on the glass slide.

STIRRING ROD



The STIRRING ROD is used for mixing liquids and to hasten the dissolving of a solid in a liquid. Always wash the Stirring Rod after it has been used in one liquid and before placing it into another.

TEST TUBES

TEST TUBES are made of a special glass to withstand heating. Liquids can be boiled in them and solids heated to a high temperature. Before cleaning a test tube, allow it to cool off.

Caution:

Do not place a hot, dry test tube in cold water or it may crack.

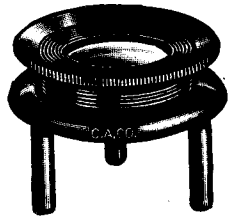
When heating a test tube keep it moving in a circle. This allows the contents of the tube to heat evenly and gradually.

Never point the mouth of a test tube at yourself or anyone else while heating it. The contents might suddenly boil over and spurt out.

Never hold your face over a test tube or other container that is being heated.

PART 1 THE HAND LENS

How to Use the Hand Lens



Materials:
Hand lens Piece of newspaper

Directions:
1. Place the hand lens over some letters on the piece of newspaper.
2. Bring the lens toward your eye until the letters become clear.
3. Move the lens around and examine letters of different sizes.

Observation: Notice how much larger the letters appear to be with the hand lens than without it.

You can make many interesting experiments with the hand lens. Following is a list of common and interesting objects which you can examine with your hand lens:

CRYSTALS

Crystals which are readily available (see inside back cover)

Aluminum Sulfate	Ferrous Ammonium Sulfate
Ammonium Chloride	Potassium Ferrocyanide
Ammonium Dichromate	Sodium Bicarbonate
Cobalt Chloride	Sodium Bisulfite
Copper Sulfate	Sodium Chromate

Common crystals found around the home:
Sugar, table salt, epsom salts.
Crystals of ice, snow, and frost on window panes.

TEXTILES

Pieces of linen, cotton, silk, wool, rayon, nylon.
Notice how each piece is woven together.
How many threads to one-quarter inch?

PLANTS

Flowers: Examine petals, stamen and pistil (these are the stalks in the center of the flower), and pollen. Notice color, size, and shape.
Leaves: Notice color (especially in the fall), veins, bristles and hairs.
Roots: Notice root hairs near the tips. Some roots have tiny swellings. Break open the swelling and examine it.

Buds: Open different kinds of buds and examine each part of the bud separately

Stems: Find scars where leaves were attached, breathing pores and other peculiar markings.

Skins of Fruits: Notice color markings, texture of the skin, spots, worm holes.

Molds: Notice the many threads and the knobs at the top of the threads.

Moss: Examine the small leaves and notice their arrangement on the plant. Some of the plants have small caps at the tips. Break the caps open and examine the "dust" or spores found there.

Ferns: Examine the under side of the leaves. Break open the brown specks found there and examine the "dust" or spores.

INSECTS

Flies, butterflies, caterpillars, moths, ants, bees, grasshoppers, beetles, dragonflies, and thousands of other common insects. Examine the head, legs, wings, body, feelers, and other parts of their bodies.

SMALL ANIMALS

Flat Worms: Found on the under sides of rocks along ponds and streams. Notice the broad head and eye spots on top of the head.

Earthworms: Examine the head end and tail end. How do they differ? Notice the bristles and holes along the sides of the body. Examine the band about one-third of the way back from the head end.

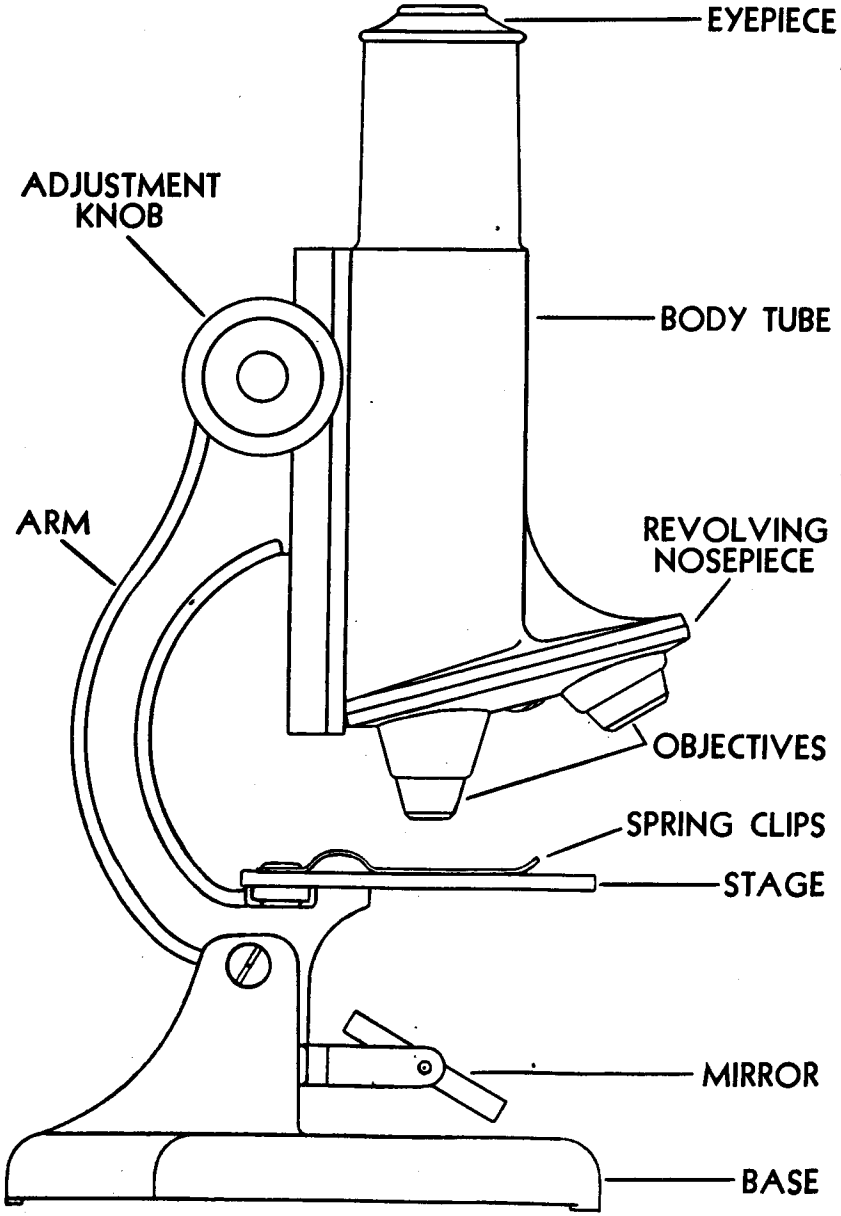
Crayfish: Examine claws, feelers, eyes, mouth parts, under side of body. A female may have small, round eggs attached to the under side of the body.

Shelled Animals: Watch a snail as it crawls. Notice how it extends and retracts its feelers. The eyes are on the tips of the feelers. Notice its mouth on the under side of its foot. Place the snail on the inside of a fish bowl or aquarium and watch it crawl along the glass.

Spiders: Notice number of legs. Compare with insects. Examine the eyes. The spinnerets are the tail end of the body. Examine its mouth parts.

Frogs and Toads: Examine small frogs and toads. Notice the color and shape of the eyes. Examine the webbing between the toes and the color pigment in the skin.

Frog Eggs: Early in the spring look for frog eggs along the edge of ponds. They are small and round, about the size of peas, and are surrounded by masses of jelly. Place some in a glass jar and examine them from day to day as the tadpoles develop inside the eggs.



PART II THE MICROSCOPE

Parts of the Microscope

Learn the parts of the microscope so that you will recognize them as they are referred to in the directions given for each experiment.

Eyepiece: Contains the lens at the top of the tube nearest the eye. There are two eyepieces in the No. 510 MICRO-PAK, one low power and one high power. Always find your object with the low power first. Then change to high power.

Body Tube: Contains the eyepieces and the revolving nosepiece.

Adjustment Knob: Raises and lowers the body tube to bring the specimen into focus.

Revolving Nosepiece: Contains the low power and high power objectives. By turning the revolving nosepiece, the objectives can be changed from one power to the other.

Objectives: Contains the lenses nearest to the specimen to be examined. There are two objectives in your microscope, a low power and a high power. Always find your object with the low power first. Then change to high power.

Stage: The platform on which you place the glass slide for examination.

Spring Clips: Used for holding the glass slide in position on the stage.

Mirror: Used for reflecting light upward through the microscope to illuminate the specimen.

Arm: Used for carrying the microscope. Always carry the microscope by the arm.

Base: Support upon which the microscope rests. Made of heavy material to prevent the microscope from tipping over.

CARE OF THE MICROSCOPE

Keep free from dust. When not in use the microscope should always be kept in its case or covered with a cloth.

Handle the microscope carefully. When moving the microscope from one place to another always carry it by the arm.

Avoid sudden jars. Always place the microscope down gently on the table or into its case.

Keep the eyepieces and objectives clean. To obtain the best results,

the lenses in the eyepieces and objectives should be kept clean at all times. To clean the lenses:

1. Remove the eyepiece from the tube.
2. With a piece of very soft paper or an old, soft linen handkerchief or other soft cloth, rub the lenses in the eyepiece gently.
3. If the lens is still dirty, breathe on it and again wipe it, or wipe it clean with a soft cloth moistened with Xylol which you will find in your set.
4. Dry the lens with another piece of clean, soft cloth.
5. Clean the lenses in the objectives the same way.

HOW TO USE THE MICROSCOPE

Adjusting the mirror for light. Proper lighting is very important. These directions should always be followed when using the microscope.

1. Place the low power eyepiece in the tube of the microscope. (Always use the low power eyepiece first when looking for an object.)
2. Turn the revolving nosepiece until the low power objective is directly under the body tube. You will know when the objective is in position when you hear a slight click as it moves into place. (Always use the low power objective first when looking for an object.)
3. Place the microscope on a table where the light from a desk lamp, a table lamp, or bright daylight (but not direct sunlight) can shine directly on the mirror. Have enough light to see clearly, but not so much that there is a glare. Direct sunlight is much too bright.
4. Look through the eyepiece and turn the mirror towards the light until you see a clear, bright circle of light.

Looking through the microscope.

1. Although the right eye is generally used in looking through the eyepiece, the left eye can also be used.
2. Learn to use the microscope with both eyes open. Although only one eye looks through the eyepiece, the other eye should be kept open at the same time.

Finding the object.

1. In your MICRO-PAK you will find a prepared slide (an oblong

piece of glass 3x1 inch) of an insect's leg, wing, or some other specimen. Place this slide on the stage of your microscope and clamp it down with the spring clips.

2. Move the slide around until the object on it comes directly over the opening in the stage.
3. With your eye at a level with the stage of the microscope, slowly lower the body tube by turning the adjustment knob, until the objective almost touches the cover glass on the slide, being careful not to touch it.
4. Now look through the eyepiece and raise the body tube by turning the adjustment knob *slowly*, until the object comes plainly into view. (Notice that you found your object by placing the objective as close to the slide as possible and then turned upward. This is very important. If you start the objective away from the slide and then turn downward, you may miss seeing the object and bring the objective down on the cover slide, which would break it and perhaps scratch the lens.) Always find your object by turning upward.
5. Remove the low power eyepiece from the tube and replace it with the high power eyepiece.
6. Look at the specimen again and notice how much larger it is. (You may have to raise or lower the objective slightly to bring the specimen into view.)
7. Turn the revolving nosepiece until the high power objective is directly under the body tube. You will know that the objective is in position when you hear a slight click as it moves into place.
8. Look at the specimen again and notice that it is now so highly magnified that you can see only a small part of it. To see other parts of the specimen, you will have to move the slide around.

PREPARING SLIDES FOR THE MICROSCOPE

A slide is an oblong piece of glass upon which an object or specimen is placed for examination under the microscope. Most of the experiments in this book require the use of slides for the examination of the various specimens which are prepared. These slides are temporary slides or slides which are used only at the time of making the experiment. Directions for their preparation are given in each experiment. If you wish to prepare a slide that can be saved for future examination, then a permanent slide must be made. Directions for making permanent slides are given in the following paragraphs.

HOW TO MAKE A PERMANENT SLIDE
(Thin Specimen)

Materials:

Specimen (piece of thread, a hair, insect's foot, wing, or any other thin specimen you wish to mount on your slide.

Glass Slide
Cover Glass
Toothpick
Alcohol lamp (or any other source of heat)
Forceps
Balsam
Xylol
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place the specimen on a glass slide.
2. Dry the specimen thoroughly by holding the glass slide over the alcohol lamp, a radiator, stove, or other source of heat. (*Note:* Your specimen must be dried thoroughly because the balsam, which you use next will not mix with water. Do not heat the specimen too long or it will "cook" and shrink.)
3. Open the bottle labeled "Balsam" and dip a toothpick or match stick into the liquid. (The balsam is quite thick and will form a drop on the end of the stick.)
4. Place the drop of balsam on the specimen. (With a little practice you will soon learn how large a drop is necessary.)
5. With the forceps, pick up a clean cover glass, place the edge of it on the edge of the drop of balsam, and slowly lower it over the specimen. (If you lay the cover glass flat on top of the drop of balsam, air bubbles will form and cloud the specimen.)
6. Place the slide on a flat surface where it will not be disturbed and allow the balsam to harden. This will take from a few days to a week. (If there is too much balsam around the edge of the cover glass, scrape off the excess with a knife and clean off the rest of the slide with a cloth moistened in Xylol, which you will find in your set.)
7. Cut a small piece of paper the width of your slide, paste it at one end of the slide, and write the name of your specimen on it.

Observation: You now have a permanent slide that you can examine as often as you please. You may want to make a collection of permanent slides and start a slide library. The slide libraries of some professional microscopists contain thousands of slides.

HOW TO MAKE A PERMANENT SLIDE
(Thick Specimen)

Materials:

Specimen (a whole small insect, part of a large insect, or some other thick specimen you wish to mount on your slide.)

Glass slide
Cover glass
Toothpick
Alcohol lamp (or any other source of heat)
Forceps
Balsam
Xylol
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place the specimen on the glass slide.
2. Dry the specimen thoroughly by holding the glass slide over the alcohol lamp, a radiator, stove, or other source of heat. (*Note:* Your specimen must be dried thoroughly because the balsam, which you use next will not mix with water. Do not heat the specimen too long or it will "cook" and shrink.)
3. Dip a toothpick or a match stick into the bottle labeled "Balsam" and collect a drop on the end of the stick.
4. Make a ring of balsam, the same size as your cover glass, around the specimen without touching it.
5. Keep adding more balsam to the ring until a wall has been built up just a little higher than the thickness of your specimen.
6. With the forceps, place the cover glass on the ring of balsam. (The cover glass makes a roof over the specimen.)
7. Place the slide on a flat surface where it will not be disturbed and allow the balsam to harden for several days. (If there is too much balsam around the edge of the cover glass, scrape off the excess with a knife and clean the rest of the slide with a cloth moistened in Xylol which you will find in your set.)
8. Cut a small piece of paper the width of your slide, paste it at one end of the slide, and write the name of your specimen on it.

Observation: You now have a permanent slide of a thick specimen that you can examine as often as you please. You may want to make a collection of permanent slides and start your own slide library.

UNIT 1
PAPER and INK

EXPERIMENT 1 — Newspaper Print

Materials:

Glass slides
Small piece of newspaper
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place a small piece of newspaper on a glass slide. (If the paper does not lie flat, place another glass slide on top of it.)
2. Place the slide on the stage of the microscope.
3. Examine some of the letters with the low power.

Observation: The lines making up each letter have rough edges but they are unbroken except where the paper did not absorb the ink.

EXPERIMENT 2 — Engraving

Materials:

Engraved calling cards or wedding invitations
Glass slide
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place a small piece of the card or invitation on a glass slide.
2. Place the slide on the stage of the microscope.
3. Examine the letters with the low power.

Observation: The engraved letters will be irregular because they are cut by hand. Engraved letters are made from a metal plate. The letters are scratched into the plate which is then covered with ink. The ink is rubbed from the surface of the plate, but the scratched letters remain filled with ink. When the plate is pressed against a card or paper, the ink from the scratched letters sticks to the paper and forms raised letters.

Imitation engraved letters are made from ordinary type but a special ink is used. After printing, the ink is heated. The ink swells and looks and feels like engraved letters.

EXPERIMENT 3 — Newspaper Pictures

Materials:

Glass slide
Picture from a newspaper
Table lamp or desk lamp (or bright daylight)

Directions:

1. Cut out a small piece from a picture in a newspaper and place it on a glass slide. (If the paper does not lie flat, place another slide on top of it.)
2. Place the slide on the stage of the microscope.
3. Examine the picture with the low power.

Observation: The picture is made up of separate dots.

4. Move the slide around and examine dark parts and light parts.

Observation: In the lighter parts of the picture the dots are fine and far apart. In the darker parts of the picture the dots are larger and closer together.

In printing pictures with different shades of gray instead of black and white, the pictures are photographed through a screen of diagonally crossed lines when the plate is made. This breaks the picture up into a lot of dots. Light gray comes out as fine dots, and black as large dots. The stages between light gray and black can be made by changing the screen.

EXPERIMENT 4 — Colored Magazine Pictures

Materials:

Glass slide
Colored picture from a magazine
Table lamp or desk lamp (or bright daylight)

Directions:

1. Cut out a small piece from a colored magazine picture.
2. Place the piece of picture on a glass slide.
3. Place the slide on the stage of the microscope.
4. Examine the picture with the low power.

Observation: The picture is made up of separate colored dots. Blue parts of the picture will be made of blue dots. Yellow parts of the picture will be made up of yellow dots. Green parts of the picture, however, will be made up of blue and yellow dots. The blue and yellow dots blend together to make green. Usually red, blue, and yellow dots are used in different combinations.

5. Examine many different kinds of colored pictures and notice the various combinations of colored dots.

EXPERIMENT 5 — Colored Comic Strip

Materials:

Glass slide
Colored comic strip
Table lamp or desk lamp (or bright daylight)

Directions:

1. Cut out a small piece from a colored comic strip.
2. Place the piece from the comic strip on a glass slide.
3. Place the slide on the stage of the microscope.
4. Examine with the low power.

Observation: Some colors will be made up of separate dots like the magazine pictures. Other colors will be smooth and solid.

UNIT 2
CRYSTAL FORMATIONS

EXPERIMENT 6 — Aluminum Sulfate Crystals

Materials:

ALUMINUM SULFATE
Glass slide
Glass dish (in microscope set)
Stirring rod
Medicine dropper
Test tube
Test tube holder
Alcohol lamp
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place a few crystals of ALUMINUM SULFATE in the glass dish and grind them to a powder with the stirring rod.
2. Fill a test tube one-quarter full of water.
3. Holding the test tube with a test tube holder, heat the water over the alcohol lamp.
4. Add the powdered ALUMINUM SULFATE crystals to the test tube of warm water.
5. Shake the tube until all the powder has dissolved.
6. With the medicine dropper, place a drop of the ALUMINUM SULFATE solution on a glass slide.
7. Place the slide on the stage of the microscope and examine the edge of the drop, first with the low power and then with the high power.
8. Turn the mirror to obtain the best light.

Observation: As the solution dries, crystals of ALUMINUM SULFATE will form and grow on the slide. Notice their color, size, and form. Try using different amounts of light by turning the mirror. Sometimes the liquid dries very slowly and you will have to be patient before you see the crystals begin to form.

EXPERIMENT 7 — Crystals Have Many Forms

Materials:

Chemicals
Glass slides
Watch glass
Stirring rod
Medicine dropper
Test tubes
Test tube holder
Alcohol lamp
Table lamp or desk lamp (or bright daylight)

Directions: Follow the directions given in Experiment No. 6, and ex-

amine the following chemicals:

Ammonium Chloride	Potassium Ferrocyanide
Ammonium Dichromate	Sodium Bicarbonate
Cobalt Chloride	Sodium Bisulfite
Copper Sulfate	Sodium Chromate
Ferrous Ammonium Sulfate	

Observation: Different chemicals form different kinds of crystals. As you watch the solutions dry you will see them form many interesting and beautiful shapes.

EXPERIMENT 8 — Crystallization of Common Substances

Materials:

Common substances found around the home (see below)	Test tubes
Glass slides	Test tube holder
Watch glass	Alcohol lamp
Stirring rod	Table lamp or desk lamp (or bright daylight)
Medicine dropper	

Directions: Follow the directions given in Experiment No. 6, and examine the following common substances found around the home.

Salt	Washing soda
Sugar	Boric acid
Aspirin	Epsom salt
Scouring powder	

Observation: Many common substances form interesting and beautiful crystals.

UNIT 3
TEXTILES

EXPERIMENT 9 — Wool

Materials:

Fibers of wool	Dissecting needle
Glass slide	Table lamp or desk lamp (or bright daylight)
Cover glass	
Medicine dropper	

Directions:

1. Take a few fibers of wool from a piece of pure woolen cloth and place them on a glass slide.
2. With the medicine dropper, place a drop of water on the ends of the fibers.
3. With the dissecting needle, spread the ends of the fibers apart.
4. Place a cover glass over the ends of the fibers.
5. Examine the fibers, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: Notice the color, thickness and texture of the fibers. Wool fibers are thick and covered with scales. The scales are arranged like the shingles on a house. The scales make it possible for the fibers to cling together and give wool its springy feeling.

7. Examine wool fibers from many different pieces of woolen cloth and compare them.
8. Examine fibers from pieces of cloth that are only partly wool. How do they compare with pure wool fibers?

Wool Fiber

EXPERIMENT 10 — Cotton

Materials:

Cotton fibers	Dissecting needle
Glass slide	Table lamp or desk lamp (or bright daylight)
Cover glass	
Medicine dropper	

Directions:

1. Take a few cotton fibers from a piece of cotton cloth, or from some absorbent cotton, and place them on a glass slide.
2. With the medicine dropper, place a drop of water on the ends of the fibers.

3. With the dissecting needle, spread the ends of the fibers apart.
4. Place a clean cover glass over the ends of the fibers.
5. Place the slide on the stage of the microscope and examine the fibers, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: Notice the thickness, color, and texture of the fibers. A fiber of cotton is like a flat, twisted ribbon. The edges of the fiber are thicker than the middle because each fiber is really a flattened or collapsed tube.

Cotton Fiber

EXPERIMENT 11 — Linen

Materials:

Linen fibers
Glass slide
Cover glass
Medicine dropper
Dissecting needle
Table lamp or desk lamp (or bright daylight)

Directions:

1. Take a few linen fibers from a piece of linen cloth and place them on a glass slide.
2. With the medicine dropper, place a drop of water on the end of the fibers.
3. With the dissecting needle, spread the ends of the fibers apart.
4. Place a clean cover glass over the ends of the fibers.
5. Place the slide on the stage of the microscope and examine the fibers, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: Notice the thickness, color, and texture of the fibers. Linen fibers are round and smaller than those of cotton. They may have small swellings or knobs along the sides. They are not twisted like cotton fibers, but are divided into sections.

Linen Fiber

EXPERIMENT 12 — Real Silk

Materials:

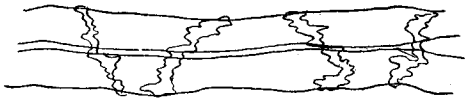
Fibers of silk
Dissecting needle

Glass slide
Cover slide
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. Take a few fibers of silk from a piece of silk cloth and place them on a glass slide.
2. With the medicine dropper, place a drop of water on the ends of the fibers.
3. With the dissecting needle, spread the ends of the fibers apart.
4. Place a cover glass over the ends of the fibers.
5. Place the slide on the stage of the microscope and examine the fibers, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: Notice the thickness, color, and texture of the fibers. Silk fibers are small and very smooth although they may vary in size.



Silk Fiber

EXPERIMENT 13 — Artificial Silk

Materials:

Fibers of rayon or artificial silk
Glass slide
Cover glass
Medicine dropper
Dissecting needle
Table lamp or desk lamp (or bright daylight)

Directions:

1. Take a few fibers of rayon from a piece of rayon cloth and place them on a glass slide.
2. With the medicine dropper, place a drop of water on the ends of the fibers.
3. With the dissecting needle, spread the ends of the fibers apart.
4. Place a cover glass over the ends of the fibers.
5. Place the slide on the stage of the microscope and examine the fibers, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: Notice the thickness, color, and texture of the fibers. Artificial silk fibers are smooth and have heavy, dark lines running along the sides. The surface may be wrinkled.

Artificial Silk Fiber

UNIT 4

HAIR AND FUR

EXPERIMENT 14 — Brunette Hair

Materials:

Human hair, brunette
Two glass slides
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place the hair on a glass slide.
2. Cover the hair with the second glass slide.
3. Place the slides on the stage of the microscope and examine the hair, first with the low power and then with the high power.
4. Turn the mirror to obtain the best light.

Observation: Notice the thickness, color, and texture of the hair. The pigment in brunette hair is dark in color.

EXPERIMENT 15 — Blonde Hair

Materials:

Human hair, blonde
Two glass slides
Table lamp or desk lamp (or bright daylight)

Directions: Same as Experiment No. 14.

Observation: The pigment is yellowish in color.

EXPERIMENT 16 — Gray Hair

Materials:

Human hair, gray
Two glass slides
Table lamp or desk lamp (or bright daylight)

Directions: Same as Experiment No. 14.

Observation: The hair will be light colored because it contains no pigment.

EXPERIMENT 17 — Red Hair

Materials:

Human hair, red
Two glass slides
Table lamp or desk lamp (or bright daylight)

Directions: Same as Experiment No. 14

Observation: There is very little dark pigment in red hair. The pigment varies from reddish brown to yellow.

EXPERIMENT 18 — Curly Hair

Materials:

Human hair, curly
Two glass slides
Table lamp or desk lamp (or bright daylight)

Directions: Same as Experiment No. 14.

Observation: Examine different parts of the hair and notice that where the hair curls or bends it is flatter than in the straight parts.

In cross section, that is, if you cut a hair across and examine it you will find that curly hair is oval. Straight hair is round or circular in cross section.

EXPERIMENT 19 — Hair from Pet Animals

Materials:

Hair from various pet animals; cats, dogs, rabbits, etc.
Two glass slides
Table lamp or desk lamp (or bright daylight)

Directions: Same as Experiment No. 14.

Observation: Notice the thickness, color, shape, and any other peculiarities of the various kinds of hairs. Each one will have its own characteristics.

EXPERIMENT 20 — Hair from Farm Animals

Materials:

Hair from various animals found on a farm; horses, cows, pigs, etc.
Two glass slides
Table lamp or desk lamp (or bright daylight)

Directions: Same as Experiment No. 14.

Observation: Notice the thickness, colors, shape, and any other peculiarities of the various kinds of hairs.

EXPERIMENT 21 — Hairs on Leaves

Materials:

Leaves from different kinds of plants
Glass slide
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place a piece of a leaf on a glass slide.
2. Place the slide on the stage of the microscope and examine the leaf, first with the low power and then with the high power.

3. Be sure there is plenty of light falling on the leaf, either daylight or the light from a table lamp.

Observation: You will find tiny hairs on almost all leaves. Notice the difference in their thickness, color, length, and the number on each leaf.

4. Place several drops of water on some of the leaves as you examine them.

EXPERIMENT 22 — Hairs on Stems of Plants

Materials:

Slender stems from various kinds of plants
Glass slide
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place a small piece of a stem on the glass slide.
2. Place the slide on the stage of the microscope and examine the stem, first with the low power and then with the high power.

Observation: You will find various kinds of hairs on different stems. Notice their length, thickness, color and number.

UNIT 5
PLANT CELLS

EXPERIMENT 23 — Onion Skin Cells

Materials:

Onion
Glass slide
Cover glass
Medicine dropper
Sharp pointed knife
Stains
Table lamp or desk lamp (or bright daylight)

Directions:

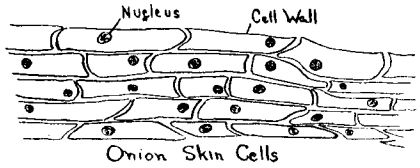
1. With the point of a sharp knife, strip off a very thin piece of skin from the inner leaves of an onion.
2. Place the piece of onion skin on a glass slide.
3. With the medicine dropper, place a drop of water on the onion skin.
4. Place the cover glass over the onion skin.
5. Place the slide on the stage of the microscope and examine the onion skin, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: In order to see the individual cells, you will have to have a piece of onion skin that is only one layer in thickness. If at first you cannot see individual cells, move the slide around until you find the thinnest part of the onion skin. Try different pieces of skin from different parts of the onion.

Onion skin cells are oblong or brick shaped. The outside covering of each cell is called the *cell wall*. The interior of the cell is filled with cell sap or *protoplasm*. There is a dark spot near the center called the *nucleus*.

7. Stain the cells with Safranin or Methylene Blue. (See Experiment No. 1.)

Observation: Notice how different parts of the cell can be seen better with the stains than without them.



EXPERIMENT 24 — Apple Skin Cells

Materials:

Apple
Glass slide
Cover glass
Sharp pointed knife
Table lamp or desk lamp (or bright daylight)

Directions:

1. Peel a piece of skin from an apple.
2. With a sharp pointed knife, scrape the inside of the peeling until light can be seen through the skin.
3. Place the peeling on the glass slide.
4. Place the slide on the stage of the microscope so that the thin part of the peeling is directly under the objective.
5. Place a cover glass over the peeling and examine it, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: The cells of the apple skin are irregular in shape. Notice the small spots of coloring matter in each cell. The coloring matter may be red, yellow, brown, or some other color, depending upon the color of the skin used.

7. Following the directions above, examine the skin of a pear, cherry, plum and other smooth skinned fruits.

EXPERIMENT 25 — Leaf Cells

Materials:

Green leaf
Glass slide
Sharp pointed knife
Table lamp or desk lamp (or bright daylight)

Directions:

1. With a sharp pointed knife, scrape the under surface of a leaf until light can be seen through it.
2. Place the leaf on a glass slide.
3. Place the slide on the stage of the microscope so that the thin part of the leaf is directly under the objective.
4. Examine the leaf, first with the low power and then with the high power.
5. Turn the mirror to obtain the best light.

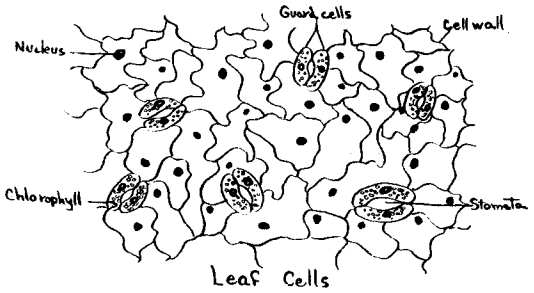
Observation: The cells of the leaf are irregular in shape. Notice the spots of green coloring matter in the cells. This green coloring matter is called *chlorophyll*. With the aid of the sun, chlorophyll manufactures food for the plant from the carbon dioxide of the air and water from the soil.

6. Scrape away the upper surface of the leaf and examine the thin part again.

Observation: The under surface of the leaf, and sometimes the upper surface has pores, or openings, called *stomata*, through which the leaf takes in the carbon dioxide and gives off oxygen.

7. Examine many different kinds of leaves following the directions above.

Observation: Notice the size, color, and shape of the cells in each.



EXPERIMENT 26 — Water Plant Cells

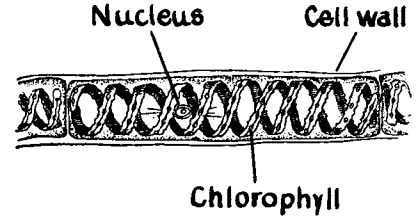
Materials:

Water plants (plants from an aquarium or fish bowl are best for this experiment)
Glass slide
Cover glass
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. Take a leaf from a water plant and place it on a glass slide.
2. With the medicine dropper, place a drop of water on the leaf.
3. Place a cover glass on the drop of water.
4. Place the slide on the stage of the microscope and examine the leaf, first with the low power and then with the high power.
5. Turn the mirror to obtain the best light.

Observation: The cells in water plants vary in shape and size. In some plants for instance, Elodea, which are often used in aquariums, the green coloring can be seen moving through the cell.



EXPERIMENT 27 — Yeast Cells

Materials:

Yeast cake
Glass slide
Cover glass
Dissecting needle
Medicine dropper
Stains
Table lamp or desk lamp (or bright daylight)

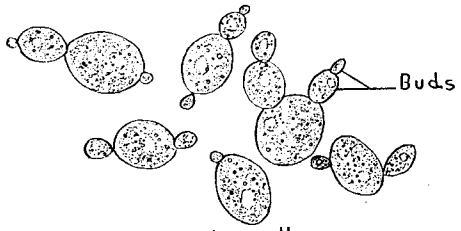
Directions:

1. With the dissecting needle, take a tiny piece of a compressed yeast cake and place it on a glass slide.
2. With the medicine dropper, place a small drop of water on the piece of yeast cake.
3. Spread the piece of yeast around through the drop of water.
4. Cover the drop with a cover glass.
5. Examine the yeast, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: Yeast cells are very small and oval shaped. If yeast cells are placed in a little sugar solution they will begin to produce new cells. First a bump appears on the side of cell. This bump is a bud. The bud grows larger and finally breaks away from the original cell and becomes a new cell.

7. Stain the cells with different colored stains.

Observation: Different parts of the cells will be brought out by the stains. Notice especially the dark spot, *the nucleus*, in the center.



Yeast Cells

EXPERIMENT 28 — Potato Cells

Materials:

Potato
Glass slide
Cover glass
Sharp knife
Stains
Table lamp or desk lamp (or bright daylight)

Directions:

1. With a sharp knife, cut a very thin slice from the inside of a potato.
2. Place the slice of potato on a glass slide.
3. Cover the slice with a cover glass.
4. Place the slide on the stage of the microscope and examine, first with the low power and then with the high power.
5. Turn the mirror to obtain the best light.

Observation: Potato cells are irregular in shape. If at first you cannot see the cells try cutting thinner slices. You may have to try many times before you see individual cells.

6. Stain the cells with different stains.

Observation: Look for starch grains (oval shaped) in the potato cells.

Potato Cells

EXPERIMENT 29 — Cells from a Celery Stalk

Materials:

Celery stalk
Glass slide
Cover glass
Medicine dropper
Sharp knife
Stains
Table lamp or desk lamp (or bright daylight)

Directions:

1. With the point of a sharp knife, cut into the side of a celery stalk a slight distance. Holding the skin of the celery stalk against the knife blade with your thumb or finger, pull downward and strip off a thin layer of the skin.
2. Place the layer of celery skin on a glass slide.
3. With a medicine dropper, place a drop of water on the celery skin.
4. Place a cover glass on the drop of water.
5. Place the slide on the stage of the microscope and examine the celery skin, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: Celery cells are long, narrow, and brick shaped. If at first you cannot find them try stripping off a thinner layer.

7. Stain some of the celery skin with different kinds of stain to bring out the different parts of the cells.

EXPERIMENT 30 — Flower Petals

Materials:

A flower
Glass slides
Desk lamp or table lamp (or bright daylight)

Directions:

1. Pull a petal from a flower and place it on a glass slide.
2. If the petal does not lie flat, place another glass slide on top of it.
3. Place the slide on the stage of the microscope and examine the petal, first with the low power and then with the high power.
4. Turn the mirror to obtain the best light.

Observation: Notice the color, size, shape, and arrangement of cells in the flower petal.

5. Examine the petals of many different kinds of flowers.

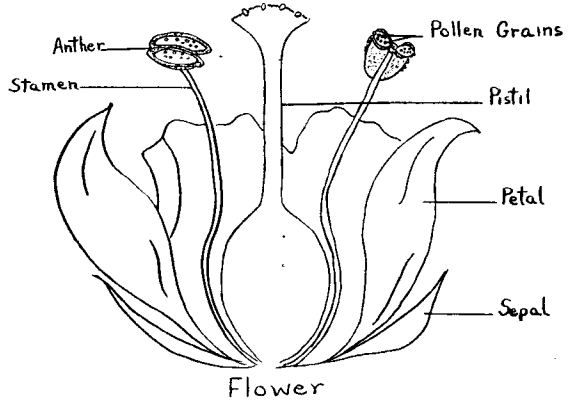
EXPERIMENT 31 — Pollen Grains

Materials:

A flower
Glass slide
Desk lamp or table lamp (or bright daylight)

Directions:

Note: In the center of most flowers there are several little stalks with small knobs at their tips. The stalks are called, *Stamen*, and the knobs at the tip, *anthers*. The anthers are often covered with little specks of powder. The specks of powder are *pollen grains*.



Flower

1. Shake some of the pollen grains on a glass slide.
2. Place the slide on the stage of the microscope and examine the pollen grains, first with the low power and then with the high power.
3. Turn the mirror to obtain the best light.

Observation: Pollen grains are interesting and beautiful to look at. Each flower has its own kind of pollen grains. Notice the color, size and shapes.

4. Examine the pollen grains of many flowers.

EXPERIMENT 32 — Composite Flower

Materials:

A composite flower (a daisy, sunflower, aster or other similarly constructed flower)
Hand lens
Glass slide
Table lamp or desk lamp (or bright daylight)

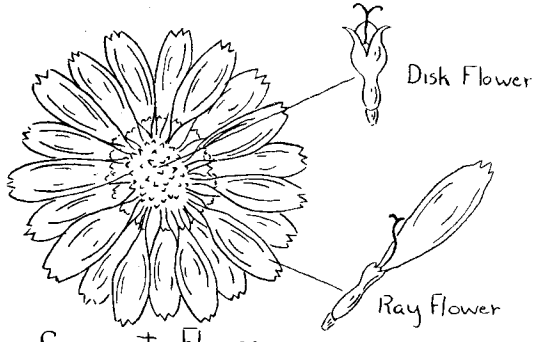
Directions:

1. Examine the center of the flower with the hand lens.

Observation: You will find that each little section in the center is a complete flower.

2. Break the center of the flower apart.
3. Place one of the little sections on the glass slide.
4. Place the slide on the stage of the microscope and examine it, first with the low power and then with the high power.
5. Turn the mirror to obtain the best light.

Observation: Notice that each little flower has its own petals, stamens and other parts. The center of a composite flower like the daisy, sunflower, or aster is really a whole group of flowers on one stem.



Composite Flower

EXPERIMENT 33 — Pond Scum (Spirogyra)

Materials:

- Pond scum (a pale green scum that floats near the surface of ponds)
- Glass slide
- Cover glass
- Dissecting needle
- Glass jar
- Table lamp or desk lamp (or bright daylight)
- Hand lens

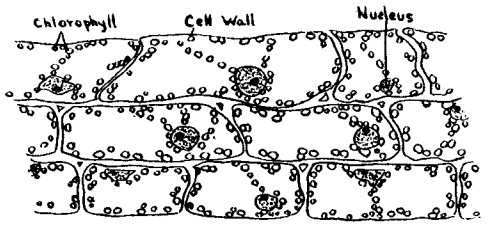
Directions:

1. Collect some pond scum in a glass jar from the nearest pond.
2. Examine the pond scum with the hand lens.

Observation: Pond scum is composed of separate tiny threads intertwined about each other.

3. Place a few threads of the pond scum on a glass slide.
4. With the dissecting needle, spread the threads around on the glass slide.
5. Place a cover slide over the threads.
6. Examine the threads, first with the low power and then with the high power.
7. Turn the mirror to obtain the best light.

Observation: Each thread is composed of a row of cells attached end to end. In each thread there is a spiral band of green *chlorophyll*. Chlorophyll is the substance found in green plants that helps the plant manufacture food for itself. Near the center of each cell is a dark spot—the *nucleus*.



Elodea Cells

EXPERIMENT 34 — Bread Mold

Materials:

- Piece of bread
- Glass slide
- Dissecting needle
- Medicine dropper
- Cover glass
- Table lamp or desk lamp (or bright daylight)

Directions:

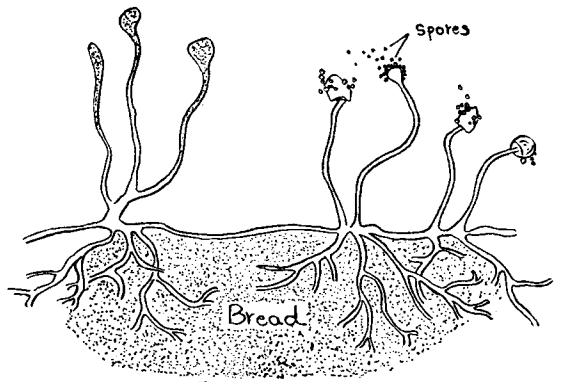
1. Moisten a piece of bread and place it in a saucer.
2. Place the saucer where it will be exposed to air for several days.

Observation: Spots of mold will appear on the bread.

3. With the dissecting needle, scrape a few strands of the mold from the bread and place them on a glass slide.
4. With the medicine dropper place a drop of water on the mold.
5. Place a cover glass on the drop of water.
6. Place the slide on the stage of the microscope and examine the mold, first with the low power and then with the high power.
7. Turn the mirror to obtain the best light.

Observation: Mold is composed of tiny threads standing upright and connected by cross threads. At the tip of each upright thread is a small, round, black knob. The knobs are called *spore cases*. Each spore case contains thousands of tiny spores, or cells. When a spore case is ripe it breaks open, the spores are set free and are carried away by air currents. If the spores land on other food they produce new mold. All food should be kept covered to prevent mold from growing on it!

8. Examine mold from fruits, jellies, and other foods.



Bread Mold

EXPERIMENT 35 — Moss

Materials:

Moss plants
Glass slide
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. Examine a single moss plant.

Observation: Notice the size, shape, arrangement, and number of leaves on the plant.

2. Place different parts of the moss plant on a glass slide and examine each one separately.
3. Before examining each part, cover it with a drop of water and a cover slide.
4. Examine the parts with the low power first and then with the high power.
5. Turn the mirror to obtain the best light.

Observation: The leaves of moss plants are scaly and only one cell thick.

EXPERIMENT 36 — Diatoms

Diatoms are microscopic plants found almost everywhere on the earth. They may be found in countless numbers in both fresh and salt water and serve as food for many animals. Each one has an outside covering like a shell or skeleton. The shell is made of two parts which fit together like a pill box.

When a diatom dies its shell sinks to the bottom of the water in which it lives. For millions of years diatom shells have been sinking to the bottoms of lakes and oceans. In some places they have collected in great quantities, forming mud and ooze. This mud is known as diatomaceous earth. This kind of earth is used as a scouring powder and if you examine some of the scouring soap your mother uses you may find some of the small shells in it.

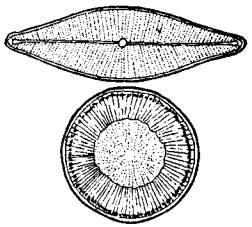
Materials:

Diatomaceous earth
Dissecting needle
Medicine dropper
Glass slide
Cover glass
Table lamp or desk lamp (or bright daylight)

Directions:

1. Moisten the tip of a dissecting needle with water and place it in a bottle of diatomaceous earth so that some of it sticks to the needle.
2. Shake the powder onto the glass slide.
3. With the medicine dropper, place a drop of water on the powder.
4. Cover the drop of water with a cover glass.
5. Place the slide on the stage of the microscope and examine the powder, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.

Observation: Most of the diatom shells have beautiful designs. Some are round, others are oblong, oval shaped, triangular, etc.



Diatom Shells

EXPERIMENT 37 — Cornstarch Grains

Materials:

Cornstarch
Glass slide
Cover glass
Dissecting needle
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place the point of the dissecting needle in the cornstarch so that some of it sticks to the needle.
2. Place the cornstarch on a glass slide.
3. With the dissecting needle, place a drop of water on the cornstarch.
4. Spread the cornstarch around with the point of the dissecting needle.
5. Place a cover glass on the drop of water.
6. Examine the starch, first with the low power and then with the high power.
7. Turn the mirror to obtain the best light.

Observation: Notice the size, shape and color of the starch grains. Compare them with the starch grains in the next experiments.

EXPERIMENT 38 — Wheat Starch Grains

Materials:

Flour (wheat)
Glass slide
Cover glass
Dissecting needle
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place the point of the dissecting needle in the flour so that some of it sticks to the point of the needle.
2. Place the flour on the glass slide.
3. With the medicine dropper, place a drop of water on the flour.
4. Spread the flour around with the point of the dissecting needle.
5. Place a cover glass on the drop of water.
6. Examine the flour, first with the low power and then with the high power.
7. Turn the mirror to obtain the best light.

Observation: Notice the size, shape, and color of the starch grains found in the flour. Compare them with other starch grains.

EXPERIMENT 39 — Rice Starch Grains

Materials:

Rice
Glass slide
Cover glass
Test tube
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place a few grains of rice in a test tube.
2. Fill the test tube about one-half full of water.
3. Place your thumb over the mouth of the test tube and shake it vigorously for about one minute.
4. With the medicine dropper, place a drop of water from the test tube on the glass slide.
5. Place a cover glass on the drop of water.
6. Examine the slide, first with the low power and then with the high power.
7. Turn the mirror to obtain the best light.

Observation: Notice the size, shape, and color of the rice grains. Compare them with the other starch grains.

UNIT 6
ANIMAL CELLS

One-celled Animals

In the section on PLANTS, you found that some of them, like the leaves of trees, are composed of many cells, while others, like yeast, are so simple that they never have more than one cell. Bacteria are also one-celled plants, but they are so small that you will not be able to see them with your microscope. Special microscopes with high powered lenses are needed to study bacteria.

Animals also are composed of one or more cells. Some of the larger animals, like dogs, horses, and elephants have so many cells that the cells in their bodies cannot be counted. Other animals are so simple that their whole body consists of only one cell which can be seen only with the aid of a microscope. You can see many of them with your microscope.

These simple one-celled animals are called *Protozoa*. Although they are found practically everywhere in the world, they are not familiar to us because of their small size. As little as they are, however, they affect us in many ways. Many of them furnish food for larger animals which in turn supply us with food. Certain types of Protozoa help destroy waste material which otherwise might produce unsanitary conditions. Some of them cause diseases like malaria. Others form soil and rock that we use for buildings and monuments.

EXPERIMENT 40 — Two Ways to Find One-Celled Animals

METHOD 1

Materials:

Several clean jars.

Directions:

1. Go to the nearest pond, garden pool, or any other body of stagnant water.
2. Fill one clean jar with some water and mud from the bottom of the pond.
3. Fill another jar with dead leaves and other decayed vegetation found along the edge of the pond. Add some of the pond water.
4. Fill a third jar with some living green plants from the pond and add some water.

5. In a fourth jar, mix some of the mud, decayed vegetation, living plants and some pond water.
6. Take the jars home and place them in a warm place where they will not be exposed to direct sunlight.

Observation: You will now have enough material to keep you busy looking for one-celled animals, and also plants, for several weeks. Follow the directions given in the next pages. An examination of the little animals found in your jars will be as interesting as a visit to the zoo.

METHOD II

If it is winter and the ponds are frozen over, you can find many one-celled animals by following Method II.

Materials:

Hay, or dry grass and leaves
Glass jar
Pan

Directions:

1. Boil about one pint of water in a pan.
2. Allow the water to cool and pour it into a clean glass jar.
3. Place the hay, or dry grass and leaves (about a handful) in the jar of water.
4. Place the jar in a warm place where it will not be exposed to direct sunlight and allow it to stand for several days.

Observation: Several kinds of one-celled animals will appear in the jar. Follow the directions given in the next pages.

These tiny animals were on the hay or grass in a resting stage and needed only the water to make them active.

EXPERIMENT 41 — Examples of One-Celled Animals

Materials:

Jars of pond water or hay infusion (see Experiment 40)
Glass slide
Cover glass
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. With the medicine dropper, place a drop of water from one of the jars which you prepared in Experiment 40, on a glass slide.
2. Place a cover glass on the drop of water.
3. Place the slide on the stage of the microscope and examine, first with the low power and then with the high power.
4. Turn the mirror to obtain the best light.

Observation: Looking for one-celled animals in a drop of water through a microscope is very much like fishing. You may find what you

are looking for the first time, or you may have to try many times before you see anything.

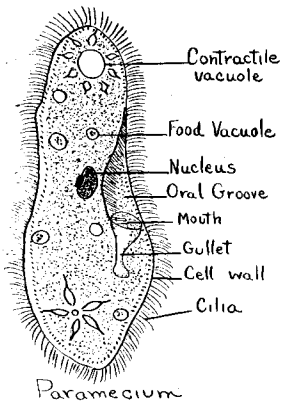
The following experiments describe some of the one-celled animals you are likely to find from time to time as you examine drops of water from your jars.

EXPERIMENT 42 — Paramecium

One of the largest and most common of the one-celled animals is the *Paramecium.* Following are some of its characteristics by which you can recognize it.

1. It is oval shaped. The front end is rounded but the back end is pointed.
2. It is covered by a thin, transparent membrane—the *cell wall.*
3. It has a dark spot near the center—the *nucleus.*
4. Its body is entirely covered with tiny hairs called *cilia.* The *cilia* wave back and forth and help the Paramecium swim through the water.
5. On one side of its body there is a narrow groove which leads into a short tube called the *gullet.* Around the opening, or mouth, of the groove there are many tiny hairs, or *cilia,* which wave back and forth and drive food inward.
6. Near each end of the body is a round circle surrounded by little canals. These circles expand and contract and force waste material out of the body.
7. Just under the *cell wall* there are many small darts. When the Paramecium is attacked, these darts are shot out and poison from them will paralyze their enemies.

Note: You may not be able to see all the parts listed above, but by careful observation and proper handling of the mirror to obtain the best light you will see most of them.



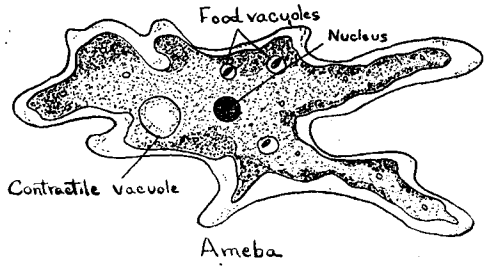
Paramecium

EXPERIMENT 43 — Ameba

Although the Ameba is a very common one-celled animal it is one that is most difficult to find. It is almost transparent and so much like the water in which it lives that it is difficult to see, even with a high power microscope. Look for them, however, and although you may not find one right away you may come across other interesting one-celled animals.

Characteristics:

1. An Ameba looks like a tiny bit of transparent jelly. It is somewhat gray in color. It has no particular shape but is continually changing from one form to another.
2. Near the center of its body there is a dark spot—the *Nucleus.*
3. By looking closely you will see a round, clear spot that looks like a bubble in the "jelly." This little round spot is a *contractile vacuole.* It fills up with liquid and then contracts, forcing the liquid out of the body.
4. The Ameba changes its shape by sending out long finger-like lobes from the sides of its body. Then the rest of the body flows into them. New lobes are then sent out and the Ameba slowly moves from place to place by following the movement of the lobes. The lobes are called *pseudopodia,* which means false feet.
5. The Ameba has no mouth but takes in food by surrounding smaller one-celled animals with its *pseudopodia* and dissolving them in its body.



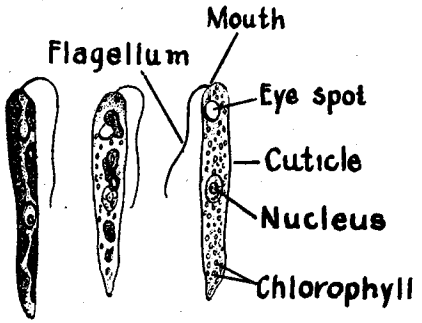
Ameba

EXPERIMENT 44 — Euglena

Although the Euglena is usually classified with the one-celled animals, some scientists think it is more like a plant than an animal. Sometimes it swims about and captures its food like an animal. At other times it remains quiet and manufactures its own food like a plant.

Characteristics:

1. Euglena varies a great deal in size and shape. One of the most common ones is somewhat cigar-shaped.
2. The outer covering of its body, the *cuticle,* is elastic, making it possible for the animal to change its shape so that it seems to squirm through the water.
3. The *nucleus,* a dark spot, is near the center of the body.
4. There is a red spot near the front end of the body. This red spot is called the *eye-spot* because it is sensitive to light and probably acts like an eye.
5. At the front end of the body there is a long hair that lashes back and forth like a whip and pulls the Euglena forward through the water. This whip-like hair is called a *flagellum.*
6. The Euglena's mouth is just below the flagellum.
7. Euglena are green in color because their bodies contain the same substance that gives plants their green color. This substance is called *chlorophyll.*
8. When the water, in which the Euglena lives, happens to dry up, the animal builds a wall around itself and remains quiet until it rains and becomes covered with water again. In some cases the Euglena might be blown about by air currents until it is dropped into water. Then the wall dissolves and the animal becomes active again.

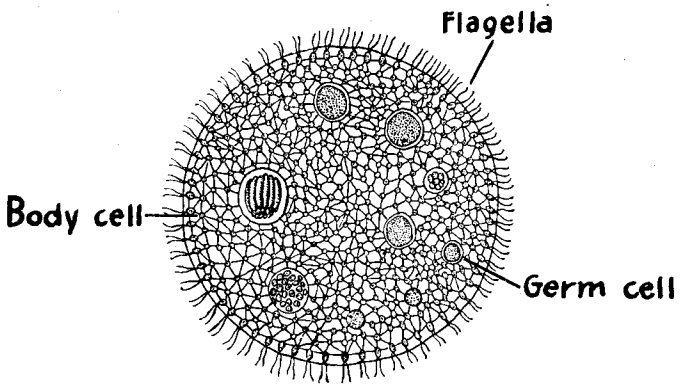


EXPERIMENT 45 — Volvox

Volvox is not a single one-celled animal but a whole colony of cells living together. The cells are held together by strands of jelly-like material forming a sphere shaped like a hollow rubber ball.

Characteristics:

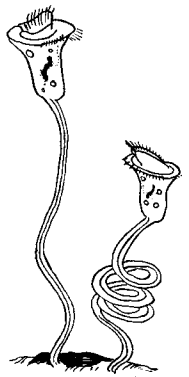
1. The cells are green in color because they contain the same substance that give plants their green color. The substance is called *chlorophyll.*
2. Each cell has a pair of hairs called *flagella,* extending out from the cell wall. The *flagella* wave back and forth, moving the whole colony of cells through the water.
3. There are two kinds of cells in the Volvox colony—*body cells* and *germ cells.* The *body cells* carry on all the work that needs to be done to keep the Volvox alive. The *germ cells* produce new individuals, and start new colonies.



EXPERIMENT 46 — Vorticella

Characteristics:

1. A Vorticella is shaped like a bell turned upside down.
2. It has a stem that looks like a rope attached to the bell.
3. The Vorticella attaches itself by the end of its stem and sways back and forth like a swinging bell.
4. Once in a while the stem suddenly winds up pulling the bell toward the place where the stem is attached. Then the stem unwinds again, allowing the bell to float out at the end of the stem.
5. The *nucleus* of the *Vorticella* is a dark L-shaped mark in the middle of the bell.



EXPERIMENT 47 — Feathers

Materials:

Feathers
Glass slide
Table lamp or desk lamp (or bright daylight)

Directions:

1. Obtain a small feather from a chicken or other bird. Small down feathers, the ones nearest the body of the bird, are best for this study.
2. Place the feather on a glass slide. If the feather does not lie flat, place another glass slide on top of it.
3. Place the slide on the stage of the microscope and examine the feather, first with the low power and then with the high power.
4. Turn the mirror to obtain the best light.

Observation: Notice the central shaft with the many small fine branches coming from it.

5. Examine the feathers of different kinds of colored birds. (Perhaps you can obtain some from a zoo.)

EXPERIMENT 48 — Fish Scales

Materials:

Fish scales
Glass slide
Table lamp or desk lamp (or bright daylight)

Directions:

1. Obtain some fish scales from a fish market or from a fish that you catch yourself.
   Note: If you use a fresh fish, you will have to rub it with a stiff brush and thoroughly clean it with water.
2. Place some of the scales on the glass slide and examine them, first with the low power and then with the high power of the microscope.
3. Turn the mirror to obtain the best light.

Observation: Different kinds of fish have different kinds of scales. Running parallel with the edge of each scale a number of rings can be seen. Some of the rings are wide and others are narrow. Each year a new ring is added to scale, so the number of rings on a scale show the age of the fish.

4. Examine the scales of many different kinds of fish and compare them as to size, color, and shape.
5. Stain some of the scales with different kinds of stains.

UNIT 7

SMALL ANIMALS OF PONDS AND STREAMS

While examining pond water you will not only see many one-celled animals but you will find a great variety of other small animals as well. Some of these animals are composed of many cells but they are so small that it is necessary to use a hand lens, and in many cases a microscope, in order to see what they look like.

Here are some of the more common ones that you will probably find.

EXPERIMENT 49 — Hydra

Materials:

Pond water
Water plants
Watch glass
Hand lens
Medicine dropper

Directions:

1. Go to the nearest pond and fill a glass jar with some pond water and plants that grow in the pond.
2. When you have brought the jar home, examine the plants and the inside of the jar with a hand lens.

Observation: If any Hydra are present, you should find them clinging to the sides of the jar or to the under sides of leaves in the jar.

What the hydra looks like:

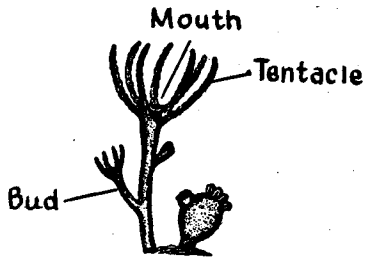
Without the aid of a hand lens, a hydra looks like a tiny piece of white thread with the fibers unraveled at one end. Its body is from ¼ to ½ inch in length when it is stretched out. At one end of the body there is a circle of arms, or *tentacles*, that wave about in the water.

The hydra attaches itself to a leaf or to the side of the jar with one end of its body leaving its arms, or *tentacles*, free. If the animal is disturbed it contracts into a small ball and pulls in its tentacles.

3. Detach a hydra from its place of attachment in the jar with a medicine dropper and place it on a glass slide.
4. Place enough water on the slide to cover the hydra.
5. Place the slide on the stage of the microscope and examine the hydra, first with the low power and then with the high power.

Observation: The body of the hydra is a hollow tube, closed at one end and open at the other. The *tentacles*, which surround the open end or *mouth*, are used to catch small animals or other food and feed them into the mouth. The tentacles also contain many small darts which can be shot out into the water to paralyze the prey of the hydra.

You may find some hydra with buds growing from the sides of their bodies. These buds will grow into other hydra which break away and become new individuals.



EXPERIMENT 50 — Round Worms

As you examine drops of water from the jar containing pond water and plants, you may come across some small, round worms wriggling on your slide. These are round worms.

Characteristics:

1. Round worms are long, slender and white.
2. The body of the round worm tapers, or is pointed, at both ends.
3. The body wall is like a tube. Inside of this tube is another tube. The inner tube is the digestive system of the worm. Food passes in one end and waste material out of the other.
4. Round worms live in fresh water, salt water, in the soil, and even in the bodies of plants and animals.

Round Worm

EXPERIMENT 51 — Flat Worms (Planaria)

Materials:

Stones from the edge of a pond
Glass slide
Small knife
Hand lens
Watch glass

Directions:

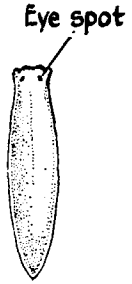
1. Gather some stones from the edge of a pond.

2. Examine the under surface of the stones for small, dark-colored flat worms about ¼ to ½ inch in length.
3. With a small knife blade scrape the worms from the stones into a watch glass. (If you do not find any flat worms on your first attempt keep trying. They are not always easy to find.)
4. Cover the worm with water and examine it with the hand lens.

Characteristics:

1. Broad flat head at one end of the body.
2. Pointed at opposite end of body.
3. Two large "eye" spots on the upper side near the head end.
4. Mouth is on the under side of the body near the middle.

Note: If you cannot find some flat worms after several attempts, try the following method. Tie a piece of fresh meat to one end of a string and fasten the other end to a stone near the edge of a pond. Place the piece of meat in the water near the edge of the pond. If there are any worms in the water they will be attracted by the meat and will begin to feed on it.



Flat Worm

EXPERIMENT 51A Experiments with Flat Worms

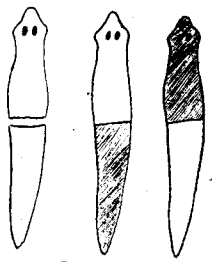
Materials:

Flat worms (see Experiment 51)
Glass slide
Sharp knife or razor blade
Two saucers or other small dishes
Hand lens

Directions:

1. Collect some flat worms from the under side of stones found near the edge of a pond. (See Experiment 51.)
2. Place a flat worm on a glass slide.
3. With a sharp knife or razor blade, cut the worm in two across the middle.
4. Place one-half of the worm in one clean dish of pond water and the other half in another dish of pond water.
5. Examine each part of the worm every day for about two weeks with the hand lens.

Observation: The front end of the worm will grow a new tail. The back end will grow a new head.


Flatworm
Dissected Crosswise

EXPERIMENT 51B Experiments with Flat Worms (Continued)

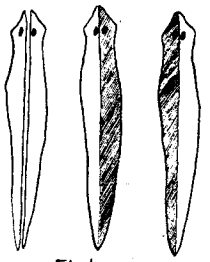
Materials:

Flat worms (see Experiment 51)
Glass slide
Sharp knife or razor blade
Two saucers or other small dishes
Hand lens

Directions:

1. Collect some flat worms from the under side of stones found near the edge of a pond. (See Experiment 51.)
2. Place a flat worm on a glass slide.
3. With a sharp knife or razor blade, cut the worm in two lengthwise.
4. Place one-half of the worm in one clean dish of pond water, and the other half in another dish of pond water.
5. Examine each part of the worm every day for about two weeks with a hand lens.

Observation: The right half of the worm will grow a left side. The left side of the worm will grow a right side.


Flatworm
Dissected Lengthwise

UNIT 8
INSECTS

EXPERIMENT 52 — The Housefly

Materials:

- Housefly
- Hand lens
- Glass slide
- Forceps

Directions:

1. Place a housefly on a glass slide and examine it with a hand lens.
2. With the forceps, turn the fly in different positions and study its various parts.

Observation: Here are some of the things you will notice about the fly.

1. The body is striped black and white on top.
2. Six legs.
3. One pair of wings (compare with other insects).
4. One pair of flaps called balancers.
5. Wings are transparent.
6. Large eyes which bulge from the side of the head.
7. One pair of feelers, or *antenna*, on its head.

EXPERIMENT 53 — Wings of a Housefly

Materials:

- Housefly
- Glass slide
- Cover glass
- Forceps
- Medicine dropper
- Table lamp or desk lamp (or bright daylight)

Directions:

1. With the forceps, gently pull off one of the wings of the fly and place it on a glass slide.
2. With the medicine dropper, cover the wing with a drop of water.
3. Place a cover glass over the wing.
4. Place the slide on the stage of the microscope and examine the wing, first with the low power and then with the high power.
5. Turn the mirror to obtain the best light.

Observation: The wing is thin and transparent.
The wing is supported by criss-crossing veins which are really tubes.

EXPERIMENT 54 — The Legs of a Housefly

Materials:

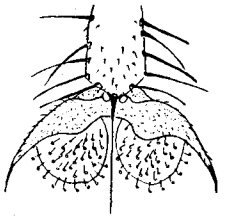
- Housefly
- Glass slide
- Cover glass
- Forceps
- Medicine dropper
- Table lamp or desk lamp (or bright daylight)

Directions:

1. With the forceps, gently pull off one of the legs of the fly and place it on a glass slide.
2. With the medicine dropper, cover the leg with a drop of water.
3. Place a cover glass over the leg.
4. Place the slide on the stage of the microscope and examine the leg, first with the low power and then with the high power.
5. Turn the mirror to obtain the best light.

Observation:

1. The leg is jointed.
2. It is covered with hairs.
3. The feet have claws, little pads, and sticky hairs. If the hairs on the fly's feet are not free from dust, they will not stick to smooth surfaces and the fly cannot walk on window panes, walls, etc. That is why the fly is always cleaning his feet by rubbing them together.



Foot of Fly

EXPERIMENT 55 — The Eye of the Housefly

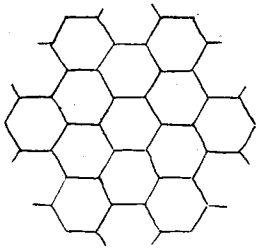
Materials:

- Housefly
- Glass slide
- Dissecting needle
- Table lamp or desk lamp (or bright daylight)

Directions:

1. With the point of the dissecting needle, dig out one eye of the housefly.
2. Using the point of the needle, clean out the inside curve of the eye.

3. Place the eye on the glass slide.
4. Place the slide on the stage of the microscope and examine the eye, first with the curved side of the eye up and then with the curved side down.
5. Turn the mirror to obtain the light.
6. Use the low power first and then the high power.



Lenses in Fly's Eye

Observation: The eye is made up of many tiny, six-sided lenses. This is called a compound eye.

EXPERIMENT 56 — The Bee

Materials:

A bee
Glass slide
Hand lens
Forceps
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place a bee on a glass slide and examine it with a hand lens.
2. With the forceps, turn the bee in different positions and study its various parts.

Observations:

1. The bee, like all insects, has six legs.
2. Two pairs of wings. The wings are thin and transparent. The front pair are larger than the back pair.
3. Two large compound eyes, on sides of head.
4. Three simple eyes on top of head.
5. One pair of feelers, or *antenna*, on head.
6. Stinger at the end of the body.

EXPERIMENT 57 — The Wings of a Bee

Materials:

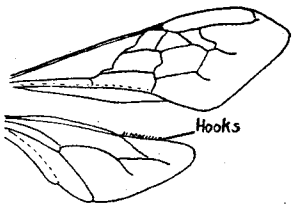
Bee
Glass slide
Cover glass
Forceps
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. With the forceps, gently pull a pair of the wings from the bee and place them on the glass slide.
2. With the medicine dropper, cover the wings with a drop of water.
3. Place a cover glass over the wings.
4. Place the slide on the stage of the microscope and examine the wings, first with the low power and then with the high power.
5. Turn the mirror to obtain the best light.

Observation:

1. The wings are thin and transparent
2. The wing is supported by criss-crossing veins which are really tubes.
3. Sometimes the wings of older bees are frayed around the edges because they are used so much.
4. Along the edges of the wings there are little hooks which hold the two pairs of wings together when the bee is flying.



Wings of a Bee

EXPERIMENT 58 — The Legs of the Bee

Materials:

Bee
Glass slide
Cover glass
Forceps
Medicine dropper
Table lamp or desk lamp (or bright daylight)

Directions:

1. With the forceps, gently pull off one of the front legs of the bee.
2. Place the leg on a glass slide.
3. With the medicine dropper, place a drop of water on the leg.

4. Cover the leg with a cover glass.
5. Place the slide on the stage of the microscope and then examine the leg, first with the low power and then with the high power.
6. Turn the mirror to obtain the best light.
7. Examine all of the other legs in the same way.

Observation: Each pair of legs has special "tools" for doing different kinds of work.

FRONT LEGS

Eye Brush: Short, stiff hairs at end of leg, near foot. Used to brush pollen from eyes.

Pollen Brush: On foot. Used to collect pollen on the hairs of the body.

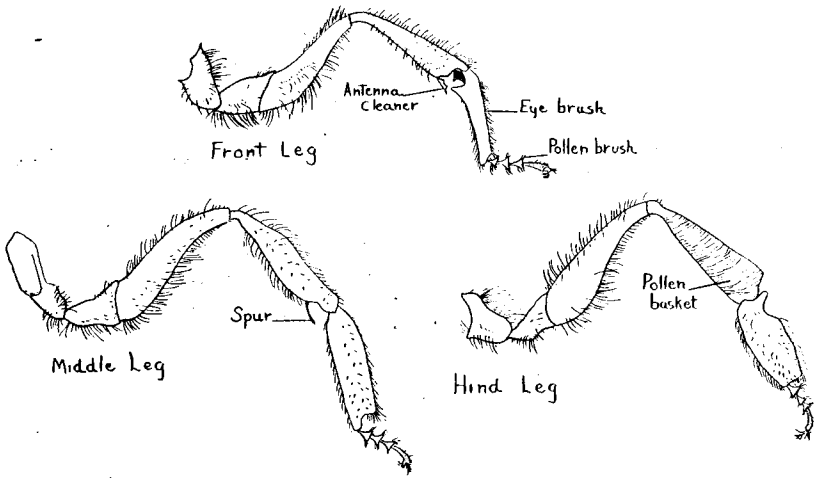
Antenna Cleaner: A notch and spine at first joint above the foot. To clean the antenna from pollen, the bee draws them between the notch and the spine and scrapes the pollen off.

MIDDLE LEGS

Spur or Spine: A sharp pointed spine at the first joint above the foot. Used to remove the flakes of wax from the under side of the body.

HIND LEGS—These legs are broader and longer than the other two pairs.

Pollen Basket: A depression along the length of the leg covered by strong, stiff hairs form a pocket or basket. In this basket the bee places pollen which it scrapes from its other legs and body and carries it back to the hive where it is deposited in special cells. The pollen, mixed with honey and saliva, is called "bee bread" and is used for food.



EXPERIMENT 59 — The Stinger of the Bee

Materials:

Bee (only the workers and queen bee have stingers)
Glass slide
Cover glass
Forceps
Medicine dropper
Dissecting needle
Table lamp or desk lamp (or bright daylight)

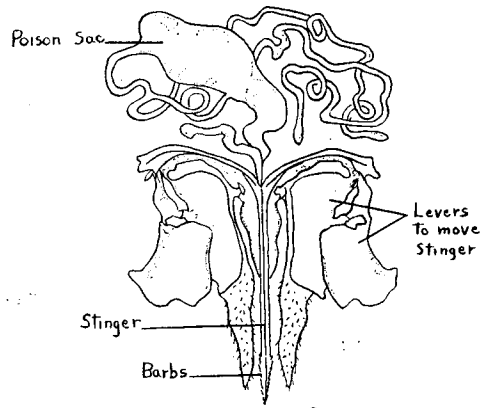
Directions:

1. Place the bee on its back on a glass slide.
2. With the side of the dissecting needle, press on the bee's body near the end. This pushes the stinger of the bee part way out.
3. With the forceps, gently pull the stinger out. If you pull very carefully, two feelers, or barbed darts on either side of the stinger, and the poison sack should come with it.
4. Place the stinger and the parts that are attached to it on a glass slide.
5. Place a drop of water on the stinger.
6. Place a cover glass over the stinger.
7. Place the slide on the stage of the microscope and examine the stinger, first with the low power and then with the high power.
8. Turn the mirror to obtain the best light.

Observation: The stinger is a hollow tube having rough edges at the end. There are two feelers on either side of the stinger which locate the place to be stung. There is a tube leading from the stinger to the poison sack. Muscles control the stinger.

When a bee stings another animal it usually dies because the stinger sticks in the skin of the animal and parts of its intestines and other organs are torn away with it.

The stinger of the queen bee is used for depositing eggs in the cells of the hive.



EXPERIMENT 60 — The Head of the Bee

Materials:

Bee
Glass slide
Forceps
Medicine dropper
Dissecting needle
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place the head of the bee on a glass slide and examine each of its parts with the low power and the high power.
2. With the forceps, gently remove the antenna (feelers) from the head and place them on a glass slide.
3. With the medicine dropper place a drop of water on the antenna.
4. Place the slide on the stage of the microscope and examine the antenna first with the low power and then with the high power.
5. Turn the mirror to obtain the best light.
6. Examine the other parts of the head listed below in the same way.

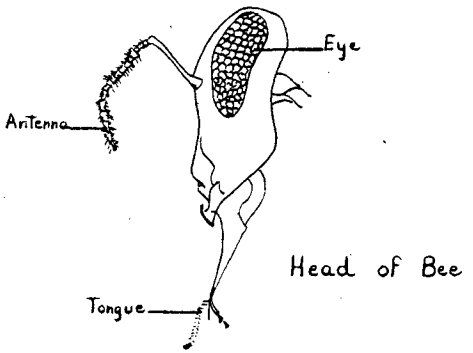
Observation:

Antenna, or feelers, are short and curved. Compare them with the antenna of other insects.

Compound Eyes are curved and contain many lenses. Compare them with the eyes of other insects.

Simple Eyes—Three simple eyes on top of head. Each contains only one lens.

Mouth Parts—Some mouth parts are fitted for chewing and cutting wax. Others are fitted for sucking nectar. The tongue is long, slender and flexible. The tip of it is rough so that it can hold nectar.



Head of Bee

EXPERIMENT 61 — Butterfly Wings

Materials:

Butterfly
Glass slide
Table lamp or desk lamp (or bright daylight)

Directions:

1. Place a piece of a butterfly's wing on a glass slide.
2. Place the glass slide on the stage of the microscope and examine the piece of wing, first with the low power and then with the high power.
3. Turn the mirror to obtain the best light.

Observation: The wing is covered with beautifully colored scales. Notice that the scales overlap like the shingles on a roof.

3. Tap the wing and shake some of the scales on the glass slide.
4. Examine the scales with the low power and the high power of the microscope.

Observation: Notice the color, shape and size of the scales.

5. Examine the eyes, antenna, mouth parts and legs of the butterfly with the low power and the high power of the microscope.
6. Examine different parts of a moth the same way and compare them with the butterfly and other insects.


Scales of Butterfly Wing

UNIT 9
STAINING

METHOD I

Material:

Small specimen (animal or plant cell)
Glass slide
Cover glass
Medicine dropper
Staining solution

Directions:

1. Place the specimen on a clean glass slide.
2. With the medicine dropper, place a drop of staining solution on the specimen.
3. Place a cover glass over the specimen.
4. Examine the specimen, first with the low power and then with high power.

METHOD II

Materials:

Thin specimen (parts of an insect or other thin objects)
Glass slide
Cover glass
Medicine dropper
Staining solution
Glass dish (in microscope set)
Forceps

Directions:

1. Place the specimen in the small round dish which you will find in your microscope set.
2. With the medicine dropper, cover the specimen with a few drops of staining solution.
3. Allow the specimen to remain in the staining solution for ten to fifteen minutes.
4. With the medicine dropper, draw off as much of the staining solution as possible.
5. Clean the medicine dropper with water and add several drops of alcohol to the specimen in the glass dish.
6. Allow the specimen to remain in the alcohol for about five minutes.
7. With the medicine dropper, draw off the alcohol.
8. With the forceps remove the specimen from the dish and place it on a glass slide.
9. Place a cover glass on the specimen and examine it, first with the low power and then with the high power.

METHOD III—TWO-COLOR STAIN

Materials:

Same as in Method II, but use two stains instead of one.

Directions:

1. Stain specimen as in Method II with one stain, following the directions through steps 1 to 8 inclusive.
2. Clean the small round dish.
3. Stain specimen again with the second stain as in Method II, following the directions through steps 1 to 9 inclusive.
4. Examination of the specimen will show two-color staining.

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NOTES

NOTES

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