EXPERIMENT MANUAL

TKx400i DUAL-LED MICROSCOPE

Instructions for using the microscope and the accessories included in the kit

Quickstart Guide: Descriptions of the permanent slide preparations and tips for initial investigations

THAMES & KOSMOS

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Safety Information

WARNING! This kit contains functional sharp edges or points. Do not injure yourself! Caution is required when handling the sharp dissecting needle, when cutting objects with the cutting tool or other blades, and when handling the fragile cover slips made of glass.

Never look directly at the sun either with the naked eye or through the eyepiece. There is a risk of blinding! Never leave the eyepiece unattended in the sun — it could cause a fire!

WARNING! Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled.

First check the list of parts to be sure all the correct parts are present in the kit.
Keep the packaging and instructions as they contain important information.

Rules for Safe Experimentation
→ Carefully prepare your work area for the experiments. Make sure you have enough room and get everything ready that you might need.
→ Perform the experiments calmly and carefully in accordance with the instructions.
→ Read the instructions before use, follow them, and keep them on hand for reference.
→ Do not use any equipment or materials other than those included in the kit or specifically mentioned in the instructions. Do not use any power supply other than what is indicated.
→ Do not eat, drink, or smoke in the experiment area.
→ If foodstuffs (such as fruit or vegetables) are used in the experiments, the part to be used should be separated from the rest before beginning the experiment. Material used in experiments should not later be consumed, and should be disposed of in the household trash after completing the experiment.
→ Some suggested objects of study may contain contents that are mildly toxic (such as ivy, tulip, etc.). It is therefore absolutely necessary to keep these away from your mouth and mucous membranes and to wash your hands after the experiments.
→ Keep small children and animals away while experimenting.
→ Store the experiment kit out of the reach of small children.

Dear Parents,

With this experiment kit, your child can discover the world of smallest things, the microcosm. Please be prepared to offer help and advice to your child when it may be required. A helping adult hand will be particularly important when it comes to preparing thin sections using the cutting device or a razor blade. You should also go through the steps in the instruction manual together with your child when performing the initial microscope setup. Please also check to make sure that the batteries are inserted correctly into the device. With a little practice, your child will soon be having fun studying objects and performing experiments independently.

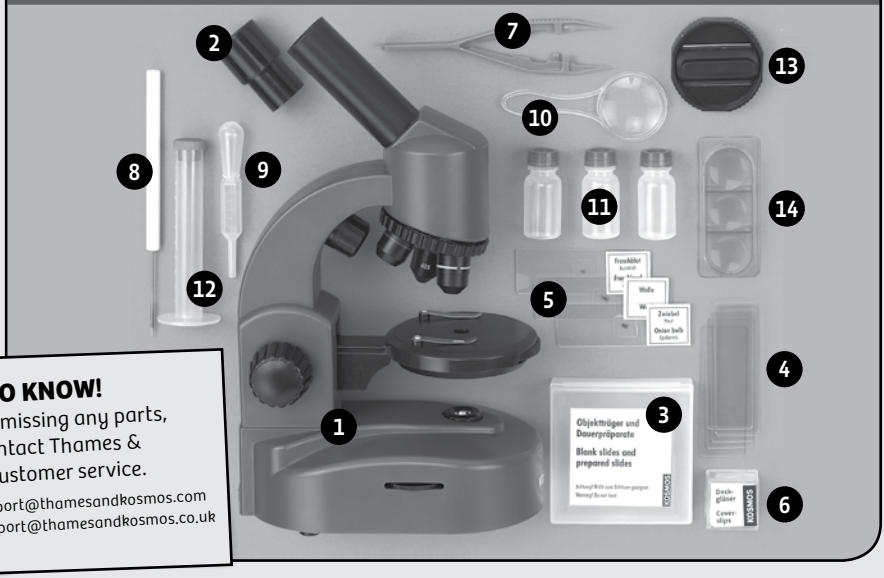
We wish you and your child a lot of fun with the experiments!

Safety for Experiments with Batteries
Three AA batteries (1.5-volt, type AA/LR6), which could not be included in the kit due to their limited shelf life, are required for use. • Non-rechargeable batteries are not to be recharged. They could explode! • To replace the 1-5-volt batteries: Remove all batteries from the battery compartment. Then insert new batteries. Always close battery compartments with the lid. • Batteries are to be inserted with the correct polarity. • Different types of batteries or new and used batteries are not to be mixed. • Do not mix old and new batteries. • Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries. • Exhausted batteries are to be removed from the toy. • Rechargeable batteries are only to be charged under adult supervision. • Rechargeable batteries are to be removed from the toy before being charged. • The supply terminals are not to be short-circuited. A short circuit can cause the wires to overheat and the batteries to explode. • Be sure not to bring batteries into contact with coins, keys, or other metal objects. • Do not throw batteries into the fire! • Avoid deforming the batteries. • Dispose of used batteries in accordance with environmental provisions, not in the household trash.

Notes on Disposal of Electrical and Electronic Components
The electronic components of this product are recyclable. For the sake of the environment, do not throw them into the household trash at the end of their lifespan. They must be delivered to a collection location for electronic waste, as indicated by the symbol shown here. Please contact your local authorities for the appropriate disposal location.

CONTENTS

What's inside your experiment kit:



GOOD TO KNOW!
If you are missing any parts, please contact Thames & Kosmos customer service.
US: techsupport@thamesandkosmos.com
UK: techsupport@thamesandkosmos.co.uk

Checklist: Find – Inspect – Check off

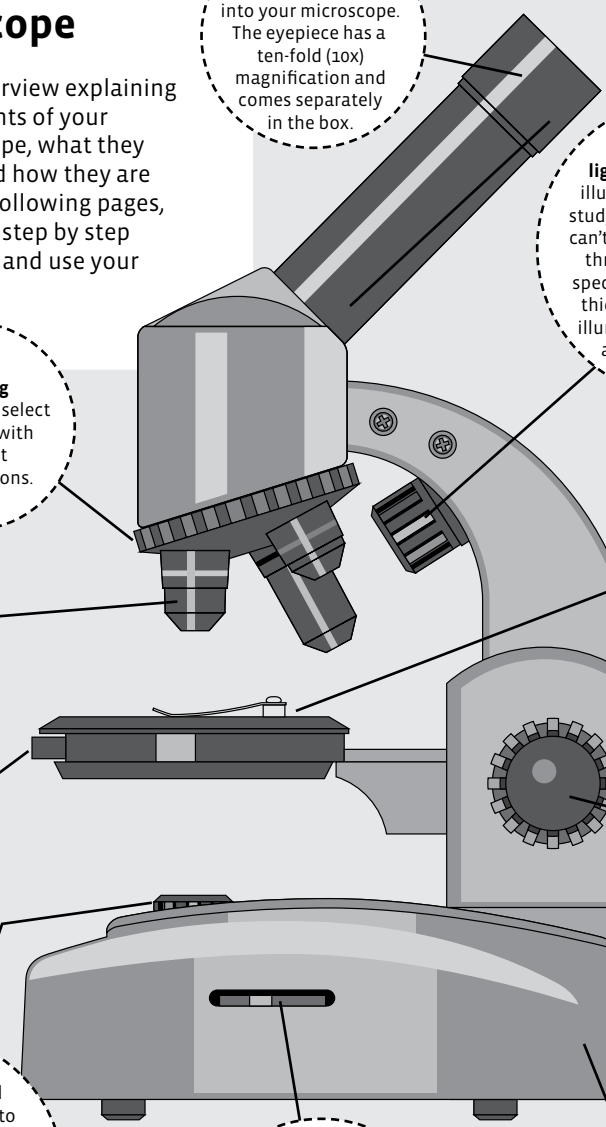
✔	No.	Description	Quantity	Order no.
☐	1	Microscope	1	717 161
☐	2	Eyepiece	1	718 090
☐	3	Box	1	717 834
☐	4	with specimen slides	10	
☐	5	and permanent mounts		
☐		Wool	1	718 086
☐		Onion skin,	1	718 087
☐		Frog's blood	1	718 088
☐	6	Box with cover slips		
☐		and sheet of labels	1	705 228
☐	7	Tweezers	1	705 321
☐	8	Dissecting needle	1	705 233
☐	9	Pipette	1	717 169
☐	10	Magnifying glass	1	717 170
☐	11	Sample container	3	717 172
☐	12	Graduated cylinder	1	717 175
☐	13	Cutting tool (microtome)	1	717 177
☐	14	Chambered sample box	1	717 178

You will also need:

Three AA batteries (1.5 Volt/LR6). In addition, you will need a variety of natural and household materials for some of the preparations. See the explanations accompanying the individual experiments.

Your New Microscope

Here is an overview explaining the components of your new microscope, what they are called, and how they are used. On the following pages, you will learn step by step how to set up and use your microscope.



Eyepiece: This is where you look into your microscope. The eyepiece has a ten-fold (10x) magnification and comes separately in the box.

Illumination unit for reflected light: This allows you to illuminate your objects of study from above when they can't be lit with light shining through from below. The specimen should not be too thick or large. This kind of illumination is only usable at low magnification levels.

Use the **revolving nosepiece** to select objectives with different magnifications.

Stage: This is where you clamp the slide holding your specimen, keeping it firmly in place.

Objectives: There are three different levels of magnification. Always start with the shortest one (lowest magnification).

Filter wheel: This rotating disk contains various colored filters and diaphragm openings for adjusting the light intensity.

Focus knob: A knob for adjusting the sharpness of the image.

The **illumination unit for transmitted light:** This allows you to illuminate your specimens when they are mounted on slides, such as your permanent mounts and other slide-mounted specimens you create yourself. The light shines through the specimen from below.

Use the **light adjustment knob** to switch on the LED and adjust its brightness. One side of the base controls the light transmitted from below, while the other controls the reflected light (from above).

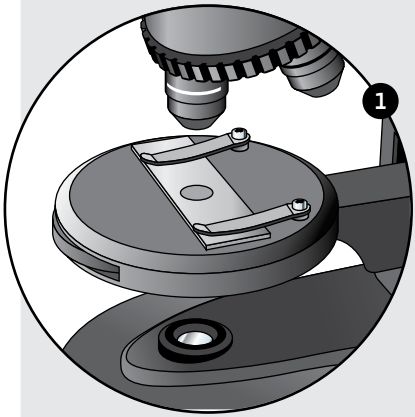
The base: You will find the **battery compartment** on the bottom. Be sure to remove the eyepiece before turning the microscope upside down.

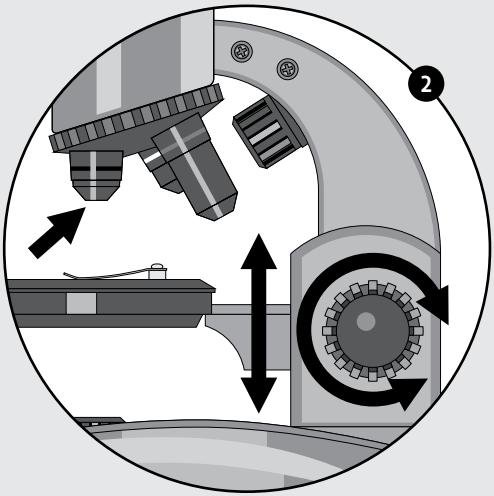
A First Look

Here's what you have to do to study an object under the microscope.

YOU WILL NEED

→ Microscope with batteries
→ Wool permanent mount (slide)





HERE'S HOW

1. Push the slide under the clamps on the stage. Turn on the illumination unit for transmitted light at a medium brightness setting by turning the light adjustment knob.

   The light should shine directly through the hole in the stage and through the center of the specimen on the slide.

   Adjust the filter wheel so that the light shines through the diaphragm opening with the largest hole.

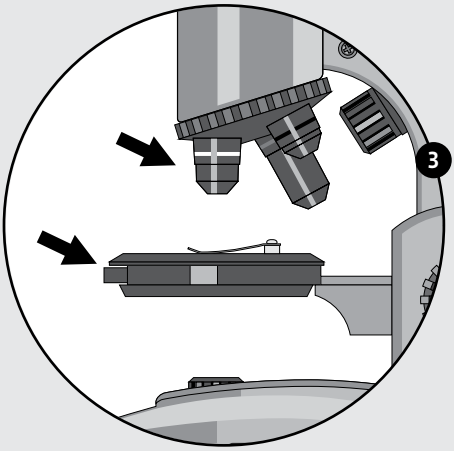
2. Turn the revolving nosepiece until it clicks into place in the position showing the lowest magnification (4x).

   Now rotate the focus knob until the objective is as close as possible to the slide.

   If you then look through the eyepiece while slowly moving the focus knob upward, a greatly-enlarged image of the wool fibers will suddenly appear as if from nowhere.

   Now study the fibers under 40-fold magnification (10x [eyepiece] times 4x [objective]).

   With the lowest degree of magnification, you can get an overview of the object by slowly moving the slide with your fingers. It's a little tricky at first, but you will soon get the hang of it.



3. Some structures will be easier to recognize if you use a color filter or a different diaphragm opening. Simply turn the filter wheel and see how the image changes.

   You will get a greater magnification if you turn the revolving nosepiece in a counterclockwise direction until it clicks into place again in a setting showing the next-higher magnification (10x, or 100-fold in total).

   If you look through the eyepiece now, you will quickly realize that you have to re-focus. Just turn the adjustment knob a little bit, though. That's normal, and you will have to do it again when you switch to the highest magnification (40x, or 400-fold in total).

→ HELP?!

Do you see nothing but blackness when you look through the eyepiece? In that case, the light is probably not on, or its light is not bright enough. It might be due to old or weak batteries. Or is it possible that the revolving nosepiece didn't click properly into place?

Is it bright enough when you look through the eyepiece, but you can't get a sharp image? The pictures on the following pages will show you what you should be seeing. If it isn't working, it might be because the specimen is not positioned directly under the objective. Nudge it a bit while looking through the eyepiece.

A common beginner's mistake is moving the focus knob too quickly. If you do that, you might not even notice when a sharp image briefly appears. Try it again!

→ TIP!

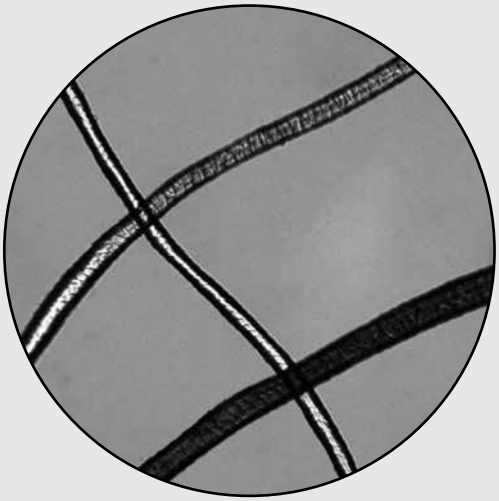
The objective with the greatest magnification is so long that it will hit the slide if the focus knob is turned all the way down. You should definitely avoid that, because it will smudge the objective lens or maybe even scratch it, and then you won't be able to see anything at all.

The Permanent Mounts

In your microscope kit, in addition to this manual, you will find a book titled “Microscopy” by Annerose Bommer. It describes all sorts of things that you can study under your microscope and explains how you can prepare your own microscope specimens. To help you get started right away, your kit contains three slides containing specimens that have already been prepared for you. These are called prepared mounts or permanent mounts. Read below to find out what you will be able to discover in them.

YOU WILL NEED

→ Microscope with batteries
→ Wool permanent mount



HERE’S HOW

1. Place the permanent mount under the microscope and adjust the focus as described on pages 6 and 7. Use the transmitted light unit on the base of the microscope and begin with the lowest magnification power.

2. Now, as you observe the wool fibers, you will notice that they are colored. After all, wool is made from the hairs of sheep, which can be white or black. In your permanent mount, the fibers have been dyed to give them better contrast and help you see more details. You will find thick and thin hairs in the specimen. The larger ones have a thick wall and are hollow in the center. Sometimes, you may also be able to see scales on the wall.

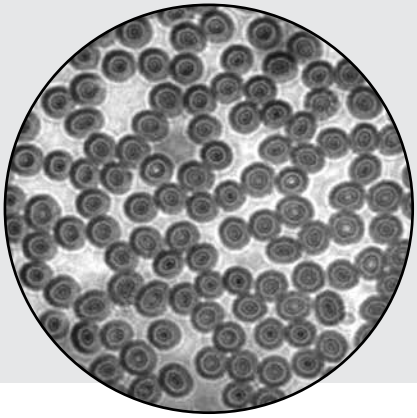
YOU WILL NEED

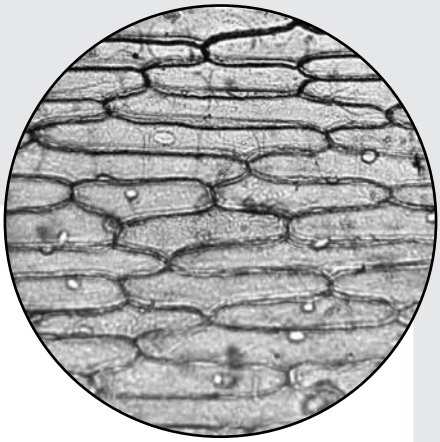
→ Microscope with batteries
→ Frog's blood permanent mount

HERE'S HOW

1. Place the permanent mount under the microscope and adjust the focus as described on pages 6 and 7. Use the transmitted light unit on the base and begin with the lowest magnification power.

2. In this permanent mount, a drop of blood was spread so thinly on the slide that you can recognize the individual red blood cells (also called red blood corpuscles). In the permanent mount, they look like circles or ovals with a wide border. Living red blood cells have the shape of a hard candy drop, round and flat with a thicker edge region — or a little like a donut without the hole. Depending on how the individual cells are arranged in the permanent mount, you will see them from above or at a slant from the side, which accounts for the various shapes you will see in the specimen. Red blood corpuscles are responsible for oxygen transport in the blood.





YOU WILL NEED

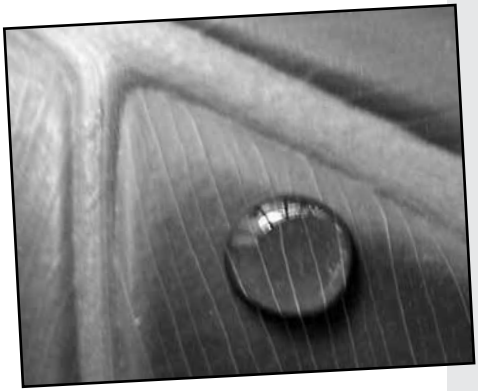
→ Microscope with batteries
→ Onion skin permanent mount

HERE'S HOW

1. Place the permanent mount under the microscope and adjust the focus as described on pages 6 and 7. Use the transmitted light unit on the base and begin with the lowest magnification power.

2. The onion skin is so thin that it consists of just one or two layers of cells. All plant cells have a wall made of cellulose, which builds a stable framework between the cells. You can recognize this quite easily in the permanent mount, with the individual cells appearing more or less hexagonal (six-sided). In your permanent mount, the cells were dyed so that the cell walls appear darker and you can see them more easily. In some cells, you will also be able to see round shapes. Those are the cell nuclei, where the chromosomes containing genetic material (DNA) are located.

CHECK IT OUT

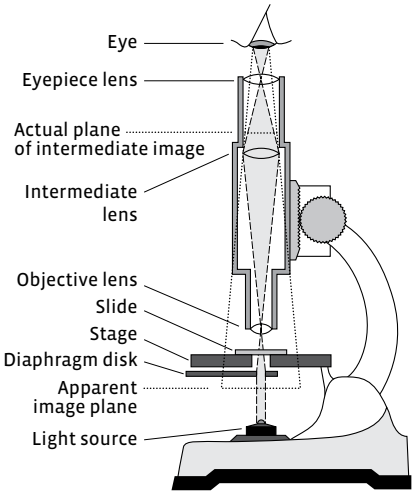


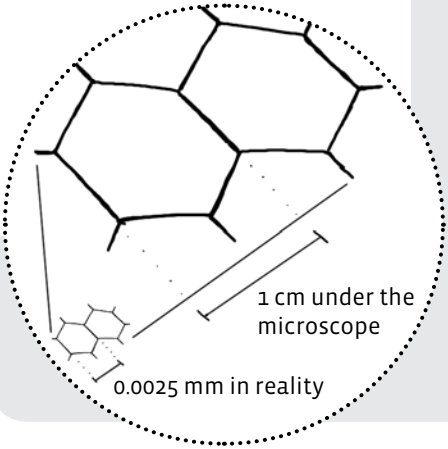
Lenses

Drops of water and curved pieces of glass have something in common: They magnify objects when you look through them. Curved pieces of glass are also known as lenses. Since the 19th century, when Ernst Abbe began improving the magnification power of lenses, not just by trial and error, but also through mathematical calculations, microscopes have become better and better.

But what exactly does "better" mean? Basically, it means getting a clearer and larger image through more skillfully shaped lenses and through the combination of various lenses. In your microscope, you will always be seeing the image through two lenses. One lens is located in the eyepiece, the other in the objective.

Each objective has a different lens, with each lens magnifying the slide specimen more strongly than the last. You can see the magnification written on the revolving nosepiece. Under the microscope's highest magnification, objects will appear 400 times larger. That means that two cells that seem to be 1 centimeter apart from each other under the microscope will actually be just 25 thousandths of a millimeter apart.





The "Macro" Function of your Microscope

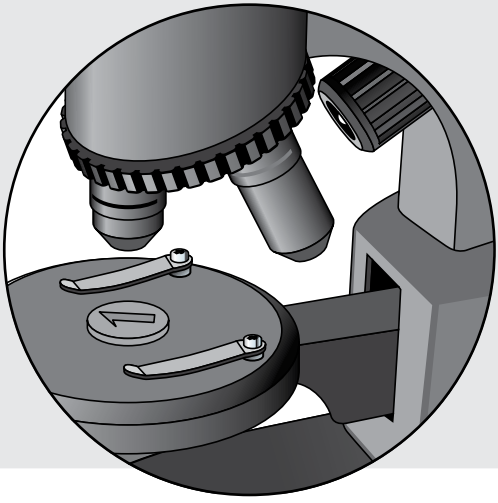
Up to now, you have familiarized yourself with the "normal" use of a microscope. Normally, you will study specimens on a glass slide that are so thin (or sliced so thinly) that light can shine through them from below. This also works for viewing microorganisms swimming in a drop of water, for example. This kind of microscopy is known as bright-field microscopy.

But you might sometimes want to study an object that is not small or thin enough to fit on a slide or for the light to shine through it — a leaf, a flower, a dead insect, or maybe a coin or a stamp. In such a case, you will only need a relatively low degree of magnification and light should shine on the object from above. This type of viewing of objects at magnifications of 40 times or less is sometimes called macroscopy, which is the viewing of objects that are visible with the naked eye, as opposed to microscopy, which is the viewing of objects that are too small to see with the naked eye.

There are special macroscopes for studying things like this, usually with 20-fold or 40-fold magnification and often with two eyepieces for binocular viewing, providing a three-dimensional image. Your microscope can do that too, though, in a simpler manner (at least for smaller and rather flat objects). For "macro" viewing, use the reflected light function of your microscope.

YOU WILL NEED

→ Microscope with batteries
→ Magnifying glass
→ Flat objects to study such as a leaf, flower, stone, coin, paper money, or stamp



HERE'S HOW

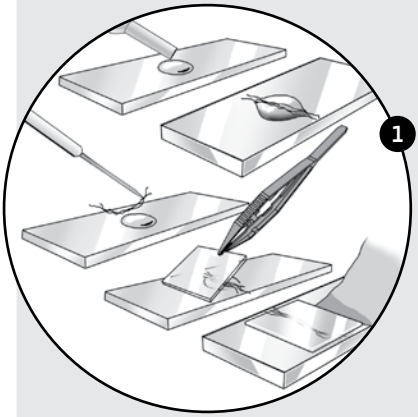
1. Start by studying your object under the magnifying glass. Which areas seem interesting enough to warrant investigation under greater magnification?

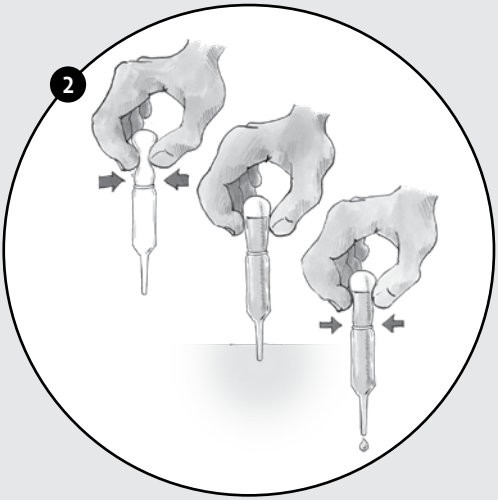
2. Turn your revolving nosepiece to the lowest level of magnification (red ring). The other objectives are not usable for "macro" viewing. Place your object of study on the stage and turn on the reflected light illumination unit.

3. Adjust the focus as you look through the eyepiece. Nudge the object to find the most interesting areas on its surface.

The Equipment

This section presents the items that you will find in your experiment kit and explains how to use them. These items constitute the basic equipment for all your microscopic investigations. Because they are used for the preparation of specimen slides, they are also called "specimen slide equipment."



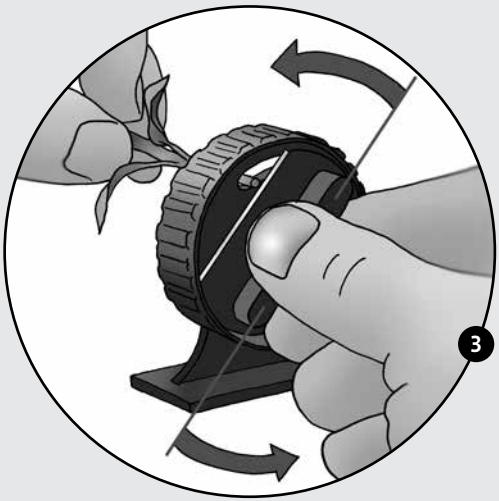


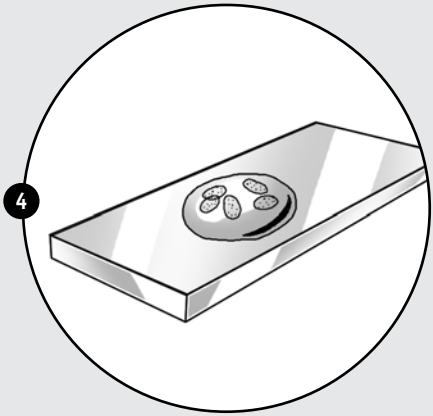
1. Without slides and cover slips, of course, you can't do much microscopic investigation. The slide serves as a foundation for all objects that you want to study under the microscope. The objects (with very few exceptions) should always be placed in a drop of water and covered with a cover slip. The illustration shows you how to do it. You will find examples of easy-to-prepare beginner's specimen slides starting on page 12 in the microscopy book.

2. For these initial specimens, you will also be using three additional specimen slide tools: the pipette, the tweezers, and the dissecting needle.

   The pipette is the standard tool for suctioning up a small quantity of liquid and transferring it to the slide or into another container.

   The tweezers and dissecting needle will help you grab very small objects, or position them or pull them apart on the slide. Be careful with the dissecting needle — it's really sharp! You can also use the tweezers to place the cover slip over the specimen. Just be careful, because cover slips break easily.





3. Your microscope makes it possible to see large images of tiny things. There are lots of objects that can be placed directly in a drop of water on the slide, covered with a cover slip, and then viewed under the microscope: strands of hair, material fibers, insect wings, strands of algae, and so on. To prepare a specimen like the permanent mount included in the kit, though, you will first have to get a little practice with one of the most important manual skills of microscopy: the preparation of thin sections.

   For viewing sections of an object under the microscope, they have to be thin enough for the light to shine through them. That means that we are talking about sections that are only about half a millimeter in thickness — or even thinner! The cutting tool included in the kit will help you prepare thin sections like that.

4. Get your slide ready and use the pipette to place a drop of water in the center of it. Now, for the cutting step, the most important thing you will need is patience! Not every slice will work. Some will be too thick, others uneven, others maybe too thin. Start by cutting several sections and place them in the drop of water on the prepared slide.

   Depending on the size of the sections, you will usually be able to fit more than one in a single water drop. The more sections you prepare, the better the chance that one will be usable.

→ TIP!

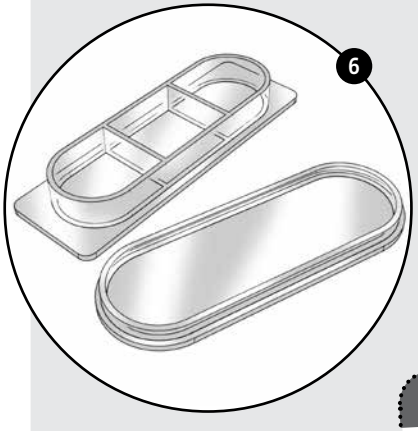
You will find a razor blade inside the cutting tool. It will gradually become less sharp over time, which will make it harder and harder to produce thin sections. You can replace the blade by loosening the screw and opening it, and exchanging a new, sharper blade for the old one. You should definitely have an adult help you replace the blade. Razor blades are extremely sharp!

5. In principle, you can take your microscope with you wherever you go. But to protect its sensitive optics and mechanics, it is best to use it on a table inside. The most interesting objects to investigate, though, will usually be found outside in nature.

   The colored microscopy book describes lots of objects of study that you can find on trees, in ponds, or in meadows. Your microscope kit contains some very handy sample containers for collecting water samples from a rain barrel, insect wings, or other interesting objects from outside and transporting them safely to your microscope.

6. Some water samples will be literally swimming with interesting things to study. For some of the larger creatures, you won't even need the microscope to view them. Use the sample container with the magnification lid to perform an initial sorting of your finds. Larger objects can be directly viewed under the magnifying lens in the lid.

   Pages 14 through 19 and 40 to 42 in the colored microscopy book will give you lots of ideas for projects using the accessories in your microscope kit.



→ TIP!

One final tip for taking care of your microscope: Always keep your microscope clean and free of dust. Only use a dry, very soft cloth to clean the lenses. Clean all items of equipment as soon as you have completed your microscopy project. The better you heed this advice, the longer you will be able to enjoy sharp, clear images from the micro-world.

CHECK IT OUT

Measurements under the Microscope

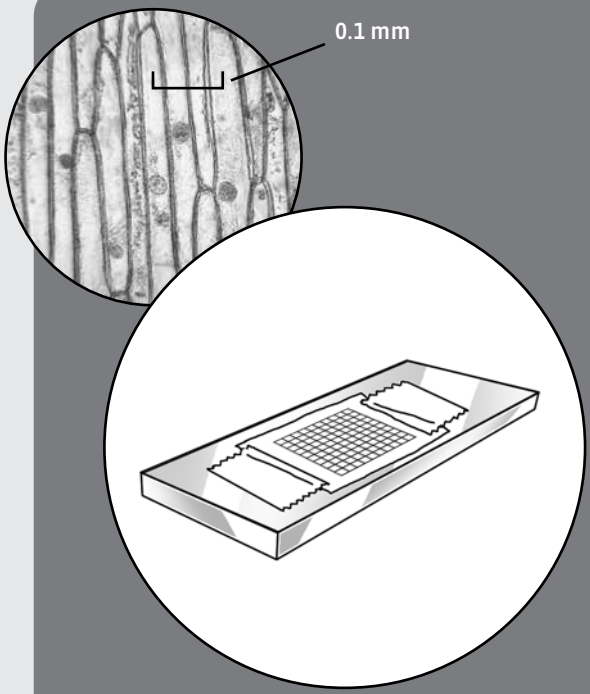
The classic method for "saving" awesome observations under the microscope is to draw what you see. You will find examples of good drawings in the colored microscopy book. In addition to an identifying description, a scientific drawing will always have a scale. The scale will help you reconstruct later on how large the studied object actually was. But how can you measure sizes under the microscope?

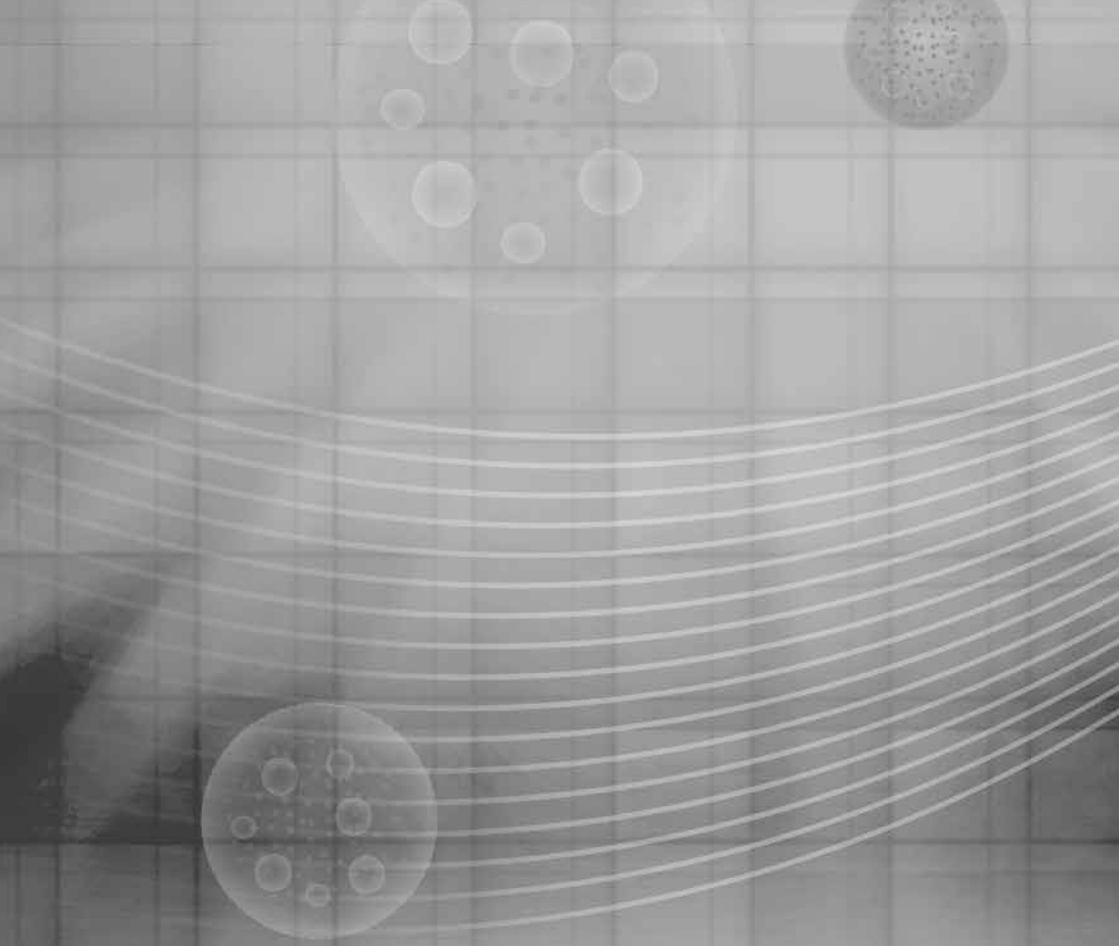
To see how, you will need: a slide, graph paper with one-millimeter squares, a permanent felt-tip marker (the thinner the better), a small piece of clear plastic film (a transparency sheet or a piece of clear plastic packaging, for example), a ruler, and transparent tape.

Place the piece of plastic film on the graph paper. Use the pen to draw the one-millimeter grid on the plastic film. Use the ruler to help you keep the lines straight.

Now tape the plastic film with the one-millimeter grid to the center of the slide.

Now, when you prepare a microscope specimen on this slide, you can easily estimate its size. The thin lines on the one-millimeter graph paper are only one millimeter apart.





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