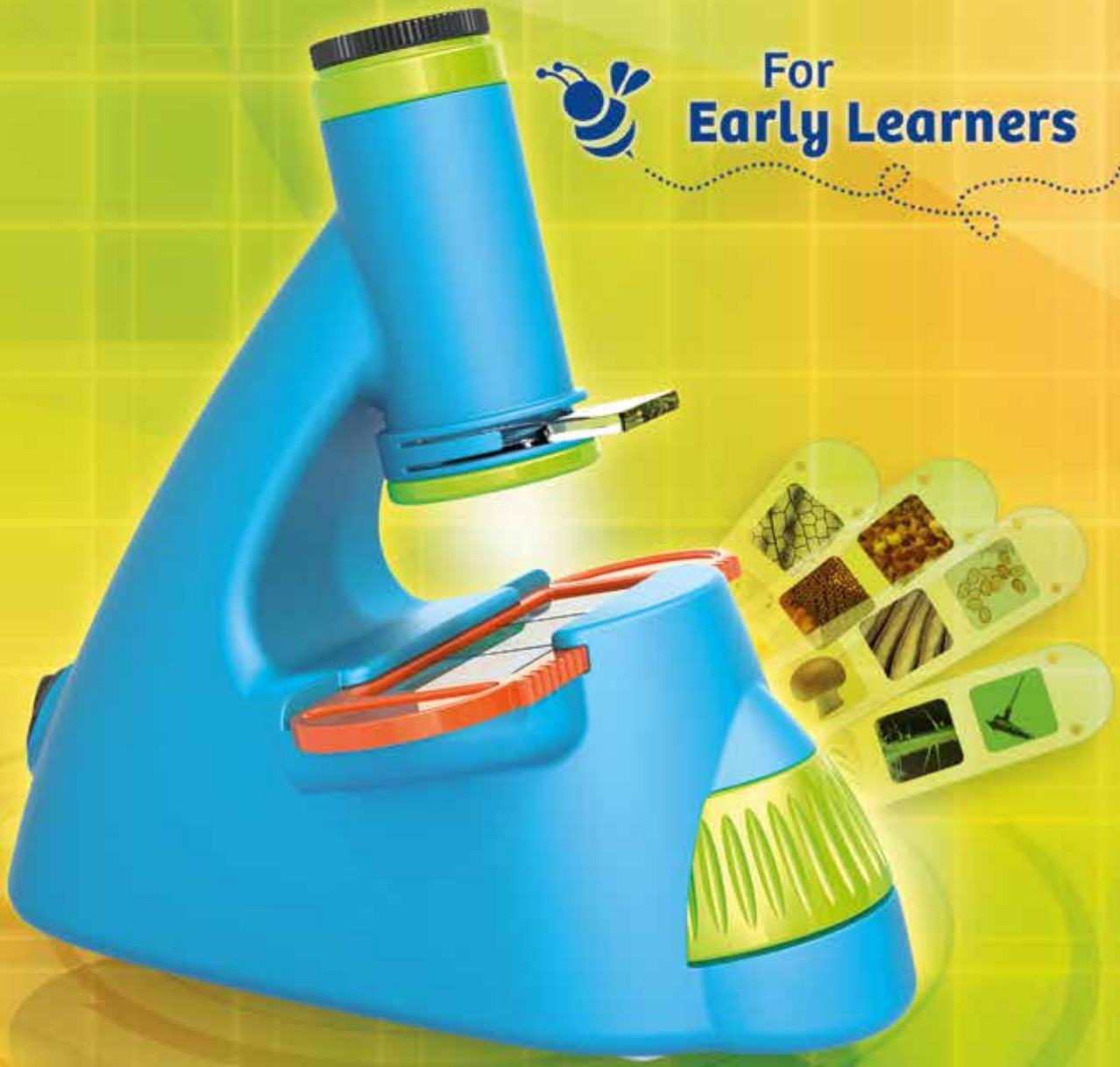
EXPERIMENT MANUAL

KIDS FIRST

BIG & FUN MICROSCOPE

For Early Learners



THAMES & KOSMOS

Franckh-Kosmos Verlags-GmbH & Co. KG, Pfizerstr. 5-7, 70184 Stuttgart, Germany | +49 (0) 711 2191-0 | www.kosmos.de
Thames & Kosmos, 301 Friendship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com
Thames & Kosmos UK LP, 20 Stone Street, Cranbrook, Kent, TN17 3HE, UK | 01580 713000 | www.thamesandkosmos.co.uk

GOOD TO KNOW! If you are missing any parts, please contact Thames & Kosmos customer service.

US: techsupport@thamesandkosmos.com
UK: techsupport@thamesandkosmos.co.uk

What's inside your experiment kit:

Checklist: Find – Inspect – Check off

✔	No.	Description	Count	Art-No.
❍	1	Microscope	1	720 609
❍	2	Specimen slide holder	1	719 359
❍	3	Specimen slide set (25)	1	719 362
❍	4	Lens/magnifying glass	1	719 361

Kosmos Quality and Safety

More than one hundred years of expertise in publishing science experiment kits stand behind every product that bears the Kosmos name. Kosmos experiment kits are designed by an experienced team of specialists and tested with the utmost care during development and production. With regard to product safety, these experiment kits follow European and US safety standards, as well as our own refined proprietary safety guidelines. By working closely with our manufacturing partners and safety testing labs, we are able to control all stages of production. While the majority of our products are made in Germany, all of our products, regardless of origin, follow the same rigid quality standards.

Project management, concept, and text: Sonja Molter
Technical product development: Sarah Trautner
Product design: Manuel Aydt, crosscreative designstudios, Pforzheim

Manual design concept: Atelier Bea Klenk, Berlin
Manual and packaging layout: Michaela Kienle, Fine Tuning, Dürmentingen
Manual illustrations: Andrea Mangold, München; Piktogramme S. 8, Aline Martin, 599media, Freiberg
Manual photos: instruction photos: picsfive (all pushpins); askaja (all paper clips); Jaimie Duplass (all tape strips); Matt Gibson, p. 29 center left bottom; Catalin Petolea, p. 29 center right top; Pavlo Baliukh, p. 29 top left; Yuri Kravchenko, p. 30 fly; Anton Watman, p. 31/32 pear; kukuruxa, p. 30 bottom left; LilKar, p. 30 bottom right; alslutsky, p. 31 top right; Eric Isselee, p. 31 top left; Mariusz Szczygie, p. 31/32 hazelnut; I wave, p. 32 top center right; Rawpixel.com, p. 32 center left; BlueOrange Studio, p. 32, umbrella; Cesarz, p. 32 shoes; Kichigin, p. 32 water; Johanna Goodyear, p. 8 preparation center; Lisa F. Young, p. 8 preparation top; Lab Photo, p. 8 preparation bottom; Daxiao Productions, p. 8 bottom right; beerkoff, p. 8 top; iordani, p. 8 bottom left; Dmytro Buianskyi, p. 9 (all previous © Shutterstock); Marco Almbauer, p. 29 center bottom; Louisa Howard, p. 30 top right; Amanda44, p. 30 center right; Cepolina family and friends, p. 30 hawkmoth (all previous © Wikipedia public domain); Marc Davis, p. 32 top left; Big Ben, p. 32 top center left (all previous © Wikipedia CC BY-SA 2.0); MichaelMaggs, p. 29 mushroom; burgkirsch, p. 29 top right; André Karwath aka Aka, p. 29 bottom left; Unistudent119, p. 30 bumblebee (all previous © Wikipedia CC BY-SA 2.5); Prof. emeritus Hans Schneider, p. 29 bottom right; Simone Beyer, p. 30 moth; Chrumps, p. 30 scarab beetle; JJ Harrison, p. 30 soldier beetle, p. 32 amethyst; Beentree, p. 30 top left; Bernd Haynold, p. 30 lichens; Schnobby, p. 31/32 currants; Fir0002, p. 31/32 raspberries; Rlaferla, p. 31/32 strawberries; Fred Hsu, p. 31/32 melon; Lucy Merriam, p. 32 top right; Rob Lavinsky/iRocks.com, p. 32 fluorite; Robert Wetzlmayr, p. 31/32 coconut (all previous © Wikipedia CC BY-SA 3.0); Augustus Binu, p. 31/32 banana (all previous © CC BY-SA Wikipedia 4.0); Michael Flaig, Stuttgart, p. 3; Dr. Mark Bachofer, Stuttgart, p. 8 resolution

Specimen film photos: jocic, bee left; John Steel, skin left; Peter Kotoff, mr; charnsitr, center left; Hintau Aliaksei, dragonfly left; WhiteHaven, r; yevgeniy11, sunflower left; Volosina, honey left; EM Arts, boletus mushroom left; Roman Samokhin, kiwi left; schankz, center; Eric Isselee, spider left; Dattenfeld, agaric mushroom left; James Wolfisz, dandelion seed head left; Potapov Alexander, center; chinahbzyg, nylon center; Cesarz, left; Tsekhmister, rabbit left; bergamont, corn left; Arun Romkaew, center; Svetlana Foote, bellflower left; Tomatito, fly right; irin-k, left; Mega Pixel, sugar left; Cornel Constantin, lichen center; Arjen de Ruiter, left; D. Kucharski K. Kucharska, right; Mr. SUTTIPON YAKHAM, salt left; Petr Salinger, dead-nettle left; kzww, feather left; Ines Behrens-Kunkel, dandelion left; Roman Pelesh, stinging nettle l (all previous © Shutterstock); Siga, bee m (previous © Wikipedia public domain); Gilles San Martin, bee right; Jason Hollinger, button mushroom m (all previous © Wikipedia CC BY-SA 2.0); J. E. Lange, button mushroom right; JJ Harrison, fly center; Roland zh, sunflower center; Michael Schönitzer, right; Lucarelli, spider center; Olei, right; Thiers, boletus mushroom center + right (all previous © Wikipedia CC BY-SA 3.0); Wanderfee11, honey right; Frank Vincentz, dandelion seed head right (all previous © CC BY-SA Wikipedia 4.0); all others: Dr. Mark Bachofer, Stuttgart

Packaging design concept: Peter Schmidt Group GmbH, Hamburg
Packaging photos and illustrations: boy, Rob Hainer (© Shutterstock); microscope, Elena Ryvkin, Stuttgart; picture of components, Michael Flaig, Stuttgart; pictograms, Aline Martin, 599media, Freiberg; specimen films, see above
The publisher has made every effort to locate the holders of image rights for all of the photos used. If in any individual cases any holders of image rights have not been acknowledged, they are asked to provide evidence to the publisher of their image rights so that they may be paid an image fee in line with the industry standard.

1st English Edition © 2018 Thames & Kosmos, LLC, Providence, RI, U.S.A.
® Thames & Kosmos is a registered trademark of Thames & Kosmos, LLC.
Editing: Camille Duhamel and Ted McGuire; Additional Graphics and Layout: Dan Freitas

Distributed in North America by Thames & Kosmos, LLC. Providence, RI 02903
Phone: 800-587-2872; Web: www.thamesandkosmos.com

Distributed in United Kingdom by Thames & Kosmos UK LP. Cranbrook, Kent TN17 3HE
Phone: 01580 713000; Web: www.thamesandkosmos.co.uk

We reserve the right to make technical changes.

Printed in China / Imprimé en Chine

››› TABLE OF CONTENTS

TIP!
You will find additional information in the **Check It Out** sections on **pages 8, 29, 30, 31, and 32.**

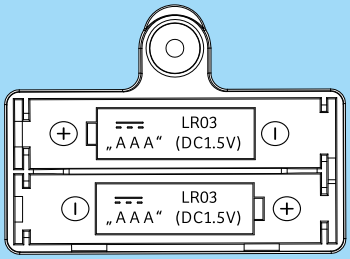
You will also need:
2 AAA volt batteries (1.5 volt, type LR03) and a small Phillips-head precision screwdriver, or jeweler's screwdriver

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

Safety Information

Inserting and Changing Batteries

Open the compartment on the bottom of the microscope with a screwdriver. Insert two AAA batteries (1.5 volt, type LR03) in the correct polarity direction, as indicated. Then close the battery compartment and tightly screw on the lid.



Notes on Handling Batteries

››› Avoid short-circuiting the batteries. A short circuit could lead to overheating and battery explosions.
››› Different types of batteries (rechargeable and non-rechargeable) 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.
››› Batteries are to be inserted with the correct polarity. Press them gently into the battery compartment.
››› Non-rechargeable batteries are not to be recharged. They could explode!
››› Rechargeable batteries are only to be charged under adult supervision.
››› Rechargeable batteries are to be removed from the toy before being charged.
››› Exhausted batteries are to be removed from the toy. Follow the above instructions when changing batteries.
››› 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!
››› Dispose of used batteries in accordance with environmental provisions, not in the household trash.
››› Avoid deforming the batteries.

Disposal of 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 following symbol:

Please contact your local authorities for the appropriate disposal location. Protect the instrument (microscope) from moisture. Return all parts to the package after use. Clean the parts by wiping with a damp cloth. Do not immerse microscope in water. Keep the packaging and instructions as they contain important information.

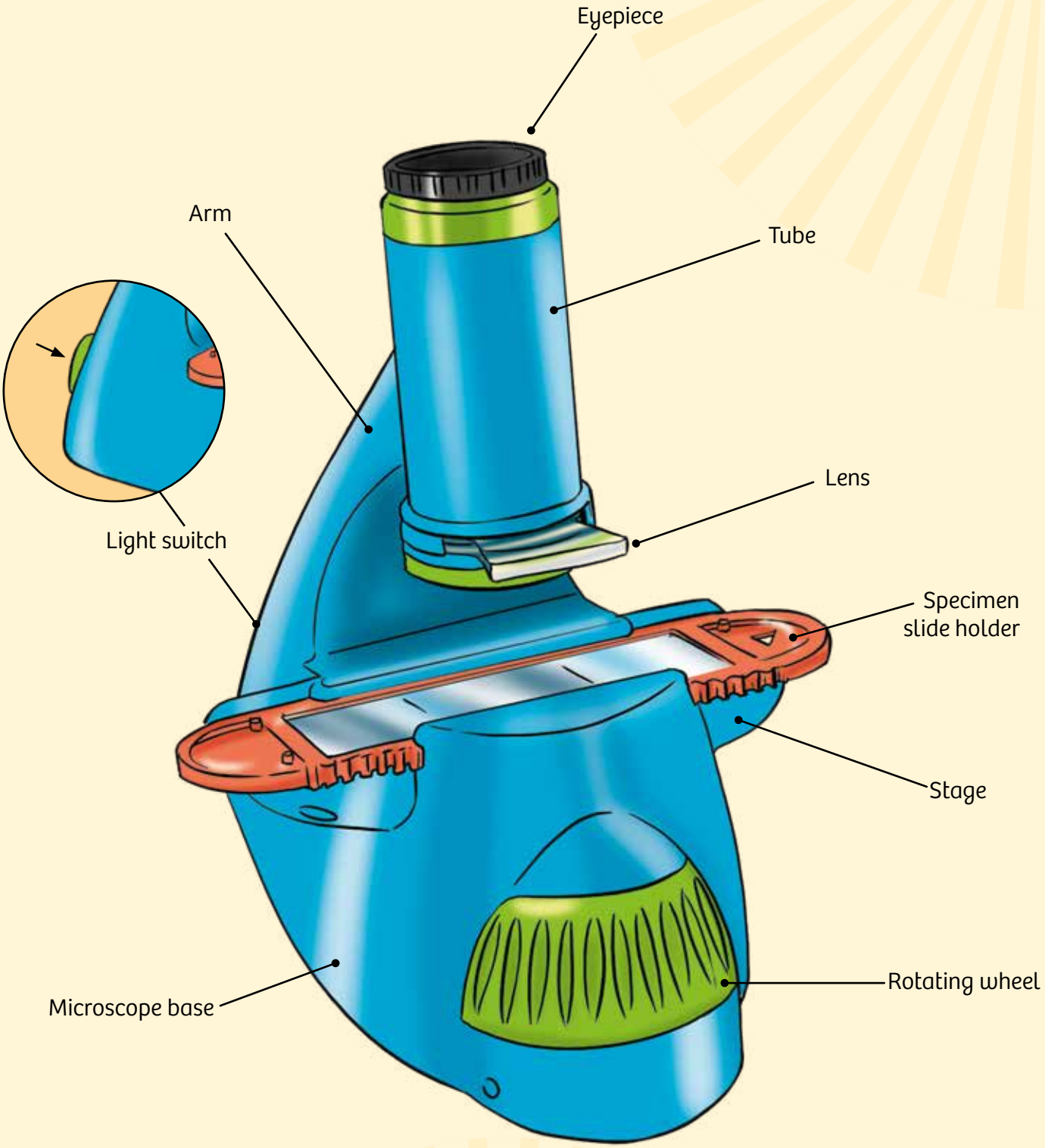
Dear Parents,

This microscope will let children ages 4 and up experience the world of tiny things. Please read through all the information on this page before you begin this adventure with your child. This manual contains two parts. The first deals with assembly, handling, and use of the microscope, and the second contains an exciting illustrated, read-aloud story that will stimulate participation and is highly instructive at the same time. The contents of the 24 printed specimen slides all have a part to play in the illustrated story, which combines play and exploration to bring the entire family together. Keep the microscope handy while reading the story. At the bottom of the page, you will find illustrations of the matching specimen slides to observe under the microscope with the corresponding story section. An additional blank specimen slide is provided in the kit — intended for your own collected specimens. Flat objects such as hair, paper, and leaves can be placed on the slide and observed under the microscope. That way, the fun and discovery can continue. As you dive into the microcosm with your child, you too will learn all sorts of fascinating things that you never knew: Each chapter closes with a Check It Out section containing extra information that is exciting for children and adults alike.

We hope you and your child have lots of fun with the illustrated story and the microscope!

Your Microscope

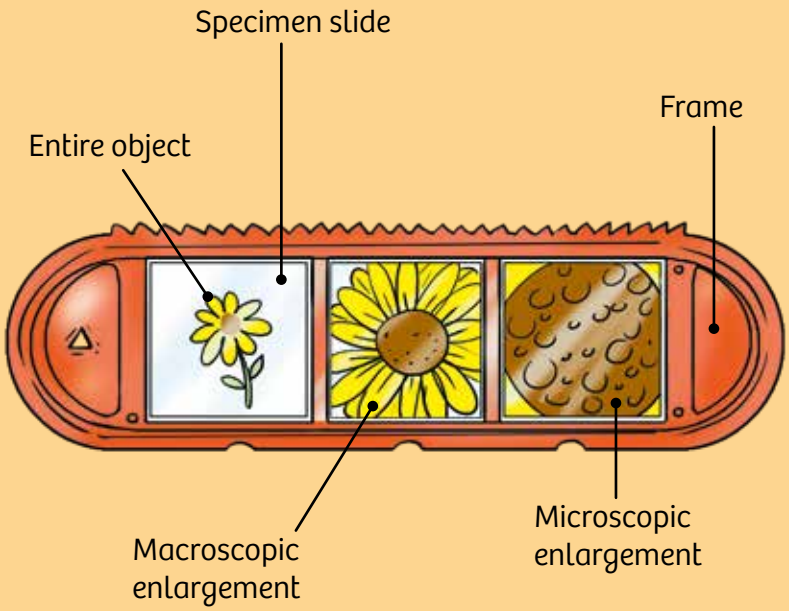
The parts of your microscope



SPECIMEN SLIDE HOLDER

Specimen slide holder

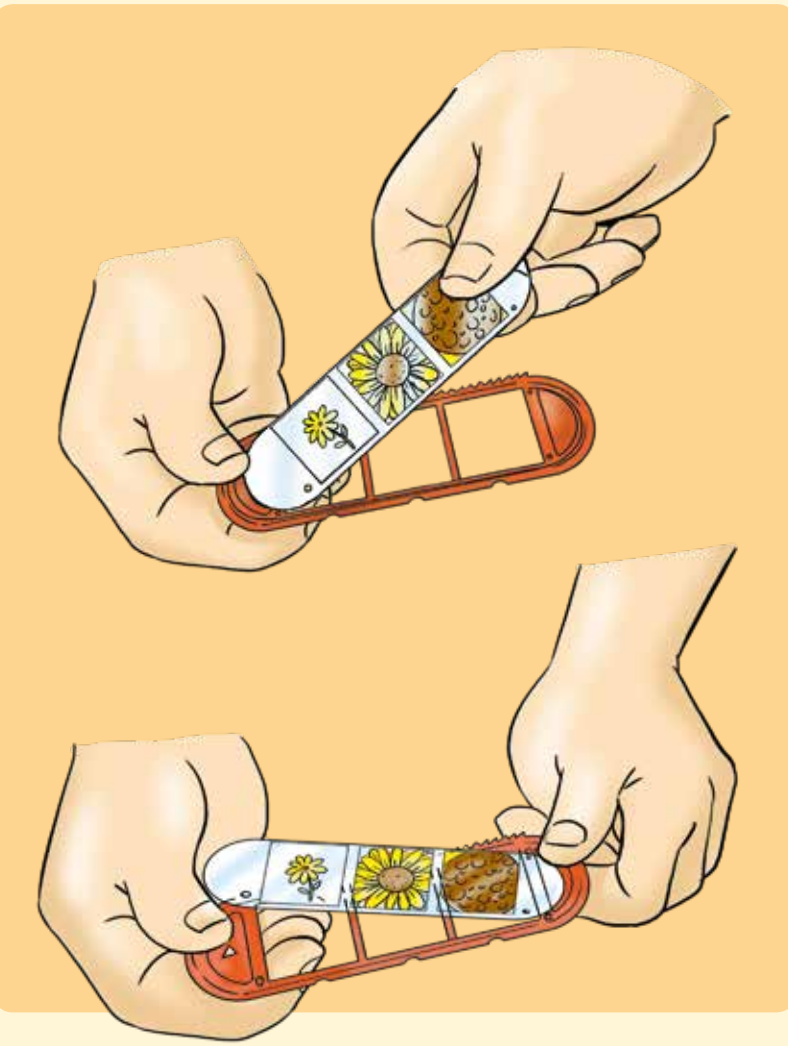
The specimen slide holder acts as the frame for the specimen slides. This is where you place the slide you would like to view under the microscope.

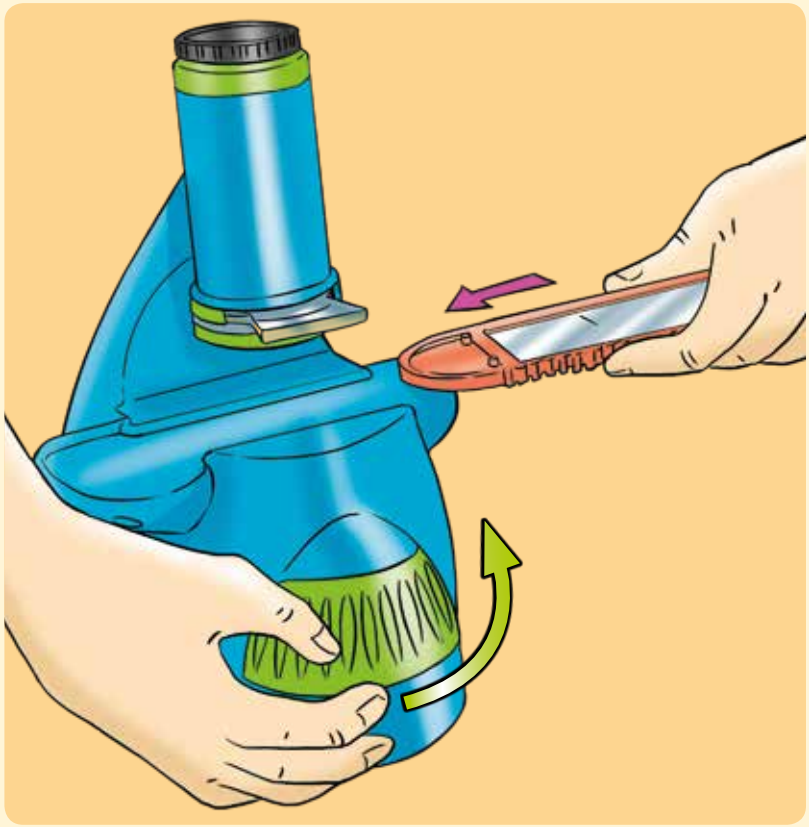


Inserting and removing the specimen slide

The slide and the slide holder each have a triangle on one side. The slide must be placed on the slide holder such that the slide's green triangle lies on top of the triangular hole of the slide holder. Then the three small holes in the slide will also be in the right position — on the slide holder's three retaining pins.

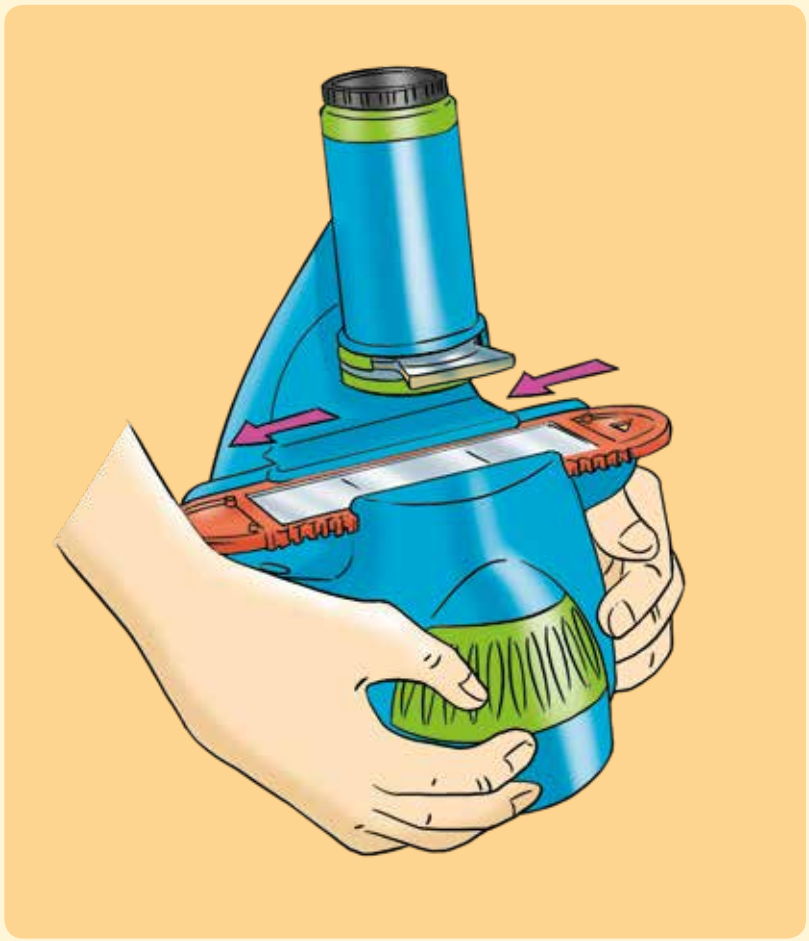
To remove the slide, simply push from below through one of the slide holder's openings against the slide.





Inserting the specimen slide holder

Push the specimen slide holder with the slide into the microscope's slide holder track from the side, and dial it in by turning the rotating wheel.



Moving the specimen slide holder

To switch from one enlargement level to the next, turn the wheel to move the slide holder to the right or left.

SPECIMEN SLIDE HOLDER

Switching on the light

Push the switch on the back of the microscope to turn the light on or off.

Looking through the eyepiece

The best technique is to close one eye and look through the eyepiece with the other. But you can also keep both eyes open. Try practicing a little — you will soon get the hang of it!

Inserting the lens

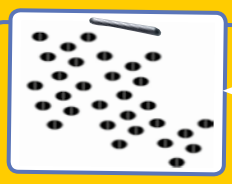
Your microscope has a built-in 4x magnification. This means the image of the object viewed through the eyepiece appears to be enlarged about four times more than the object on the slide. You can double this to 8x by snapping in the insertable lens, which has a 2x magnification power. Then, your microscope will enlarge images about eight times. You can also use this lens independently as a magnifying glass. Try looking at objects at various magnifications.

CHECK IT OUT

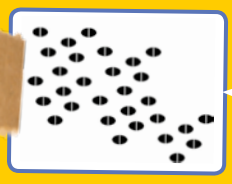
Microscopy

MICROSCOPE

Scientists use microscopes primarily in biology and medicine. These instruments help them to see things that cannot be seen with the naked eye. Most people are familiar with an optical microscope, which uses light for viewing the object. But there are also electron microscopes, which work differently from optical microscopes.



Low resolution



High resolution

RESOLUTION AND MAGNIFICATION

Many people believe that the quality of a microscope can be determined by its highest degree of magnification. But that is not really true. Much more important is the resolution, or how sharp the image is, which is determined by the quality of the individual lenses and their refractive power. In the example on the left, with a bad lens you might only see a single dot with slightly blurry edges. If the same object is viewed under a higher-quality lens, however, you will see two dots close together with a noticeably sharper border.

PREPARING SPECIMENS

With many scientific microscopes, specimens first have to be prepared for viewing. If they are going to be translucent, they have to be very thin. That means that experts have to prepare precise slices of the specimen using a sharp blade. This part of microscopy is very time-consuming and must be performed correctly if the specimen is to be recognizable under the microscope.

Promoting children's abilities

Learning to use a microscope helps children learn many important skills:

- Fine motor skills and the ability to perform precise movements
- Hand-eye coordination
- The ability to abstract
- An understanding of nature
- Perception skills, concentration, patience, logic, and the ability to solve problems

Microscope Adventure: Where Is Hopper?

Where Is Hopper?

Meet Lisa and Jon. They live with their parents and their little rabbit, Hopper, in a pretty house with a garden. Behind the house, there is a path leading to the woods, meadows, and fields. Jon and Lisa often take walks there with their parents.

"We're taking Hopper to play on the grass!" called Lisa to her parents.

"Okay, but sit with him in the garden and make sure that he doesn't run away," their mom called back.

"OK!" answered Jon.

As they walked out the door, Jon grabbed the microscope that belonged to both him and Lisa, while Lisa carried Hopper in her arms.

While Hopper hopped around happily on the lawn, Jon and Lisa sat down on the grass with their microscope and watched the rabbit for a while. Their dad brought them a container of fruit.

"Thanks, Dad," said Lisa and Jon.

"Hey look, a feather!" said Jon.

"Let's look at it under the microscope," suggested Lisa.

Jon and Lisa set up the instrument on the ground and looked through the eyepiece.

"Interesting," exclaimed Lisa. "It looks a little like a zipper!"

You can see for yourself by placing the slide holder with the feather slide under the microscope and taking a look. What do you see?

"Come on, let's take a look at my zipper for comparison," said Lisa as she pulled off her sweater.

The children were eager to see how the zipper looked under the microscope. And Lisa was right — the barbs of the feather really did look like a zipper.

Jon ran his finger over an opening in the feather. "You can even close it again by running your finger across it. Look — just like a real zipper!"

Do you think someone might have figured this out by observing feathers in nature?

The two siblings were totally fascinated and absorbed in looking at the feather and zipper under the microscope.

Suddenly Jon cried out in horror, "Where is Hopper?"

The children looked all around the garden but couldn't find their rabbit anywhere.

"He must have run away!" cried Lisa.

"Oh no, the garden gate is open!" cried Jon, pointing to the wide-open gate leading to the path.

In a rush, the children ran through the gate, calling for Hopper — Jon still holding the microscope and Lisa clutching the container of fruit.

Feather

Zipper

Hopper was not on the path nor anywhere nearby. He couldn't have fallen in the pond, could he? Jon and Lisa anxiously approached the water and peered in.

"No, not here either," concluded a relieved Jon.

"But look — there are dragonflies all over the place!" said Lisa, watching the elegant insects as they zoomed around.

"They have such delicate shimmering wings!" she said excitedly.

"I wonder how they would look magnified," wondered Jon.

You can see for yourself by placing the dragonfly specimen slide under your microscope.

Finally, the children returned to the path and looked around. Hopper must have run farther along. So Jon and Lisa kept walking.

Dragonfly

The children approached the first trees along the edge of the woods, where the fork in the path led to the road. A little way ahead of them, they saw a woman carrying a cloth bag picking plants along the edge of the path.

"The lady is touching the stinging nettles!" cried Jon in horror.

"Those are white dead nettles," said the woman, who heard Jon's cry. She handed him one of the plants. "But there are also stinging nettles growing over there at the edge of the woods. I'm going to collect some of them too."

"Oh," said Jon, taking the nettles cautiously in his hand. Nothing happened even though he was afraid of being stung. "I'll look at these under the microscope," he said.

The woman put on a pair of gloves and pulled a stinging nettle out of her pocket. "Here, you can take a look at this too, but be careful." Lisa took the stinging nettle using her shirt to protect her hand.

"The leaves do look similar, but the dead nettle has no stinging hairs," explained the woman.

"Why are you collecting them?" asked Lisa.

"Because both are delicious herbs, and both make excellent tea," answered the woman.

"Did you see a rabbit come hopping by here?" asked Lisa.

"No, I'm afraid not," answered the woman. So Jon and Lisa continued on their way along the path.

Dead nettle

Stinging nettle

They came to the fork in the path along the edge of the woods.
"Which way?" asked Lisa as they both looked around for signs of Hopper.

"I hope he didn't run into the road!" said Jon anxiously, casting a glance in the direction of the cars rushing by.

"There!" cried Lisa as she picked up a hair from a branch on the path leading toward the woods.

"Here's another one!" yelled Jon as he picked up a hair from the path leading toward the road. "We'd better look at them under the microscope. Maybe we will be able to tell if one of these is Hopper's hair."

Jon and Lisa took turns looking at the two hairs.

Help them by looking at what they found under your own microscope. Look for the right specimen slides by checking the pictures.

Rabbit hair

Artificial fiber

So, do you know which path Jon and Lisa have to take to find Hopper? The path towards the woods!

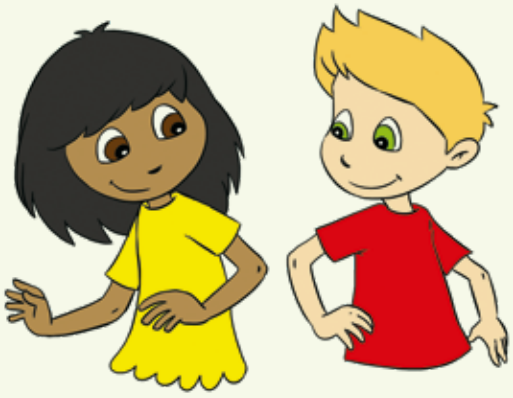
"This one isn't a hair at all," said Lisa, who recognized the artificial fiber right away under the microscope.

"So Hopper must have run into the woods," said Jon, pointing in the direction from which the rabbit hair came.

The children set forth, hoping very much to find Hopper soon.

"I wonder what our own hairs look like under the microscope? Do you think they would look like Hopper's?" asked Jon.

"Who knows?" said Lisa. "But we can take a look."



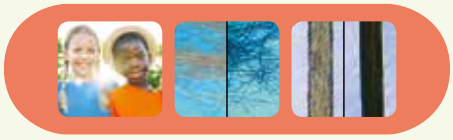
What do you see under your microscope? Can you see a difference between Lisa's and Jon's hairs and the rabbit's hair? Do the blond and the black hair look the same?

Lisa and Jon continued along the path. Hopper was still nowhere to be seen.

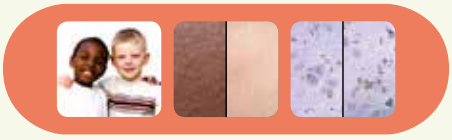
"That was interesting looking at our hairs," said Lisa. Then she looked at her skin pensively. "It must be like that with our skin too."

So, do you think she's right? Or are these two things totally different? Take a look for yourself.

Human hair



Skin



"Agh!" cried Jon suddenly.
"What's wrong?" asked Lisa.
"I walked into a spider web!"

The spider web got stuck to Jon, so Lisa tried to wind it up with a stick.

"So," she said as she finished, "shall we take a closer look at it? There's a spider there too!"

While the children were investigating the spider web, they heard someone whistling happily in the woods. As they approached, they saw a man collecting mushrooms from the forest floor.

When he saw the children, he said "Hello! What are you doing out here in the woods?"

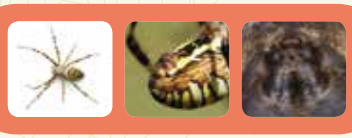
"We are looking for our rabbit, Hopper," Jon answered.

"I'm afraid I haven't seen him," said the man. Then he began to laugh as he noticed the spider web that the children were holding. "There are lots of spiders in these woods. But at least they don't eat the good mushrooms. A lot of insects do. Flies, for example."

"But aren't spiders insects too?" asked Lisa softly.

"No, no," answered the man. "Spiders are a separate group. You can tell because they have eight legs. Insects have just six — and they usually have wings as well."

Spider



"Right, insects have six legs and wings," said Lisa as she recalled the dragonflies at the pond.

"And insects have very special eyes, called compound eyes," said the man, passing the two children a dead fly that he found on a mushroom.

Jon was a little grossed out by the dead fly, but curiosity got the better of him. He took the fly and looked at it under the microscope.

"What kind of mushrooms are you collecting?" Lisa asked the man.

"These are porcini. They are really delicious. And a little while ago I also found some wild button mushrooms. But when you collect those you have to be very careful not to confuse them with poisonous death caps. You really have to know your stuff."

He showed the children the mushrooms he had collected.

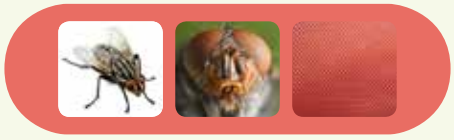
"Take a look at them under your microscope," suggested the man. "The porcini are from the genus *Boletus*, while button mushrooms are in the genus *Agaricus*, also known as gilled mushrooms — they have gills." He pointed to the underside of the caps.

"That is fascinating," said Jon and Lisa together.

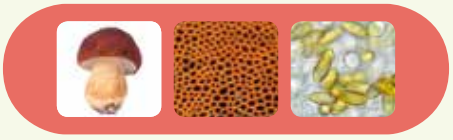
They returned the man's mushrooms and set out on the path again.

"Good luck finding your rabbit!" said the man as they set off.

Fly



***Boletus* mushroom**



***Agaricus* mushroom**

The children did not get far before they saw a gray-haired man in the distance. As they approached, they saw that he was a forest ranger examining a tree.

He noticed Jon and Lisa and looked pleased. "Oh, hello you two. Can you give me a hand? My eyes aren't what they used to be and my back is hurting today, so I can't see the lichens very well down here at the base of the tree. Would you be willing to count them for me?"

Jon and Lisa hurried up to the man to help him. "What on Earth are lichens?" asked Jon bashfully. He wasn't at all sure what he was supposed to do.

The ranger smiled kindly and explained, "Lichens are these patches here on the tree bark, you see?"

Jon nodded.

"They are organisms formed from a combination of plants and fungi, and they can provide an indication of the air quality in this region."

"Oh, does that mean that fungi are not actually plants?" asked Lisa.

"Exactly right. Fungi are fungi and plants are plants," said the man.

"And animals are animals," Jon said, then laughed.

The man laughed too and said, "Good point! You may find this hard to believe, but it's true: mushrooms and other fungi are actually more closely related to animals than they are to plants."

Jon and Lisa were astonished to hear that.

"And the lichens tell you if the air is good?" asked Lisa.

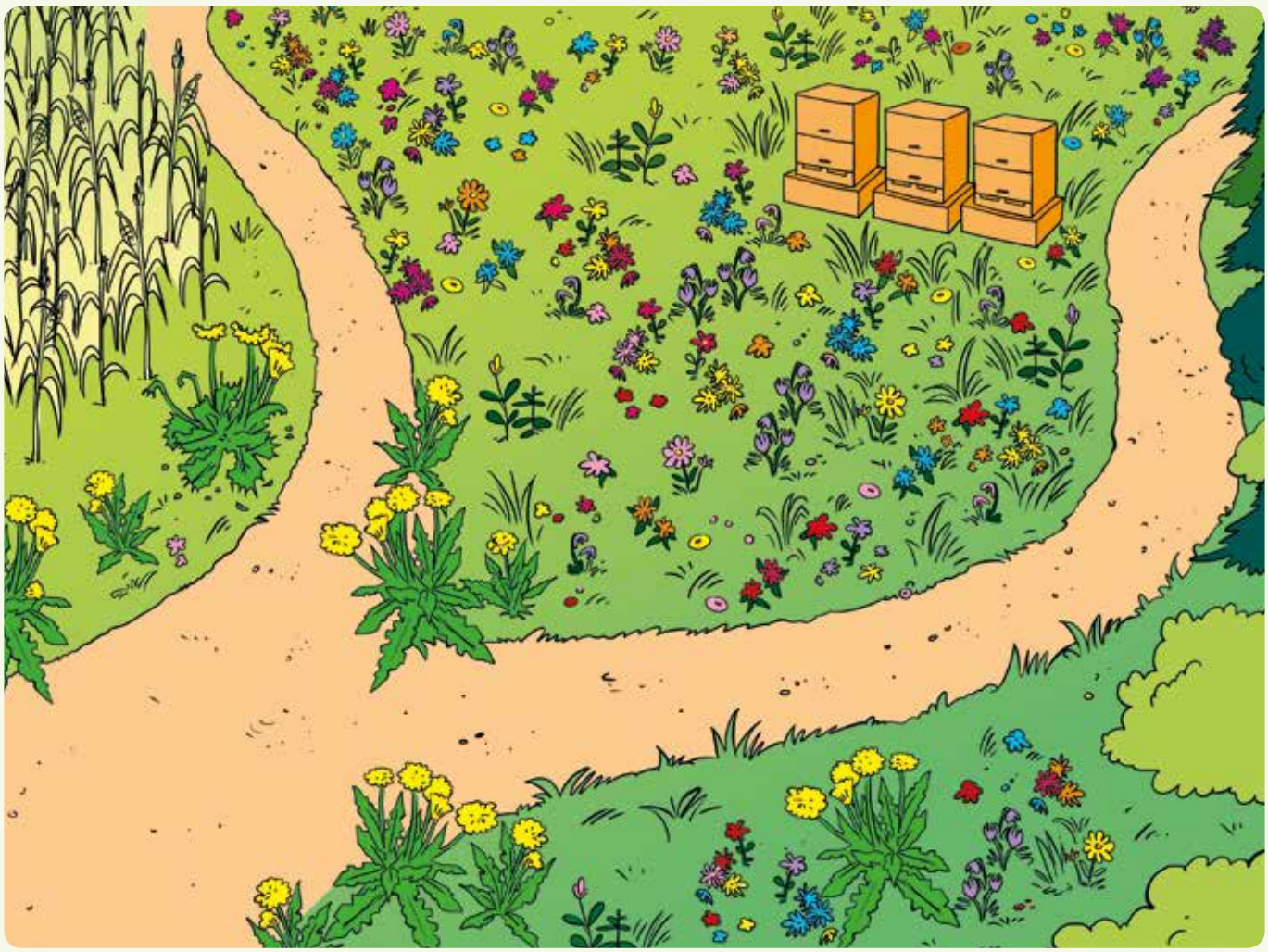
The man nodded.

It took a while for Jon and Lisa to answer all the ranger's questions about the lichens at the base of the tree. But they were extremely proud to be able to help with such an important task.

"May we take a look at a lichen under the microscope?" asked Jon as they finished.

"Of course," answered the man, "and you will be able to see both the fungus and the plant parts."

Foliose lichen



Jon and Lisa resumed their search for Hopper. They soon reached the end of the forest. The path continued straight along a cornfield with a meadow of tall flowers on the other side. A second branch went off to the right along the edge of the woods. The branch straight ahead led to a circular path that returned to the house.

"Hopefully Hopper went along that one!" cried Jon pointing to the path straight ahead.

But how are Lisa and Jon supposed to know? Do you see a clue that might help them?

"Look! Something has chewed on the dandelion!" cried Lisa excitedly, pointing at the plant.

Then Jon saw it too. "Hopper loves dandelions!"

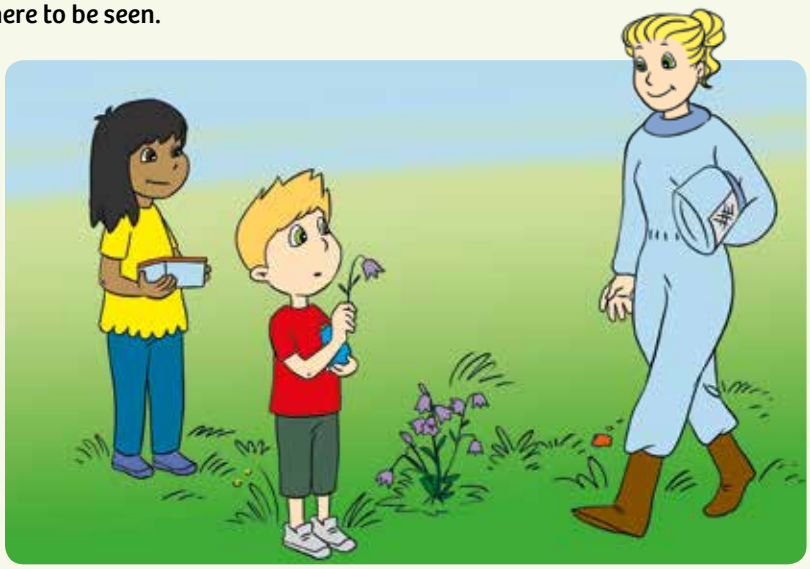
The children ran straight ahead toward the dandelion, where they stopped and looked around. The rabbit was nowhere to be seen.

"Take a look at the leaves," said Lisa, standing in front of the corn and dandelion plants, looking back and forth between the two plants.

"What's up?" asked Jon.

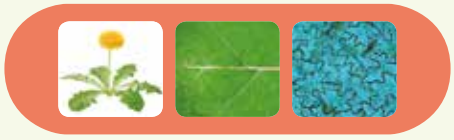
"These little lines look so different," said Lisa in bewilderment, "between the corn and the dandelion." Can you also see the difference in the leaf veins of the two plants?

While Lisa was still looking at the leaves, Jon walked to the meadow and started to pick a flower. "I'd like to look at this under the microscope too," he said.



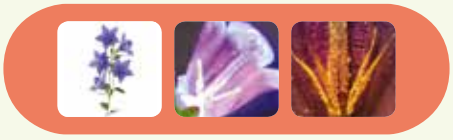
Right at that moment, a woman in a white suit came walking toward them. She was carrying a white hat with a net-like veil under her arm. As she noticed the children with the microscope, she came over and said, "I see you're looking at flowers. Did you know that flowers turn into fruits?"

Dandelion leaf



Corn leaf

Flower



Jon shook his head and Lisa nodded a little hesitantly.

"Like an apple?" she asked.

The woman nodded. "Yes, exactly. An apple also comes from a flower. But for the apple to form, the flower first has to be pollinated. Bees often do that. I have bees back there in my beehives. I'm a beekeeper."

When Lisa and Jon looked at where she was pointing, they saw wooden boxes in the meadow.

"Would you like to see the bees?" asked the beekeeper.

As they walked to the beehives, Lisa asked the beekeeper, "And what kind of fruit will this flower turn into?"

She showed the woman the flower that Jon had picked.

The beekeeper laughed and said, "I don't know either. Most wildflower fruits are not tasty. They are not the kind of thing you would eat."

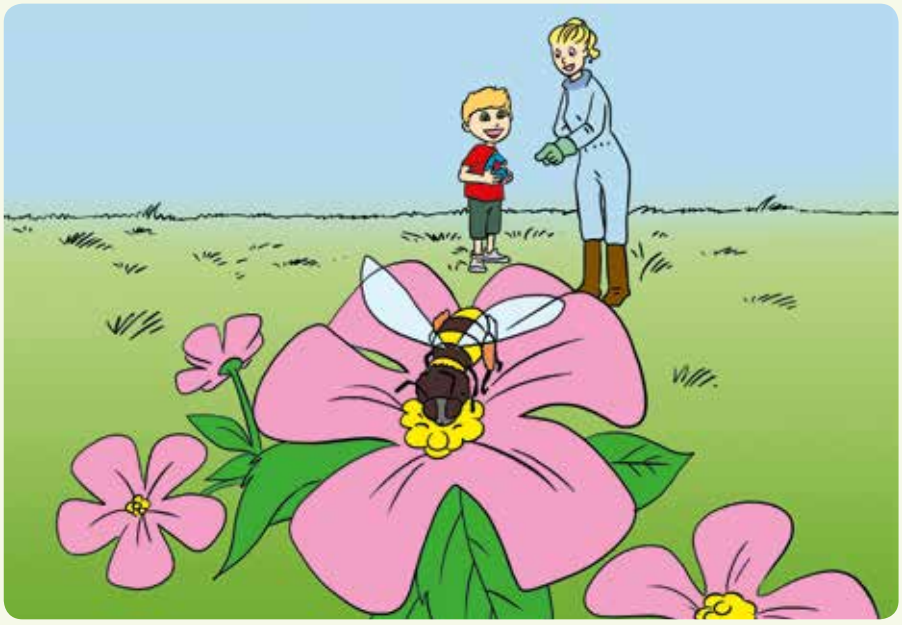
They reached the beehives, and the woman placed her veiled hat on her head.

"Stay back a little," she said as she opened a box. She checked something and then closed the box again.

"Here," she said to Jon and Lisa, "this one is dead, so you can look at it under the microscope."

Lisa carefully took the bee as the beekeeper handed it to her.

"You can see the special pollen baskets on its legs where it collects the pollen," explained the beekeeper. "Bees eat pollen to get important nutrients, such as protein. You can find the pollen shapes from different kinds of wildflowers later on in their honey."



"How many kinds of pollen are there?" asked Jon.

"As many as there are different species of plants. Every kind of flower has its own shape of pollen. And when the bees carry the pollen from flower to flower, the flowers recognize the pollen that matches. That's when the fruit starts to grow." Jon and Lisa were surprised to learn how much happens in such a tiny flower.

"We have to leave now," said Lisa, who was worried about Hopper. "We are looking for our rabbit."

"Oh," said the beekeeper. "Good luck then!"

Jon and Lisa continued on their way between the cornfield and meadow, staying on the lookout for Hopper.

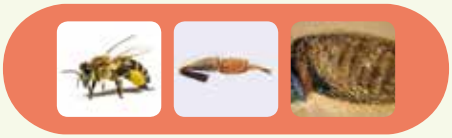
Soon they had came to the end of the cornfield, which adjoined a field of sunflowers.

"I'm hungry," said Jon.

"We have some fruit," said Lisa, offering him the box with the fruit pieces, which she was still carrying with her.

"Yes!" cried Jon as he helped himself to the fruit.

Bee



The children sat down on the grass beside the path and ate their fruit. Lisa examined a kiwi slice.

"I wonder what kind of flower a kiwi fruit comes from."

"Or what kind of fruit a dandelion makes," said Jon, looking at the dandelion flower next to him.

"I know that!" yelled Lisa happily, picking up a dandelion seed head and blowing. The dandelion seeds went flying through the air. "Those are the fruits!" cried Lisa, pointing at the flying parachutes.

Jon raced among them excitedly. "Awesome fruits" he said, "even if you can't eat them."

The two children eagerly blew a few more seeds into the air, jumping around among them as they floated down.

As Jon and Lisa continued on, walking along the sunflower field, they could see their house in the distance. Lisa was still thinking about fruit.

"Funny how so many seeds can come from a single flower. I thought a flower could only produce a single fruit."

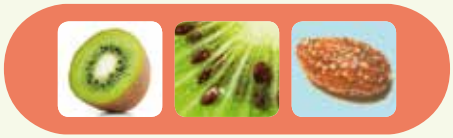
"Take a look at the sunflowers," said Jon, pointing to one in the field.

"What about them?" asked Lisa.

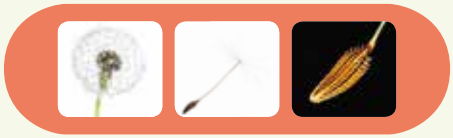
"They have a lot of fruits in one flower too."

"Oh, right, they do!" said Lisa in astonishment.

Kiwi



Dandelion seed



A man in a pair of green overalls walked out of the field of sunflowers. He had heard what the children were discussing.

"You're correct that just one fruit comes from a single flower."

"But why do dandelions and sunflowers have so many fruits then?" asked Jon as he scratched his head.

"There are plants with flowers consisting of lots of tiny individual flowers, even though they have the appearance of being one single big flower," explained the man. "Neat, right?"

"Does that mean that there are lots of little flowers hidden inside of a dandelion flower or sunflower?" asked Lisa.

"Exactly," said the man.

"Oh, that's funny," said Jon, laughing.

"Thanks for the explanation," said Lisa politely, "and do you also know where our rabbit Hopper might be?"

The man shook his head and said, "That is not something I happen to know. I haven't seen him, unfortunately."

So the children left and continued down the path until they had finally arrived home. Jon and Lisa hung their heads sadly. Where on Earth could Hopper be?

"There he is!" cried Jon excitedly, pointing over the gate to their garden.

The children threw their hands in the air and jumped up and down for joy. Then they ran into the garden to greet Hopper.

Do you think he might have been hiding there the whole time?

Sunflower

The children's mom and dad came out of the house to set the garden table. It was already dinner time!

"Kids, take Hopper back inside and wash your hands, so we can eat," said their dad. Jon and Lisa raced into the house.

They passed through the kitchen on their way back out.

"Let's take a look under the microscope to see what honey looks like," said Lisa to Jon. "I want to see if there's really pollen in there from the flowers."

And it was true, just as the beekeeper said. Do you see the pollen in the honey too?

After the children returned to the garden, the whole family ate dinner together. It was a nice warm evening, and Jon and Lisa talked about their search for Hopper and all the things they saw and learned.

"How exciting!" said their mom, picking up the salt shaker. "Why don't we take a look at the salt under the microscope?" she said.

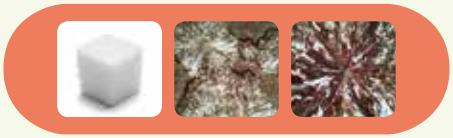
"And the sugar!" said their dad, holding the sugar bowl.

Do you already know about all the interesting crystal shapes that Jon, Lisa, and their parents will see?

Honey

Table salt

Household sugar



OVERVIEW OF THE SPECIMENS

Feather

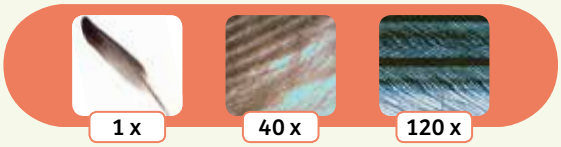


Image 1: Pigeon feather
Image 2: Arrangement of the barbs
Image 3: Structure of barbs and barbules

Artificial fiber

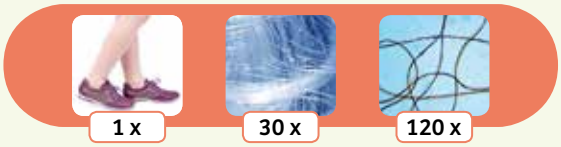


Image 1: Nylon stocking, white
Image 2: Nylon fibers, transparent
Image 3: Polyester fibers, red

Zipper

Image 1: Zipper section close up
Image 2: Closed zipper
Image 3: Open zipper, showing interlocking gripping parts

Human hair

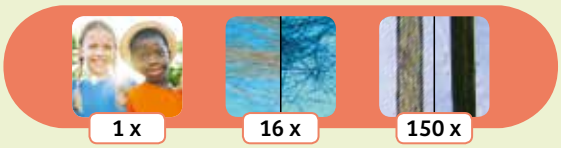


Image 1: Blond- and black-haired child
Image 2 Blond and black hairs
Image 3 Individual blond and black hair, showing fine structure

Dragonfly

Image 1: Black-tailed skimmer (*Orthetrum cancellatum*), male
Image 2: Left-side wings of a large red damselfly (*Pyrrhosoma nymphula*)
Image 3: Network structure of the wing of a green snaketail (*Ophiogomphus cecilia*)

Skin

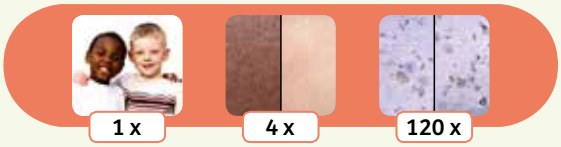


Image 1: Dark- and light-skinned child
Image 2: Dark and light human skin
Image 3: Dark and light human skin flakes

Stinging nettle

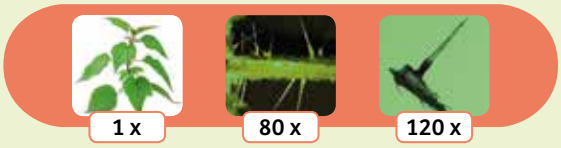


Image 1: Stinging nettle (*Urtica dioica*)
Image 2: Stinging hairs on a stinging nettle leafstalk
Image 3: Individual stinging hair

Spider

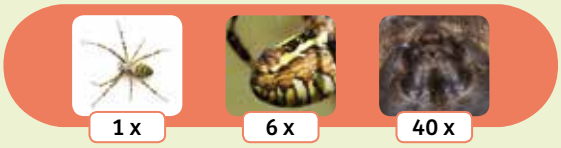


Image 1: Wasp spider (*Argiope bruennichi*)
Image 2: Abdomen of the wasp spider showing spinneret and thread
Image 3: Spinneret with thread

Dead nettle

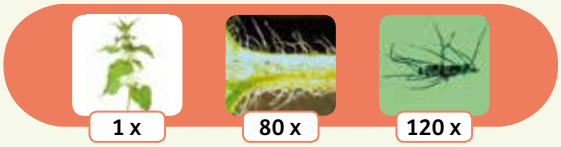


Image 1: White dead nettle (*Lamium album*)
Image 2: Leaf hairs on dead nettle leafstalk
Image 3: Individual leaf hairs

Fly

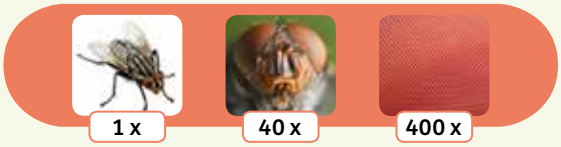


Image 1: Housefly (*Musca domestica*)
Image 2: Head of a bluebottle fly (*Calliphora vomitoria*)
Image 3: Section of a compound eye of a hoverfly (*Episyrphus balteatus*)

Rabbit hair

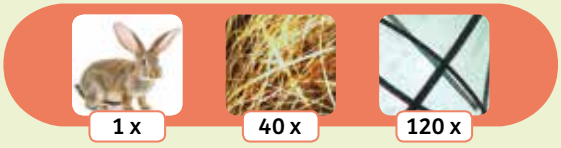


Image 1: Young rabbit
Image 2: Rabbit fur
Image 3: Individual rabbit hair, showing typical striations

Agaricus mushroom

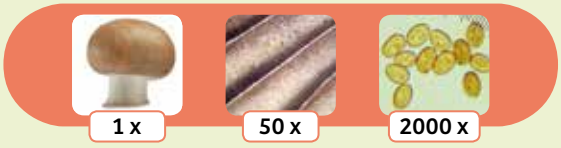


Image 1: Cultivated mushroom (*Agaricus bisporus*)
Image 2: Gills of a button mushroom *(Agaricus diminutivus)*, where the spores are formed
Image 3: Spores of a cultivated mushroom

OVERVIEW OF THE SPECIMENS

Boletus mushroom

Image 1: Common porcini *(Boletus edulis)*
Image 2: Tubes of a *Boletus amygdalinus*
Image 3: Spores of a *Boletus amygdalinus*

Kiwi

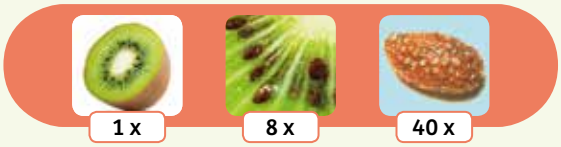


Image 1: Half of a kiwi fruit *(Actinidia deliciosa)*
Image 2: Seeds inside the kiwi
Image 3: Individual kiwi seed

Foliose lichen

Image 1: Common orange lichen *(Xanthoria parietina)* on a twig
Image 2: Fruiting bodies of common orange lichen, or apothecia, where the spores are formed
Image 3: Cross section through the thallus ("leaf") of a foliose lichen with differential staining, fungal hyphae with incorporated algae cells (top, dark)

Dandelion seed

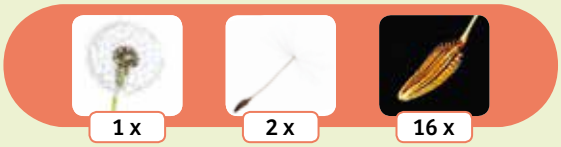


Image 1: Seed head, ripe fruits of a dandelion *(Taraxacum officinale)*
Image 2 Individual dandelion fruit with "parachute"
Image 3 Individual dandelion fruit

Dandelion leaf with leaf veins

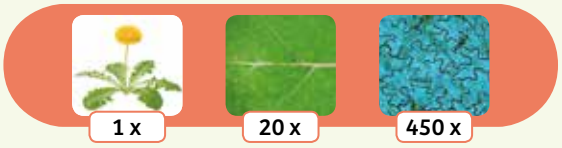


Image 1: Dandelion plant *(Taraxacum officinale)*
Image 2: Dandelion leaf with branching vein structure
Image 3: Flat section of a dandelion leaf, cells grouped around openings (stomata)

Sunflower

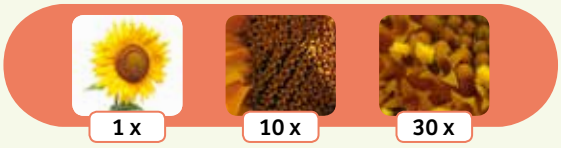


Image 1: Composite flower of a sunflower *(Helianthus annuus)*
Image 2: Arrangement of individual flowers in a sunflower; they bloom from the outside in
Image 3: Individual flowers of the sunflower with projecting stamen and centrally divided stigma

Corn leaf with leaf veins

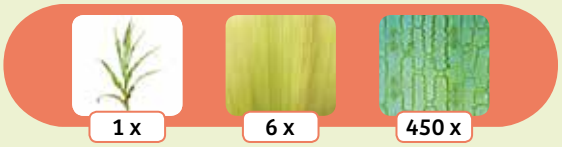


Image 1: Corn plant *(Zea mays)*
Image 2: Corn leaf with parallel vein structure
Image 3: Flat section of corn leaf, openings (stomata) integrated into parallel rows of cells

Honey

Image 1: Honeycomb with honey
Image 2: Honey with flower pollen (round structures) from cruciferous plants (*Brassicaceae)* with sugar crystals (angular structures)
Image 3: Flower pollen from daisy *(Bellis perennis)*

Flower

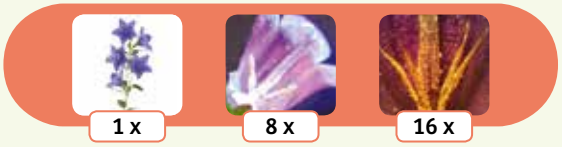


Image 1: Spreading bellflower *(Campanula patula)*
Image 2: Longitudinal section of a bellflower *(Campanula portenschlagiana)*, showing stamens and ovary with three-part stigma
Image 3: Longitudinal flower section with stamens and pollen

Household sugar (sucrose)

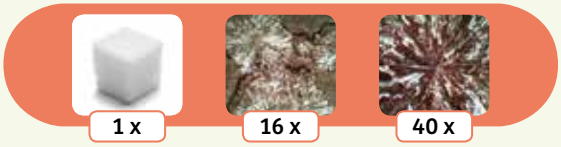


Image 1: Sugar cube
Image 2: Crystallized sugar against black cardboard
Image 3: Typical sugar crystal shape

Bee

Image 1: Western honey bee *(Apis mellifera)* with pollen baskets on leg
Image 2: Hind leg of honey bee
Image 3: Hind leg with hairs, showing scattered pollen

Table salt (sodium chloride)

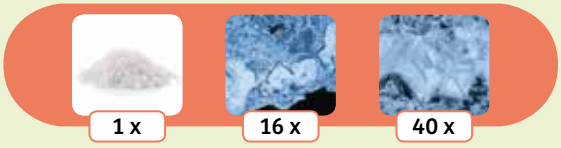
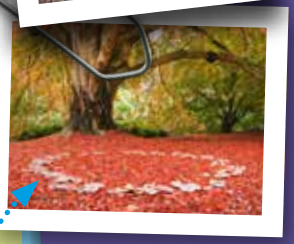


Image 1: Sea salt
Image 2: Crystallized salt against black cardboard
Image 3: Typical salt crystal shape

CHECK IT OUT

Different plants

There are lots of different groups of plants — starting with mosses, clubmosses, and ferns all the way to **seed plants,** the group to which all trees, flowers, and grasses belong. These are in turn divided into several groups. Roughly speaking, we distinguish between **monocotyledonous** and **dicotyledonous** — meaning that these plants have either one or two leaves when they germinate, or come out of the ground. Most monocotyledonous plants (such as corn and other grasses) have parallel, nonbranching **leaf veins,** while dicotyledonous ones (such as dandelions, oaks, and beeches) have veins that form branching networks.



FUNGI

Fungi form their own kingdom among living organisms — just as plants and animals each form their own kingdom. Unlike most plants, fungi cannot cover their own sugar needs through photosynthesis. Instead, they depend on food. The mushrooms that are visible above the ground are usually just the fruiting bodies, or the parts responsible for distributing spores and, thus, for reproduction. By far the largest portion of the mushroom lives underground as an invisible mass of filaments, often extending for miles through the soil. With some mushroom species, you can follow the growth of the plant by paying attention to "fairy rings," the fruiting bodies of a single mushroom arranged in a circle. Over the course of a year, the mushroom grows underground by about one yard in every direction, so each year's fairy ring is larger than the last.

DISSEMINATION STRATEGIES OF SEED PLANTS

When a fruit ripens, it has to somehow get from the mother plant to another location where it can germinate and grow into its own plant. Since plants can't just get up and walk away, they need a different method. There are many different ways that plants accomplish this. Some fruits fly **with the wind** to new locations — for example, the dandelion.

Others **taste delicious,** so they are eaten by animals and their seeds are then deposited somewhere else — where they may grow. **Waterways** distribute other seeds, while still others use **catapult mechanisms** to shoot seeds through the air.

Touch-me-not

COMPOSITE FLOWERS

The family that includes daisies is one of the few plant families to form composite flowers. These consist of lots of tiny individual flowers that are often hard to see with the naked eye. Daisies, asters, and sunflowers are a few examples. In a daisy, what seem to be the white petals are structures called ray flowers designed to attract insects. These surround the many tiny true flowers (known as disk flowers), which create the illusion of a single larger bloom. Composite flowers have the advantage of being able to have a lot of flowers pollinated by one insect in a single visit.

CHECK IT OUT

Pollinating flowers

Bees are well-known flower pollinators. But there are other insects that perform this task as well — for example, butterflies, flies, and many beetles.


Hawk moth


Soldier beetle

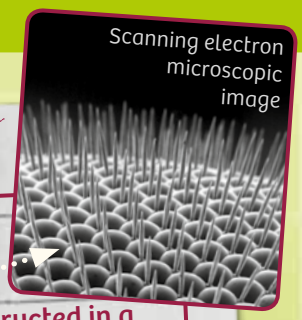

Bumblebee


Scarab beetle


Fly


Moth

COMPOUND EYES


Scanning electron microscopic image

The eyes of insects are constructed in a very special way. They consist of lots of small individual eyes (ommatidia), each of which perceives a separate image. The individual images created in that way are then assembled into a single overall picture by the insect's brain. These are known as compound eyes. Insects can use them to perceive many more individual images per second than we humans can with our lensed eyes. While we can process just 60 to 65 images per second, a housefly can process about 300. So if a fly is looking at a television screen, which may be operating with 100 images per second, what the fly sees is a lot of still images in sequence.

LICHENS


Bioindicators: Foliose lichen *Lobaria pulmonaria*


Beard lichen *Usnea filipendula*

These peculiar organisms are created out of a symbiosis between certain fungi and plants. Symbiosis means that the fungus and plant each gains an advantage from the relationship, even if the advantages are not evenly divided. The plant provides the fungus with nutrients, while the fungus enables the plant to thrive on inhospitable ground and without direct access to water. However, the fungus also restricts the growth of the plant quite a bit.

HONEY

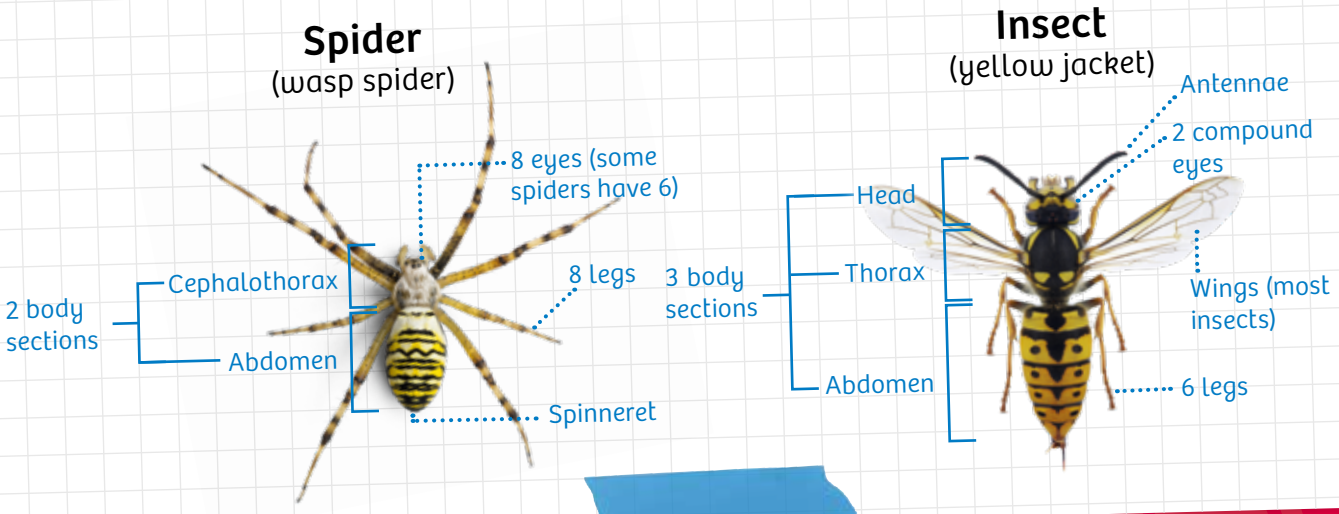
Bees make honey from flower nectar. Honey consists mostly of sugar (fructose and glucose). Different kinds of honey can be distinguished by various qualities — for example, by color and taste, or whether they are solid or liquid. The honey's qualities depend on the flowers that the bees visited, and sometimes also on whether it has been further processed by humans.

KIWI

The kiwi, also known as "Chinese gooseberry," sometimes comes in such a small size that it really does resemble a gooseberry (a small berry). The plant on which the kiwi fruit grows is sometimes called a tara vine.

Insects and arachnids

Spiders and insects both belong to the group of animals known as **arthropods** — as do crustaceans and millipedes. They are both small and similar looking, but within the group of arthropods insects are more closely related to crabs than to **spiders.** Arachnids form a larger group that includes spiders, along with scorpions and ticks, for example. If you look closely at insects and spiders, you can see several differences.



Fruits

Most fruits belong to the **dehiscent** or **indehiscent** fruit groups. These names mean more or less "opening" and "non-opening," depending on whether they have **husks or capsules** that burst open. The ones that we know as "fruit" mostly belong to the indehiscent group. Apples and pears, however, actually belong to the dehiscent group, even though they do not exhibit the "opening" behavior. **Indehiscent fruits** are in turn subdivided into **stone fruits (or "drupes"), nuts, and berries.** But these technical terms are often used differently from what we would expect. See how you do in the quiz below.

QUIZ

The pictures show nuts, berries, and stone fruits. Do you think you know which is which? You will find the answers on the next page. You might be surprised!

CHECK IT OUT

Pigments

HAIR COLOR

Everybody has pigments, or coloring materials, in their hair. The hair color that somebody has depends on how many pigments are in their hair and which ones they are. There are only two different pigment types (red-blond and black-brown melanin), which are present in varying ratios and amounts in different hair colors. Eventually, the responsible hair-root cells stop producing pigments and the hairs become white. The white color that we see arises due to the refraction of light on the hairs — in other words, there is not actually any white pigment. Since not all the hairs lose their color at the same time, dark-haired people look as if their hair were gray, due to some of their hair being white while some still has color.

SKIN COLOR

The skin is colored by pigments too. They are formed — especially under strong solar radiation — to protect us from sunburn. Some people naturally have more pigment than others. If you look at flakes of skin under the microscope, you cannot see any difference in skin color because the pigments are located in deeper layers of skin.

Nylon

Nylon was the first completely synthetically produced fiber. With its high degree of elasticity, it became a competitor with natural silk soon after it was first produced. The material is used for many purposes, such as stockings, tents, and umbrellas.

CRYSTALS

Sugar and salt form crystals, as do many other materials — even water, when it freezes. Crystals come in all possible symmetrical shapes. The differences come about due to the type and arrangement of particles composing the material.

Quiz answers: nuts, berries, stone fruits

Hazelnut = nut | Currant = berry | Banana = berry | Raspberry = stone fruit (aggregate fruit) | Peach = stone fruit | Strawberry = nut (aggregate fruit) | Melon = berry | Coconut = stone fruit

The classification works as follows: all indehiscent fruits have three "layers." If all three are woody, the fruit is called a nut. If the inner ones are soft and the outer one is membranous, it is a berry. And if the outer one is membranous while the middle one is soft and the inner one is woody, it is called a stone fruit (or drupe). Aggregate fruits are unusual, each consisting of several individual fruits that collectively have the appearance of a single fruit. In a strawberry, for example, the little "seeds" are the actual nut fruits.

634032-03-070218