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Insect wings

Compare the wings of the fly and the butterfly.

Can you identify the separate scales on the butter-fly's wing?

Insect wings are as diverse as the many different insects.

You can use light to shine through the fly's wing and see through it. It is made of trans-parent membranes that are supported by a dense network of veins that runs throughout the membranes.

The wings of a butterfly, on the other hand, are not transparent, but colourful. Have you ever caught a moth in your house and then set it free again? Have you noticed the fine dust that has stuck to your fingers? This dust is also called butterfly dust. It is the fine scales on the butterfly's wing that you can see through the microscope. Arranged like roof tiles, they provide the coloration and patterns on the butterfly and moth wings. They are reminiscent of the many short brushstrokes in Impressionist paintings, such as those by Claude Monet. The shimmering of butterfly wings is caused by fine grooves in the scales where the light is reflected.

Only dead insects were collected for this sample.

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Colour

How are the differences in brightness in the black-and-white image caused?

Examine the printed paper under the microscope. Which colours do you see?

Turn on your smartphone and put it under the microscope. Which colours do you see now?

The black-and-white image is created from many tiny black dots. The darker an area in the image, the larger the black dots.

If you want to print something in colour, you only need four colour cartridges for your printer: magenta, cyan, yellow, and black. But where do the many other colours, such as green, on a colour print come from? In fact, only the four colours in the cartridges are printed. However, they are printed as tiny dots. Our eyes cannot see the individual dots. They mix into different colours, depending on the portion of the four colours. For exam-ple, the green of the tomato stalks is made from a certain portion of cyan and yellow.

If you put a banknote under the microscope, you will not see any dots in magenta, cyan or yellow, because banknotes are printed in full-colour, which is mixed beforehand.

The colours in the screen of your smartphone are also mixed. If you look at it under the microscope, you can see the many tiny LEDs in red, green and blue. A white area sud-denly appears colourful. The same portion of red, green, and blue light lets the screen appear white in our eyes.

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Surfaces

Does the piece of microfibre cloth still look soft under the microscope?

Are the aluminium foil and the bolt really as smooth as they seem?
Can you read the writing on the nut?

What does the sandpaper look like under the microscope?

If you zoom in on the microfibre cloth, you can see why it catches dust so well. Dirt par-ticles easily get caught in the spaces between the structure. However, the polyester mate-rial, which the individual threads of the cloth are made of, is very hard and can leave scratches on soft surfaces, such as plastic lenses.

Even though mechanical production is very precise, it is not perfect. Under the micro-scope you can see that there are grooves in the seemingly smooth metal surfaces of the aluminium foil and the bolt.

Also take a look at your jewellery, your wristwatch or a coin under the microscope. You will see that the hard metal is softer than you may think. Over time, dents appear on the coins.

There is an H on the nut. It indicates that it is made of steel of a certain hardness. The number 8 which you can see between two vertical lines is a measure of the strength of the nut when turned.

If you look at magnified surfaces, they often appear completely different and you can hardly recognise them. For example, the image of sandpaper is reminiscent of a liquid in which particles float.

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Senses

Do you see the hairs on the head of the fruit fly?

Take a closer look at the fly‘s eye as well. Does it look different from your eye?

We know fruit flies as annoying visitors in our kitchens. Where there is fruit, there is the little flies, especially when the fruit is slowly going bad. But how do the fruit flies smell the fruit? You probably did not find a nose like ours on the fly‘s head but several little hairs. The olfactory receptors with which it can detect odours are located on these hairs.

But not only the „nose“ of the fruit fly, its eye also looks different from ours. It is a com-pound eye that con-sists of several hundred individual eyes. The individual images seen with each eye are combined in the brain to form a complete image, similar to the pixels in a camera image.

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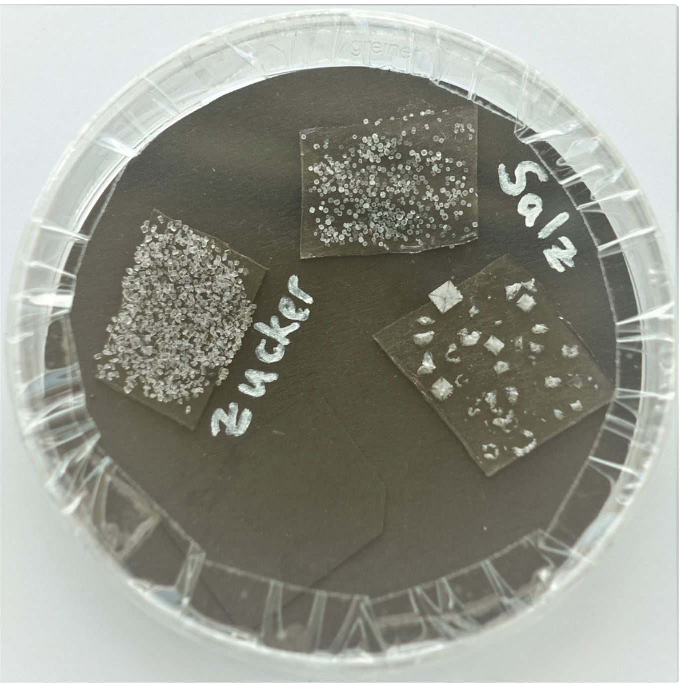
Salt and Sugar



What do salt and sugar look like under the microscope?

At first sight, salt and sugar look similar: small white grains. But when you take a closer look, you can distinguish them not only by their taste, but also by their different crystal structure: Salt is square and sugar is hexagonal. However, you can only partially see the cube-shaped structure in the table salt from the package on closer inspection. Most grains of salt appear roundish, as the corners rub against each other and wear out over time. The square shape becomes more visible when the salt is first mixed with water and then the water evaporates again. The salt molecules dissolve in the water and when the water evaporates, they come together again and arrange themselves as cubes.

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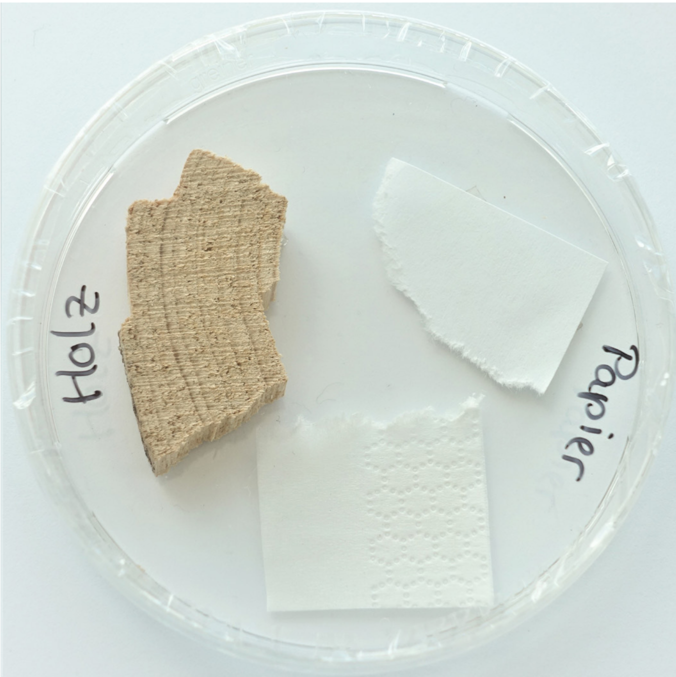
Wood and Paper



Compare the piece of wood, the paper and the tissue.

Do you see the growth rings in the wood?

Can you spot the single fibres?

Have you ever counted the growth rings on a wooden disc? Wood, like other parts of plants, consists of single cells. These grow in thin layers under the bark of a tree trunk, making the trunk thicker from year to year. However, the cells formed in spring and summer are larger than those formed in autumn. In the wooden disc, the larger cells are brighter than the smaller ones, thus making growth rings visible.

Wood is not only used for building furniture and boats, for example, but also for the production of paper. A sheet of paper looks even, but as soon as you rip it apart, you notice that it is made of single fibres. You can see them clearly under the microscope.

For tissues, however, a mixture of different fibres is used. The long fibres of the coniferous trees make them tear-resistant, and the shorter fibres of the deciduous trees make them absorbent and soft.

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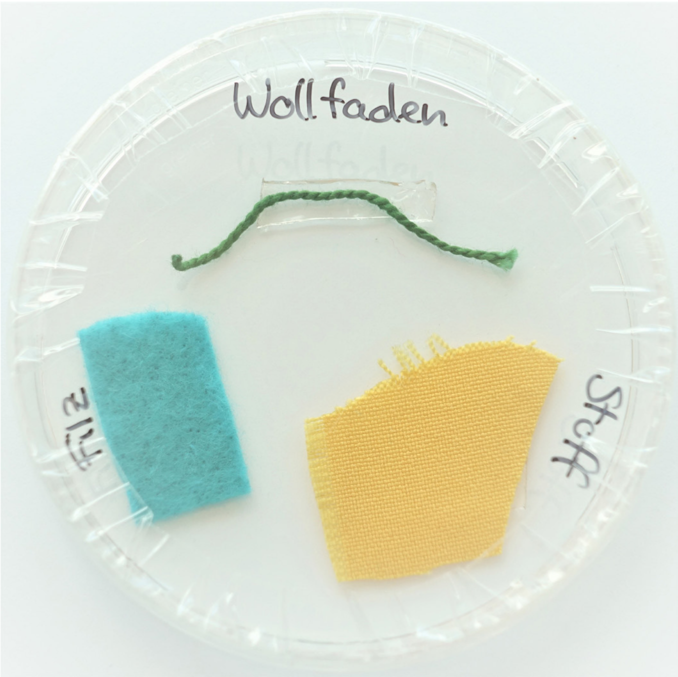
Wool thread - Fabric - Felt



Can you spot the fibres in the wool thread and in the fabric?

Compare the yellow fabric and the piece of felt. Zoom into the different layers of the felt.

What do your clothes look like under the microscope?

Fabrics are woven from many threads. If you look closely, you can even see it without a microscope. The microscope also renders the fibres of the threads visible.

In contrast to woven fabrics, the fibres in felt are fuzzy and difficult to separate.

A single thread consists of several fibres that are intertwined. If you take a closer look under the microscope, you can see the ends of the fibres sticking out of the thread. The thread in this dish is made of cotton, which is a plant-based natural fibre found at the seeds of the cotton plant. Cotton fibres have a diameter of 12 to 35 µm and a length of 15 to 56 µm (1 µm = 0.001 mm).

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Sand

Compare the different sand samples.

Can you find the small seashell particles in the beach sand?

Do you notice how porous the large grains of volcanic sand are?

Each sand is different and has its own history. Not only does sand have different colours, but the type and shape of the sand grains also tell you how it was formed. Sand consists mainly of small stones. They are formed by weathering (wind, rain, frost) from the large rocks of the mountains, such as in the Harz Mountains. From there the small stones are partly washed into the sea by rivers, where they settle on beaches, for example. In the beach sand you can also find small pieces of seashells that have crumbled over time.

If you look closely at the volcanic sand, you can see holes in the larger stones. Volcanic rock can be very porous due to trapped gas.

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Outer shell

Do you see the individual spines on the skin of the spiny leaf insect?

Take a close look at your own skin under the micros-cope.

Not only snakes shed their skin, but insects as well. In contrast to our skin, insects' skin is much harder because it is their skeleton. Because of its hardness, insects must shed their skin several times before they are fully grown.

This dish contains the skin of a spiny leaf insect. These insects shed their skin up to six times as they grow. We have collected this sample in our spiny-leaf-insect terrarium in the biology lab. Please ask a phaenoman or a phaenowoman if you want to be shown the insects.

If you look at your finger under the microscope, you can see single beads of sweat and dirt particles.

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Writing differently

What happens if you write on paper with a pencil?

Have you ever taken a close look at the tip of a biro?

How does the ink get on the paper when you use a felt-tip pen?

The pencil lead is not actually made of lead, but of a mixture of graphite and clay. Be-cause of its similar appearance, it was previously confused with lead, thus giving the pen-cil lead its name. Graphite is a form of carbon. The higher the portion of graphite in the lead, the softer it is. When writing on paper, small particles of graphite are rubbed off the paper. This is because the seemingly smooth paper surface is rougher than expected. You can also check out the little dish with the paper and the wood.

A biro refill looks much different from a pencil lead. A plastic tube contains viscous ink and the metal tip contains a tiny ball of hard metal. When writing, this metal ball rolls over the paper, taking some ink from the plastic tube and releasing it back onto the paper. The diameter of the metal ball determines the thickness of the stroke.

In a felt-tip pen, the coloured ink is stored in the spaces between many small polyester fibres. The tip con-sists of even finer fibres which draw the ink from the inside of the felt-tip pen by capillary action and release it to the paper when writing or painting. In the past, the tip was made of felt, which gave the felt-tip pen its name. Take a look at the dish with the piece of felt. You will also discover many small fibres there.

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Feather

What do the fine structures of the feather remind you of?

The barbs, which start from the long quill in the middle, work like the zippers on our clothes. Through small hooks on the barbs, they interlock to form firm, closed feathers that allow the bird to fly and protect it from weather and water. Birds therefore pull every single feather on the outside of their bodies through their beaks every day to clean them and close them again like a zipper.

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Sharkskin Effect

Can you identify the striped structure of the foil?

What could the structure be useful for?

The stripes on this surface are fine ribs and serve to reduce the frictional resistance on surfaces. This so-called riblet foil (from the English word rib) is a classic example from bionics, because sharkskin served as a model. Sharks also have fine ribs on the scales of their skin, which enable them to swim faster. In technology, turbulent currents are often created, meaning that there are vortices on surfaces. Therefore, the friction of, for exam-ple, an airplane wing in the air is higher than in a laminar flow without vortices. A riblet foil prevents the transverse movement of the vortices, thereby reducing friction and ena-bling the aircraft to fly up to 8% faster and consume considerably less fuel. Other fields of application include wind power and competitive sports. The distance between the ribs differs for varying speed ranges and viscosities of different fluids.

This surface is courtesy of bionic surface technologies GmbH.

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