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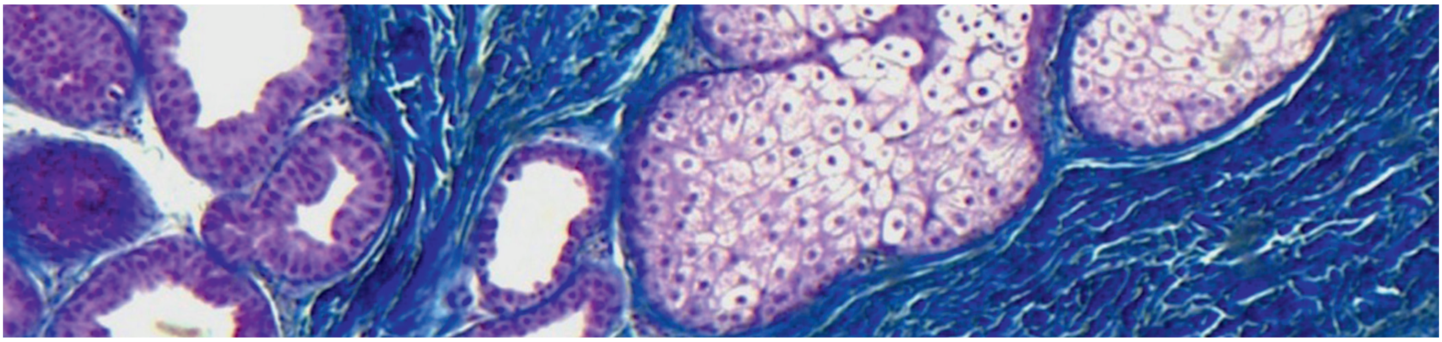

It's a small world – using microscopy to link science, technology, and art

Julianna Patricia Varga

Great and small: use this photomicroscopy project to explore the way structure relates to function and the links between science and art.

The development and first uses of microscopy date back hundreds of years.

The ability to view things normally not seen with the naked eye opened the door to numerous discoveries and new scientific fields, such as microbiology, histology, and cell biology. Microscopy is now an indispensable tool for modern life sciences and, over the years, has branched out into several fields, including optical, electron, scanning probe, and X-ray microscopy.

Despite all the beautiful images that can be taken using microscopes, the arts and sciences are often seen as completely independent disciplines. Upon closer inspection, however, the influence of one on the other becomes clear. While creativity is involved in scientific experiments, art is also often inspired by science. In the end, both disciplines try to describe life and the world around us. The connection between science and art allows for an interdisciplinary approach to teach students to delve into creative and innovative thinking.

The following activities allow students to familiarise themselves with a light microscope, view the overlap between science and art through a visual approach, consider structure–function relationships, and recognise science in their daily lives.

The activities are ideal for groups of two to three students. The suggested age range is 11 and older. Younger students can focus on getting the images and making comparisons, and older students can do some research to learn more about the science behind the function of whatever they have imaged.

Activity 1: Preparing microscope slides

In this activity, students choose the specimen they would like to observe under the microscope and, depending on time, they can prepare one or more microscope slides. Through this, students learn the basic techniques of microscope slide preparation. This activity takes around 1.5 h.

Sample selection and microscope setups

Depending on the sample to be imaged, different microscope types and/or setups need to be used. Transmission microscopy illuminates the sample from below and reflectance microscopy from above.

The mushroom lamellae, for example, are a thick specimen. The depth and contrast in the photo would be lost, if it were sliced thinly. As this sample is quite thick, transmission microscopy is not suitable for its imaging, as no light would pass through the specimen and reach the eyepiece. Instead, reflectance microscopy should be used to light the sample from above.

Generally, reflectance microscopy is a good choice if you are particularly interested in studying the surface of objects. Transmission microscopy, on the other hand, is particularly suitable for samples that are thinly sliced.

In the supporting material, you can find a list of sample suggestions to try out using different microscope setups.

Lamellae (2017)
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Safety notes

The following activity requires the use of sharp objects (a razor blade or knife). Please remind students to be cautious when cutting and preparing the specimen. Alternatively, cutting can be done by the teacher in advance.

Materials (per group of pupils)

- Specimens
- 2 razor blades or 2 knives
- 2 pipettes (alternatively: 2 droppers)
- Microscope slides
- Microscope coverslips
- 2 pairs of tweezers

Procedure

1. Collect specimens. These can, for example, be plant leaves or small insects one might find. This can be done by the students themselves prior to the lesson or, alternatively, specimens can be provided for them on the day of the lesson.

Optional: in a previous lesson, ask students whether there are certain specimens they would particularly like to view under the microscope. For inspiration, feel free to use the sample suggestions in the supporting material.

2. To observe the surface of an object, simply cut it to fit on the slide if necessary, place it directly on the microscope slide and continue with step 6.

3. To study different tissues or cells of the sample, a thin slice of the sample needs to be made using a razor blade or knife. Cutting the sample as thin as possible ensures that what is seen under the microscope is only a few layers of tissue or cells, making it easy to distinguish structures from one another. This technique prevents many layers being seen at once, which would make it difficult to see individual structures or even appear dark, as light can no longer pass through the specimen and reach the eyepiece.

Tip: try cutting in different directions (a cross section/transverse or b longitudinal section) to see if different things are observed under the microscope.

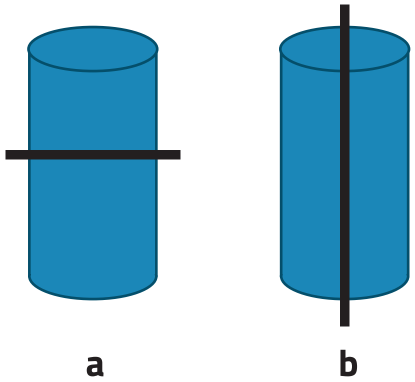


Image courtesy of the author

Note that, with such thin samples, they are usually translucent and do not have much colour and contrast to them. To better visualise structures, the use of staining might help.

4. Using tweezers, place the specimen on the microscope slide.
5. Put a drop of water on the specimen using a pipette or dropper. This prevents the specimen from drying out.
6. Cover the specimen using a microscope coverslip.
7. Depending on the sample, different microscopy setups might need to be used. To observe the surface of the sample, the sample needs to be lit from above, so that the surface is visible through the eyepiece. To study a thin sample and observe different tissues or cells, on the other hand, the sample should be lit from the bottom (it is also possible to light the sample from above, but this often makes the results too bright, so the images are saturated with light and lacking in contrast).
8. To capture an image of the specimen, hold a phone camera close to one of the eyepieces of the microscope. This may take several tries and needs some practice. Here is a video[1] that nicely shows how this is done.

   Alternatively, if the microscope has a camera attached, it can also be connected to a computer or laptop and the image can be captured by using this camera.
9. Take several photos (at least one per student). Ideally, these should be of different cuttings and/or different specimens.
10. In groups, let the students choose at least one photo each that appeals to them visually.

Activity 2: Photomicroscopy – micro and macro art

The goal of this activity is to create a visual comparison of the micro and macro images. This activity asks students to think about their microscope image(s) and any overlap with the macro realm. Students, in groups, can be asked to present their photo comparisons to the rest of the class and explain how they ended up with this comparison.

This is also a good opportunity to allow students to think about structure–function relationships and find out the role(s) of the structure(s) they have observed under the microscope. This activity takes about 1 h.

Safety notes

Teachers may want to restrict search engines to results appropriate to the age range of students.

Materials

- Worksheet 1 and example answers
- Images from Activity 1 or microscope images found online
- A computer (per student or group of 2–3 students if there are not enough)

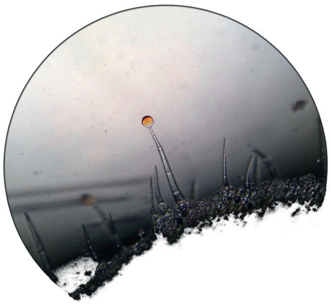
Procedure

1. Optional: as a warm up, students should fill out Worksheet 1. Alternatively (or in addition), look at the example answers to get a sense of the comparisons that can be made.
2. Students can work individually or in groups. Once each student/group has decided on an image they like, ask them to think about the following question: do any of the microscopic structures they see in the image remind them of anything?
3. They should find an image of the object it reminds them of and place it next to their chosen microscope image. The images can be printed out or arranged on a slide for presentation in the last step.
4. Students should look up the role(s) of the structure(s) they have observed under the microscope and then think about structure–function relationships and consider whether the similarity to the macrostructure is coincidental or indicates a similar function.
5. Ask the students (in their groups) to present their photo comparisons to the rest of the class and explain how they ended up with this comparison.

Discussion

As an example of the kinds of comparisons that can be made, while visiting Brighton in the UK, I visited British Airways i360 tower. This reminded me of a microscope image I previously took during my bachelor's studies of a geranium trichome at 100× magnification using transmission microscopy.

Trichomes are tiny hairs found on plants, algae, and lichens and have a variety of functions. The trichome seen in this image belongs to a geranium and is called a glandular trichome. Essential oils produced by the plant are stored in the spherical structure at the tip. When something touches the plant, the trichomes are damaged and release their essential oils.




Left: *Geraniaceae* trichome (2015). Right: British Airways i360 in Brighton.

Images: Trichome: ©Julianna Patricia Varga. British Airways i360: Hassocks5489/ Wikipedia, Public Domain

Link to functionality? Yes: in both cases, the thin stalk serves to elevate the globe at the top above the surface. For the i360 viewing tower, this is to give visitors a good view. For the trichomes, this is to ensure that physical contact with the plant breaks the tip and releases the essential oil.

This image was made with more sophisticated microscopy techniques than may be available in the classroom (staining and phase-contrast microscopy), but the supporting material gives some comparison examples that should be achievable by students, and further examples can be found in the Instagram photomicroscopy project it's a small world.

Discussion

This project is an opportunity for students to be creative and engage with the world around them. This is also a good opportunity to allow students to think about structure–function relationships.

In the supporting material, there is an extension activity on 'Photoediting to imitate art', which can be used to allow students to learn more about artists and photoediting techniques, while using their works as inspiration to create micro–macro comparisons. This project can be run in cooperation with art or informatics teachers in an open-ended combined STEAM approach. «

References

[1] A video by John Hindmarsh on how to use your mobile phone to photograph down the microscope: https://youtu.be/ajXUzNeQcUc.

[2] Information about the 'it's a small world' project: https://www.instagram.com/itsasmallworld.png/.

Resources

- Explore a similar concept using makeup as a comparison for microscope images.
- Find out about 'Microscope in Action', an educational microscopy kit that brings fluorescence microscopy to schools and can be used as an extension to teaching light microscopy.
- Engage with biomimetic design to explore evolution: Toro S (2021) Biomimicry: linking form and function to evolutionary and ecological principles. *Science in School* **53**.
- Read about how cells control their shape: Chungh P (2019) Cells: why shape matters *Science in School* **49**: 8–13.
- Learn how fluorescence microscopy can illuminate our gut microbiome: Ponnudurai RP (2022) Shedding light on the gut microbiome. *Science in School* **60**.
- Build an effective microscope using simple materials: Tsagliotis N (2012) Build your own microscope: following in Robert Hooke's footsteps *Science in School* **60**: 29–35.

AUTHOR BIOGRAPHY

Julianna Patricia Varga, originally from the Philippines, Julianna moved to Germany to pursue her bachelor's in biology and master's in molecular biology. Currently working at the European Molecular Biology Organisation, Julianna is passionate about science communication and the different media used to achieve this.