SCIENCE

Lessons 6–7

Year 8

Topic: Examining the building blocks of life

Analysing cellular structure and function

Today you will:

- understand the advantages and disadvantages of cell specialisation
- make links between specialised cell structure and function.

Resources

Digital

Slideshow — Structure and function of specialised cells

Slideshow — Generalised animal structure

Slideshow — Generalised plant structure

Find and prepare

Sheet 4 — Cell specialisation

Exercise book

Key terms

cell specialisation, investigation

For definitions and explanations of terms, please see the Glossary.

Science start-up

Identify structural similarities and differences

When early scientists, like Matthias Schleiden (1804–1881) and Theodor Schwann (1810–1882) observed plant and animal tissues under the microscope, they found striking similarities in the overall structure of plant and animal cells that led them to claim the cell as the basic building block of all living things.

The desire to explain the nature of the cell has driven the need for improved microscope technology. In turn, advancements in microscope technology have enabled scientists to conduct detailed studies of how cellular structure and function keep organisms alive.

Recall the following terminology:

Cell	the smallest living unit of an organism.
Unicellular	consisting of one cell.
Multicellular	consisting of many cells.
Organelle	smaller structures within a cell, enclosed in a membrane and with a specific cellular function.
Prokaryote	unicellular organism; cell **without** membrane-bound organelles.
Eukaryote	unicellular or multicellular organism; cell/s **with** membrane-bound organelles.

1. To review the similarities and differences in the general structure and function of plant and animal cells, go the **Website — Plant and animal cell organelles** (Cells alive!) cellsalive.com/cells/cell_model.htm.

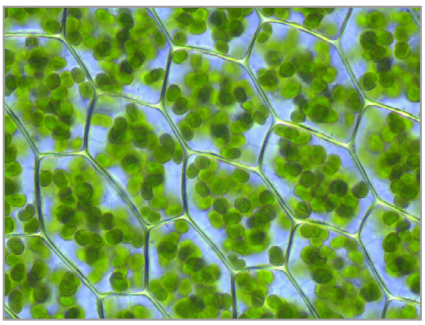
   Start the animation using the navigation button provided. You can navigate between *Animal Cell* and *Plant Cell*. Hovering over the diagram provides a label for each organelle. Clicking on an organelle provides a description of its structure and function.

   a. Name three organelles and/or cell structures that plant and animal cells have in common.

   b. What function do each of these structures have in keeping the cell alive?

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c. If you, like Schleiden or Schwann, were looking at this image under the microscope, what structures would indicate to you that these were plant cells?



Peters, K, *Plagiomnium affine laminazellen*,
https://commons.wikimedia.org/wiki/File:Plagiomnium_affine_laminazellen.jpeg
CC BY-SA 3.0 creativecommons.org/licenses/by-sa/3.0/deed.en

Scientists use their own prior knowledge and ongoing observations, as well as that of other scientists, to develop **investigable questions**. These questions provide the starting point for any scientific investigation.

Investigable questions are those that can be **investigated scientifically** through fair testing, repeated trials, collection of quantitative data and consistent observations, or the gathering of evidence to support/refute a hypothesis. They lead to deeper understanding of the relationships that exist in the natural and physical worlds and how these are explained. They also lead to the development of new technologies and techniques that facilitate further scientific investigation.

For example, unlike many scientists at the time, Schwann did not believe cells develop spontaneously out of non-living matter. He used newly developed microscopes to observe yeast cells in detail, which he recognised shared features in common with plant cells and led to his conclusion that yeast is a microorganism. This understanding then led him to question the cause of fermentation in the production of alcohol. *Was fermentation a spontaneous reaction between chemical compounds or was it caused by living yeast cells?* Schwann conducted a series of carefully planned experiments in which he compared heated and unheated fermenting beer (in closed vessels in the presence of oxygen). Once heated, the liquid no longer continued to ferment; the reaction stopped when the yeasts stopped growing. Schwann had demonstrated that living yeast was necessary for fermentation as well as the production of more yeast.

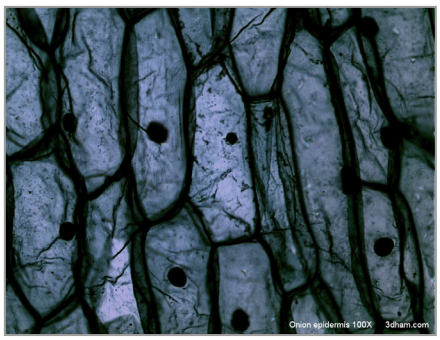
2. Knowing the cells in the above image are from a plant, what investigable questions could you ask about the visible structures?

In these lessons, you will consider the variety of cell types found in multicellular organisms and how structural differences in these cell types are related to their specific function within tissues, organs and systems.

Lesson

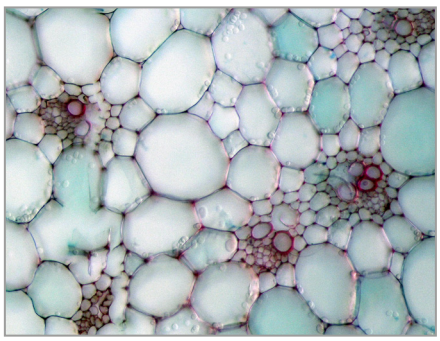
Identify specialised plant and animal cells

3. Look at the following images of cells from two different parts of plants. The first image shows **epidermal** cells in the transparent tissue covering each fleshy layer of the onion bulb. The second image is a cross-section of the lily stem showing the central section, called the **pith**.



Onion bulb, epidermal cells

Elson, J.A, *Onion epidermis 100x*, https://commons.wikimedia.org/wiki/File:Onionepidermis100x2.jpg, CC BY-SA 3.0 creativecommons.org/licenses/by-sa/3.0/deed.en



Spider lily stalk, pith cells

Cropped from: Micropix, *Tradescantia, stalk, Etzold green*, https://commons.wikimedia.org/wiki/File:Tradescantia,_stalk,_Etzold_green_6.jpg, CC BY-SA 3.0 creativecommons.org/licenses/by-sa/3.0/deed.en

a. What is different about the structure of the cell types compared to each other or compared to the general plant cell? (**Note:** You may need to zoom in on each image to identify all the visible cellular structures.)

b. What possible explanations could you give for these observable differences in structure?

When cells from previous parts of multicellular organisms or from different organisms are studied under the microscope, we begin to see that while all cells contain a general set of organelles essential to survival, cells from different tissues have unique structural features that distinguish them from cells in other tissues and from the general cell structure. As scientists, we would ask ourselves why this is the case.

You know from previous study of materials and machines that structure and function are interrelated. For example, a bicycle has any number of parts, each of which has a job to perform. Each part functions the way it does because its structure is suited to that function. What would it be like riding a bike if the wheels were square, or were metal rings without rubber tyres? The relationship between structure and function also exists in living systems at each level of the organisational hierarchy.

You will now examine structural differences in certain plant and animal cell types, and make links to the function of these cell types within the plant or animal body.

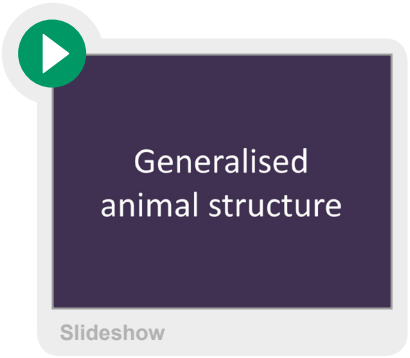
4. Open the **Slideshow — Structure and function of specialised cells**.

   This slideshow contains images and information about structural differences in particular animal and plant cell types. There are accompanying notes with each slide, so ensure you read these for further explanation.



5. Open and complete **Sheet 4 —** Cell specialisation, using the slideshow. Each slide has one or more guiding questions to help you think about how the structural differences in the cells are related to function. Write notes in response to these questions in your exercise book and use them to complete **Sheet 4**.

   In completing **Sheet 4**, you may also find it useful to refer back to the **Slideshow — Generalised animal structure** and **Slideshow — Generalised plant structure**.





   Ensure you use all the information provided about animal and plant tissue/cell structure and function and appropriate scientific terminology in developing cohesive and coherent responses to **Sheet 4**. Use the provided example as a model for your own responses.

Analyse cell specialisation

The structural and functional differences you have examined in plant and animal cell types are examples of **cell specialisation**.

Cell specialisation refers to differences in cellular structure and function found in multicellular organisms.

There is a strong link between multicellular structure and cell specialisation. Structurally complex organisms like mammals and flowering plants have extremely high levels of cell specialisation within their bodies.

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6. a. Consider the following list of points with another person. Write whether you think each point about cell specialisation would be an advantage or disadvantage to an organism.

Cell specialisation	Advantage or disadvantage
Having greater complexity and being able to complete more complicated tasks.	
Specialised cells require less energy to perform their specific role and there is less wastage of resources.	
More simplified individual components.	
The organism can be larger in size and have a variety of body forms.	
Time taken to reproduce is longer and requires more energy and resources.	
Materials need to be transported further, so the whole organism requires more energy to function.	
Ability to live in a range of environments.	
Processes within the organism are more efficient because they can occur in different parts of the organism and at different times.	
Organism has a longer life span and injury or death of some cells has a small impact on the whole organism.	
Separation of functions requires a complex system of coordination and control within the body of the organism.	
Reproductive and development processes, and regulation of these processes, is far more complex to ensure cells differentiate correctly.	

b. Reflect on your responses in the table and write a paragraph analysing the value of cell specialisation within organisms. Use examples wherever possible to support your evaluation.

Reflection

When modern scientists **investigate** cells under the microscope they do so in order to understand more about the relationship between structure and function in living organisms. This type of investigation has led to many advancements that we may take for granted — development of cures and preventative measures for many diseases; production of disease-resistant high-yield crops to meet growing food demands; development of reproductive technologies that give humans the chance to have children or may give a near-extinct species a chance for survival; an understanding of the interconnectedness of the human species to other life on Earth.

7. In these lessons, you have explored some of what is known about the relationship between cell structure and function in multicellular organisms.

   a. Taking into account what you have learned, construct an investigable question that could be used to further explore the relationship between structure and function in plant or animal cells.

   b. Explain how the question you have chosen would help develop understanding of cell structure and function.

In the next lesson, you will review early scientists' understanding of the nature of the cell and evaluate their ideas about cells in light of later research.

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