TOPIC
1.2

Where do living things come from?

For thousands of years, people observed that maggots (fly larvae) seemed to appear suddenly in rotting meat that had been left out. Frogs and salamanders seemed to appear suddenly when it rained. A "recipe" for making mice called for mixing dirty shirts with grains of wheat. Based on observation alone, the idea that living things could come into being, spontaneously, from meat, mud, and dirty clothes made sense. As the processes and tools of scientific inquiry began to develop from the 1600s onward, ideas about where living things come from began to change.

Key Concepts

- Living things come only from other living things.
- Scientists debate about whether viruses are living things or not.

Curricular Competencies

- Collaboratively plan a range of investigation types to answer questions or solve problems.
- Seek patterns and connections in data from investigations and secondary sources.
- Use scientific understandings to identify relationships and draw conclusions.
- Demonstrate an awareness of assumptions and identify information given and bias in your own work and secondary sources.

Starting Points

Choose one, some, or all of the following to start your exploration of this topic.

1. **Identifying Preconceptions** Reflect on the observation that maggots appear in rotting meat. What questions would you ask about where the maggots come from if you made this observation yourself? What hypothesis could you come up with to investigate it? Discuss how you would plan an experiment to test your hypothesis.
2. **Analyzing Information** Examine the photograph on the right. How might this photo support the idea that life only comes from pre-existing life? How do you think the development and use of microscopes helped scientists investigate this idea?

3. **Evaluating** The "recipe" for making mice seems to work. Mice often do appear in a mixture of wheat grains and a dirty shirt. Explain why their appearance is not evidence that living things can come from lifeless matter.

Key Terms

There are two key terms that are highlighted in bold type in this Topic:

- cell theory
- virus

Flip through the pages of this Topic to find these terms. Add them to your class Word Wall along with their meaning. Add other terms that you think are important and want to remember.

CONCEPT 1

Living things come only from other living things.

Activity

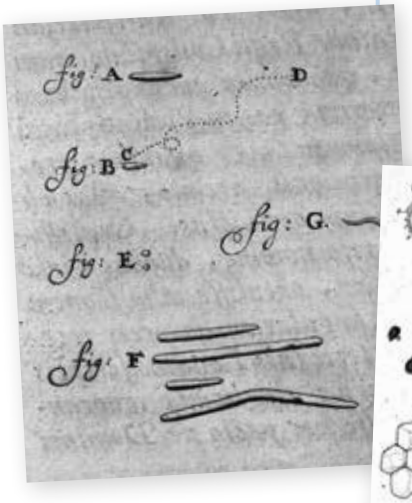
Viewing Cells

Imagine you are a scientist more than 300 years ago and you make your own microscope. You look at a thin strip of bark from a cork oak tree and see the image shown in **Figure 1.6**. How would you describe these structures? What questions would you have after looking at the bark? How might you try to answer these questions?

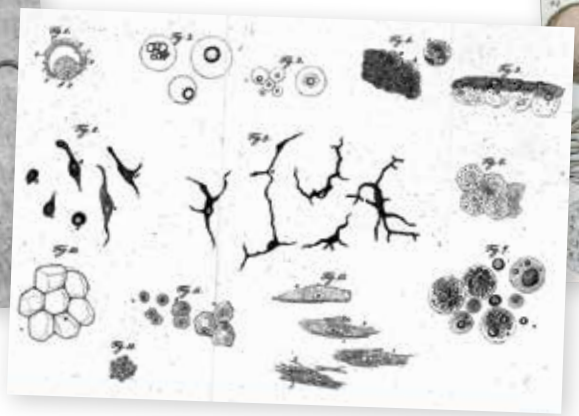
Figure 1.6 These are drawings that Robert Hooke made after viewing tree bark with the microscope that he designed.

Robert Hooke was a British scientist in the 17th century. In the 1660s, he created a microscope to observe tree bark. He called the structures that he saw cells, which is the term still used today to describe the structures that living things are made of. Around the same time, other scientists also made their own microscopes and observed single-celled organisms living in pond water (**Figure 1.7**). As technology for making microscopes improved, scientists were able to observe and learn more about different types of cells.

Figure 1.7 Drawings of different organisms and cells as seen under the microscope by scientists who were pioneers in this field. **What ideas and questions do you have, and what conclusions might you propose, from looking at these organisms and cells?**



Early drawings of bacteria



Early drawings of different types of animal cells

Early drawings of pond organisms

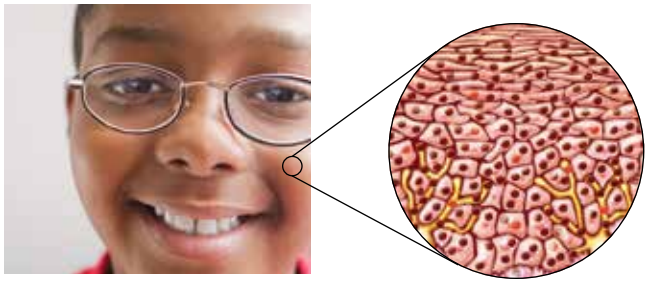
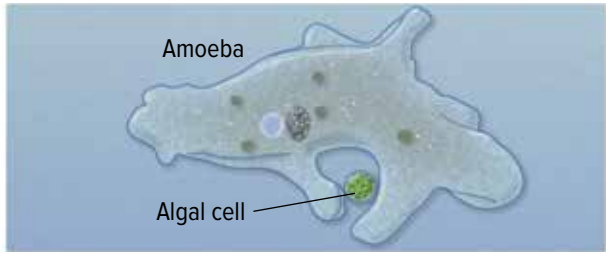
The Cell Theory

By the middle of the 1800s, scientists had made extensive observations of the cells of plants, animals, and other kinds of organisms. Based on the evidence they collected, scientists agreed on three important statements about cells and their connection with living things. These statements appear in Table 1.1. Taken together, these statements about cells are called the **cell theory**.

Connect to Investigation 1-A on pages 22–23

cell theory the theory in biology that explains the structure and source of all living things

Table 1.1 The Cell Theory

Statement	Example
All living things are made up of one or more cells.	
All new cells come from pre-existing cells.	
The cell is the basic unit of life.	This unicellular amoeba is surrounding an algal cell to get food and energy. 

Before you leave this page . . .

1. Identify the statements that make up the cell theory. Give an example that supports each statement.
2. What processes of scientific inquiry do you think scientists used to establish the cell theory?

CONCEPT 2

Scientists debate about whether viruses are living things or not.

Activity

Know-Want To Know-Learn (KWL) Chart

Use a KWL chart to organize the ideas you have about viruses. How many different viruses can you name? What roles do they play in ecosystems? How do viruses interact with humans and with other organisms? Record the answers to these questions or anything else you know or want to know about viruses. After you finish Concept 2, fill in the "What I Learned" column of your chart.

virus a strand of genetic material surrounded by a protein layer that can infect and reproduce in a host cell

A **virus** is a strand of genetic material surrounded by a layer of protein that can infect and reproduce in a host cell. Figure 1.8 shows the basic structure of a virus. The genetic material is surrounded by a protein coat. Some viruses have a tail-like structure and fibres. Others have a fatty membrane that surrounds the protein coat.

How Viruses Work

Viruses do not contain the cell parts that plant and animal cells do. So viruses cannot take in nutrients, use energy, or produce wastes like cells do. They cannot even reproduce on their own. Viruses must be inside the cell of another organism, called a host, to reproduce.

Before they enter a host, viruses are dormant (inactive). They cannot carry out any life functions. Viruses can exist in a dormant state for hours, days, and in some cases even months before they reach a host. For example, viruses that cause colds can stay dormant for up to 7 days on indoor surfaces. Viruses that cause the flu can stay dormant for 24 hours on a hard surface, such as a countertop. If these viruses do reach a host, they will use its cells to reproduce. That is all viruses do inside the host: reproduce.

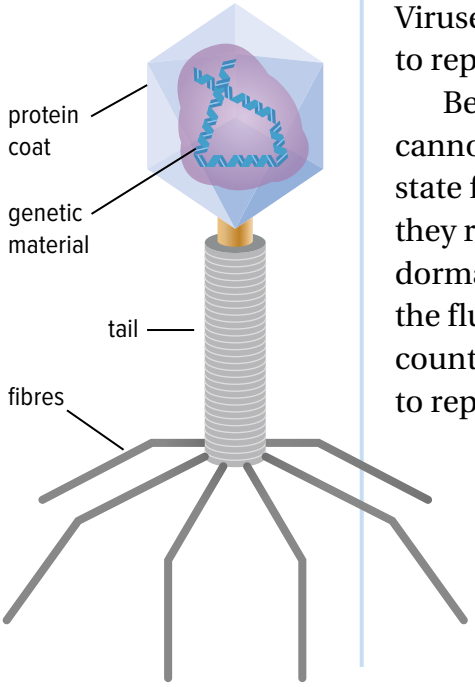


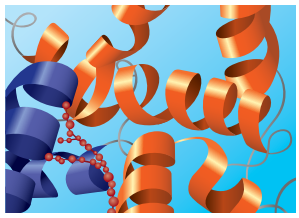
Figure 1.8 This is one type of virus called a bacteriophage. It infects bacteria.

How Recent Evidence Has Changed How Scientists View Viruses

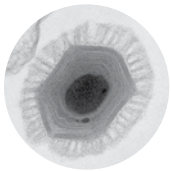
Most scientists do not consider viruses to be alive, because they do not have the characteristics of living things. They cannot even reproduce without hijacking the structures and processes of host cells. However, in the last few decades, scientist have made discoveries that support the idea that viruses could be considered living things. The timeline in **Figure 1.9** describes some of these discoveries and what they mean.

Figure 1.9 The timeline shows some of the discoveries that provide evidence that viruses were once living things and may be more complex than previously thought.

2011: Scientists discover another large virus called the Megavirus. It has even more genetic material than Mimivirus. After comparing the genetic material of these two viruses, scientists believe that they may have evolved from a common ancestor that was able to make its own proteins.



1992–2008: Scientists discover and research the largest and most complex virus to date: the Mimivirus. It is up to 10 times as large as most viruses. It also has up to 5 times as much genetic material as other viruses. Some of the genetic material had never been seen before in viruses.



2015: Scientists trace the evolutionary history of more than 3000 viruses by comparing the folds in their proteins. Results show that more than 400 protein folds are shared between viruses and cells from other organisms and that 66 folds are unique to viruses. Based on these results, scientists infer that viruses once, long ago, had the same properties as cells. This could mean that viruses at some time in the past were alive and that they evolved as separate "organisms" at some later time.

Activity

Are Viruses Alive?

Hold a class debate on whether viruses are living things or not. Your teacher will assign your group to a position. Do research to prepare and strengthen your arguments. Then hold your debate. Afterwards, write a summary of your own opinion about whether viruses should be considered alive or not.

Before you leave this page . . .

1. Why do many scientists consider viruses to be non-living?
2. What new evidence is most convincing to you that viruses should be considered living things?
3. A number of fish farms raise salmon on the east and west coasts. A deadly flu virus that infects farm-raised salmon in the east is of concern in B.C. How could such a virus affect people and B.C. culturally and economically?

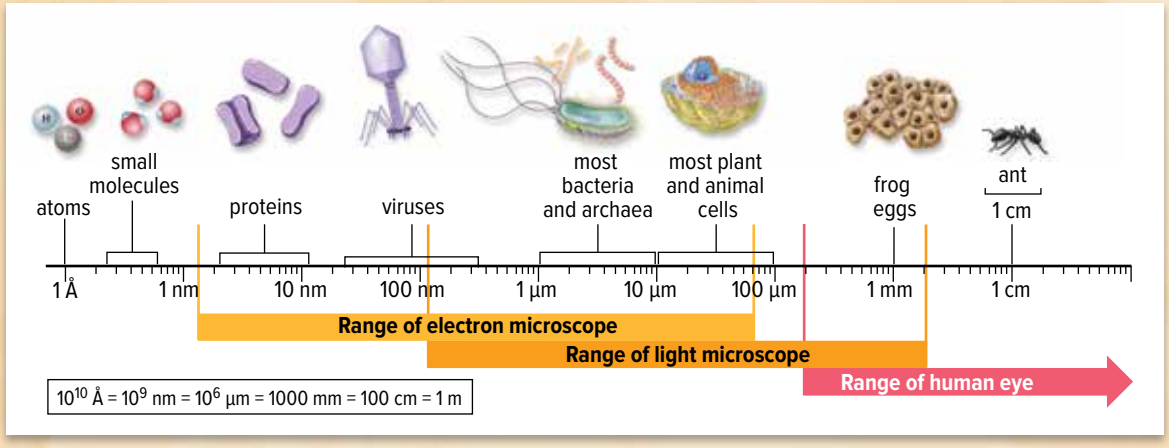
AT ISSUE

How can you visualize and compare the sizes of different objects?

What's the Issue?

The term *scale* refers to comparing objects by their size or by their amount. Look at the diagram below. Start at the left and focus your attention on the numbers. See that each segment in the scale represents 1/10 (one-tenth) of the length of the segment to its right.

In this diagram, pictures are used to help give a sense of the kinds of objects that are visible at different segments of the scale. The three coloured bars under the number scale show the range of sizes that are visible with the unaided eye, the light microscope, and the electron microscope. The kind of microscope that you use at school is a light microscope. The very powerful (and very expensive) kind of microscope used by researchers is an electron microscope.



Dig Deeper

Collaborate with your classmates to explore one or more of these questions—or generate your own questions of interest to explore.

1. Microscopes like those you use at school have two lenses. An early, extremely powerful microscope used only a single lens. The person who invented it was an amateur, self-taught scientist. Investigate Antony van Leeuwenhoek to find out how he was able to see things in the late 1600s that scientists would not be able to see for another 150 years.
2. What kinds of light microscopes and electron microscopes are there? Why would you choose one kind of microscope over another for different kinds of research work?
3. The scale in the diagram compares objects only up to 1 cm in size. Find suitable objects to extend the scale farther—as far as you can. How cosmic can your sense of scale get?

Check Your Understanding of **Topic 1.2**

QP Questioning and Predicting PC Planning and Conducting PA Processing and Analyzing E Evaluating
AI Applying and Innovating C Communicating

Understanding Key Ideas

1. Record each statment of the cell theory, and explain what you understand each statement to mean. PA C

2. One of the scientists who contributed to the cell theory wrote: "Cells are the last link in a great chain [that forms] tissues, organs, systems, and individuals." PA E AI C

a) Which statement(s) of the cell theory are supported by this quotation?

b) The quotation continues: "Where a cell exists, there must have been...." What do you think the rest of the sentence says? Explain your answer using reasons that demonstrate a scientific understanding.

3. You are a science journalist writing for a popular online science magazine. Write a short article that explains

a) how recent evidence has changed the way scientists view viruses

b) why you think viruses should or should not be classified as living things PA AI E C

Connecting Ideas

4. A common way to diagnose a bacterial infection is to take a sample from a patient. Part of the sample is swabbed onto a jelly-like material in which the bacteria can grow. The material has nutrients such as sugars and minerals that the bacteria need to reproduce. Could this method be used to determine if an infection is due to a virus? Explain why or why not. PA AI

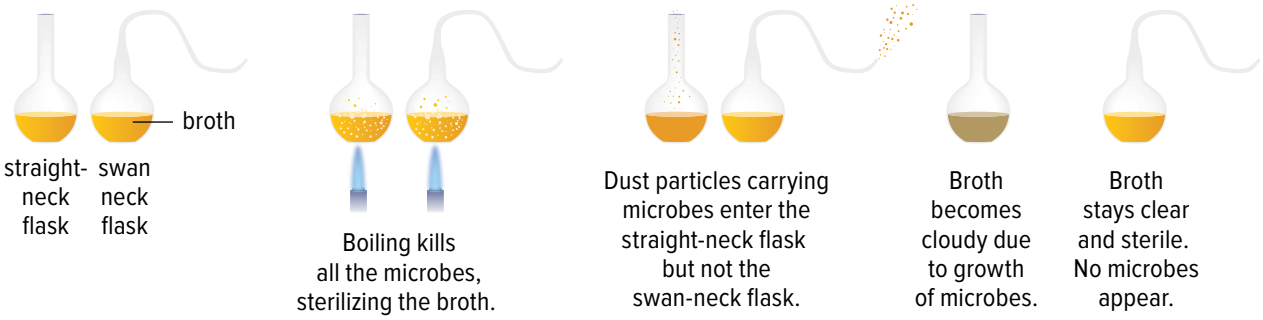
Making New Connections

5. Reflect on the paragraph used to introduce Topic 1.2. The idea that living things could come into being suddenly is called spontaneous generation. Louis Pasteur was one scientist who designed an experiment to disprove this idea. The diagram below summarizes the experiment. QP PA E C

a) Explain how it demonstrates that spontaneous generation cannot be correct.

b) How does the experiment provide support for the cell theory?

Use this diagram to answer question 5.



INVESTIGATION
1-A

STRUCTURED INQUIRY

Using a Microscope to Look at Objects

Skills and Strategies

- Planning and Conducting
- Processing and Analyzing
- Evaluating
- Communicating

Safety

What You Need

- Appendix A on page 364 (Care and Use of the Microscope)
- microscope
- microscope slide and cover slip
- forceps
- piece of thread
- piece of hair
- prepared slides provided by your teacher
- other objects to observe: for example, paper, pine needle, rice grain, cotton swab, piece of wool

In Appendix 1, you will have been introduced to the microscope—its parts, the proper way to use and care for this delicate piece of equipment, and some techniques for preparing materials to view them. Now, in this Investigation, you will use a microscope to observe different objects at different magnifications. This will allow you to practise and become comfortable using a microscope, which is an important skill that biologists use all the time.

Question

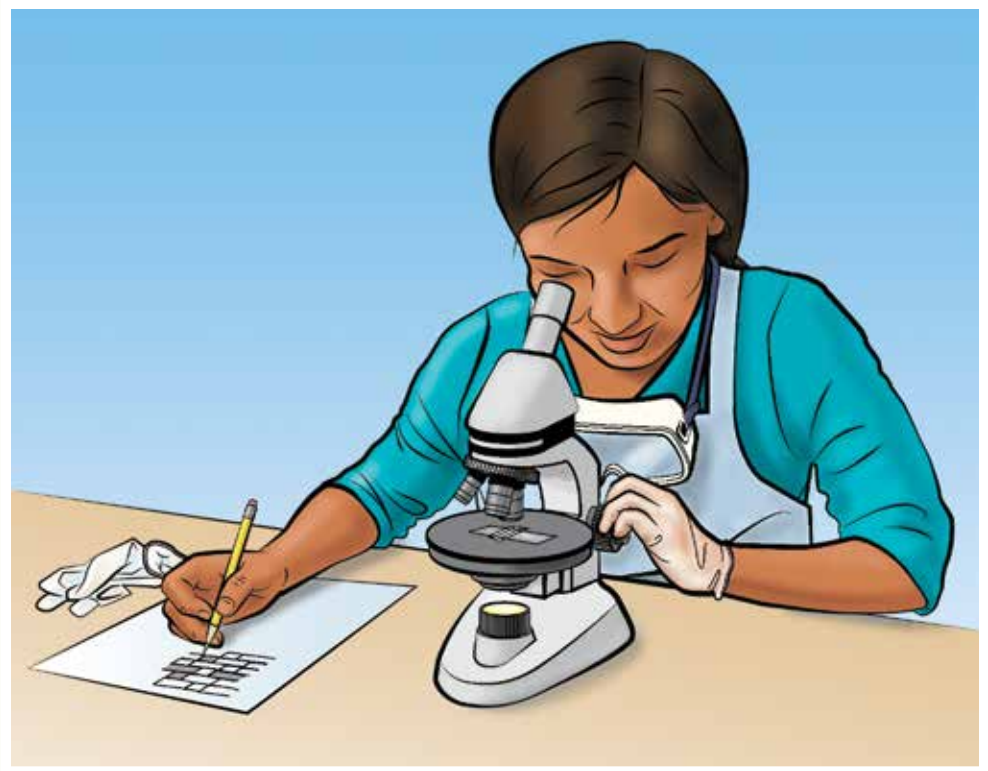
How can you build on your microscope experiences from Appendix 1 to observe an object?

Procedure

1. Obtain a microscope and set it up safely and properly at your work table.
2. Choose an object to observe.
3. Observe the object on low power. Make and label a sketch of the object.
4. Observe the same object on high power. Make and label a sketch of the object.
5. Repeat steps 2 through 4 with three other objects.
6. Clean up and put away the equipment you have used. Follow directions to safely dispose of materials.

Analyze and Interpret

1. Choose one of the objects you observed. Describe the differences you saw at low power and high power. How do your sketches reflect these differences?
2. Compare two similar objects, such as a piece of thread and a piece of hair, or a piece of cotton and a piece of wool. How are the objects similar? How are they different?



Conclude and Communicate

3. **a)** Share your sketches with your classmates. Can you identify what they were looking at based on the sketch? Did they notice things you didn't? Did you notice things they didn't?
   b) How can comparing your sketches with others help you to improve your skills?
4. Why is it important to accurately record your observations, whether you are making a drawing or making notes?
5. What are some sources of error in this Investigation? How might errors have affected your observations?