Lesson 2

Levels of Organization

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

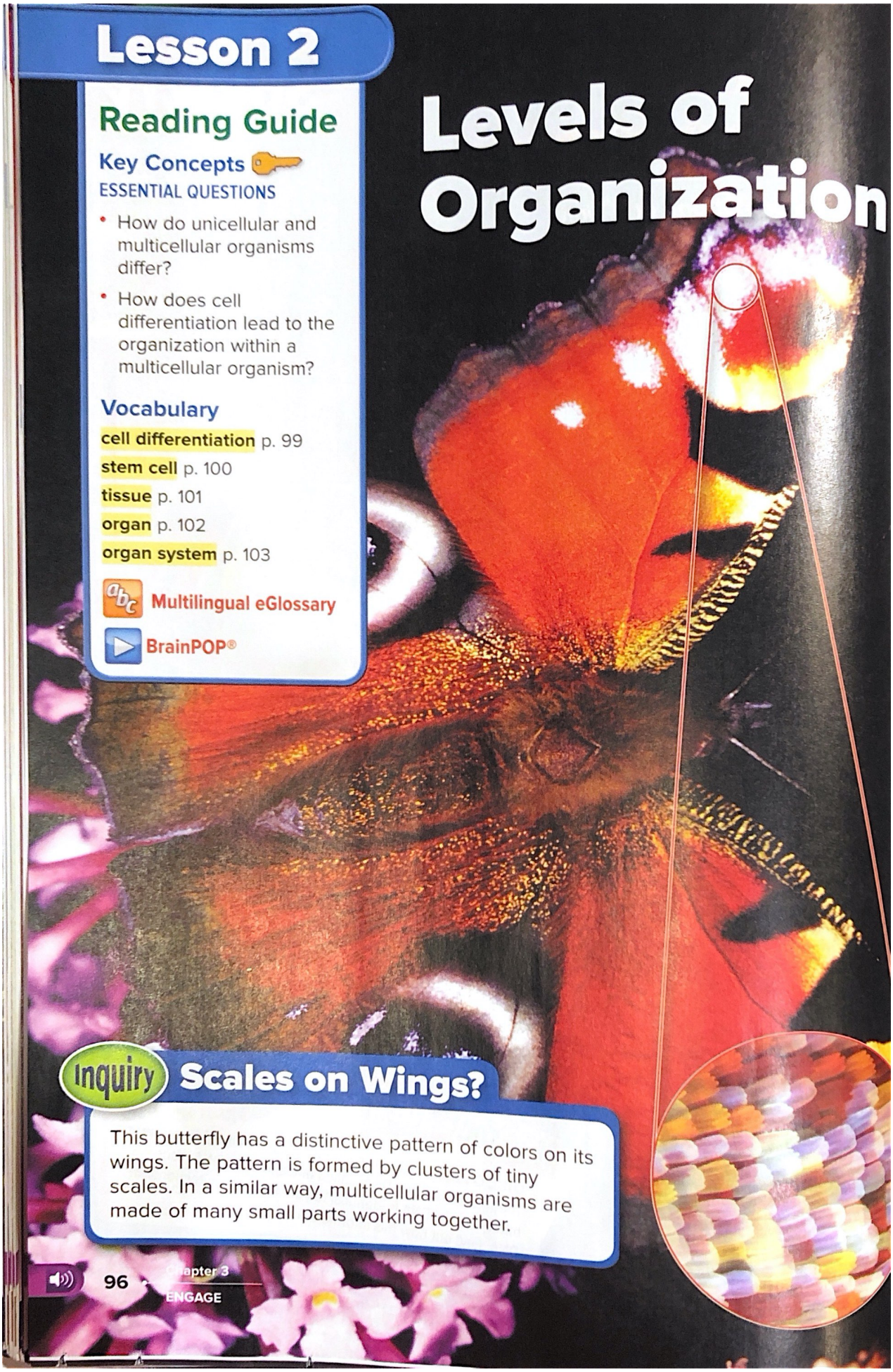
- How do unicellular and multicellular organisms differ?
- How does cell differentiation lead to the organization within a multicellular organism?

Vocabulary

cell differentiation p. 99
stem cell p. 100
tissue p. 101
organ p. 102
organ system p. 103

Multilingual eGlossary

BrainPOP®



Inquiry Scales on Wings?

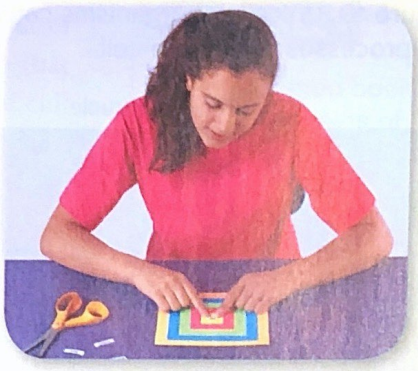
This butterfly has a distinctive pattern of colors on its wings. The pattern is formed by clusters of tiny scales. In a similar way, multicellular organisms are made of many small parts working together.

Launch Lab

15 minutes

How is a system organized?

The places people live are organized in a system. Do you live in or near a city? Cities contain things such as schools and stores that enable them to function on their own. Many cities together make up another level of organization.



1. Read and complete a lab safety form.
2. Using a **metric ruler** and **scissors,** measure and cut squares of **construction paper** that are 4 cm, 8 cm, 12 cm, 16 cm, and 20 cm on each side. Use a different color for each square.
3. Stack the squares from largest to smallest, and glue them together.
4. Cut apart the *City, Continent, Country, County*, and *State* labels your teacher gives you.
5. Use a **glue stick** to attach the *City* label to the smallest square. Sort the remaining labels from smallest to largest, and glue to the corresponding square.

Think About This

1. What is the largest level of organization a city belongs to?
2. Can any part of the system function without the others? Explain.
3. **Key Concept** How do you think the system used to organize where people live is similar to how your body is organized?

Life's Organization

You might recall that all matter is made of atoms and that atoms combine and form molecules. Molecules make up cells. A large animal, such as a Komodo dragon, is not made of one cell. Instead, it is composed of trillions of cells working together. Its skin, shown in **Figure 9,** is made of many cells that are specialized for protection. The Komodo dragon has other types of cells, such as blood cells and nerve cells, that perform other functions. Cells work together in the Komodo dragon and enable it to function. In the same way, cells work together in you and in other multicellular organisms.

Recall that some organisms are made of only one cell. These unicellular organisms carry out all the activities necessary to survive, such as absorbing nutrients and getting rid of wastes. But no matter their sizes, all organisms are made of cells.

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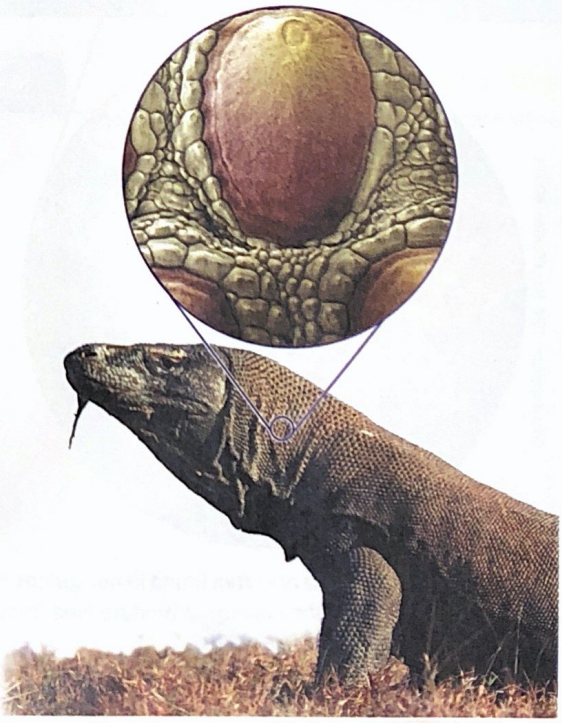
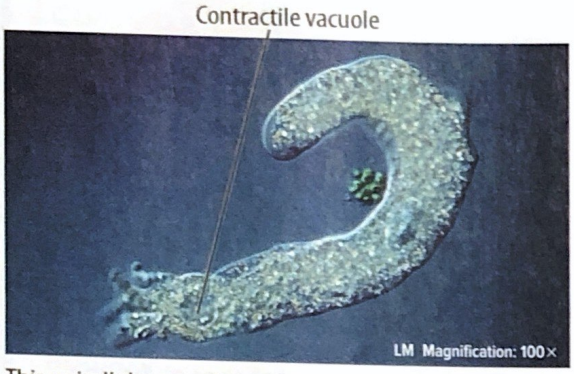
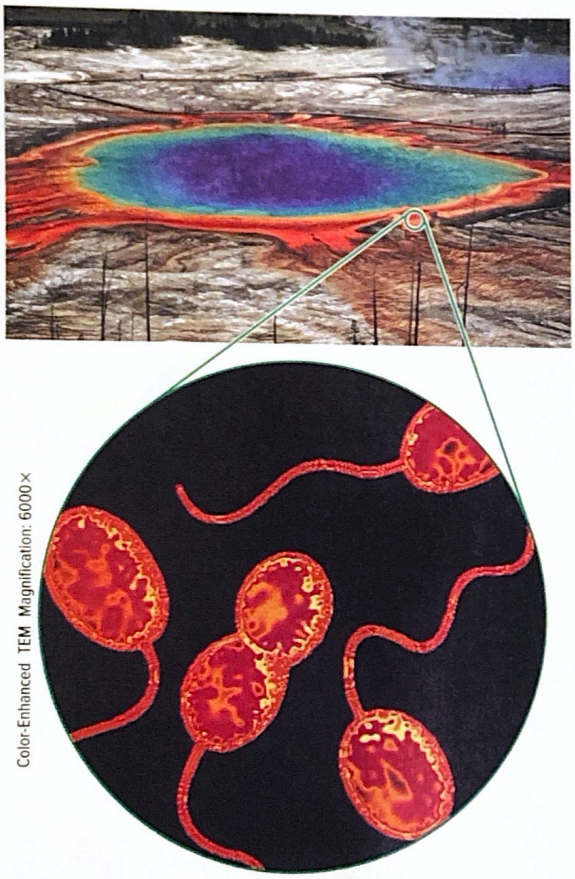


Figure 9 Skin cells are only one of the many kinds of cells that make up a Komodo dragon.

Figure 10 Unicellular organisms carry out life processes within one cell.



This unicellular amoeba captures algae for food.



These heat-loving bacteria are often found in hot springs as shown here. They get their energy to produce food from sulfur instead of from light like plants.

Unicellular Organisms

As you read on the previous page, some organisms have only one cell. Unicellular organisms do all the things needed for their survival within that one cell. For example, the amoeba in **Figure 10** is ingesting another organism, a type of green algae called *Pandorina* spp., for food. Unicellular organisms also respond to their environment, get rid of waste, grow, and even reproduce on their own. Unicellular organisms include both prokaryotes and some eukaryotes.

Prokaryotes

Recall that a cell without a membrane-bound nucleus is a prokaryotic cell. In general, prokaryotic cells are smaller than eukaryotic cells and have fewer cell structures. A unicellular organism made of one prokaryotic cell is called a prokaryote. Some prokaryotes live in groups called colonies. Some can also live in extreme environments, as shown in **Figure 10.**

Eukaryotes

You might recall that a eukaryotic cell has a nucleus surrounded by a membrane and many other specialized organelles. For example, the amoeba shown in **Figure 10** has an organelle called a contractile vacuole. It functions like a bucket that is used to bail water out of a boat. A contractile vacuole collects excess water from the amoeba's cytoplasm. Then it pumps the water out of the amoeba. This prevents the amoeba from swelling and bursting.

A unicellular organism that is made of one eukaryotic cell is called a eukaryote. There are thousands of different unicellular eukaryotes, such as algae that grow on the inside of an aquarium and the fungus that causes athlete's foot.

Reading Check Give an example of a unicellular eukaryotic organism.

Multicellular Organisms

Multicellular organisms are made of many eukaryotic cells working together, like the crew on an airplane. Each member of the crew, from the pilot to the mechanic, has a specific job that is important for the plane's operation. Similarly, each type of cell in a multicellular organism has a specific job that is important to the survival of the organism.

Key Concept Check How do unicellular and multicellular organisms differ?

Cell Differentiation

As you read in the last lesson, all cells in a multicellular organism come from one cell–a fertilized egg. Cell division starts quickly after fertilization. The first cells made can become any type of cell, such as a muscle cell, a nerve cell, or a blood cell. *The process by which cells become different types of cells is called* **cell differentiation** (dihf uh ren shee AY shun).

You might recall that a cell's instructions are contained in its chromosomes. Also, nearly all the cells of an organism have identical sets of chromosomes. If an organism's cells have identical sets of instructions, how can cells be different? Different cell types use different parts of the instructions on the chromosomes. A few of the many different types of cells that can result from human cell differentiation are shown in **Figure 11.**

FOLDABLES®

Make a layered book from three sheets of notebook paper. Label it as shown. Use your book to describe the levels of organization that make up organisms.

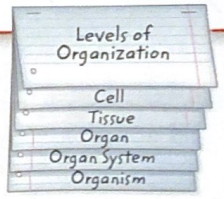
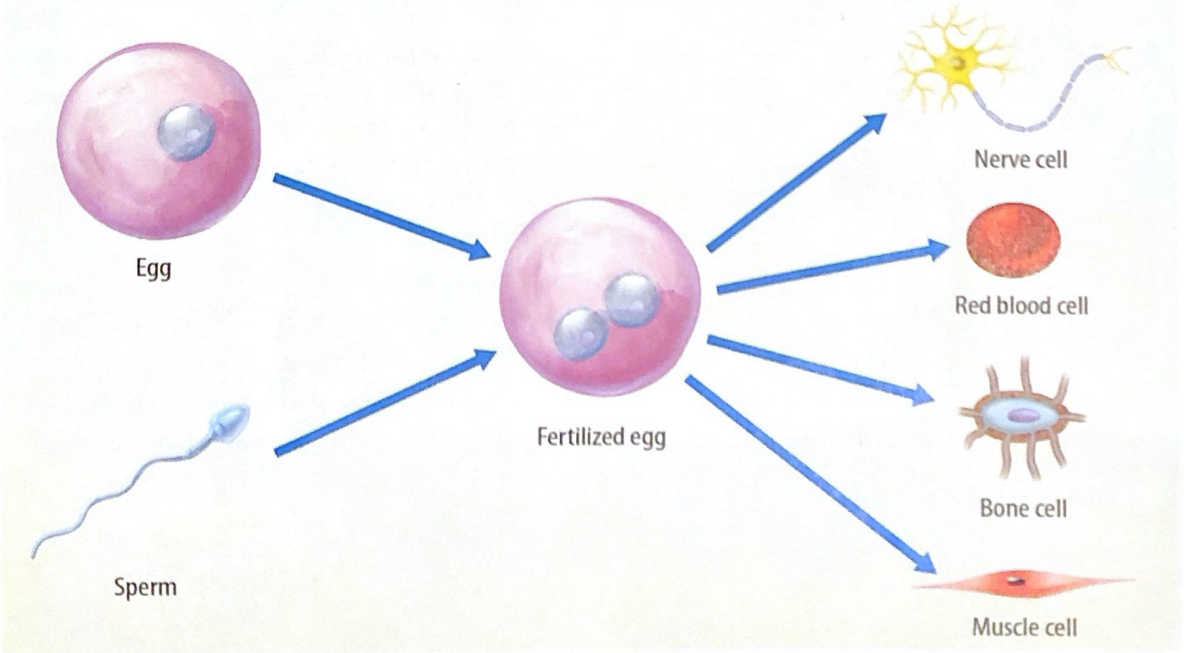


Figure 11 A fertilized egg produces cells that can differentiate into a variety of cell types.

Cell Differentiation in Eukaryotes

Personal Tutor



Animal Stem Cells Not all cells in a developing animal differentiate. **Stem cells** *are unspecialized cells that are able to develop into many different cell types.* There are many stem cells in embryos but fewer in adult organisms. Adult stem cells are important for the cell repair and replacement you read about in Lesson 1. For example, stem cells in your bone marrow can produce more than a dozen different types of blood cells. These replace ones that are damaged or worn out. Stem cells have also been discovered in skeletal muscles. These stem cells can produce new muscle cells when the fibers that make up the muscle are torn.

Plant Cells Plants also have unspecialized cells similar to animal stem cells. These cells are grouped in areas of a plant called meristems (MER uh stemz). Meristems are in different areas of a plant, including the tips of roots and stems, as shown in **Figure 12.** Cell division in meristems produces different types of plant cells with specialized structures and functions, such as transporting materials, making food, storing food, or protecting the plant. These cells might become parts of stems, leaves, flowers, or roots.

SCIENCE USE V. COMMON USE

fiber

Science Use a long muscle cell

Common Use a thread

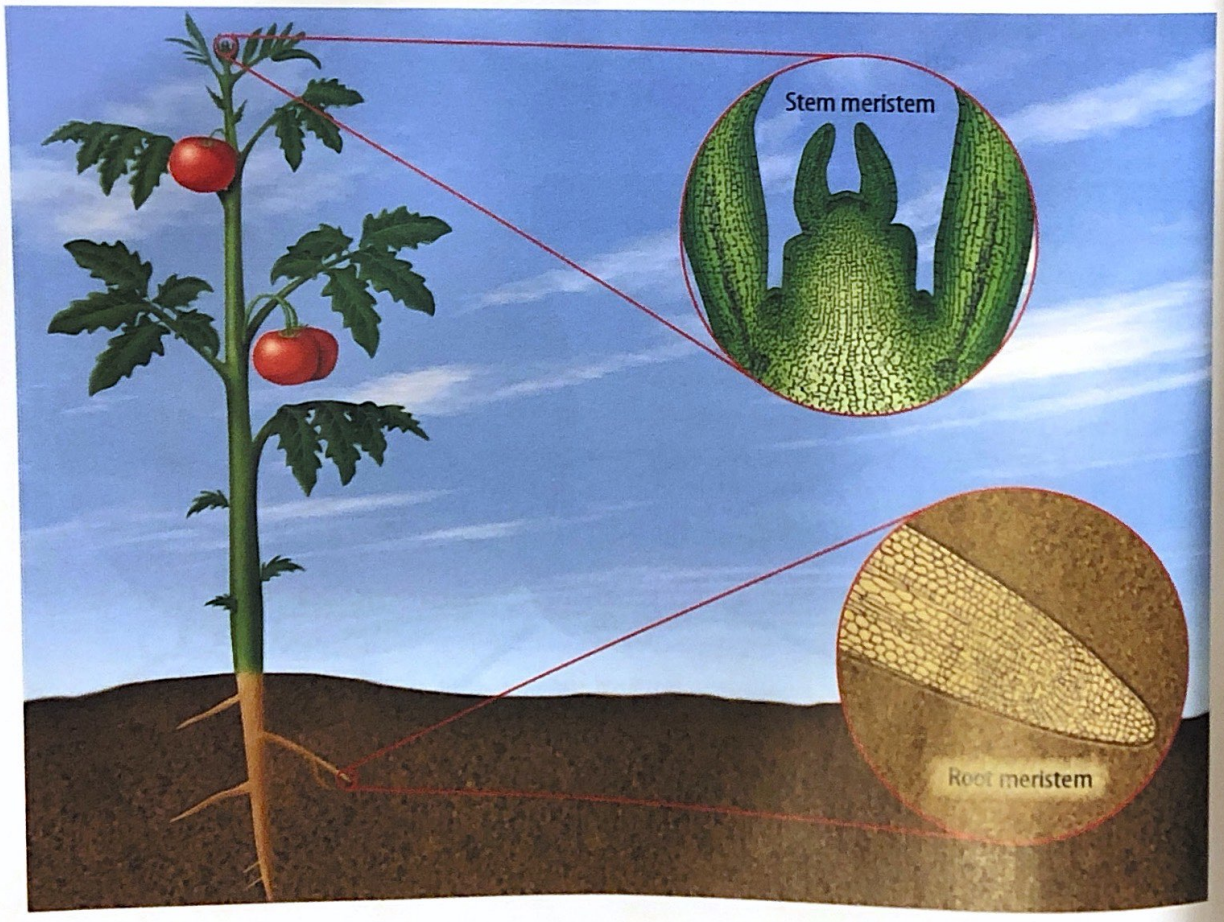
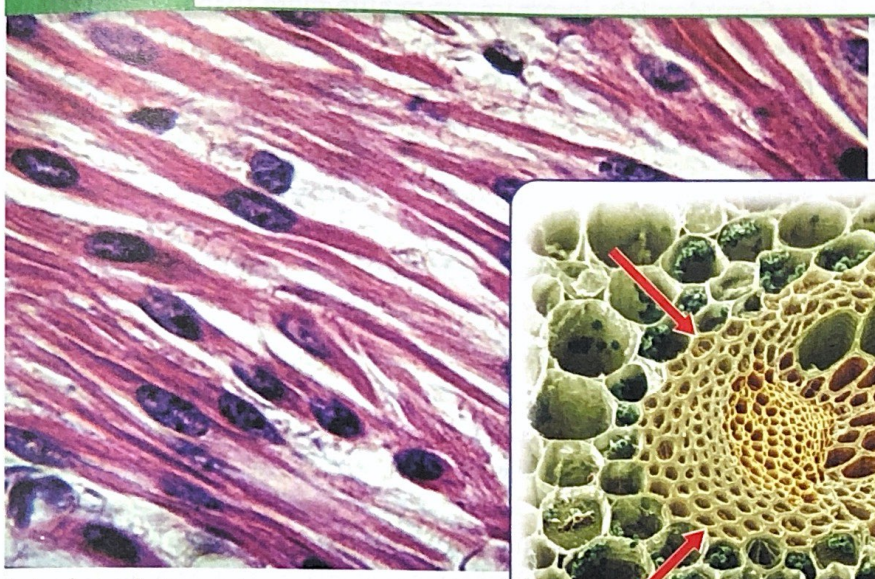
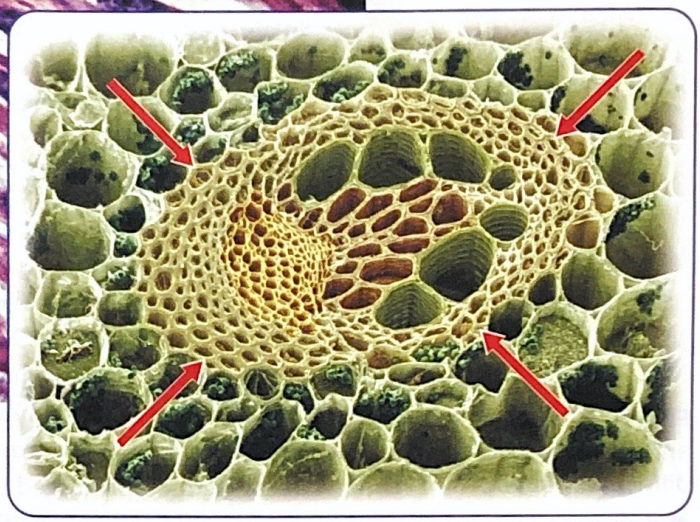


Figure 12 Plant meristems produce cells that can become part of stems, leaves, flowers, or roots.



Animal muscle tissue

LM Magnification: 100×



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Plant vascular tissue

Figure 13 Similar cells work together and form tissues such as this animal muscle tissue that contracts the stomach to help digestion. Plant vascular tissue, indicated by red arrows, moves water and nutrients throughout a plant.

Tissues

In multicellular organisms, similar types of cells are organized into groups. **Tissues** *are groups of similar types of cells that work together to carry out specific tasks.* Humans, like most other animals, have four main types of tissue–muscle, connective, nervous, and epithelial (eh puh THEE lee ul). For example, the animal tissue shown in **Figure 13** is smooth muscle tissue that is part of the stomach. Muscle tissue causes movement. Connective tissue provides structure and support and often connects other types of tissue together. Nervous tissue carries messages to and from the brain. Epithelial tissue forms the protective outer layer of the skin and the lining of major organs and internal body cavities.

Plants also have different types of tissues. The three main types of plant tissue are dermal, vascular (VAS kyuh lur), and ground tissue. Dermal tissue provides protection and helps reduce water loss. Vascular tissue, shown in **Figure 13,** transports water and nutrients from one part of a plant to another. Ground tissue provides storage and support and is where photosynthesis takes place.

Reading Check Compare animal and plant tissues.

WORD ORIGIN

tissue
from Latin *texere*, means "weave"

Organs

ACADEMIC VOCABULARY

complex
(adjective) made of two or more parts

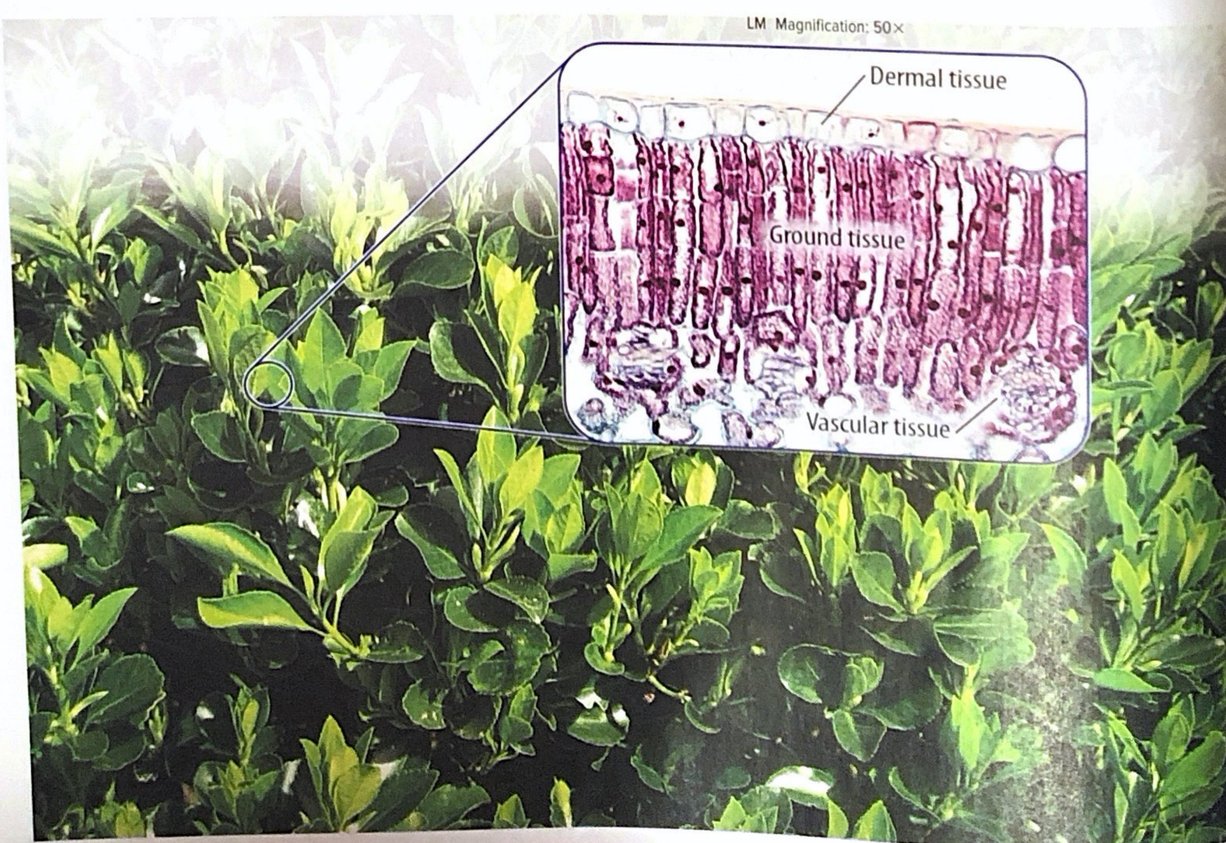
Complex jobs in organisms require more than one type of tissue. **Organs** *are groups of different tissues working together to perform a particular job.* For example, your stomach is an organ specialized for breaking down food. It is made of all four types of tissue: muscle, epithelial, nervous, and connective. Each type of tissue performs a specific function necessary for the stomach to work properly. Layers of muscle tissue contract and break up pieces of food, epithelial tissue lines the stomach, nervous tissue sends signals to indicate the stomach is full, and connective tissue supports the stomach wall.

Plants also have organs. The leaves shown in **Figure 14** are organs specialized for photosynthesis. Each leaf is made of dermal, ground, and vascular tissues. Dermal tissue covers the outer surface of a leaf. The leaf is a vital organ because it contains ground tissue that produces food for the rest of the plant. Ground tissue is where photosynthesis takes place. The ground tissue is tightly packed on the top half of a leaf. The vascular tissue moves both the food produced by photosynthesis and water throughout the leaf and the rest of the plant.

Reading Check List the tissues in a leaf organ.

Figure 14 A plant leaf is an organ made of several different tissues.

Visual Check Which plant tissue makes up the thinnest layer?



Organ Systems

Usually organs do not function alone. Instead, **organ systems** *are groups of different organs that work together to complete a series of tasks.* Human organ systems can be made of many different organs working together. For example, the human digestive system is made of many organs, including the stomach, the small intestine, the liver, and the large intestine. These organs and others all work together to break down food and take it into the body. Blood absorbs and transports nutrients from broken down food to cells throughout the body.

Plants have two major organ systems–the shoot system and the root system. The shoot system includes leaves, stems, and flowers. Food and water are transported throughout the plant by the shoot system. The root system anchors the plant and takes in water and nutrients.

Reading Check What are the major organ systems in plants?

MiniLab

25 minutes

How do cells work together to make an organism?

In a multicellular organism, similar cells work together and make a tissue. A tissue can perform functions that individual cells cannot. Tissues are organized into organs, then organ systems, then organisms. How can you model the levels of organization in an organism?

1. Read and complete a lab safety form.
2. Your teacher will give you a **cardboard shape, macaroni,** and a **permanent marker.**
3. The macaroni represent cells. Use the marker to draw a small circle on each piece of macaroni. This represents the nucleus.
4. Arrange and **glue** enough macaroni on the blank side of the cardboard shape to cover it. Your group of similar cells represents a tissue.
5. One of the squares on the back of your shape is labeled *A, B, C,* or *D.* Find the group with a matching letter. Line up these squares, and use **tape** to connect the two tissues. This represents an organ.
6. Repeat step 4 with the squares labeled *E* or *F.* This represents an organ system.
7. Connect the organ systems by aligning the squares labeled *G* to represent an organism.

Analyze and Conclude

1. Each group had to work with other groups to make a model of an organism. Do cells, tissues, and organs need to work together in organisms? Explain.
2. **Key Concept** How does your model show the levels of organization in living things?

Organisms

Multicellular organisms usually have many organ systems. These systems work together to carry out all the jobs needed for the survival of the organisms. For example, the cells in the leaves and the stems of a plant need water to live. They cannot absorb water directly. Water diffuses into the roots and is transported through the stem to the leaves by the transport system.

In the human body, there are many major organ systems. Each organ system depends on the others and cannot work alone. For example, the cells in the muscle tissue of the stomach cannot survive without oxygen. The stomach cannot get oxygen without working together with the respiratory and circulatory systems. **Figure 15** will help you review how organisms are organized.

Key Concept Check How does cell differentiation lead to the organization within a multicellular organism?

Animation

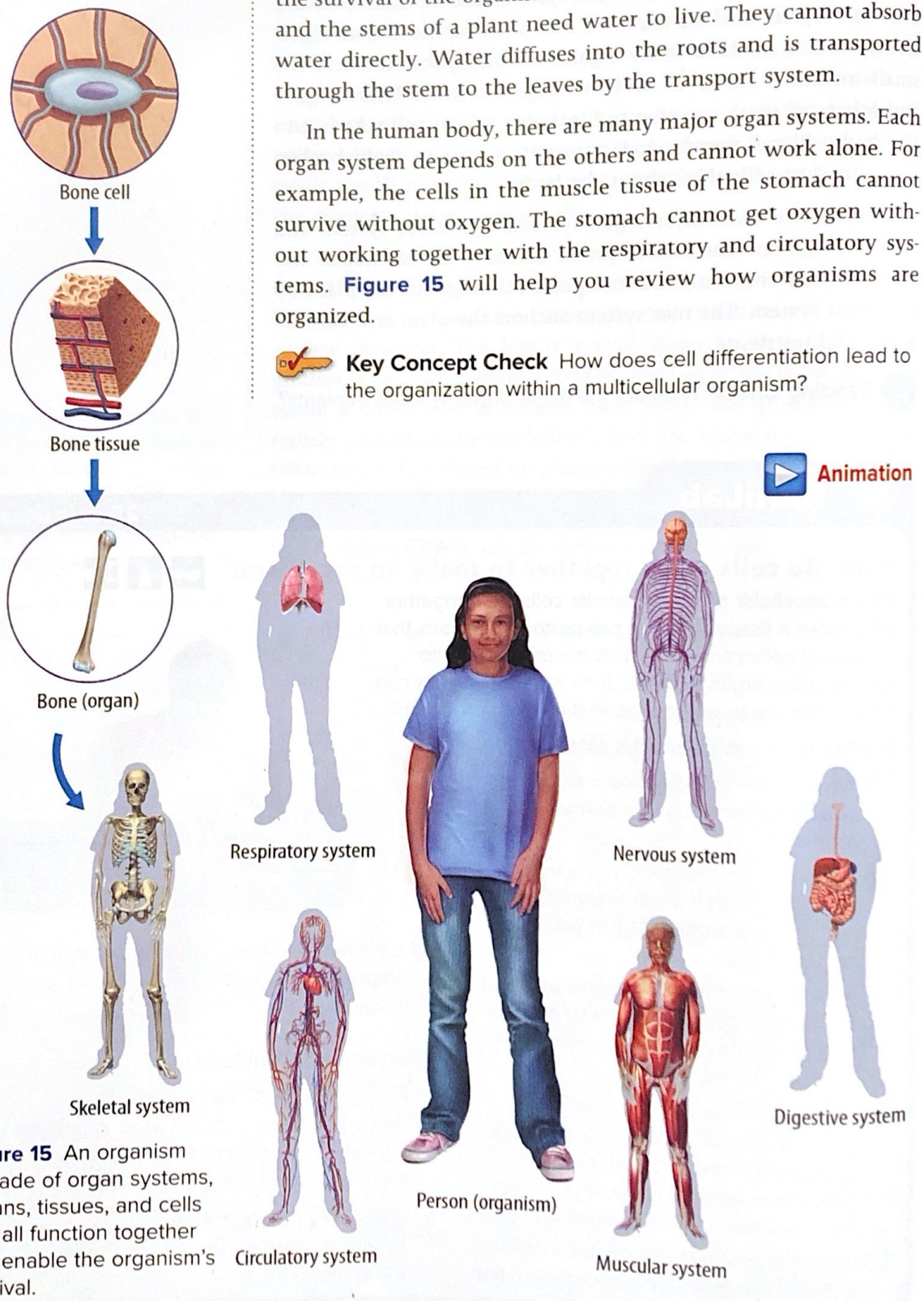


Figure 15 An organism is made of organ systems, organs, tissues, and cells that all function together and enable the organism's survival.

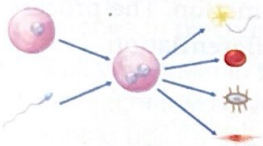
Lesson 2 Review

Online Quiz

Virtual Lab

Visual Summary

A unicellular organism carries out all the activities necessary for survival within one cell.



Cells become specialized in structure and function during cell differentiation.

Organs are groups of different tissues that work together to perform a job.

FOLDABLES®

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

4. Unicellular organisms do not have all the characteristics of life.

5. All the cells in a multicellular organism are the same.

6. Some organs work together as part of an organ system.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1 **Define** *cell differentiation* in your own words.

2 **Distinguish** between an organ and an organ system.

Understand Key Concepts

3 **Explain** the difference between a unicellular organism and a multicellular organism.

4 **Describe** how cell differentiation produces different types of cells in animals.

5 Which is the correct sequence of the levels of organization?

A. cell, organ, tissue, organ system, organism
B. organism, organ, organ system, tissue, cell
C. cell, tissue, organ, organ system, organism
D. tissue, organ, organism, organ system, cell

Interpret Graphics

6 **Organize** Copy and fill in the table below to summarize the characteristics of unicellular and multicellular organisms.

Organism Characteristics	
Unicellular	Multicellular

Critical Thinking

7 **Predict** A mistake occurs during mitosis of a muscle stem cell. How might this affect muscle tissue?

8 **Compare** the functions of a cell to the functions of an organism, such as getting rid of wastes.

Michael Abbey/Science Source

Cell Differentiation

Materials


cooked eggs


boiled chicken leg


forceps


dissecting scissors

plastic knife


paper towels

Safety

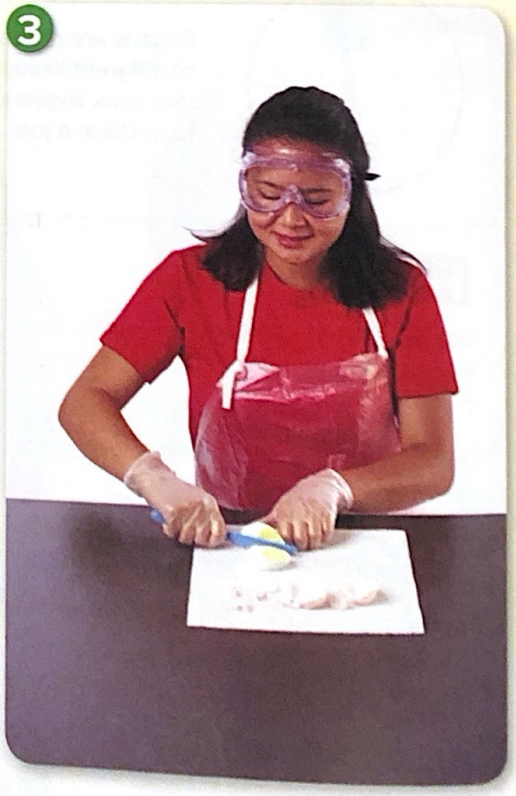
It's pretty amazing that a whole chicken with wings, feet, beak, feathers, and internal organs can come from one cell, a fertilized egg. Shortly after fertilization, the cell begins to divide. The new cells in the developing embryo become specialized both in structure and function. The process by which cells become specialized is called cellular differentiation.

Question

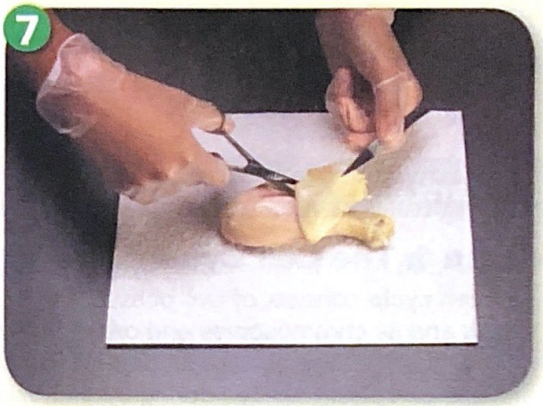
How does a single cell become a multicellular organism?

Procedure

1. Read and complete a lab safety form.
2. Carefully examine the outside of your egg. Remove the shell.
3. Dissect the egg on a paper towel, cutting it in half from tip to rounded end. Examine the inside.
4. Record your observations in your Science Journal. Include a labeled drawing. Infer the function of each part.
5. Discard all your trash in the container provided.
6. Examine the outside of the chicken leg. Describe the skin and its functions.



7. Carefully remove the skin using forceps and dissecting scissors. Put the skin in your discard container. Now you should see evidence of fat and muscles. You may also be able to see some blood vessels and tendons, but these are not always visible after cooking. Describe each part that you see and explain its function.
8. Peel back the muscles to reveal the bones. Tendons, ligaments, and cartilage holding the bones in place may also be evident.
9. Put all your trash in the discard container. Your teacher will give you instructions about cleaning up.



Analyze and Conclude

10. **The Big Idea** A single cell can become a multicellular organism through the process of cell differentiation. How do the organization of the egg and the chicken leg compare?
11. **Summarize** How many different types of cell differentiation did you observe in the chicken leg?

Communicate Your Results

Make a poster about how an egg transforms into a chicken through the process of cell differentiation.

Inquiry Extension

Examine a whole raw chicken or a raw chicken leg that is still attached to a thigh. You might be able to move the muscles in the legs or wings and see parts that were not visible in this lab. Be sure to wear gloves and to wash well with soap and water after touching the raw chicken.

Lab Tips

☑ Work slowly and carefully on your dissections so as not to destroy any structures. Report any accidents to your teacher immediately. Cleaning up is important!

Remember to use scientific methods.