




22.1 What Is a Plant?

Lesson Objectives

-  Describe what plants need to survive.
-  Describe how the first plants evolved.
-  Explain the process of alternation of generations.

Lesson Summary

Characteristics of Plants

- ▶ Plants are eukaryotes that have cell walls containing cellulose. Mostly autotrophs, plants use chlorophyll *a* and *b* to carry out photosynthesis.
- ▶ Without moving about, plants get what they need from the environment.
 - Sunlight: gathered by leaves arranged in ways that maximize absorption
 - Gas exchange: brings in oxygen and carbon dioxide and releases excess oxygen
 - Water: absorbed mostly from the soil and transported internally
 - Minerals: absorbed along with water from the soil

The History and Evolution of Plants Ancestors of today's land plants were water-dwellers similar to today's green algae. Over time, the demands of life on land favored the evolution of plants more resistant to the drying rays of the sun, more capable of conserving water, and more capable of reproducing without water.

- ▶ The first land plants were dependent on water and lacked leaves and roots.
- ▶ Five major groups of plants are classified based on four important features:
 - embryo formation
 - specialized water-conducting tissues
 - seeds
 - flowers

The Plant Life Cycle The life cycle of land plants has two alternating phases, a diploid (2N) phase and a haploid (N) phase. This shift between haploid and diploid is known as the **alternation of generations**.

- ▶ **Sporophyte:** the multicellular diploid phase, a spore-producing plant
- ▶ **Gametophyte:** the multicellular haploid phase, a gamete-producing plant

Characteristics of Plants

For Questions 1–8, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

- _____ 1. Both grasses and mosses are examples of plants.
- _____ 2. Green algae are now considered to be protists.
- _____ 3. Most plants are either parasites or saprobes.
- _____ 4. In plants, chlorophyll *a* and *b* are located in chloroplasts.

- _____ 5. Besides oxygen, plants need water and carbon dioxide for photosynthesis.
- _____ 6. Plants require oxygen for cellular respiration.
- _____ 7. Land plants evolved with structures that promote water loss.
- _____ 8. Plants usually take in water and minerals through their leaves.

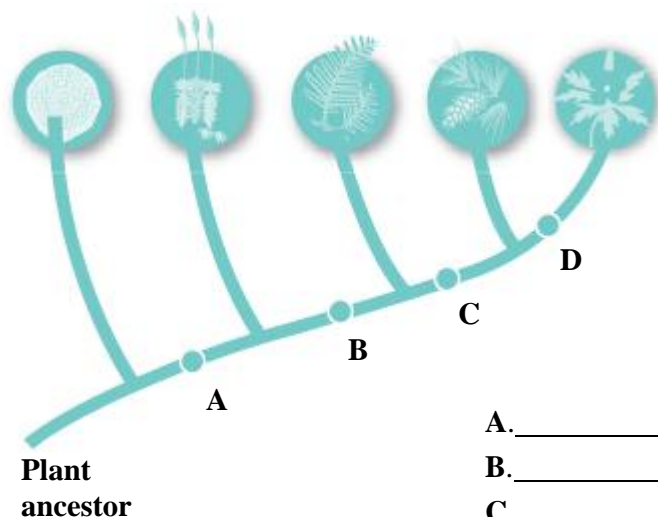
The History and Evolution of Plants

For Questions 9–12, complete each statement by writing the correct word or words.

9. _____ The ancestors of land plants lived in _____.
10. _____ The oldest fossils of land plants are roughly _____ years old.
11. _____ The greatest challenge faced by early land plants was obtaining _____.
12. _____ Early land plants obtained enough water because they grew close to the ground in _____ places.
13. Describe why biologists now classify green algae as plants.

14. Describe three characteristics of plants that helped them meet the demands of life on land.

15. Identify the important features that separate the five major groups of plants by writing each correct answer on the corresponding line provided.

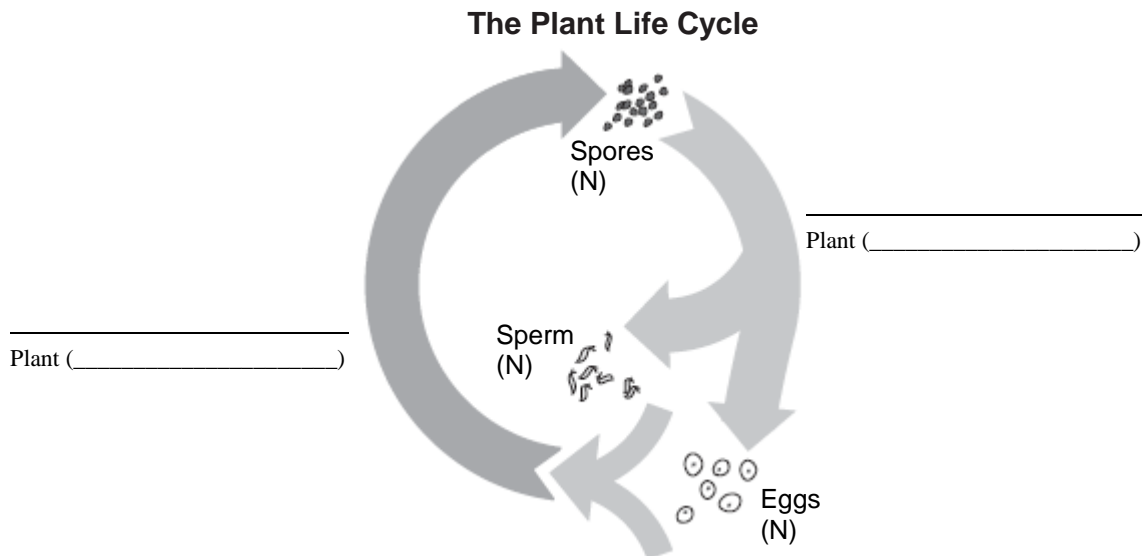


- A. _____
- B. _____
- C. _____
- D. _____

The Plant Life Cycle

16. What is the shift between haploid and diploid phases in the sexual life cycle of a plant called?

17. Complete the diagram below by writing the name of each phase in a plant's life cycle. Also indicate whether the phase is haploid (N) or diploid (2N).






18. What evolutionary trend is observable in the relative sizes of the stages in the life cycles of plants, starting with green algae and ending with seed plants?

Apply the Big idea

19. Would a type of algae that has only chlorophyll *a* be considered a plant? Explain your answer.

22.2 Seedless Plants

Lesson Objectives

-  Identify the characteristics of green algae.
-  Describe the adaptations of bryophytes.
-  Explain the importance of vascular tissue.

Lesson Summary

Green Algae Green algae are mostly aquatic. They are found in fresh and salt water, and in some moist areas on land.

- ▶ Most do not contain the specialized tissues found in other plants.
- ▶ Some may not alternate between haploid and diploid stages with every generation.
- ▶ Green algae form colonies providing a hint about how multicellular plants evolved. Although most cells in a *Volvox* colony are identical, a few are specialized for reproduction.

Mosses and Other Bryophytes The **bryophytes** have specialized reproductive organs.

- ▶ Bryophytes are small because they lack **vascular tissue**, which is specialized for conducting water.
- ▶ Bryophytes display alternation of generations:
 - Gametophytes produce eggs in **archegonia** and sperm in **antheridia**. Sperm and egg cells fuse to produce a diploid zygote.
 - The zygote is the beginning of the sporophyte stage. The sporophyte grows out of the gametophyte and develops a long stalk and a spore-producing capsule called a **sporangium**. Here, haploid spores are produced by meiosis. When the capsule opens, the haploid spores are scattered to start the cycle again.

Vascular Plants These plants are also known as **tracheophytes**.

- ▶ Vascular plants have vascular tissues that make it possible to move fluids through their bodies against the force of gravity.
 - **Tracheids** are hollow tubelike water-conducting cells with thick cell walls strengthened by lignin. Tracheids are found in **xylem**, a tissue that carries water upward from the roots to every part of a plant.
 - **Phloem** is a vascular tissue that carries nutrients and carbohydrates produced by photosynthesis.
- ▶ In a fern life cycle, spores grow into haploid gametophytes that produce eggs in archegonia and sperm in antheridia. The diploid zygote develops into a sporophyte. Haploid spores will develop on the undersides of a fern's fronds, actually the diploid sporophyte stage of the life cycle, and the cycle continues.

Green Algae

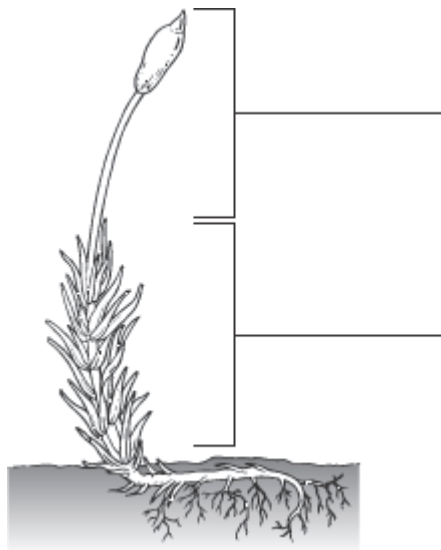
For Questions 1–7, complete each statement by writing the correct word or words.

1. Alga is the Latin word for _____.
2. Large mats of green algae lived during the _____ Period, more than 550 million years ago.
3. Green algae are mostly aquatic, but some live in _____ areas on land.
4. _____ is an example of a single-celled green alga.
5. The _____ of a green alga are able to survive freezing or drying conditions.
6. _____ is a colonial green alga shaped like a filament.
7. Volvox is a colonial green alga that shows some cell _____.

Mosses and Other Bryophytes

For Questions 8–14, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

- _____ 8. Mosses and their relatives belong to a group called sporophytes.
 - _____ 9. The moss life cycle is highly dependent on fertile soil.
 - _____ 10. Bryophytes stay small because they lack true vascular tissue.
 - _____ 11. The gametophyte is the dominant stage of bryophytes.
 - _____ 12. Bryophytes must live in places where there is standing water for at least part of the year because, for fertilization to occur, eggs must swim.
 - _____ 13. The egg producing organs of bryophytes are called antheridia.
 - _____ 14. When a moss spore germinates, it grows into a sporangium.
15. **THINK VISUALLY** Label the gametophyte and sporophyte in the illustration of a moss plant below.



Vascular Plants

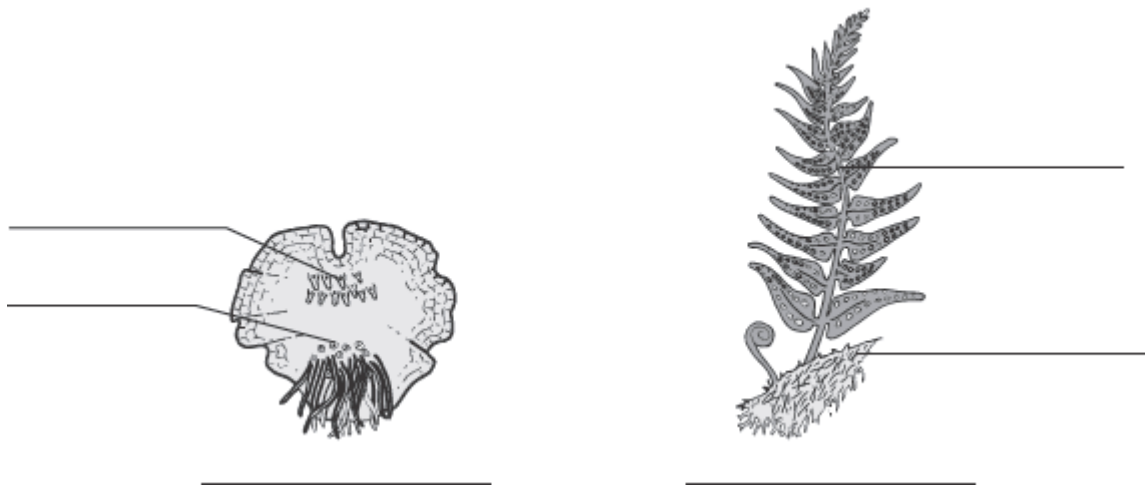
16. What is vascular tissue?

17. Complete the compare and contrast table for the two main types of vascular tissue.

Xylem and Phloem	
Similarities	Differences

18. What is the dominant stage in the life cycle of ferns?

19. **THINK VISUALLY** Label the parts of a fern in the illustrations below. Then label each drawing as either the sporophyte or the gametophyte.



Apply the Big idea

20. Which type of plant reproductive cell—spore or gamete—is better adapted for dispersing, or spreading, bryophytes and ferns to other places? Justify your answer.

22.3 Seed Plants

Lesson Objectives

- Describe the reproductive adaptations of seed plants.
- Identify the reproductive structures of gymnosperms.

Lesson Summary

The Importance of Seeds A **seed** is a plant embryo and a food supply, encased in a protective covering. The embryo is an early stage of the sporophyte.

- ▶ Ancestors of seed plants evolved with many adaptations that allow seed plants to reproduce without open water. These include a reproductive process that takes place in cones or flowers, the transfer of sperm by pollination, and the protection of embryos in seeds. These adaptations enabled plants to survive on dry land.
- ▶ The gametophytes of seed plants grow and mature within the sporophyte.
 - The **gymnosperms** are seed plants that bear their seeds directly on the scales of cones.
 - The **angiosperms** are seed plants that bear their seeds in flowers inside a layer of tissue that protects the seed.
- ▶ In seed plants, the entire male gametophyte is contained in a tiny structure called a **pollen grain**.
 - The sperm are produced inside pollen grains and do not have to swim.
 - Pollen grains are carried to female reproductive structures by wind or animals.
 - The transfer of pollen from the male reproductive structure to the female reproductive structure is called **pollination**.
- ▶ After fertilization, the zygote in the seed grows into a tiny plant—the sporophyte embryo. A tough **seed coat** surrounds and protects the embryo and keeps the contents of the seed from drying out.

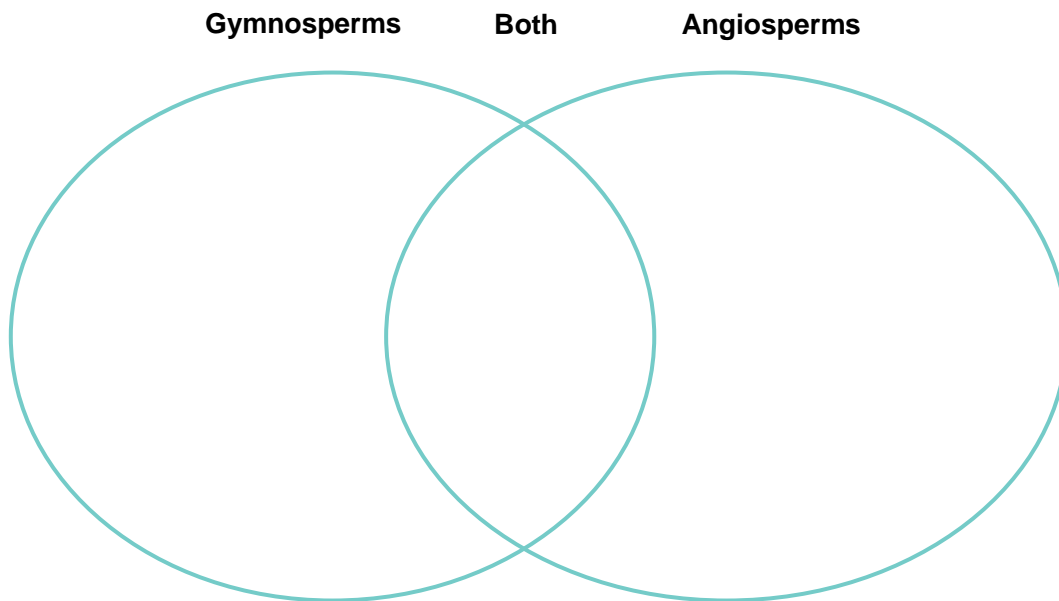
The Life Cycle of a Gymnosperm The word *gymnosperm* means “naked seed.” Gymnosperms include cycads, ginkgoes, and conifers such as pines and firs.

- ▶ Conifers produce two types of cones: pollen cones that produce the pollen grains and seed cones that produce female gametophytes.
- ▶ Near the base of each scale of the seed cones are two **ovules**, the structures in which the female gametophytes develop.
- ▶ Wind carries pollen from pollen cones to new female cones.
- ▶ In gymnosperms, the direct transfer of pollen to the female cone allows fertilization to take place without the need for open water.
- ▶ If a pollen grain lands near an ovule, the grain begins to grow a structure called a **pollen tube**, which allows the pollen to travel without water and which contains two haploid sperm nuclei.
- ▶ Once the pollen tube reaches the female gametophyte, one sperm nucleus disintegrates, and the other fertilizes the egg contained within the gametophyte.
- ▶ Fertilization produces a zygote, which grows into an embryo. The embryo is then encased in a seed and is ready to be dispersed.

The Importance of Seeds

For Questions 1–4, complete each statement by writing the correct word or words.

1. Acorns, pine nuts, and beans are examples of _____.
2. The living plant within a seed represents the early developmental stage of the _____ phase of the plant life cycle.
3. In seed formation, fertilization does not require _____.
4. The gametophytes usually develop in reproductive structures known as _____ or _____.
5. Complete the Venn diagram by correctly placing terms in the diagram. Use the terms that follow: cones, fertilization, flowers, pollen grains, pollination, seeds, and seed coats.



The Life Cycle of a Gymnosperm

For Questions 6–10, write the letter of the correct answer on the line at the left.

- _____ 6. In which part of a pine tree are pollen grains produced?
 - A. pollen cones
 - B. male flowers
 - C. seed cones
 - D. female flowers
- _____ 7. Which is one entire male gametophyte of a gymnosperm?
 - A. a diploid cell
 - B. a haploid nucleus
 - C. a pollen cone
 - D. a pollen grain



- _____ 8. The structures of gymnosperms in which the female gametophytes develop are called
- A. needles.
 - B. ovules.
 - C. pollen grains.
 - D. pollen tubes.
- _____ 9. How much time does the conifer life cycle typically take to complete?
- A. 2 days
 - B. 2 months
 - C. 2 years
 - D. 2 centuries
- _____ 10. In gymnosperm reproduction, which of these takes the place of water in the transfer of sperm to eggs?
- A. haploid cells
 - B. male cones
 - C. small gametophytes
 - D. pollen tubes

Apply the Big idea

11. The dominant phase of the life cycle of seed plants is the sporophyte, or spore-producing plant. Like all plants, seed plants produce spores. However, the spores are never released from the body of the sporophyte. The spores remain inside of the cones of gymnosperms and the flowers of angiosperms, where they develop into the male and female gametophytes. In what ways has this change in the plant life cycle been an evolutionary advantage to seed plants as they adapted to life on land?

22.4 Flowering Plants

Lesson Objectives

-  Identify the reproductive structures of angiosperms.
-  Identify some of the ways angiosperms can be categorized.

Lesson Summary

Flowers and Fruits Angiosperms reproduce sexually by means of flowers.

- ▶ Flowers contain **ovaries**, which surround and protect the seeds. *Angiosperm* means “enclosed seed.”
- ▶ Flowers are an evolutionary advantage because they attract animals that carry pollen with them as they leave flowers.
- ▶ After fertilization, ovaries within flowers develop into fruits that surround, protect, and help disperse the seeds.
- ▶ A **fruit** is a structure containing one or more matured ovaries.
- ▶ For many years, angiosperms were classified according to the number of seed leaves, or **cotyledons**.
 - **Monocots** have one seed leaf.
 - **Dicots** have two seed leaves.
 - Scientific classification now places the monocots into a single group and dicots in a variety of categories. Recent discoveries are used to place angiosperms in clades. Five of these clades are *Amborella*, water lilies, magnoliids, monocots, and eudicots.

Angiosperm Diversity Scientific classification reflects evolutionary relationships. Farmers, gardeners, and other people who work with plants group angiosperms according to the number of their seed leaves, the strength and composition of their stems, and the number of growing seasons they live.

- ▶ Monocots and dicots, grouped according to the number of cotyledons they produce, differ in several other characteristics, including:
 - the distribution of vascular tissue in stems, roots, and leaves
 - the number of petals per flower
- ▶ Plants are also grouped by the characteristics of their stems.
 - **Woody plants** have stems that are made primarily of cells with thick cell walls that support the plant body.
 - **Herbaceous plants** have smooth and nonwoody stems.
- ▶ Plants are grouped according to life span as annuals, biennials, or perennials. Annuals live one year; biennials live two years; and perennials can live for several years.

Flowers and Fruits

For Questions 1–4, complete each statement by writing the correct word or words.

1. _____ are seed plants that produce flowers and fruits.

2. Flowering plants first appeared during the _____ Period.
3. The seeds of flowering plants are encased in _____.
4. The success of angiosperms on land is attributed to their flowers, which attract animal _____, and to their fruits, which disperse _____.

For Questions 5–6, write the letter of the correct answer on the line at the left.

- _____ 5. Which plant's discovery caused botanists to rearrange the classification of plants?
- A. *Amborella*
 - B. *Archaeofructus*
 - C. *Cooksonia*
 - D. *Magnolia*
- _____ 6. Which major group of angiosperms is by far the largest?
- A. *Amborella*
 - B. Eudicots
 - C. Magnoliids
 - D. Monocots

Angiosperm Diversity

7. Complete the table about groups of angiosperms.

Groups of Angiosperms Based on Seed Structure			
Group	Number of Seed Leaves	Other Characteristics	Examples
Monocots			
Dicots			

For Questions 8–11, match each example with the type of plant it is. Each type may be used more than once.

Example

_____ 8. Rose shrubs

_____ 9. Oaks

_____ 10. Sunflowers

_____ 11. Dandelions

_____ 12. Grape vines

_____ 13. Petunias

Type of Plant
A. Herbaceous
B. Woody

14. Complete the table about plant life spans.

Plant Types Based on Life Spans		
Category	Definition	Examples
Annuals		
Biennials		
Perennials		

Apply the Big idea

15. Could the terms *woody* and *herbaceous* be used to describe other types of plants besides angiosperms? Justify your answer.

Chapter Vocabulary Review

Crossword Puzzle Complete the puzzle by entering the term that matches the description.

Across

5. a moss or its relative
8. plant with two seed leaves in seeds
9. sugar-conducting vascular tissue
10. structure in which a female gametophyte develops
11. sperm-producing organ of seedless plants
12. plant with vascular tissues
13. spore-producing structure of seedless plants

Down

1. egg-producing organ of seedless plants
2. spore-producing stage of plant life cycles
3. water-conducting vascular tissue
4. embryo plant, food supply, and protective covering
6. gamete-producing stage of the plant life cycle
7. the transfer of pollen
10. egg-containing structure of flowering plants

