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 ______ seeds ______.
2. The living plant within a seed represents the early developmental stage of the ______ sporophyte ______ phase of the plant life cycle.
3. In seed formation, fertilization does not require ______ water ______.
4. The gametophytes usually develop in reproductive structures known as ______ cones ______ or ______ flowers ______.

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.

Gymnosperms

Both

Angiosperms

cones

seeds

fertilization

pollen grains

pollination

seed coats

flowers

The Life Cycle of a Gymnosperm

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

A 6. In which part of a pine tree are pollen grains produced?
   A. pollen cones
   B. male flowers
   C. seed cones
   D. female flowers

D 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

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?

   **SAMPLE ANSWER:** Because the spores of seed plants are not released, the gametophytes that develop from the spores are protected from drying out by the tissues of the sporophyte. This enables seed plants to survive and reproduce in environments that have limited amounts of water. The gametophytes do not dry out and can still complete the reproductive process without having to wait for an abundance of water for the transfer of sperm to eggs. Additionally, since the zygote also remains within structures of the sporophyte (cones in gymnosperms and flowers in angiosperms), the embryo that develops from it is protected from drying out. The embryo and the tissues that surround and protect it become a seed, which is also able to survive in dry conditions for long periods of time.
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.

For Questions 1–4, complete each statement by writing the correct word or words.
1. _______ Angiosperms _______ are seed plants that produce flowers and fruits.
2. Flowering plants first appeared during the **Cretaceous** Period.
3. The seeds of flowering plants are encased in **fruits**.
4. The success of angiosperms on land is attributed to their flowers, which attract animal **pollinators**, and to their fruits, which disperse **seeds**.

**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. *Archaefructus*
   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.

<table>
<thead>
<tr>
<th>Groups of Angiosperms Based on Seed Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group</strong></td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Monocots</td>
</tr>
<tr>
<td>Dicots</td>
</tr>
</tbody>
</table>
For Questions 8–11, match each example with the type of plant it is. Each type may be used more than once.

<table>
<thead>
<tr>
<th>Example</th>
<th>Type of Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Rose shrubs</td>
<td>A. Herbaceous</td>
</tr>
<tr>
<td>10. Sunflowers</td>
<td>A. Herbaceous</td>
</tr>
<tr>
<td>11. Dandelions</td>
<td>A. Herbaceous</td>
</tr>
<tr>
<td>12. Grape vines</td>
<td>B. Woody</td>
</tr>
<tr>
<td>13. Petunias</td>
<td>A. Herbaceous</td>
</tr>
</tbody>
</table>

14. Complete the table about plant life spans.

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annuals</td>
<td>Angiosperms that have a life span of one year</td>
<td>Marigolds, petunias, pansies, wheat</td>
</tr>
<tr>
<td>Biennials</td>
<td>Angiosperms that have a life span of two years</td>
<td>Parsley, celery, evening primroses, foxgloves</td>
</tr>
<tr>
<td>Perennials</td>
<td>Angiosperms that live more than two years and reproduce many times</td>
<td>Peonies, asparagus, many grasses, palm trees, honeysuckle, maple trees</td>
</tr>
</tbody>
</table>

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

**Sample answer:** Yes. Most gymnosperms are trees with woody trunks and, therefore, could be referred to as woody plants. All green algae, bryophytes, and most ferns do not produce wood, and, therefore, could be referred to as herbaceous plants.
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
Iceman of the Future?

The environmental conditions where Iceman died were unique. The glacial ice he was found in helped to preserve him and many of his belongings for thousands of years before hikers discovered him in 1991. Consider what might happen to a climber today who died on a mountaintop and whose body became trapped in ice. The article below is a fictional broadcast account of the discovery of Iceman II in the year 3008.

**Afternoon Mindcast, January 8, 3008**—Hikers on Pike’s Glacier literally stumbled upon a major anthropological discovery this morning. When Klendon Deel, 85, tripped over something in the trail, his hiking companion and mother, Mender Yayv Akong, 122, helped him up and then looked for the partially hidden obstacle. It turned out to be an ancient electronic device called a “Hype-Odd,” which was used for listening to music aurally. But the most amazing part of the discovery was the skeletal hand still clutching the device.

Akong and Deel beamed the authorities, and within an hour scientists had uncovered the remains of an adult male human. Preliminary tests indicate the man died in February or March of 2016. At that time the glacier did not cover the mountain, which is in an area that was then called “Colorado.”

Scientists say that unfortunately most of the man’s soft tissue disintegrated through the 100-Year Heat Wave of the 22nd century, the Crustal Shocks of the 24th century, and the Kelvin Ice Age of the 29th century. But according to spokesbeing Nkavrjd*n, the skeleton, nails, hair, and many of the belongings were all remarkably well preserved. “The lead scientist studying the find is particularly fascinated with the objects remaining in the man’s pack,” Nkavrjd*n says. “For example, she thinks she has found what is left of an ancient apple. While the actual fruit is gone, a stem and a pile of seeds remained in the pack.”

In addition, a clear bottle was found in the pack. Scientists are planning on doing tests to try to determine what the bottle contained. The only marking they could find on the bottle was a small triangular shape composed of three arrows. Scientists are unsure what this mysterious symbol meant.
1. Consider the items you take with you when hiking. Suppose Iceman II had these items. Which of these items do you think would survive?

**SAMPLE ANSWER:** plastic items, items made of synthetic material such as nylon, metal items

2. Which of the items that Iceman II possibly took with him on his hike do you think would not survive? Explain your answer.

**SAMPLE ANSWER:** foods such as bread, cheese, and lettuce; paper; cotton clothing; straw hat. These items would probably not survive because they have a high water content or are made of relatively fragile fibers that can easily disintegrate.

3. Describe what future scientists might be able to learn about the 21st century by studying Iceman II’s belongings. What type of evidence would be difficult for them to interpret?

**SAMPLE ANSWER:** Scientists would be able to learn about 21st-century clothing, material technology, diet, music, and other information about human culture during that period. Scientists may have a hard time interpreting the symbols and brand names found on many objects. They also may no longer be able to read or translate 21st-century languages.

**21st Century Skills**

**Pondering Plant Products**

The skills used in this activity include information and media literacy, communication skills, creativity and intellectual curiosity, and social responsibility.

Synthetic materials, such as nylon and plastic, tend to be more durable than plant-based materials, such as cotton and paper. Because of this, many modern products are made out of synthetic materials. However, most synthetic materials are made from nonrenewable resources. Use library and Internet resources to compare plant-based materials to synthetic materials. For example, visit the Web sites of companies that manufacture plastic, nylon, paper, or cotton fabric. Consider the following questions:

- How do the costs of plant products compare with those of synthetic products?
- What sort of business opportunities are there in manufacturing products out of plant materials instead of synthetic materials?

*With a group, come up with a new plant-based product. Identify potential customers for the product and discuss how you would market the product to them.*

*Evaluate students’ work based on the accuracy of their information, the clarity of their product description, and the effectiveness of their marketing proposal.*