Gymnosperms and Angiosperms

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Student Learning Objectives

Upon viewing the video and completing the enclosed activities, students will be able to do the following:

• Understand that vascular seed plants are the most successful and widespread plants on Earth.

• Differentiate between seedless vascular plants and vascular seed plants.

• Explain some of the evolutionary advantages of seeds.

• Know that gymnosperms were the first vascular seed plants, appearing about 350 million years ago.

• List some of the defining characteristics of gymnosperms including the absence of flowers, presence of naked seeds, and the development of seeds within cones.

• Generally describe the life cycle of a pine tree. Include the following terms in the explanation: sporophyte, diploid, gametophyte, haploid, cone, sperm, egg, ovule, and fertilization.

• Differentiate and describe the general characteristics of the following four gymnosperm phyla: Cycadophyta, Ginkophyta, Gnetophyta, and Pinophyta.

• Understand that angiosperms evolved after gymnosperms, and first appeared about 125 million years ago.

• Know that flowering plants are the most prolific plants on the planet.

• List some examples of angiosperm plants.

• Explain the function of flowers in angiosperms and describe the basic male and female structures.

• Describe the general process of pollination in angiosperms and list some of the means by which pollination may occur.

• Describe the role of the seed and its surrounding fruit.

• Identify the cotyledon(s) on a seed and explain the function of the cotyledon.

• Understand that angiosperms are often described as being monocots or dicots. Explain the difference between monocots and dicots.

• List examples of plants that are monocots or dicots.
Assessment

Preliminary Assessment (p. 14-15):
The Preliminary Assessment is an assessment tool designed to gain an understanding of students’ preexisting knowledge. It can also be used as a benchmark upon which to assess student progress based on the objectives stated on the previous pages.

Post Assessment (p. 16-17):
The Post Assessment can be utilized as an assessment tool following student completion of the program and student activities. The results of the Post Assessment can be compared against the results of the Preliminary Assessment to assess student progress.

Video Review (p. 18):
The Video Review can be used as an assessment tool or as a student activity. There are two sections. The first part contains questions displayed during the program. The second part consists of a ten-question video assessment to be answered at the end of the video.
Introducing the Program

Obtain a flower and a pine cone. Before showing the video program to your students, hold each of the items up in front of the class. Explain that each of these is similar in that they are reproductive structures of plants. However, they belong to two very different groups of plants.

Next, ask students if they have any idea what group of plants produce cones. Write their suggestions on the board. Tell them a group of plants called gymnosperms reproduce via cones. Ask students to list gymnosperms with which they are familiar. Discuss the general characteristics of these gymnosperms.

Next, ask students if they know what group of plants reproduce via flowers. Tell students that plants that reproduce via flowers are called angiosperms. Ask them to list some plants that are angiosperms. Tell students to pay close attention to the video to learn more about the characteristics of gymnosperms and angiosperms. Following the program, discuss some of the similarities and differences of gymnosperms and angiosperms.

Program Viewing Suggestions

The student master “Video Review” (p. 19) is provided for distribution to students. You may choose to have your students complete this master while viewing the program or do so upon its conclusion.

The program is approximately 20 minutes in length and includes a ten-question video assessment. Answers are not provided to the Video Assessment in the video, but are included in this manual on page 13. You may choose to grade student assessments as an assessment tool or to review the answers in class.

The video is content-rich with numerous vocabulary words. For this reason you may want to periodically stop the video to review and discuss new terminology and concepts.
Video Script: Gymnosperms and Angiosperms

1. Every time you use a pencil...
2. ... eat a fruit or a vegetable...
3. ... sit on a piece of wooden furniture...
4. ... or read a magazine, you are using products derived from vascular seed plants – specifically from the two largest plant groups - gymnosperms and angiosperms.
5. What are gymnosperms and angiosperms?
6. What are some of their characteristics?
7. How are gymnosperms and angiosperms similar and how are they different from each other?
8. How do they reproduce?
9. What are some of the various types of plants within these groups?
10. And, what are some of the ecological and economic contributions of gymnosperms and angiosperms?
11. During the next few minutes we are going to answer these questions and others...
12. ... as we explore the fascinating features of gymnosperms and angiosperms.

13. Graphic Transition – Vascular Seed Plants
14. In the humid Carboniferous period, plants in the form of seedless spore-producing ferns and tree ferns, were abundant.
15. It was during this period that most of the earth’s coal deposits were formed, as lush vegetation sank quickly into vast swamps.
16. Toward the end of the Carboniferous period seed plants began to become more common.
17. As earth’s climate changed to a drier, cooler one during the Permian period, 248 to 290 million years ago, seed plants proliferated and became the dominant plants.
18. Vascular seed plants have continued to be the most successful and widespread plants on the planet, with over 290,000 known living species. Many more will undoubtedly be discovered.
19. Vascular seed plants contain vascular tissue in their roots, stems, and leaves. They reproduce via seeds.
20. Gymnosperms and angiosperms are the two major groups of vascular seed plants.
21. From an evolutionary perspective, seeds represent an important advance.
22. You Decide! Why do you think seeds are advantageous?
23. Seeds have several advantages. Seeds are protected from many environmental factors such as drought and predators by an extra layer of tissue.
24. Seeds can also be dispersed in a variety of ways.
25. Because seed plants don’t need to rely on water to reproduce,…
26. … they have been able to spread to drier climates.
27. And, the presence of seeds introduces a dormant phase into the life cycle of seed plants. This enables the embryo inside the seed to survive until environmental conditions are favorable for growth.
28. These distinct evolutionary advantages have enabled gymnosperms and angiosperms to become prolific, colonizing most parts of the globe.
**Video Script: Gymnosperms and Angiosperms**

29. **Graphic Transition – Characteristics of Gymnosperms**
30. Gymnosperms are the most ancient groups of seed plants, first appearing about 300 million years ago.
31. During the age of the dinosaurs, 65 to 230 million years ago, they were the dominant form of plant life on Earth.
32. While they are not quite as prolific today, gymnosperms still make up vast tracts of forests, particularly in the mid and upper latitudes of the northern hemisphere.
33. What makes a gymnosperm a gymnosperm?
34. Gymnosperms are non-flowering vascular plants that produce seeds not encased within specialized structures.
35. The name gymnosperm combines the Greek word *gymnos*, or naked, with *sperma*, or seed. In other words, Gymnosperms are naked seed plants.
36. The ovules are naked at the time of pollination, but the seeds can be enclosed by tissue at maturity.
37. The seeds of most gymnosperms develop within cones.
38. Gymnosperms have true roots, stems, and leaves. But, in many species leaves take the form of hard, stiff needles.
39. The stems of gymnosperms contain cambium that enables the stem to grow in diameter.
40. Let’s take a look at the life cycle of a common gymnosperm, the pine tree.
41. Pines exhibit alternating generations, with separate sporophyte and gametophyte forms. The sporophyte phase is dominant in gymnosperms. The sporophyte phase is diploid. That means it has double the number of chromosomes.
42. The gametophyte phase consists of male pollen that contains sperm cells, and part of the female pine cone. The gametophyte phase is haploid which means it has half the number of chromosomes.
43. You have probably seen pine cones either on pine trees or laying on the ground.
44. Pine trees produce two types of cones: male cones that produce pollen,…
45. … and larger female cones, called seed cones, that generate ovules.
46. Most pine trees have both male and female cones on the same tree.
47. **You Observe!** Do these cones look the same?
48. No, the male pine cone seen here looks quite different from the female cone. The male cone produces huge amounts of pollen which is released in the spring. Pollen grains contain male sperm cells.
49. Female cones seen here possess ovules that produce egg cells.
50. Pollination occurs when pollen lands on the female cone. Once on the cone the pollen grain forms a pollen tube that extends to the female ovule. When the ovule is reached, a sperm cell fertilizes an egg in the ovule.
51. The fertilized eggs develop and become seeds within the female cone. When they are mature, the cone opens and the seeds are released. This usually occurs in the fall or winter.
Video Script: Gymnosperms and Angiosperms

52. The complete pine life cycle often takes two to three years from the time cones form until seeds are released.

53. **Graphic Transition – Grouping Gymnosperms**
54. There are over 700 species of gymnosperms worldwide. They are grouped into four phyla:
56. Cycads, in the phylum Cycadophyta number about 100 species and grow in subtropical and tropical climates.
57. These slow growing plants look similar to palm trees but tend to be shorter.
58. The trunk is topped by a cluster of feathery leaves. They produce cones and have a life cycle similar to that of pines.
59. Although ginkgoes, in the phylum Ginkgophyta, were common during the age of the dinosaurs, only one species remains, the maidenhair tree.
60. This tree sheds its broad, fan-shaped leaves in the fall and has separate male and female reproductive structures on the same plant.
61. Due to its beauty, resistance to air pollution, and its ability to survive with limited water, it’s commonly planted along city streets.
62. Gnetophytes, in the phylum Gnetophyta, include about 65 different species of plants.
63. About half the species of gnetophytes are in the genus Ephedra, a common plant found in arid regions of North America.
64. Conifers, in the phylum Pinophyta, are the largest and tallest living things on the planet. Most conifers in the phylum Pinophyta possess needles or scaly leaves that remain green throughout the year. They are commonly referred to as evergreens.
65. Their needles prevent water loss, thus enabling them to live in drier, colder climates than other gymnosperms. Conifers also reproduce via cones.
66. Conifers also are the oldest living organisms on Earth. Bristlecone pines, such as this one can live to be nearly 5,000 years old!
67. Examples of conifers include pines, spruces, firs, larches, yews, cedars, hemlocks, redwoods, and cypress trees.
68. Spruce and fir trees commonly live at high altitudes and in colder climates.
69. Cypress trees, on the other hand, tend to live in moderate and warm climates.
70. Regardless of their type or location, conifers make-up significant tracts of forest, providing valuable habitat for a wide range of living things.
71. Conifers serve as a valuable source of wood for buildings, furniture and fencing, and they’re used in producing a wide range of paper products.

72. **Graphic Transition – Characteristics of Angiosperms**
73. The vegetables in this salad,...
74. … the grass this deer is eating,...
75. … and the sugar used to sweeten this cake are all foods derived from the most abundant group of plants on the planet – angiosperms – the flowering plants.
Video Script: Gymnosperms and Angiosperms

76. Over 290,000 known species of angiosperms live from the poles to the tropics.
77. Angiosperms are by far the most abundant, diverse, and successful group of plants.
78. Flowering plants inhabit dry deserts, extremely cold arctic environments, and can live even directly in water.
79. Angiosperms not only include plants with readily noticeable flowers, but also most trees such as oaks, maples, and birches. Angiosperms also include coconut and cactus.
80. Fruits, vegetables, nuts and herbs, as well as corn, wheat, rice and grains are all foods derived from angiosperms.
81. Angiosperms are noted by the presence of flowers that contain the reproductive structures of the plant. Other plant groups do not have flowers.
82. Separate male and female parts, often contained in the same flower, produce male pollen and female eggs.
83. The process of pollination involves the transfer of male pollen from the male part of the flower, called the anther to the female stigma on the same plant or another plant.
84. Pollination can be carried out by the wind or by animals such as birds or insects.
85. In flowering plants, seeds develop in a structure called a fruit that is actually the mature ovary.

86. **You Decide!** Where are the seeds in an apple tree located?
87. The seeds are contained within the edible fleshy fruit toward the center.
88. Fruits house and protect seeds, and they often help disperse them to new locations.

89. **Graphic Transition – Grouping Angiosperms**
90. Angiosperms are grouped, described, and classified based on a wide variety of characteristics.
91. One common way angiosperms are grouped is based on the characteristics of their seeds. Angiosperms are often described as being monocots or dicots.
92. Monocot seeds have one cotyledon, or seed leaf that nourishes a young seedling.
93. Examples of monocots include corn, grasses, palms, and lilies.
94. These plants have parallel leaf veins, fibrous root systems, flower parts that come in multiples of three, and other common characteristics.
95. Dicots, on the other hand, possess seeds with two cotyledons.
96. Roses, beans, and most broad-leaved trees are examples of dicots.
97. Dicots have leaf veins that are in a branching net-like arrangement.
98. They possess taproots, and flower parts that come in multiples of four or five.
99. Regardless of whether angiosperms are monocots or dicots, their fundamental reproductive structure is the flower.

100. **Graphic Transition – Video Review**
101. During the past few minutes we have explored some of the fascinating features of gymnosperms and angiosperms.
Video Script: Gymnosperms and Angiosperms

102. We began by discussing some of the general characteristics and organs of vascular seed plants.
103. Gymnosperms – the naked seed plants – were then investigated.
104. The four main phyla of gymnosperms were highlighted.
105. Next, the main features of angiosperms – the flowering plants, were explored.
106. Special attention was given to the general process of angiosperm reproduction.
107. Last, the characteristics of monocots and dicots were investigated, rounding out our investigation of the fascinating features of gymnosperms and angiosperms.

108. Graphic Transition – Video Assessment
Fill in the correct word to complete the sentence.
1. ____ and angiosperms are the two major groups of vascular seed plants.
2. ___ are the primary reproductive structures in gymnosperms.
3. The diploid ______ phase in gymnosperms is dominant
4. Seeds in plants such as pines and cycads are referred to as being ______.
5. Conifers possess stiff ______ instead of broad leaves.
6. Fruits and vegetables are in the group referred to as _____.
7. Angiosperms are often referred to as the ______ plants.
8. _____ involves the transfer of pollen from the male part of a flower to the female part of a flower.
9. The ripened ovary that surrounds a seed is called the ____.
10. ______ possess seeds with a single cotyledon.
Answer Key to Student Assessments

Preliminary Assessment (p. 15-16)
1. d - seed-producing plants
2. a - 290,000
3. d - gymnosperms
4. c - flowers
5. d - cones
6. b - cycads
7. a - Pinophyta
8. c - angiosperms
9. b - reproductive structures
10. a - wind or animals
11. d - fruits
12. a - stigma
13. c - dicots
14. b - diploid
15. a - needles
16. Gymnosperms are vascular seed-producing plants that have reproductive structures contained in cones. They do not produce flowers and their seeds are not encased within specialized structures at the time of fertilization.
17. Pollination is the transfer of pollen from the male reproductive structure to the female reproductive structure. It occurs in both gymnosperms and angiosperms.
18. In seed plants the diploid sporophyte form is dominant and is the form we most readily recognize. The haploid gametophyte form is not readily noticeable.
19. Angiosperms are vascular seed plants that reproduce via structures contained in flowers.
20. Monocot seeds have one cotyledon (seed leaf). Dicot seeds have two cotyledons.

Post Assessment (p. 17-18)
1. d - cones
2. a - wind and animals
3. b - diploid
4. b - cycads
5. a - stigma
6. d - gymnosperms
7. d - fruits
8. c - flowers
9. a - needles
10. b - reproductive structures
11. c - angiosperms
12. c - dicots
13. a - 290,000
14. a - Pinophyta
15. d - seed-producing plants
16. Pollination is the transfer of pollen from the male reproductive structure to the female reproductive structure. It occurs in both gymnosperms and angiosperms.
17. Angiosperms are vascular seed plants that reproduce via structures contained in flowers.
18. Monocot seeds have one cotyledon (seed leaf). Dicot seeds have two cotyledons.
19. Gymnosperms are vascular seed-producing plants that have reproductive structures contained in cones. They do not produce flowers and their seeds are not encased within specialized structures at the time of fertilization.
20. In seed plants the diploid sporophyte form is dominant and is the form we most readily recognize. The haploid gametophyte form is not readily noticeable.

Video Review (p. 19)
1. Seeds are protected from many environmental factors such as drought and predators by an extra layer of tissue. Seeds can be dispersed in a variety of ways. Seed plants have been able to spread to drier climates because they don't need to rely on water to reproduce.
2. No, these cones do not look the same. The male pine cone produces huge amounts of pollen which is released in the spring. Pollen grains contain male sperm cells. The larger female cone possess ovules that produce egg cells.
3. The seeds in an apple tree are contained within the edible fleshy fruit toward the center. The fruit houses and protects the seeds.

Vocabulary (p. 20)
1. c - seed
2. i - gymnosperms
3. l - cones
4. e - pollen grain
5. g - cycads
6. b - Pinophyta
7. j - needles
8. k - gingkoe
9. n - angiosperms
10. d - flowers
11. a - fruit
12. h - pollination
13. f - monocot
14. m - cotyledon
15. o - dicot
Answer Key to Student Activities

Amazing Gymnosperms (p. 21)

Sample Answer:

This tree is a redwood tree. It is a tall coniferous tree with reddish bark that lives in California and Southern Oregon. It is wide at the base. The cones are quite small.

Plants Through Time (p. 22)

Before students begin creating their own plant timelines, it would be a good idea to explain how to create a scaled timeline. Many students probably have not created a scale before and will need your assistance.

The Awesome Angiosperms (p. 23)

1. Examples include apples, oranges, bananas, potatoes, and carrots.
2. Many products made of wood and many foods are derived from angiosperms.
3. Examples include sunflower seeds, walnuts, and peanuts.
4. Examples of fruits include apples, pears, and peaches. Examples of vegetables include carrots, beets, and potatoes.
5. Three products derived from angiosperms include wood for building furniture and houses, many medicines.

Living Large (p. 24-25)

1. Redwoods are the largest living things on Earth. They reach great heights, and they also can live to be 2,000 to 3,000 years old.
2. Redwoods first appear in the fossil record about 160 million years ago. They were common throughout North America. Redwoods first appeared on the coast of North America about 20 million years ago.
3. Giant Sequoias live on the western slopes of the Sierra Nevada - inland from the California coast. They tend to be shorter and stouter than Coast redwoods. They also live longer - up to 3,000 years. Coast redwoods are found along the Pacific coast of California and southern Oregon. These trees are the tallest plants on Earth.
4. Coast redwoods once spanned about 2 million acres along a 724 kilometer (450 miles) stretch of land along the California and southern Oregon coasts. Less than 5% of the original redwood forest is still intact.
5. About 40,469 hectares (100,000 acres) of Coast redwood forests are located in Redwood National Forest and several state parks in northern California. Several state parks were founded in the 1920s. Redwood National Park was created in 1968.
Gymnosperms and Angiosperms

Name: ________________________________

1. Gymnosperms and angiosperms are the two major groups of:
   a. seedless plants
   b. vascular plants
   c. spore-producing plants
   d. seed-producing plants

2. There are approximately how many known species of vascular seed plants?
   a. 290,000
   b. 12,000
   c. 1.2 million
   d. 52,000

3. The oldest group of seed plants on earth, dating back about 350 million years are the:
   a. angiosperms
   b. bryophytes
   c. flowering plants
   d. gymnosperms

4. Gymnosperms differ from angiosperms in that they do not produce:
   a. cones
   b. pollen
   c. flowers
   d. chloroplasts

5. The reproductive structures in gymnosperms are contained in:
   a. flowers
   b. stems
   c. needles
   d. cones

6. Slow growing tropical gymnosperms that look similar to palm trees but are shorter are:
   a. pines
   b. cycads
   c. maples
   d. banana trees

7. Which of the following gymnosperm phyla includes spruces, fir, and pines?
   a. Pinophyta
   b. Cycadophyta
   c. Gnetophyta
   d. Ginkophyta

8. The most abundant, diverse, and successful group of plants are:
   a. conifers
   b. gymnosperms
   c. angiosperms
   d. liverworts

9. Flowers contain the following:
   a. roots
   b. reproductive structures
   c. stems
   d. cones

10. The process of pollination is carried out mainly by:
    a. wind or animals
    b. water
    c. plants touching other plants
    d. underground fertilization

11. In angiosperms, ovaries often mature into structures referred to as:
    a. seed coats
    b. pollen grains
    c. stems
    d. fruits

12. Pollination involves the transfer of pollen from the male anther to the female part of the flower called the:
    a. stigma
    b. style
    c. membrane
    d. nucleus

13. Plants that possess seeds with two cotyledons are referred to as:
    a. monocots
    b. gametophytes
    c. dicots
    d. gymnosperms

14. In seed plants, the gametophyte generation is haploid, and the sporophyte phase is:
    a. absent
    b. diploid
    c. triploid
    d. semi-haploid

15. Instead of broad leaves, many gymnosperms possess:
    a. needles
    b. bark
    c. scales
    d. flowers
Preliminary Assessment

Directions: Answer the following using complete sentences:

16. List two key features of gymnosperms.

17. What is pollination?

18. Describe sporophyte and gametophyte forms in seed plants.

19. List two key features of angiosperms.

20. Explain the difference between monocot seeds and dicot seeds.
Post Assessment

Directions: Circle the best answer for each of the following:

1. The reproductive structures in gymnosperms are contained in:
   a. flowers
   b. stems
   c. needles
   d. cones

2. The process of pollination is carried out mainly by:
   a. wind or animals
   b. water
   c. plants touching other plants
   d. underground fertilization

3. In seed plants, the gametophyte generation is haploid, and the sporophyte phase is:
   a. absent
   b. diploid
   c. triploid
   d. semi-haploid

4. Slow growing tropical gymnosperms that look similar to palm trees but are shorter are:
   a. pines
   b. cycads
   c. maples
   d. banana trees

5. Pollination involves the transfer of pollen from the male anther to the female part of the flower called the:
   a. stigma
   b. style
   c. membrane
   d. nucleus

6. The oldest group of seed plants on earth, dating back about 350 million years are the:
   a. angiosperms
   b. bryophytes
   c. flowering plants
   d. gymnosperms

7. In angiosperms, ovaries often mature into structures referred to as:
   a. seed coats
   b. pollen grains
   c. stems
   d. fruits

8. Gymnosperms differ from angiosperms in that they do not produce:
   a. cones
   b. pollen
   c. flowers
   d. chloroplasts

9. Instead of broad leaves, many gymnosperms possess:
   a. needles
   b. bark
   c. scales
   d. flowers

10. Flowers contain the following:
    a. roots
    b. reproductive structures
    c. stems
    d. cones

11. The most abundant, diverse, and successful group of plants are:
    a. conifers
    b. gymnosperms
    c. angiosperms
    d. liverworts

12. Plants that possess seeds with two cotyledons are referred to as:
    a. monocots
    b. gametophytes
    c. dicots
    d. gymnosperms

13. There are approximately how many known species of vascular seed plants?
    a. 290,000
    b. 12,000
    c. 1.2 million
    d. 52,000

14. Which of the following gymnosperm phyla includes spruces, fir, and pines?
    a. Pinophyta
    b. Cycadophyta
    c. Gnetophyta
    d. Ginkophyta

15. Gymnosperms and angiosperms are the two major groups of:
    a. seedless plants
    b. vascular plants
    c. spore-producing plants
    d. seed-producing plants
Post Assessment

Directions: Answer the following using complete sentences

16. What is pollination?

17. List two key features of angiosperms

18. Explain the difference between monocot seeds and dicot seeds.

19. List two key features of gymnosperms.

20. Describe sporophyte and gametophyte forms in seed plants.
Video Review

Directions: Answer these questions as you watch the video:

1. **You Decide!**
   Why do you think seeds are advantageous?

2. **You Observe!**
   Do these cones look the same?

3. **You Decide!**
   Where are the seeds in an apple tree located?

Video Assessment

Directions: After you watch the video, fill in the blank to complete the sentence.

1. _______________ and angiosperms are the two major groups of vascular seed plants.

2. _______________ are the primary reproductive structures in gymnosperms.

3. The diploid _______________ phase in gymnosperms is dominant.

4. Seeds in plants such as pines and cycads are referred to as being _______________.

5. Conifers possess stiff _______________ instead of broad leaves.

6. Fruits and vegetables are in the group referred to as _______________.

7. Angiosperms are often referred to as the _______________ plants.

8. _______________ involves the transfer of pollen from the male part of a flower to the female part of a flower.

9. The ripened ovary that surrounds a seed is called the _______________.

10. _______________ possess seeds with a single cotyledon.
## Gymnosperms and Angiosperms Vocabulary

**Directions:** Unscramble the vocabulary words in the first column. Match the words to the definitions in the second column.

1. **esde**
   - a. The ripened ovary that contains seeds in angiosperms.
2. **ynsemmspgro**
   - b. Group that includes conifers such as spruce, fir, and pine.
3. **oecsn**
   - c. A structure that contains the complete embryo of a plant, seed coat, and stored nutrients.
4. **lpleon rigna**
   - d. Contain the reproductive structures in angiosperms.
5. **acdyse**
   - e. The male gametophyte in seed plants; contain male sperm cells.
6. **aptiynhop**
   - f. Flowering plants that have a seed with a single cotyledon.
7. **deleens**
   - g. Slow-growing gymnosperms that grow in tropical and subtropical areas; resemble palm trees but are shorter.
8. **noiekgg**
   - h. The transfer of pollen from the male part of the flower to the female part of the flower.
9. **noriagemssp**
   - i. Non-flowering vascular plants that possess seeds not encased within specialized structures.
10. **sfrelew**
    - j. Thin, stiff structures that serve as leaves on conifers.
11. **uftri**
    - k. An ancient gymnosperm that has broad leaves and is the only surviving species in its phylum.
12. **pnooliltian**
    - l. Contain the reproductive structures of gymnosperms.
13. **coomnto**
    - m. The part of the seed that nourishes some plants; referred to as the seed leaf.
14. **ooycntel**
    - n. Referred to as the flowering plants; number over 290,000 species; vascular seed plants that reproduce via flowers.
15. **ctdoi**
    - o. Flowering plants that produce seeds that possess two cotyledons.
Amazing Gymnosperms

**Background:** If you live in the mid or high latitudes, then you are probably familiar with a group of plants referred to as gymnosperms. Even though you may not realize it, gymnosperms most likely live near your home. What exactly are gymnosperms? Gymnosperms are non-flowering vascular plants that produce seeds not encased within specialized structures. The name gymnosperm comes from the Greek word, γυμνός, or naked with sperma, or seed. In other words gymnosperms are naked seed plants. The ovules are naked at the time of pollination, but the seeds can be encased by tissue at the time of maturity.

What are some of the identifiable characteristics of gymnosperms? Gymnosperm plants are often in the form of woody trees or shrubs. They have true leaves, stems, and roots. Many times, as in the case with conifers, leaves are in the form of hard, stiff needles. Other gymnosperms, such as cycads, look somewhat like shortened palms, while other gymnosperms, such as the gingko tree have broad leaves. Many gymnosperms keep their leaves throughout the year and are sometimes referred to as evergreens.

The presence of cones is one true-tell sign of gymnosperms. The seeds of most gymnosperms develop within cones which are the reproductive structures. In this activity you will describe a few species of the more than 700 species of gymnosperms.

**Materials:** colored pencils, examples of gymnosperms

**Directions:** In this activity you will locate, identify, and describe three examples of gymnosperms near your school or home. Your instructor will give you specific directions on where to locate gymnosperms. Your instructor will also explain safety concerns. Do not touch any unknown plants. Once you have found a gymnosperm, complete the information in the chart below.

<table>
<thead>
<tr>
<th>Name</th>
<th>Sketch of plant or branch</th>
<th>Description of plant</th>
<th>Diagram or description of cone</th>
</tr>
</thead>
</table>
Plants Through Time

**Background:** Plants have been on the planet for a relatively short period of time. For the first billion years of Earth’s history little transpired biologically speaking. The first prokaryotes cells appeared about 3 to 3.5 billion years ago. And, the first eukaryotes cells appeared about 1.5 billion years ago. The precursors to plants are hypothesized to be aquatic green algae. Several lines of evidence link early plants to multicellular green algae. For about 500 million years algae were restricted to the watery domain. Somewhere around 476 million years ago, the first plants invaded the land. The first plants were likely similar to modern-day mosses.

Not long after the transition to land, plants evolved into two separate lineages - the bryophytes, and the vascular plants. The bryophytes first appeared in the fossil record over 350 million years ago. These ancient fossils are similar to present-day bryophytes, forming low-lying mats in moist environments.

The first vascular plants for which a reliable fossil record exists, first appeared about 420 million years ago. Fossils of a vascular plant called, *Cooksonia*, reveal plants that were only a few centimeters tall, and had no roots or leaves. Its upright fronded stems terminated in sporangia that produced spores. These plants probably lived in moist environments. They likely developed water and food conducting tissues called vascular tissues. The development of vascular tissue is an evolutionary milestone, enabling plants to eventually colonize drier environments, and to grow to greater heights.

The earliest vascular plants lacked seeds. Four living phyla and three extinct phyla are collectively referred to as the seedless vascular plants. Approximately 350 to 300 million years ago, seedless vascular plants became widespread. Cycads, club mosses, horsetails, and numerous types of ferns proliferated. Ferns, the largest group of seedless vascular plants alive today once dominated Earth’s landscape. In fact, the late Carboniferous is sometimes referred to as the Age of Ferns.

As Earth’s climate changed to a drier, cooler one, seed plants proliferated and became the dominant plants. The development of seeds was another evolutionary milestone in the history of plants. Seeds are protected from the environment, are dispersed in a variety of ways, and introduce a dormant phase into the plant life cycle. Gymnosperms were the first seed plants, appearing about 300 million years ago. During the age of the dinosaurs, 65 to 230 million years ago, they were the dominant form of plant life on Earth. Over 700 species of gymnosperms exist today.

Approximately 140 million years ago, the flowering plants, angiosperms, first appeared. Flowers, that contain reproductive organs, distinguish angiosperms from all other plants. It is hypothesized that angiosperms evolved from gymnosperms 245 to 202 million years ago. They became widespread about 100 million years ago, and replaced gymnosperms as the dominant plants around 60 to 70 million years ago. Angiosperms are by far the most abundant and diverse group of plants on the planet.

**Materials:** long piece of paper, ruler, colored pencils.

**Directions:**

1. Carefully read the Background section above.
2. Obtain the items listed in the materials.
3. Using the ruler and paper, create a timeline scale starting at about 4½ billion years ago, at Earth’s beginning and ending at the present day. If you are not sure how to create a scaled timeline, ask your instructor for assistance.
4. Create a title of your timeline - “Plants Through Time”.
5. Using colored pencils, place the important dates of plant history on the timeline. Place the date in the correct spot on the timeline, and label it. You can also create a sketch of the plants to which the date is referring.
6. When you are done with your timeline, feel free to add other information about plants not discussed in the Background.

Gymnosperms and Angiosperms
The Awesome Angiosperms

**Background:** Angiosperms - the flowering plants - are amazing! They are everywhere you look. The vast majority of the plants with which you are familiar are angiosperms. Over 290,000 known species of angiosperms live from the poles to the tropics. Today, angiosperms are by far the most abundant, diverse, and successful group of plants.

Angiosperms not only include plants with readily noticeable flowers, but also include most trees such as oaks, elms, maples, and birches. They also include coconuts as well as many different species of cacti. Fruits, vegetables, nuts, and herbs, as well as corn, wheat, rice, and grains are all foods derived from angiosperms. Most vertebrate animals, including humans, are either directly or indirectly dependent on angiosperms. Needless to say, angiosperms are incredibly important!

**Directions:**

1. Take a minute to think about three fruits or vegetables you have eaten in the past couple of days. Write these in the spaces below.

2. Next, think about a product you have used today that is derived from an angiosperm. Write the name of the product and a brief description in the box below.

3. Think of a nut or seed you like to eat from an angiosperm. Write the name of the nut or seed below.

4. Everyday you eat fruits and vegetables that are produced by angiosperms. List two examples of each.

   Fruit: ___________________________   ___________________________

   Vegetable: ___________________________   ___________________________

5. There are many products we use that are derived from angiosperms. For example, paper is produced from pulp that comes from trees. List three products that are directly or indirectly produced from angiosperms.
Living Large

The largest living things on the planet - redwood trees, start their lives from a tiny seed the size of a tomato seed. A mature, large redwood giant weighs more than 4,535,923.7 kilograms (5,000 tons) and stands as tall as a 30-story building. Redwoods, in fact, represent the greatest volume of biologic activity per land area on the planet. They are the most dramatic examples of gymnosperms. To stand amidst a grove of towering redwoods thousand of years old is likened to visiting the great cathedrals of the world.

Ancestors to redwoods first appear in the fossil record about 160 million years ago. Many redwood fossils have been found throughout North America, as well as in Greenland and Siberia. Paleontologists are not in agreement as to whether these fossil relatives can be placed in the same genus, *Sequoia*, as modern-day species. It is thought redwoods first appeared on the west coast of North America over 20 million years ago as climates cooled and became drier.

When people talk about redwoods, they can be referring to one of two different species of trees. Coast redwoods, with the scientific name *Sequoia sempervirens*, grow primarily along a narrow strip on the Pacific coast of California and southwestern Oregon. Giant Sequoias, a related cousin, with the scientific name *Sequoiadendron giganteum*, grow only on the western slopes of the Sierra Nevada mountains. Giant Sequoias tend to be shorter, stouter, and live as much as a thousand years, longer than the coast redwoods - up to 3,000 years! You can see Giant Sequoia trees in parks such as Yosemite National Park and Great Sequoia National Park where the ancient behemoths are preserved and protected.

Let’s turn our attention more specifically to Coast redwoods. Coast redwoods are unusually long-lived trees, living up to 2,000 years. Most live 500 to 700 years. Perhaps the most astonishing feature is that they can reach nearly 113 meters (370 feet) in height. The bark can be 31 centimeters (12 inches) thick, and the base diameter can reach to 7 meters (22 feet). Redwoods do not have a taproot. Their roots only penetrate three to four meters into the soil, but they spread 18 to 24 meters (60 to 80 feet). Like many conifers, Coast redwoods produce both male and female cones. Pollen is dispersed in winter or in spring. Mature ovulate cones ripen in early fall and shed seeds in late fall or early winter. Seedlings are relatively shade tolerant, having to survive underneath a shade-casting canopy. Redwoods have no known killing diseases or pests. They commonly die from toppling over.

Great forests of Coast redwoods once spanned approximately 809,371 hectares (two million acres) along 724 kilometers (450 miles) of California and Oregon coastline. Today, old growth redwood forest only occupy about 115,335 hectares (285,000 acres), less than 5% of their original range. Over 95% of the original redwood forest is gone. By the mid 1800s, redwoods were felled for lumber, and cleared for agriculture and settlements.

Native Americans lived in the redwood forest along the Pacific coast for thousands of years. Multiple Indian groups speaking different languages lived in villages, and subsisted off fish, game, nuts, seeds, and berries. In the early 1800’s European settlers began to establish settlements along the coast. Settlements greatly accelerated during the Gold Rush period in the mid 1800s. In the mid and late 1800s leading conservationists such as John Muir urged governments to preserve the ever-shrinking redwood forest. But, by 1890 almost all redwood forest lands had passed from the public domain to speculators or loggers.

When it became clear after World War I that the last large tracts of virgin redwoods in Humboldt and Del Norte counties would soon be logged, concerned scientists and museums helped found the Save-the-Redwoods League to preserve surviving stands. Between 1920 and 1960, the League purchased more than 40,469 hectares (100,000 acres) of redwood forest. Most of these lands were placed in four preserves - Humboldt, Prairie Creek, Del Norte Coast, and Jedidiah Smith Redwood state parks. As a result of increased concern over loss of more redwood forest and threats to existing parks, Redwood National Park was created in 1968. It was later expanded in 1978. If you visit the national park today you will see a park that encircles several state parks giving additional protection to the ancient redwood forest that once stretched hundreds of kilometers along the Pacific Ocean.
Living Large

**Directions:** From the information you have just read, answer the questions below.

1. What makes redwoods biologically unique?

2. Briefly describe the ancestors of modern-day redwoods.

3. Explain the difference between the Giant Sequoia and the Coast redwoods.

4. Describe the original range of Coast redwoods. Explain the current status of Coast redwood forests.

5. Where can you see the largest tracts of coast redwood forests today?