

**LIFE ON EARTH
UNIT TWO
SUMMARY**

UNIT TWO MATERIAL

The videotapes to watch for this unit are:

- Video Program 3 - THE FIRST FORESTS
- Video Program 4 - THE SWARMING HORDES

Read the CONCEPTS in the study guide:

- CONCEPTS FOR EPISODE 3
- CONCEPTS FOR EPISODE 4

Answer the QUESTIONS in the study guide:

- QUESTIONS FOR EPISODE 3
- QUESTIONS FOR EPISODE 4

OVERVIEW OF LEARNING OBJECTIVES

Video Episode 3

To become acquainted with:

1. the effects of land formations and moving continents on land-dwelling organisms
2. the problems that plants had to solve in order to successfully move to land
3. characteristics of the algae
4. characteristics of the various group of land plants: mosses, liverworts, club mosses, horsetails, tree ferns, cycads and conifers. (Flowering plants are discussed in episode 4.)
5. characteristics of the various forests that have appeared (and disappeared)
6. adaptations to living on the land that were developed by the plants and the animals
7. characteristics of land invertebrate groups: millipedes, scorpions, spiders, insects
8. methods of plant reproduction
9. impact of flying insects on the evolution of plants
10. adaptations of insects for flight
11. insect wing structure and flight

Video Episode 4

To become acquainted with:

1. characteristics of flowering plants
2. the parts of the flower
3. the significance of the flower in reproduction
4. co-evolution of flowering plants and insects
5. characteristics of the insects
6. reproduction within the insects
7. molting
8. social insects and colonies
9. mimicry
10. insect larvae versus adults

CONCEPTS FOR EPISODE 3: THE FIRST FORESTS

CHARACTERISTICS OF PLANTS

Plants are multicellular eukaryotes. Their cell walls contain a carbohydrate called cellulose. Their cells contain chloroplasts with chlorophylls and other pigments used in photosynthesis. On land, plants carry out most of the photosynthesis. Plants store their carbohydrate reserves in the form of starch.

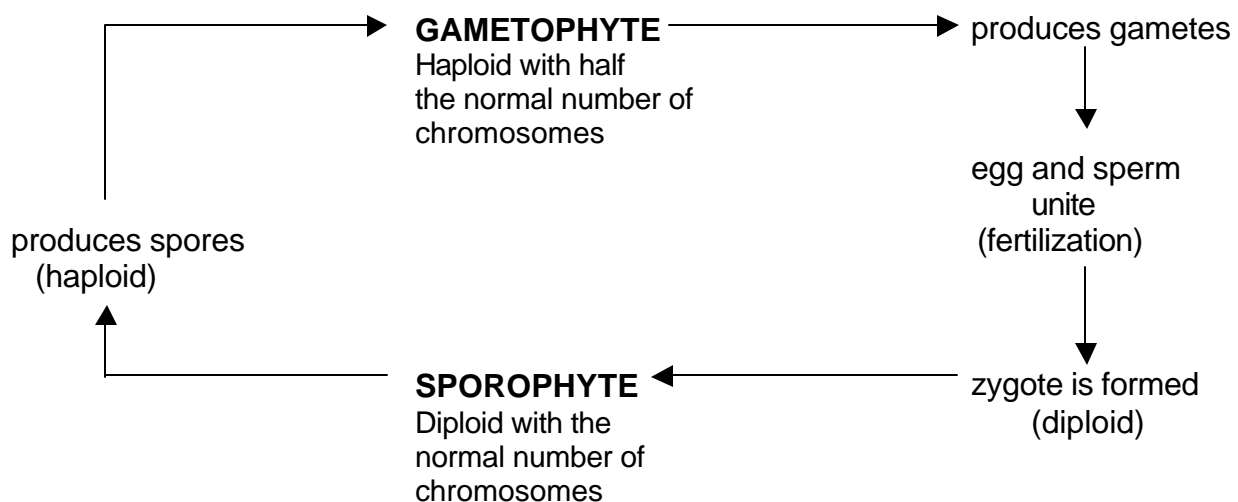
EVOLUTIONARY TRENDS IN PLANTS

The most probable ancestors of the plants were multicellular green algae. Some of the major evolutionary changes seen in plants are:

1. The formation of a waxy layer, called the **cuticle**, to prevent dehydration.
2. The development of vascular tissue (used for support, and conducting water and food)
3. The development of distinct, specialized roots and shoots
4. The development and diversification of leaves
5. Changes in reproductive structures
6. The change from the dominant gametophyte generation to the dominant sporophyte generation (see the next section on "alternation of generations").

ALTERNATION OF GENERATIONS IN PLANTS

One of the most unusual characteristics of plants is their reproductive strategy. All plants produce one plant form (called the **sporophyte** generation) that has the full number of chromosomes (a condition known as **diploid**). The sporophyte undergoes a special type of cellular reproduction (**meiosis**) to produce **spores** that contain half the normal number of chromosomes (**haploid**). These spores grow and form a second plant form (known as the **gametophyte** generation). This plant form always has half the number of chromosomes. It will undergo a more common type of cellular reproduction (**mitosis**) to form sexual **gametes** (eggs and sperm). The sperm fertilize the eggs. Fertilization results in diploid **zygotes** (fertilized eggs) that will grow into the sporophyte generation.



Glossary in Review:

Sporophyte - diploid generation that produces spores

Gametophyte - haploid generation that produces gametes (eggs & sperm)

Diploid - complete number of chromosomes (DNA)

Haploid - half the number of chromosomes

Meiosis - sexual reproduction that produces haploid cells

Mitosis - asexual reproduction that produces cells that are identical to the original cell; produces diploid cells

TRADE-OFFS

Let's take a land plant with a cuticle and examine some of the evolutionary implications. As discussed above, land plants developed a cuticle to prevent dehydration. But that creates other problems: how does the plant now move gases (carbon dioxide and oxygen) in and out of its body?

Algae live in the water, so absorbing CO_2 across the epidermis is no big deal for them. On the other hand, there is not a whole lot of CO_2 dissolved in the water. One advantage to moving to land is the relative abundance of CO_2 in the atmosphere compared to the water. However, there is always a trade-off.

Land = lots of CO_2 but also = dry

So the cuticle evolved, a waxy covering to prevent water loss. The cuticle does a great job at this but it also prevents gas exchange. So, the new problem becomes how to get the CO_2 .

This leads to "poking" holes in the surface of the epidermis (somewhat similar to poking holes in the plastic cover of a frozen dinner before you nuke it in the microwave so the steam can escape). In plants, the holes are called **stomata**, thus compromising the waterproofing solution. However, since no CO_2 = no food for plants, this is necessary for survival. Most plants evolved an adaptation to control water loss through the stomata by regulating when the stomata open and where the stomata are found on the plant body.

Evolutionary adaptation is thus a series of compromises as organisms change to meet new conditions and have to develop new solutions to new problems as they arise.

ALGAE AS DISCUSSED IN THE VIDEO

At the time that **LIFE ON EARTH** was originally produced, green algae were categorized as plants. In the early 1990s, most biologists classified them with Kingdom Protista. The information about algae discussed in the video is still accurate and pertinent, as long as you remember that the algae are not "plants". Since the green algae **are** considered to be the ancestors of plants, the information in the video is still relevant for understanding the evolutionary history of the plants, as long as you remember algae are NOT land plants.

Now, the current view is to put the plants with their green algae ancestors in Kingdom Plantae (but not **all** algae, just certain green algae). Remember the changing nature of science?

NON-VASCULAR PLANTS

There are three groups of plants that do not have efficient specialized tissue for conducting water and food. These three groups are known as the **non-vascular** plants. The three groups include **mosses**, **liverworts** and **hornworts**. You will see the mosses and liverworts in the video.

These plants were the first plants that adapted to living on land. Their bodies have no true roots, stems or leaves. These non-vascular plants are small, simple and relatively unspecialized plants. They are small because they lack vascular tissue and cannot transport things through their bodies efficiently. However, large numbers of these organisms can live together, spreading out over the ground to cover large areas, thus potentially being dominant organisms in some regions. A great example is the peat bog. More information about peat bogs can be found at these websites:

<http://www.epa.gov/owow/wetlands/types/bog.html>

<http://www.ipcc.ie/factsfigures.html>

<http://www.archaeology.org/online/features/bog/index.html>.

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AUTHORS' NOTE: This last website has an article from *Archaeology* (1997) that discusses the amazing archaeological finds found in the peat bogs of Northwestern Europe. These finds include the bodies of criminals and other people whose bodies are so well preserved that their skin and clothing is still intact. You can even see their facial features! These finds make the point that peat bogs are very sterile environments, in which bacterial decomposition is negligible.

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The **gametophyte** generation is usually the dominant form that you see; the gametophyte is nutritionally independent of the sporophyte. The **sporophyte** is attached to the gametophyte and depends on the gametophyte for its nutrition.

These plants live in moist habitats. In addition to needing water to grow and develop, the plants require water in order to reproduce because sperm must swim to reach the eggs.

VASCULAR PLANTS

There are nine groups of living vascular plants. The first fossils of vascular plants date to about 430 million years ago. For more information, see the Rhynie Chert websites at:

<http://www.ucmp.berkeley.edu/devonian/rhynie.html>

<http://www.abdn.ac.uk/rhynie/>

(The Rhynie Chert is a fossil locality in Scotland. In the Devonian, volcanoes and hot springs were located in this area. The mineral-rich water from the springs and volcanic deposits have preserved in amazing detail some of the earliest plants, fungi and terrestrial animals. The detail preserved in these fossils is so good that the internal structures of plant organs can be seen at the cellular level.)

All vascular plants share three common characteristics:

1. Vascular tissue: conducting vessels that transport water or food and also help to support the plant walls.
2. The sporophyte generation is large, independent and dominant; the gametophyte generation can be dependent or independent.
3. The plant body has specialized roots, stems and leaves.

Another major trend is seen in the evolution of vascular plants: the evolution of the **seed**. A seed contains a developing embryo surrounded by a tough seed coat. The embryo is a young sporophyte in a dormant state of arrested development. Many seeds also contain abundant food stores for the embryo. The seed appears in the advanced vascular plants and provides a great way for a parent plant to disperse its offspring by using wind or animals. Also, the embryo can stay dormant for some time if environmental conditions do not favor development (such as drought).

Vascular Plants Discussed in LIFE ON EARTH:

Club Mosses:

Body with roots, erect stems as well as trailing stems; numerous small leaves; water necessary for reproduction because sperm must swim to reach eggs; seedless.

Horsetails:

Underground stems gives rise to hollow, erect stem with tiny leaves; water necessary for reproduction because sperm must swim to reach eggs; seedless.

Ferns:

Underground stem, roots, large leaves (called fronds) with many veins; water necessary for reproduction because sperm must swim to reach eggs; seedless; sperm and eggs are produced on the underside of the gametophyte, thus protecting them and minimizing the amount of water needed for the sperm to swim to the egg.

Cycads:

Large leaves, aboveground roots, sexes separate; reproductive organs in cones; swimming sperm delivered in pollen; produces seeds. (In a plant nursery, these are often called "sago palms".)

Conifers:

Needle-like or scale-like leaves; reproductive cones with seeds; produces wind-carried pollen that deliver sperm to eggs.

Flowering Plants (discussed in Episode 4):

Last plant group to evolve; reproductive organs in flowers; seeds enclosed in fruit; pollen often delivered to female parts of flowers by animals; flowering trees, shrubs and herbs.

CONIFERS

Conifers are **cone**-bearing trees. Their seeds develop inside cones instead of flowers. The reproductive cycle of a typical conifer, such as a pine tree, takes two years to complete. During the first year, both male and female cones are produced. The **male cones** are very small and are grouped together in clusters. They produce enormous amounts of **pollen**. The **female cones** are larger than the male cones, but still smaller than a mature female pine cone. They are soft, and the eggs are located within the cone, between the scales.

The male cones release their pollen, which is carried by the wind to the female cones. Since the pine relies on the wind to spread its pollen, the male cones produce abundant pollen. Most of the pollen never reaches a female cone. The wind carries it everywhere (including our noses) instead of directly and efficiently to the female cones. The male cones must make enormous amounts of pollen to be sure some of it will reach a female cone.

When the pollen reaches a female cone, the scales of the cone separate just enough to allow the pollen to fall between the scales, reaching the ovules of the cone, where the eggs are located. Then the female cone closes up again. So ends the first year.

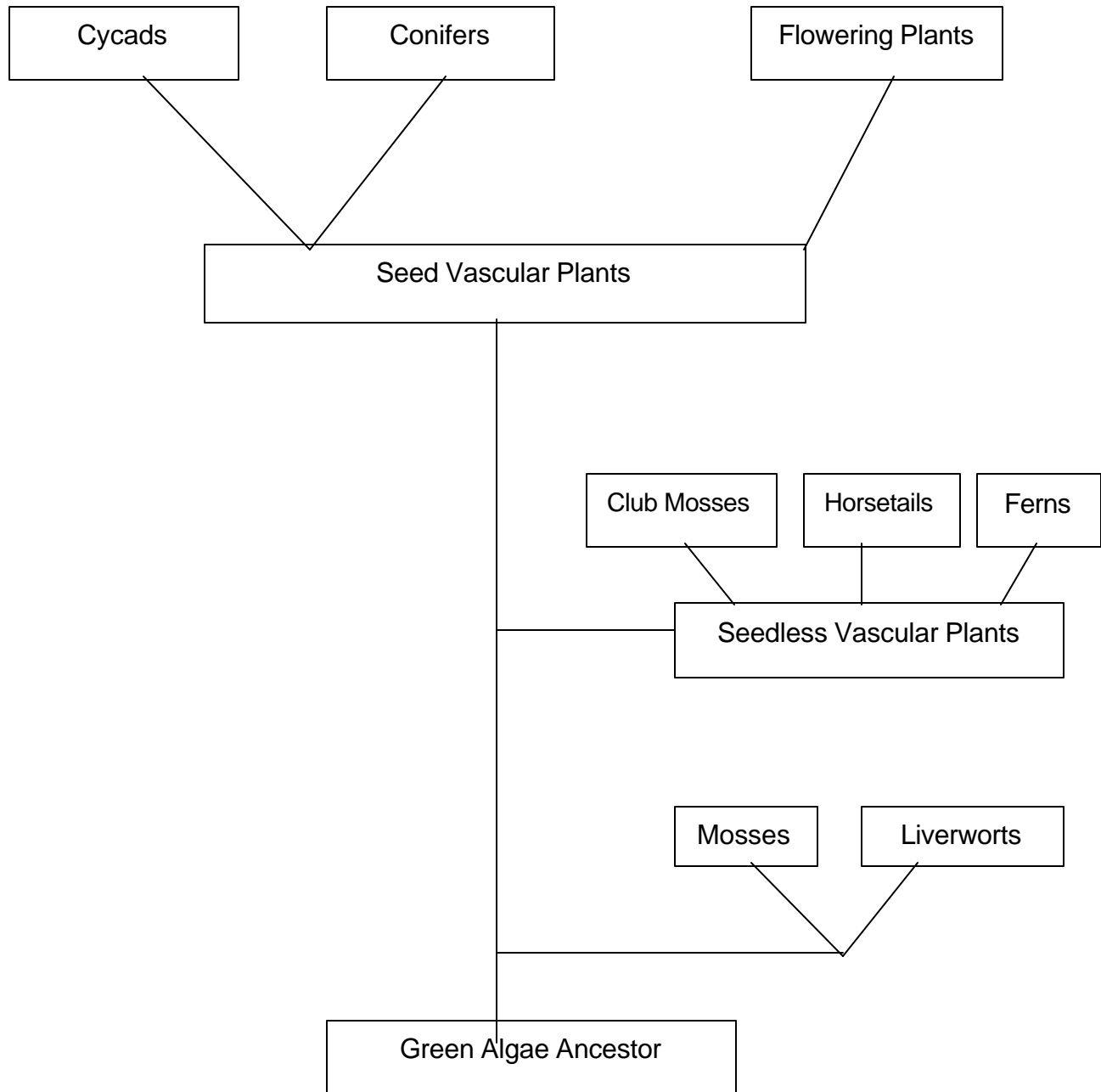
During the second year, the pollen eats away at the ovule tissue until they reach the eggs. Then the pollen produces sperm that fuse with the eggs to form zygotes, cells that will divide to form the embryos inside the seeds. The ovules develop into seeds, and the female cones grow and mature until they are as large as the familiar pine cones used as decorations during the winter holidays.

Conifers are usually evergreens that have leaves shaped like **needles**. The shape and structure of the needles are adaptations for dry conditions. The long thin shape of the needles decreases the amount of surface from which water can evaporate. The leaves have a thick cuticle with stomata that are sunken into pits, which reduces evaporation even further. Conifers often live in areas with long cold winters when water is frozen and cannot be used by the trees. So, adaptations for dry conditions, such as the structure of their leaves, help the conifers survive the winters.

Most of the conifers live in regions just south of the Arctic tundra. The summers are very short there, so the growing season may be as short as 90 days. Because the conifers are evergreen, they do not need to waste time in making new leaves in the spring. Instead, their needles can start producing food right away, allowing the conifers to maximize their growth during the short summer.

There are coniferous forests in other places. There are pine forests in the southeastern United States instead of broad-leaved forests. They are found in sandy soils, which do not retain water. You can see an example at Bastrop State Park – the Lost Pines of Bastrop.

EVOLUTIONARY TREE FOR PLANTS



Websites: For more information about plants, see:
<http://www.ucmp.berkeley.edu/help/taxaform.html>
<http://www.adonline.id.au/plantevol/>
<http://www.palaeos.com/Plants/default.htm>

A BRIEF REVIEW OF SELECTED ARTHROPODS

Arthropods were previously discussed in Unit One. Let's review some of these characteristics as they apply to the arthropods seen in this video. Arthropods have segmented bodies, an exoskeleton and jointed appendages, such as legs. The major arthropods discussed in this episode are millipedes, scorpions, spiders and insects.

Millipedes eat plant material, either living or dead. Most eat decaying vegetation. You will find them in damp protected areas, such as leaf litter, under bark or inside a rotting log. The body has a distinct head with antennae and chewing appendages. Each segment has two pairs of walking legs; a typical millipede has 60+ legs. There are glands in each body segment that produce a nasty-smelling chemical that is used to deter predators.

Spiders and scorpions are **arachnids**. An arachnid has a segmented body, usually divided into two parts with four pairs of walking legs. Most people know that spiders and scorpions have eight legs. Both spiders and scorpions are fierce predators. Watch the video carefully for the courtship rituals of these predators!

Scorpions have large pincers that they use to handle and tear up food. The abdomen is long and jointed, ending in a stinger which contains venom which is used to paralyze their prey. As you will see in the video, the scorpion holds its abdomen up over its body. Scorpions are thought to be the oldest terrestrial arthropod, with fossils dating to 425 million years old.

Spiders have silk glands on their abdomen from which they produce silk. Silk is used to form their remarkable webs; some spiders also spin gossamer parachutes that catch the wind and carry the spider away to a new location. Not all spiders spin webs. As you will see in the video, some spiders actively hunt or ambush their prey. Spiders also have poison glands. Fangs are used to inject the venom into the prey's body, paralyzing it.

There are more insects than any other group of animals on this planet. **Insects** have a body divided into three parts: a head, thorax and abdomen. They have one pair of antennae. There are three pairs of legs that attach to the thorax. Most insects also have one or two pairs of wings. Insects have compound eyes and elaborate mouthparts. There are many insects seen in this video: bristle tails, silverfish, dragonflies, damselflies, aphids, locusts, grasshoppers, beetles, lace wings, caddis flies, bees and several flies.

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Website: For more information about arthropods, see:

<http://www.ucmp.berkeley.edu/arthropoda/arthropoda.html>

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QUESTIONS FOR EPISODE 3: THE FIRST FORESTS

1. Name three forces that helped contour the planet.

ALGAE, MOSSES AND LIVERWORTS

2. Identify the first plants that made the move to land.
3. What was a major problem that faced plants when they moved to land? How did mosses and liverworts resolve this problem?
4. Name the two methods of reproduction found in the algae.

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Website: <http://www.seaweed.ie/>
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5. Why do algae and the primitive land plants (mosses, liverworts) require water for reproduction?
6. Describe sexual reproduction in the liverworts. What is formed by the spores? When are spores released?

- 7. Mosses and liverworts have two generations: sexual and asexual.
 - a. What is the function of the sexual generation?

- b. What is the function of the asexual generation?

- 8. Describe the spore capsules of mosses.

MILLIPEDES, SCORPIONS AND SPIDERS

- 9. Describe the millipedes.

- 10. Describe the changes in the respiratory system (responsible for breathing) that were necessary in order for the first animals to move to land.

- 11. The early land animals were vegetarians. Predators developed and preyed upon the early herbivores. According to the video, what two groups of predators still survive today that descended from these early predators?

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Additional Information: Centipedes evolved first in the oceans, followed by scorpions. However, scorpions came on land about 440 mya, with centipedes following about 400 mya. Which means centipedes were here first but scorpions beat them to the resorts.
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15. a. Why did the scorpions have to develop ritualized courtship patterns?

b. Describe the courtship and mating behavior of the scorpions.

16. Describe the courtship and mating behavior of the following spiders:

a. jumping spider

b. wolf spider

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Websites: <http://www.arachnology.be>
 <http://mamba.bio.uci.edu/~pjbryant/biodiv/spiders/index.htm>
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17. Describe the first miniature forests that grew on land.

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Website: <http://www.uni-muenster.de/GeoPalaeontologie/Palaeo/Palbot/ewald.html>
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18. a. What is the function of roots?

b. Under the electron microscope, what is revealed about the structure of a moss?

Locator: Welsh Hillside (Refer to the Rhynie Chert websites.)

19. a. Describe the first plants that had strong support vessels.

b. How old are the fossil remains of such plants?

c. What was the function of the thicker walls?

CLUB MOSSES, HORSETAILS AND TREE FERNS

Three plant groups with roots and support vessels evolved from the mosses and liverworts.

These three groups were the:

1. club mosses
2. horsetails
3. tree ferns

20. Club mosses

a. What is the function of the thick cells found in the stem?

- b. How tall did club mosses grow in the past?

 - c. How tall do club mosses grow today?
21. Horsetails
- a. How tall is the largest horsetail found today?

 - b. How tall did horsetails grow 300 million years ago?

 - c. What is the function of their hard, outer skin?

 - d. What is the function of the minute pores in the skin?
22. Attenborough speaks while surrounded by tall trees with fronds at the top. What are these plants called?
23. What impact did **height** of these new, taller plants have on reproduction?

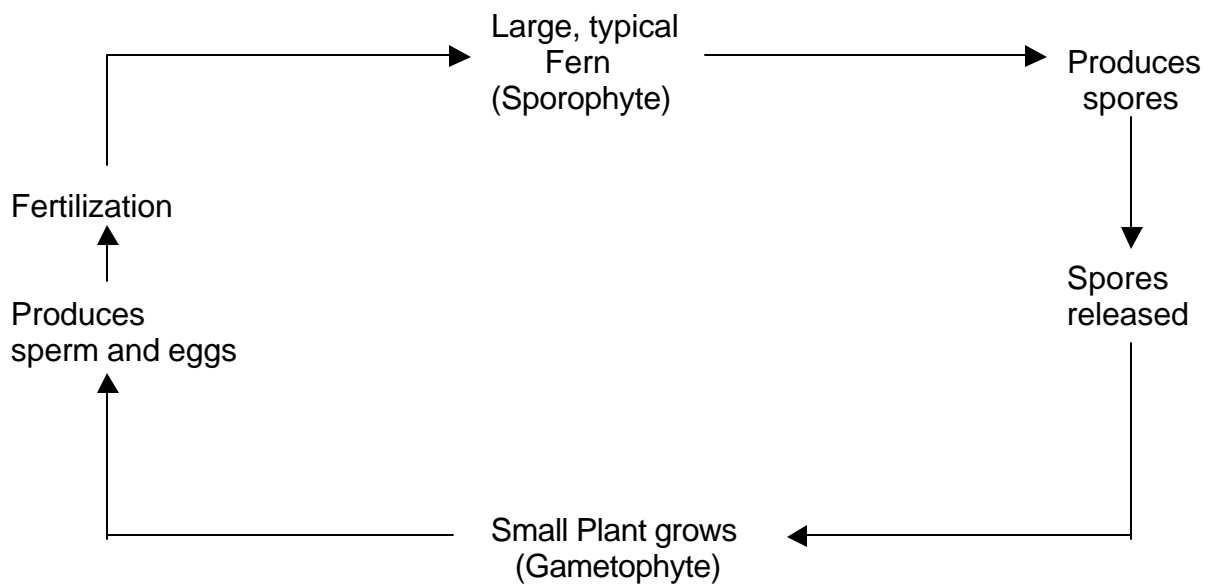
24. Some ferns produce cups at the end of coiled strips.
a. What is the function of these cups?

b. How do the ferns release spores?

c. What structures in the spores enable them to move by wind more efficiently?

25. Understand the fern reproductive cycle, as diagrammed below.

Which generation is dominant? _____



26. 400 million years ago, the descendants of the ancestral millipedes, such as the bristle tails and silverfish, developed. What changes had occurred in their bodies?

27. a. What problems were created for the animals by the first tall forests?

b. How did the animals solve this problem?

FLYING INSECTS

28. Describe the development of the dragonfly wing.

29. Describe the natural history of the dragonfly.

30. Explain how dragonflies and damselflies actually fly. How do they navigate?

31.
 - a. What was the size of the largest fossil dragonfly?

 - b. When did the first dragonflies appear in the fossil record?

CYCADS

32. What impact did flying insects have on plant reproduction?

33. Describe the cycads. How do they reproduce?

Locator: Petrified Forest, Arizona

CONIFERS

34.
 - a. Describe the conifers.

- b. Are male and female cones located on the same tree?
 - c. How is pollen transported?
 - d. How much pollen is produced by one male tree?
 - e. Describe female cones. How do these differ from male cones?
 - f. How much time is involved in the reproduction of conifers (from the time that pollen is released until the development and release of the seed?)
35. What is a seed? Why is the seed considered to be a major significant development in the evolution of plants?
36. Give examples of the various types of conifers.

37.
 - a. How do conifers protect themselves from injury?

 - b. What is amber?

 - c. What information does amber provide about the early insects?

38. What part of the tree is eaten by the following insects?
 - a. aphids

 - b. locusts and grasshoppers

 - c. beetles

39. How do some insects camouflage themselves against the trees?

40. How are flying insects captured by predatory spiders?

41. Describe the wing structure (and flying skills) of the following insects:

a. lace wings

b. caddis fly

c. bees

d. beetles

e. chafer

f. hover fly

g. crane fly

h. house fly

CONCEPTS FOR EPISODE 4: THE SWARMING HORDES

FLOWERING PLANTS

The members of this group are vascular seed plants. Reproductive structures are found within the **flower**. The seeds are enclosed in **fruit**. This group includes all plants that produce a flower: trees, shrubs and herbaceous (non-woody) plants. As mentioned previously, the flowering plants were the last group of plants to evolve. Beginning 80 to 90 million years ago, flowering plants became the dominant form of terrestrial plant life.

The trees in this group are often called **broad-leaved trees** and they produce their seeds inside **flowers**. They are much more closely related to other flowering plants, such as daisies and roses, than to conifers. The reproductive cycle of a typical broad-leaved tree, such as an oak tree, is completed in a much shorter time than in conifers. Oak trees in the Austin area, for instance, produce flowers in the spring (March and April) and produce fruits (acorns) by September and October. Thus, broad-leaved trees can reproduce in a matter of months instead of years.

Although most flowering plants (especially in the tropics) use animals to transfer pollen from flower to flower, most temperate broad-leaved trees rely on the wind instead. The wind-pollinated flowers of broad-leaved trees are inconspicuous with green petals (elms, oaks and pecans). And they produce enormous amounts of pollen, just like in the conifers, and for the same reasons. Some broad-leaved trees have large, brightly-colored flowers, such as peach trees and magnolias. These trees rely on bees and other animals to transfer pollen instead of the wind. The brightly-colored petals of the flowers are signals used to attract the animals.

In the temperate regions of the planet where there are four distinct seasons, plants must get through the winter somehow. Here, broad-leaved trees are deciduous, dropping their leaves in the autumn. As the nights get longer in autumn, biochemical changes in the tree trigger the dropping of leaves. All the recyclable parts of the leaf are removed and stored in the trunk and roots, so the green color disappears, revealing the brilliant oranges, reds and golds of unrecyclable pigments. Eventually, the stalk that holds the leaf to the tree weakens and it separates from the tree. Why lose leaves just before winter? Water is not available during the winter months. Large amounts of water will be lost across the broad surface of the leaves. During the winter, lost water cannot be replaced by the absorption of water from the soil by the roots. So, it is better to get rid of the leaves all together.

This means that every spring, deciduous trees must produce new leaves. This is only possible in areas where the summers are long enough for leaf replacement, growth and reproduction. Broad-leaved forests are thus generally restricted to areas south of approximately 45 degrees North latitude.

Websites: <http://www.ucmp.berkeley.edu/anthophyta/anthophyta.html>
<http://www.colby.edu/info.tech/BI211/Bio211.html>
<http://whyfiles.org/shorties/O80corpseflower>

REPRODUCTION IN FLOWERING PLANTS

Flowering plants are different than animals in that an individual plant usually contains both sexes. Not all plants contain both male and female reproductive parts, but most do. Furthermore, male and female reproductive parts are usually contained within a single flower. The **flower** functions to attract pollinating insects to the reproductive structures within the plant.

Each flower consists of structures that produce pollen (**stamens**), structures that produce ovules (**pistils**), and accessory structures (**petals**) to attract insects. **Pollen** produces male gametes, known as sperm cells, while the pistils produce the female gametes, known as **eggs** contained within **ovules**. Once a pollen grain lands on a pistil, it releases its sperm cells. The sperm cell unites with an egg to form a fertilized egg, which then develops into an **embryo**. A seed consists of a dormant embryo, some stored food and a protective covering: everything necessary for the seed to develop into a new plant.

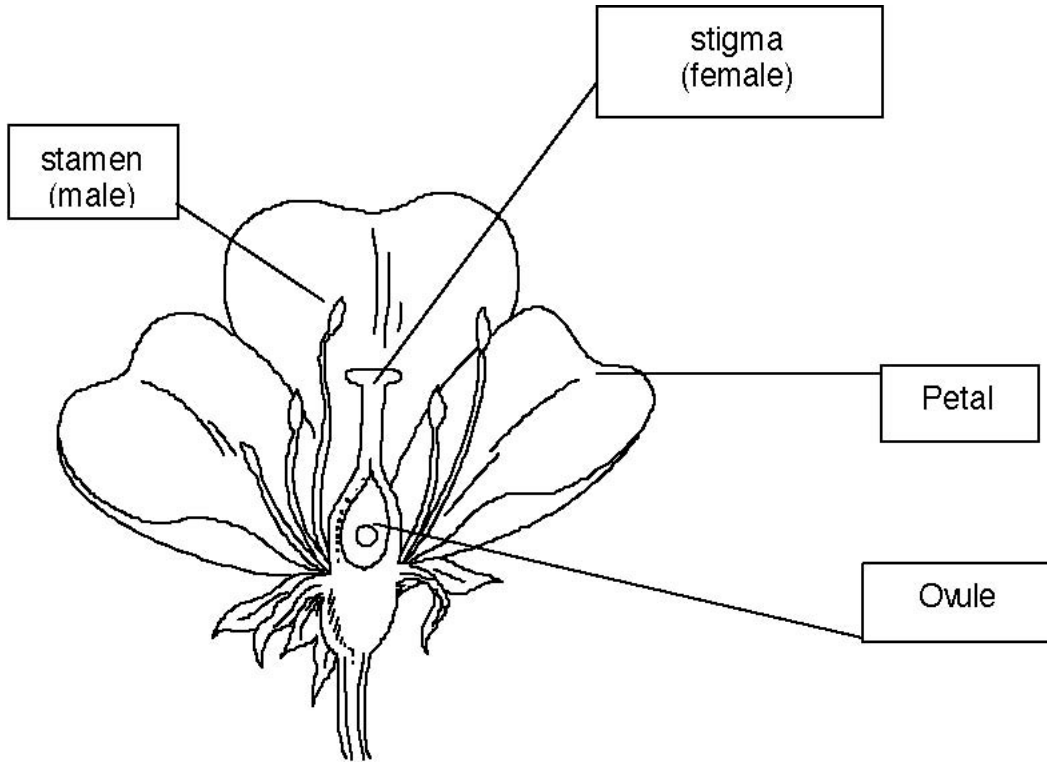
Although most plants contain both male and female reproductive parts within one flower, it is usually best for the plant if it does not pollinate its own flowers. If the plant is fertilized by a different individual, the reproductive success of the offspring is enhanced. In order to accomplish this "cross-pollination," pollen is moved from plant to plant. Plants that use insects to carry the pollen have a better chance of successful cross-pollination than plants that rely upon wind. Plants entice insects to the flowers by offering a variety of rewards, such as pollen, nectar, oils or a place to spend the night. As a precaution against accidental self-pollination, plants often have stamens that mature at different times than the pistils. One example of such a plant is the magnolia.

As explained by Attenborough, the magnolias were the earliest and simplest flowering plants to appear approximately 100 million years ago. New fossil evidence has shown there are earlier forms dating back to 130 million years ago. (See this website on water lilies: <http://www.nsf.gov/od/lpa/news/02/pr0209.htm>.) Magnolia fossils are still the best documented fossils in the early history of flowering plants.

As Attenborough describes the magnolia in his book, *Life on Earth* (page 80): "The eggs are clustered in the center, each protected by a green coat with a receptive spike on the top called a stigma, on which the pollen must be placed if the eggs are to be fertilised. Grouped around the eggs are many stamens producing pollen. In order to bring these organs to the notice of the insects, the whole structure is surrounded by brightly coloured modified leaves, the petals."

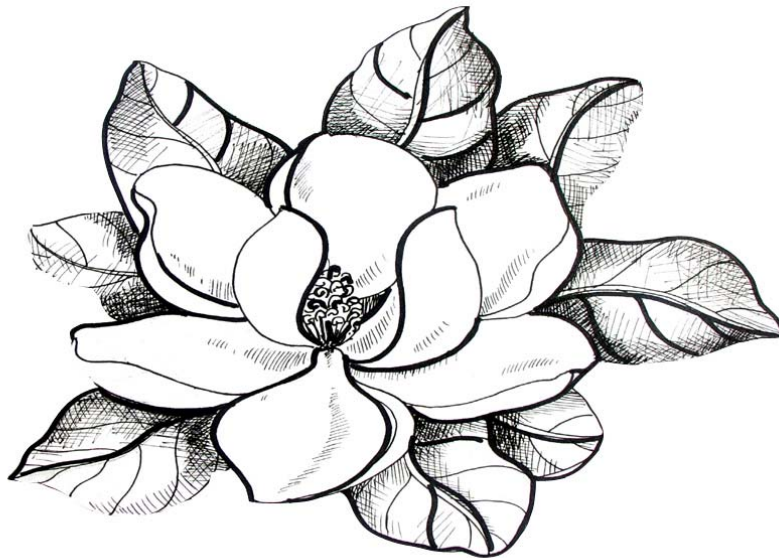
Magnolias avoid the problem of self-fertilization by different maturation dates of the stigma and stamens. The stigmas can be pollinated as soon as the flowers open. However, the stamens on the flower will not mature until a later time. This allows the eggs of that flower to be fertilized by the pollen of another magnolia plant, thus enhancing the chances of "cross-pollination."

Parts of a Flower



drawn by Katie Bear

Magnolia Flower



<http://www.rickandersonart.com/search.htm>

COEVOLUTION

Coevolution means that two different species are evolving (changing) together. Once again, they **don't decide** to evolve together. It is a cycle. Species A changes in response to something that Species B is doing. Species B then responds by changing, which causes Species A to change..... You get the picture.

The tropical rain forest is a wonderful community in which to look for coevolution. The plants in the canopy cannot rely upon wind to transport their pollen or disperse their offspring. One solution for this dilemma is to "trick" or "lure" animals into doing the job for them. Many plants offer copious pollen or nectar to attract animals that are always in the market for an easy meal. As the pollen clings to the animal, it has the chance to carry off the pollen to another plant, which gets the job of reproduction done.

Many plants wrap enticing flesh around their offspring (the seeds). Many animals, including monkeys and fruit bats arrive at the tree for a tasty meal. The seeds are often eaten and carried away in the body of the animal. Later, when the animal defecates, the seeds will be dispersed away from the parent. [And, even though it may seem disgusting to you, the seed is also packaged in instant fertilizer.]

So, where's the coevolution? Some plants have developed flowers that can only be pollinated by one species of animal. Think about a hummingbird with a long, narrow beak and the ability to hover. They need a **lot** of fuel to support their lifestyle. Also, hummingbirds are attracted to the color red. Now think about a plant with long, tubular red flowers with copious amounts of nectar; the flowers are open during the day. This plant has "packaged" its flowers to attract hummingbirds.

Targeting a specific market (hummingbirds) is a distinct advantage to a plant as long as hummingbirds are available and if the rewards are enough that the hummingbirds will be exclusive about the type of flower that they visit. That ensures that only hummingbirds are going to visit this particular type of flower, thus picking up and distributing pollen. This should increase the likelihood that the pollen will reach another flower of the same species, which should promote fertilization.

The drawback, of course, is one of overspecialization. If the plant becomes so exclusive that only one type of animal can pollinate its flower, then the plant is dependent upon the survival of that animal. Watch the video for the relationship between the yucca plant and yucca moth. If the animal becomes extinct, then the plant is not going to be able to produce any more offspring. From an evolutionary standpoint, that means the plant will become extinct.

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Website: Yuccas and yucca moths are further explained at this website:
<http://waynesword.palomar.edu/ww0902a.htm>
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INSECTS AND METAMORPHOSIS

Many insects play a major role in the day-to-day life of flowering plants. This episode also discusses an interesting facet of insect life: the ability to undergo metamorphosis. Most insects develop from fertilized eggs that are laid outside the body of the female. The zygote develops into a young insect inside the egg and escapes from the shell. The insect then undergoes growth and development. As it grows, it must shed its exoskeleton (a process called molting) several times. Eventually, the insect becomes an adult and stops molting.

Most of us are familiar with complete metamorphosis in insects -- the caterpillar eats, enters a resting stage as a pupa and a gorgeous butterfly emerges. In **complete metamorphosis**, there is a distinct difference between the appearance of the larva (caterpillar) and the adult (butterfly). Typically, juvenile larval stages are involved in eating and growing. Before the final molt, the larva enters a resting stage; at this point, the larva is called a pupa. The pupa does not feed and is primarily inactive. They are often covered with a cocoon or other protective structure. During this "resting" stage, major changes occur to the internal structures. After the final molt, the insect takes on the adult form, which typically is involved with reproduction. Most insects undergo complete metamorphosis. These insects include moths, butterflies, beetles, bees, wasps, ants and flies.

In **simple metamorphosis**, the immature insects (called nymphs) resemble the adults. Usually, there is no "resting" stage before the final molt. Insects with simple metamorphosis include springtails, silverfish, mayflies, dragonflies and grasshoppers.

INSECTS AND PHEROMONES

Insects, like most complex animals, produce chemicals which affect changes in their bodies and behavior. Some of these chemicals are released into the surrounding environment and act as a message to other individuals, often affecting their behavior. This type of chemical is called a **pheromone**.

Pheromones are not limited to insects, of course. Many animals, including humans, produce mating pheromones for attracting and recognizing members of the same species. Social insects also apparently use pheromones to communicate to other members of the society. Scout ants mark their trails back to the nest with pheromones. Members of the same ant colony "recognize" each other by pheromones. The queen of a colony probably uses pheromones to direct the activity of her workers.

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Interesting Websites:

I. Anachronistic Plants: These are plants that have edible fruits believed to be dispersed by animals that are now extinct. For example, osage orange, a tree found in the central Texas area, has large fleshy fruits that no native mammal will touch. However, horses will eat them and disperse the seeds. But domestic horses only arrived in North America with the Spanish in the 15th-16th centuries. Perhaps the osage orange was originally dispersed by the ancestors of the horse that lived in North America. For more formation visit:
<http://www.ontarioprofessionals.com/botaniq.htm#anachro>

II. Forgotten Pollinators Overview: <http://www.desertmuseum.org/pollination/introduction.html> is the home page of the Forgotten Pollinators Campaign, whose mission is to "call international attention to the critical role pollination plays in putting food on our plates, and in maintaining healthy wild communities around the globe." This website has links to pages on Migratory Pollinators and Their Corridors, a reading list, and links to sites on pollination and butterfly gardening.

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QUESTIONS FOR EPISODE 4: THE SWARMING HORDES

1. Describe the body of a typical insect.

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Websites: <http://www.bugbios.com>
 <http://tolweb.org/tree?group=Insecta&contgroup=Hexapoda>
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2. What is chitin? How do insects modify chitin?
3. How many insect species have been identified?
4. When did the first insects appear in the fossil record?
5. How do plants use insects?
6. Describe the flower of the magnolia.

7. Be able to identify the parts of a flower. Know the function of each part.
 - a. stigma

 - b. stamens

 - c. pollen

 - d. petals

 - e. ovary with eggs

8. What are the advantages of using insects to transport pollen?

9.
 - a. Why does the flower represent an improvement in plant reproduction?

 - b. How do plants avoid being cross-pollinated by another species?

 - c. What is the advantage of being pollinated by a different plant of the same species?

10. What is nectar? Why did nectar develop? What insects were among the first to use the flower as food?

11. Why are flowers brightly colored?

12. Why did plants evolve flowers with odors?

13. What is the function of markings on the petals of flowers, such as shading, lines, different shapes, etc.?

14. Why have some plants developed tiny flowers gathered into a bunch or even fusing into one large entity? Give examples.

15. Some plants rely upon wind for pollination. What changes can be seen in the male and female flowers of wind-pollinated plants?

- b. What is the function of insect impersonation or mimicry by flowers? How does this ensure reproductive success?
20. Describe the dependency of the yucca plant and the moth that pollinates it.
21. What is the function of impersonating plant parts (like flowers) by insect predators? Give an example of 1 predator.
22. What are the limitations of a hard exoskeleton?

23. Describe the phenomenon of molting.

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Website: <http://insected.arizona.edu/insectinfo.htm>
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24. What is the advantage of having different life styles for the larval stage versus the adult stage?

25. What is the primary function of the larvae of advanced insects? How does the body of the larva reflect its primary purpose?

26. What defense mechanisms have developed to protect exposed larvae, such as caterpillars? What does bright coloration or bold markings on the body of a caterpillar signify?

44. Discuss the symbiotic relationships that exist between ants and other organisms. Explain how the relationship benefits the ants involved. Explain how the relationship benefits the other organism.

a. Parasol ants (also called leaf cutter ants) and fungus

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Website: http://www.bbc.co.uk/nature/reallywild/amazing/leafcutter_ant.shtml
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b. Acacia trees and ants

45. Describe the life cycle of army ants.