

# BRYOPHYTES

Bryophytes are non-vascular plants that first appear on land during the early Silurian period more than 430 million years ago.

## LIVING ON LAND

a) To live on land, plants needed to reduce water loss. The evolution several structures were critical to the ability of bryophytes to live on land. Two of these structures are the cuticle and pore.

i) Examine the cross section of the bryophyte in the picture below.



Fig 1. Cross section means a lateral (not a longitudinal) section.

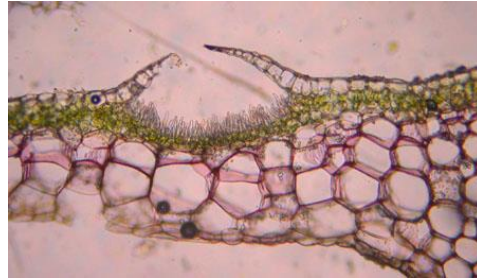


Fig 2. Cross section under a compound scope

ii) In Fig. 2. Label the cuticle and pore.  
What is the function of the cuticle?  
What is the function of the pore?

b) **Station 1:** The figure below shows a close up of a typical NON-BRYOPHYTE plant leaf.



iii) Compare the picture of the vascular plant leaf above with a close up of a bryophyte under both a dissecting microscope (2.5X) and a compound scope (10X). You should see that, unlike the leaf above, bryophytes have no veins. In other words, they have NO vascular tissue (xylem and phloem).

*Do bryophytes have true leaves? The answer is NO. Instead, bryophytes have thalli. Thalli are leaf like but they have NO vascular tissue.*

iv) Draw the thalli of a bryophyte under a compound scope 10X.

c) **Station 2:** Not only do bryophytes lack true leaves, they also lack true roots. Instead they have rhizoids, simple hair like structures that extend from the underside of the plant.

v) Go to the LIVING PLANTS station and gently lift the living bryophyte specimen from the container and take it back to your lab bench.

In the figure below, the fine hair-like structures are rhizoids.

vi) Compare the picture below with a close up of bryophyte rhizoids under a dissecting scope. Identify the rhizoids on your sample.



## **REPRODUCING ON LAND**

In addition to living on land, plants must also be capable of reproducing on land. To understand how it does this, it is important to understand the basics of the bryophytes life cycle.

**See the “Life Cycle of a Bryophyte”. You will need this to complete the following section**

a) **Stage 1:** Bryophytes are unique amongst other land plants in that the gametophyte is the dominant stage of its life cycle. The gametophyte of the bryophyte are the green structures you see in this photo.

vii) In this case, what do we mean by dominant?

b) The gametophyte is haploid. This means the ploidy level is n.

viii) For each of the stages of the bryophyte live cycle, fill in the ploidy levels in the spaces indicated.

c) **Stages 2A and 2B:** The archaegonium and antheridium can be found on the thalli of the bryophyte,. Within these structures respectively, the egg and sperm are produced. The production of gametes from the gametophyte occurs through mitosis.

ix) Between each of the other stages, fill in the type of division (mitosis or meiosis) that occurs.

d) Fertilization occurs when the sperm produced in the antheridium reaches the egg in the archaegonium.

x) How does the sperm reach the egg and what limitation does this place on bryophyte reproduction?

**e) Stage 3:** After fertilization, a zygote forms which then ultimately becomes a sporophyte.

xi) Draw the specimen at station 3 and label BOTH the sporophyte and the gametophyte.

**f)** Inside each sporophyte, spores are made. Bryophytes make only one type of spore. They are homosporous. *These spores have NO equivalent structure in animal reproductive cycles so don't even try to make that comparison.* Spores will ultimately produce the multicellular gametophyte.

xii) Are spores multicellular or unicellular?

### **DIVERSITY**

**a)** There are three basic types of bryophytes. They are mosses, liverworts and hornworts. Note the height of each of these bryophytes. Why do you think bryophytes are so small compared to other land plants? In other words, what limits the growth of bryophytes?

**b)** Identify (moss, liverwort, or hornwort) and draw the three specimens.

**c)** What type of habitat will you most likely find bryophytes and why?

**d)** Staying on campus, find three DIFFERENT types of bryophytes.

You can tell the differences by observing the differences in thalli morphology. Document your findings by taking a photo. Include the index ID card provided to you by your lab instructor in your photo. Identify your specimens as a moss, a hornwort, or liverwort. The photos with their ID will be placed in your lab book.

# SEEDLESS VASCULAR PLANTS

## LIVING ON LAND

As their name suggests, seedless vascular plants have vascular tissue. Vascular tissue (xylem and phloem) allow for the transportation of water and nutrients throughout the plant. The evolution of vascular tissue was a key adaptation for living on land. These plants likely originated during the mid Silurian about 410 million years ago.

**Station 1:** A fern is a common example of a seedless vascular plant.

i) Recognize the morphology of a typical fern.

**Station 2:** Examine the fern leaves under dissecting scope to see the pattern of veins (vascular tissue). Try 1.5X and increase the magnification if necessary

ii) Draw the leaf with its vascular tissue.

iii) What is the difference between true leaves and thalli?

**Station 3:** Seedless vascular plants also have true roots.



iv) What is the difference between true roots and rhizoids?

## **REPRODUCING ON LAND**

In addition to living on land, plants must also be capable of reproducing on land.

To understand how it does this, it is important to understand the basics of the seedless vascular plant life cycle.

**See the “Life Cycle of a Seedless Vascular Plant”. You will need this to complete the following section**

**a) Stage 1:** The fern you see here is the sporophyte stage.

The sporophyte is the dominant stage of a seedless vascular plant life cycle.

**b)** The sporophyte is diploid . This means the ploidy level is  $2n$ .

v) For each of the stages of the seedless vascular plant life cycle, fill in the ploidy levels in the space indicated.

**c) Stage 1 a and 1b:** On the underside of the fern leaves, you will see a number of brown circular spots, the sori (sorus - singular). The sori are actually clusters of sporangia.

vi) Locate and identify the sori.

**d) Stage 2:** Examine the sori under the compound microscope at 10X.

vii) Identify and draw the individual sporangia.

Within the individual sporangia, you can see individual spores. Seedless vascular plants make only one type of spore. They are homosporous. *These spores have NO equivalent structure in animal reproductive cycles.*

e) The spores will eventually undergo cell division to produce the gametophyte, the next stage in the life cycle. What type of division (mitosis or meiosis) does the spore undergo?

viii) Between each of the other stages of the life cycle, fill in the type of division (mitosis or meiosis) that occurs.

**f) Stage 3:** Examine the gametophyte (aka prothallus) of the seedless vascular plant. The gametophyte of a fern is a small heart-shaped structure. It has no vascular tissue and has little root like hairs or rhizoids, which attaches it to the ground.

ix) Is the gametophyte multicellular or unicellular?

The gametophyte stage in the life cycle of a seedless vascular plant is small and bisexual. In other words, the gametophytes has BOTH the archaegonium and the antheridium.

x) Locate the archaegonium and antheridium on the gametophyte.

e) ) Fertilization occurs when the sperm produced in the antheridium reaches the egg in the archaegonium.

xi) How does the sperm reach the egg and what limitation does this place on the reproduction of seedless vascular plants?

f) **Stage 4:** After fertilization, a zygote forms which then ultimately becomes a sporophyte.

xii) Draw the specimen at station 4 and label BOTH the sporophyte and the gametophyte.

### **DIVERSITY**

a) Seedless vascular plants include ferns, horsetails and whisk ferns. Examine the representative specimens and identify them as one of the three types of seedless vascular plant listed above.

b) What type of habitat would you find seedless vascular plants and why?

c) Staying on campus, find three DIFFERENT types of seedless vascular plants. You may find more ferns than horsetails and whisk ferns. However, you can distinguish differences between ferns based on the shape or morphology of the leaves. Look at the examples below.



# SEED VASCULAR PLANTS - GYMNOSPERMS

## LIVING ON LAND

As their name suggests, seed vascular plants have BOTH seeds and vascular tissue. Vascular tissue (xylem and phloem) allow for the transportation of water and nutrients throughout the plant. The evolution of vascular tissue was a key adaptation for living on land. Seeds were another major adaptation. Not only did seeds allow for long distance dispersal but also allowed for survival during harsh environmental conditions such as drought, fire, or extreme cold.

Based on fossil records, gymnosperms are believed to have originated during the Devonian about 390 million years ago but really expanded and diversified between 60-220 million years ago.

**Station 1:** A Norfolk pine is a common example of a gymnosperm. The sporophyte is what you see here. The sporophyte typically has leaves that are needle shaped.

i) Recognize the typical morphology of a gymnosperm.

**Station 2:** Although it is unlikely that you will see any cones on the particular gymnosperm at Station 1, on most other gymnosperms, you will see both male and female cones. The cones that you are accustomed to seeing are likely to be female cones. Compared to male cones, female cones are quite large and will fall to the ground. Seeds are found on the female cones.



ii) Examine the cones at this station. Identify where the seeds on the cones would be found.



## **REPRODUCING ON LAND**

In addition to living on land, plants must also be capable of reproducing on land.

To understand how it does this, it is important to understand the basics of the gymnosperm life cycle.

**See the “Life Cycle of a Gymnosperm”. You will need this to complete the following section**

**a) Stage 1:** The picture you see here is the sporophyte stage.

The sporophyte is the dominant stage of a gymnosperm’s life cycle. The ploidy level of the sporophyte is  $2n$ .

iv) For each of the stages of the gymnosperm life cycle, fill in the ploidy levels in the space indicated.

**b) Stages 2A and 2B:**

The microsporangium and megasporangium are found on the sporophyte. In gymnosperms, the microsporangium is found in the male cone while the megasporangium is found in the female cone.

v) Identify the male and female cones. Describe their differences.

**c) Stages 3A and 3B :** In gymnosperms, there are two types of spores, microspores and megaspores.

Gymnosperms exhibit heterospory. *Spores have NO equivalent structure in animal reproductive cycles.*

These spores are made in the microsporangium and megasporangium respectively. Microsporangia are located in the male cone while the megasporangia are located on the female cone.

At these two stations, you are looking at lateral sections of a male (3A) and female (3B) pine cone.

vi) Draw and identify the microsporangium, megasporangium, microspores and megaspores.



*Lateral section of female pine cone*

The micro and megaspores will eventually undergo cell division to produce the male and female gametophyte, the next stage in the life cycle. What type of division (mitosis or meiosis) does the micro and megaspore undergo?

vii) Between each of the other stages of the life cycle, fill in the type of division (mitosis or meiosis) that occurs.



**d) Stage 4A:** The male spore or microspore ultimately undergoes cell division to become the male gametophyte.

viii) In seed vascular plants, the male gametophyte is also known as \_\_\_\_\_. During the spring it is released from the male cone and dispersed via the wind.

ix) Examine the male gametophyte. Note the tough outer coating.

x) The male gametophyte makes gametes (sperm), which must reach the egg in order for fertilization to occur. How does the sperm reach the egg in gymnosperms?

**e) Stage 4B:** The female gametophyte develops from the microspore through meiosis within the megasporangium. It produces the egg.

xi) Examine the slide of the female gametophyte.

Draw and identify the megasporangium, the archegonium, the gametophyte and the egg.

### **DIVERSITY**

**a)** Gymnosperms are typically recognized by their needle like or scaly leaves. Gymnosperms with these types of leaves are also referred to as conifers. However, not all gymnosperms have this trait. Two strange exceptions are the ginkgo and Welwitschia. Welwitschia is endemic to the deserts of Namibia while the ginkgo is native to Asia.



**ginkgo**



**Welwitschia**

Although you won't find welwitschia growing outside in CT, there is a ginkgo located on campus somewhere on the Bellarmine lawn.

b) Examine the representative specimens. Are ALL of these specimens conifers?

c) Staying on campus, find three DIFFERENT types of gymnosperms. If possible, try to find the ginkgo on campus.

# ANGIOSPERMS

## LIVING ON LAND

Angiosperms first appeared about 65 million years (about the time the major dinosaurs were going extinct). Angiosperms are well adapted to living on land. They have vascular tissue, true leaves and roots. A key innovation of angiosperms was the evolution of vessel elements, a specialized xylem cell which is much more efficient than tracheids for conducting water.

**Station 1:** Angiosperms are well adapted for living on land. In addition to having tracheids which are found in other land plants with vascular tissue, Angiosperms have vessel elements.

i) List one reason why vessel elements are more efficient at transporting water than tracheids.

## REPRODUCING ON LAND

In addition to living on land, plants must also be capable of reproducing on land.

To understand how it does this, it is important to understand the basics of the angiosperm life cycle.

**See the “Life Cycle of an Angiosperm”. You will need this to complete the following section**

**a) Stage 1:** The angiosperm that you see in the figure is the sporophyte. The sporophyte is the dominant stage of the angiosperm plant life cycle.

**b)** The sporophyte is diploid . This means the ploidy level is  $2n$ .

iii) For each of the stages of the angiosperm life cycle, fill in the ploidy levels in the space indicated.

**c)** The key feature to note in the sporophyte is the flower. The evolution of the flower was one of the most important traits that improved the reproduction of angiosperms over all other land plants.

iv) What advantage did the flower offer to angiosperms? Hint: Think about pollen dispersal.

**d) Stage 2: Locate the anther. This is the male part of the flower.**

**e) Stage 2:** Examine the cross section of the anther. On this slide, you will see four pollen sacs. Pollen sacs are also known as microsporangia.

Microsporangia produce microspores.

v) What type of cell division (mitosis or meiosis) produces the microspore?

vi) Between each of the other stages of the life cycle, fill in the type of division (mitosis or meiosis) that occurs.

**f) Stage 3:** Examine the cross section of ovary. On this slide you will see the ovules. Ovules are also known as megasporangia. Megasporangia produce megaspores.

vii) Draw the cross section of the ovary. Identify and label the ovary and the megasporangium.

**g) Stage 4:** The microspore produced by the microsporangia ultimately produces pollen. The pollen is also known as the male gametophyte or microgametophyte. At this station examine the slide of mixed pollen. You will notice that pollen morphology is very distinct and species specific.

viii) Draw at least two different types of pollen that you see on this slide.

**h) Stage 5:** Examine the angiosperm embryo sac. On this slide you will see the embryo sac. The embryo sac is also known as the female gametophyte or the megagametophyte. Within the megagametophyte, the egg is made.

Eventually the pollen makes it to the style. The sperm contained within the pollen makes its way to the egg and fertilizes it. This results in a zygote.

**i)** Another key, unique adaptation in the angiosperm reproductive cycle is the evolution of fruit. The fruit forms from the ovarian tissue (yum), and the seeds form from the ovule. Examine the different fruits and seeds at this station.

ix) What TWO functions does fruit serve **the plant**?

### **DIVERSITY**

Angiosperms are the most widespread type of land plant due to their adaptations for living and reproducing on land. Although angiosperms are most easily recognized by their flowers, they can also be recognized by the presence of fruits (including pods, berries etc).

a) Examine the representative angiosperm specimens.

c) Staying on campus, find three DIFFERENT types of angiosperms. Remember that they may not currently have flowers or fruits. However, if the plant is NOT a bryophyte, a seedless vascular plant or a gymnosperm, by process of elimination, it must be an angiosperm!