Name: _____ Date/Lab time: _____

Lab 9:VASCULAR PLANTS: Seedless Vascular Plants (Pterophytes)

Supplies:

Dissection scope	*Lycopodium* and *Selaginella,*
Compound microscope	*Equisetum*
Psilotum	Ferns and fern prothallium
Germinated fern spores	Slide of fern prothallium
Fern gametophyte slide	

Vocabulary to know: Antheridia , Archegonia , Dichotomous branching, Fronds , Indusium, Phloem, Prothallium, Rhizomes, Sporangia , Sporophylls, Strobili

LAB SYNOPSIS:

We will compare and contrast the available non-seed vascular plants in lab

We will examine the morphology and anatomy of the vegetative and reproductive organs of the non-seed vascular plants.

Pterophytes- Vascular plants that do not produce seeds. They lack pollen and seeds. They only have one way to disperse their offspring, the spore.

There are 4 phyla of plants that fit the above definition of Pterophytes:

Kingdom Plantae
- Phylum Psilophyta (whisk ferns)
- Phylum Lycophyta (club mosses)
- Phylum Equisetophyta (horsetails)
- Phylum Polypodiophyta (ferns)

Introduction:

Ferns, gymnosperms, and flowering plants, have a system of specialized tissues called **vascular tissue** for long distance transport. Vascular tissue is made up of 2 separate systems: the **xylem,** which carries water and dissolved minerals and the **phloem**, which carries "food" throughout the plant. These "vascular plants" are therefore able to transport materials over relatively long distances. As a result, vascular plants can grow much larger than mosses and liverworts.

In this lab, we will look at vascular plants that lack seeds and rely upon spores for their dispersal (spores are also how non-vascular plants like mosses reproduce). At the end of these exercises you should be familiar with the structure and reproductive patterns of these major groups of seedless vascular plants.

"Pterophytes"

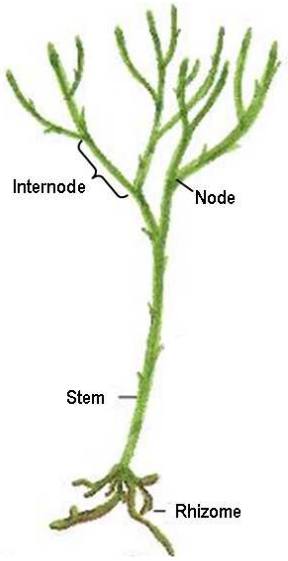
Non-seed Vascular Plants (4 phyla)
- Phylum Psilophyta (whisk ferns)
- Phylum Lycophyta (club mosses)
- Phylum Equisetophyta (horsetails)
- Phylum Polypodiophyta (ferns)

We will look at the sporophytic generation of each of these phyla in lab. We will focus our attention on the largest group, Polypodiophyta (ferns) looking at both the sporophyte and gametophyte generations.

The life cycle of the non-seed vascular plants differ in a number of ways from that in the seed plants (angiosperms and gymnosperms).

Seed plants	Non-seed plants
2 types of spores (male and female)	1 type of spore
Spores stay and mature into gametophytes on the parent sporophyte	Spores are released from the parent sporophyte. Spores germinate and develop into gametophytes away from the parent plant.
The microscopic female gametophyte forms the egg, is fertilized and develops into an embryo on the parent plant. AKA forms a seed on the parent sporophyte	Gametophytes are about ½ inch in size. These develop independently from the parent sporophyte.

PHYLUM PSILOPHYTA (WISKFERN)



The whiskferns used to be considered amongst the most primitive of extant vascular plants as they lack true leaves and roots. Resent analysis indicates however, that these structures may have been secondarily lost from an ancestor that may have had both leaves and roots. However, for lab purposes, we will examining the psilophyta first as it is thought to resemble the earliest vascular plants. The horizontal stem growing at or below ground level is a **rhizome** that produces downward growing **rhizoids** and upwardly growing stems. Note the aerial branching pattern of *Psilotum* stems. Each branch point produces 2 identical new branches. This is called **dichotomous branching**. This branching form is considered ancestral amongst vascular plants. Branch points are called nodes. Between branch points are internodes. This presence of nodes and internodes defines a stem. The globular, yellowish or greenish outgrowths of the aerial stem are the spore making sporangia. *Psilotum* occurs naturally in the U.S. in Florida and Hawaii.

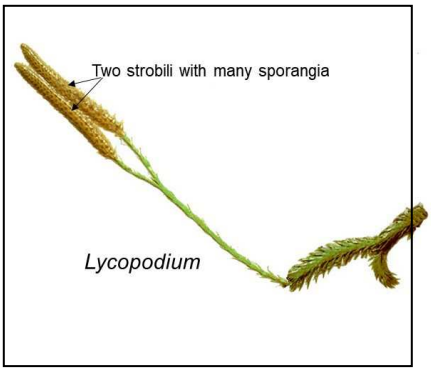
A. The Sporophyte Generation of *Psilotum*

PROCEDURE- Observation

1. Examine the potted plant of *Psilotum*, notice the dichotomous branching.

2. Under the dissecting scope, look for sporangia on the upper portions of stems.

PHYLUM LYCOPHYTA- CLUB MOSSES



During the Carboniferous period (~300 million years ago) some lycopods grew quite tall (40 m) (as tall as a 10 storey building) and formed the early forest canopy. These large species are now all extinct. Living species today are small inconspicuous plants that are usually found in moist habitats. Two members of the Lycophyta, *Lycopodium* and *Selaginella,* are found in Oregon.

The Lycophyta have true roots (roots lack nodes and internodes that are seen in stems). They have small simple leaves and long underground stems that produce true roots as well as new aerial stems (a form of asexual reproduction).

A. The Sporophyte Generation Of Club Mosses

1. Examine the material in lab of *Selaginella* and/or *Lycopodium*. Notice the branching patterns and the small simple leaves.

2. Look for spore containing sacs, **sporangia**. Many sporangia found at the tips of stems form **strobili** (cones) or they may be dispersed along the stems. Use the dissecting scope to examine these.

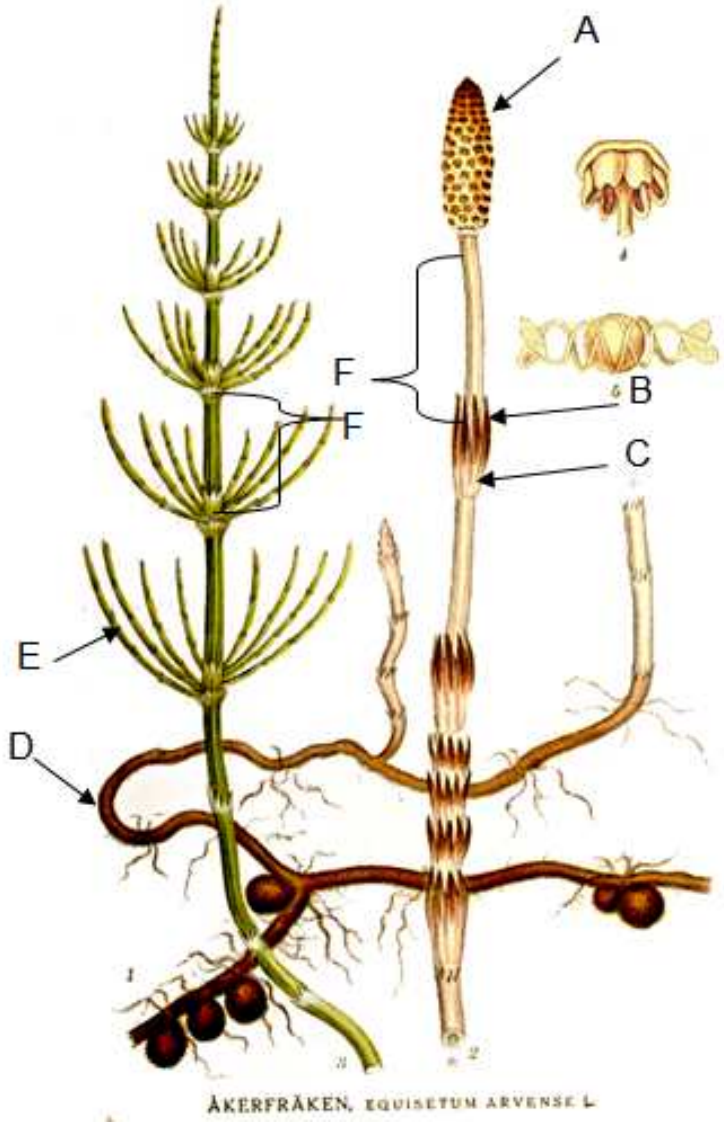
⇨ 3. Note on the *Lycopodium* and *Selaginella* (rhizomes, stem, strobilus (cone), simple leaves)

PHYLUM EQUISETOPHYTA - HORSETAILS

The Equisetophyta (horsetails) like the Lycophyta had tall growing species (~10 m), as tall as a 3 story building! in the Carboniferous period and were important components of the forest canopy. Today we have a single extant genus within the Equisetophyta, *Equisetum.* Some species grow up to 3 meters (10 feet). *Equisetum* grows widely in the Pacific NW.

Equisetum has ribbed stems, which, in some species are branched. Along the stems are <u>very</u> small leaves appressed to the stem. The sporangia are clustered in strobili (cones) at the tips of fertile stems (some species do not have separate fertile and vegetative stems). Roots develop from the underground stem. Unfortunately, we only have time to look at this Phylum superficially.

PROCEDURE- Observation and labeling
1. Examine the fresh specimens of *Equisetum* present in lab. Identify the aerial stems. Branches and leaves. Identify the cones bearing sporangia with spores. Feel the roughness of the shoot, which is due to silica in their cell walls. *Equisetum* is also known as scouring rush as it can be used for cleaning dishes.



⇨ 2. <u>Label the *Equisetum* figure above</u> with all the following (rhizomes, cone (strobilus), simple leaves, nodes, internodes, branches)

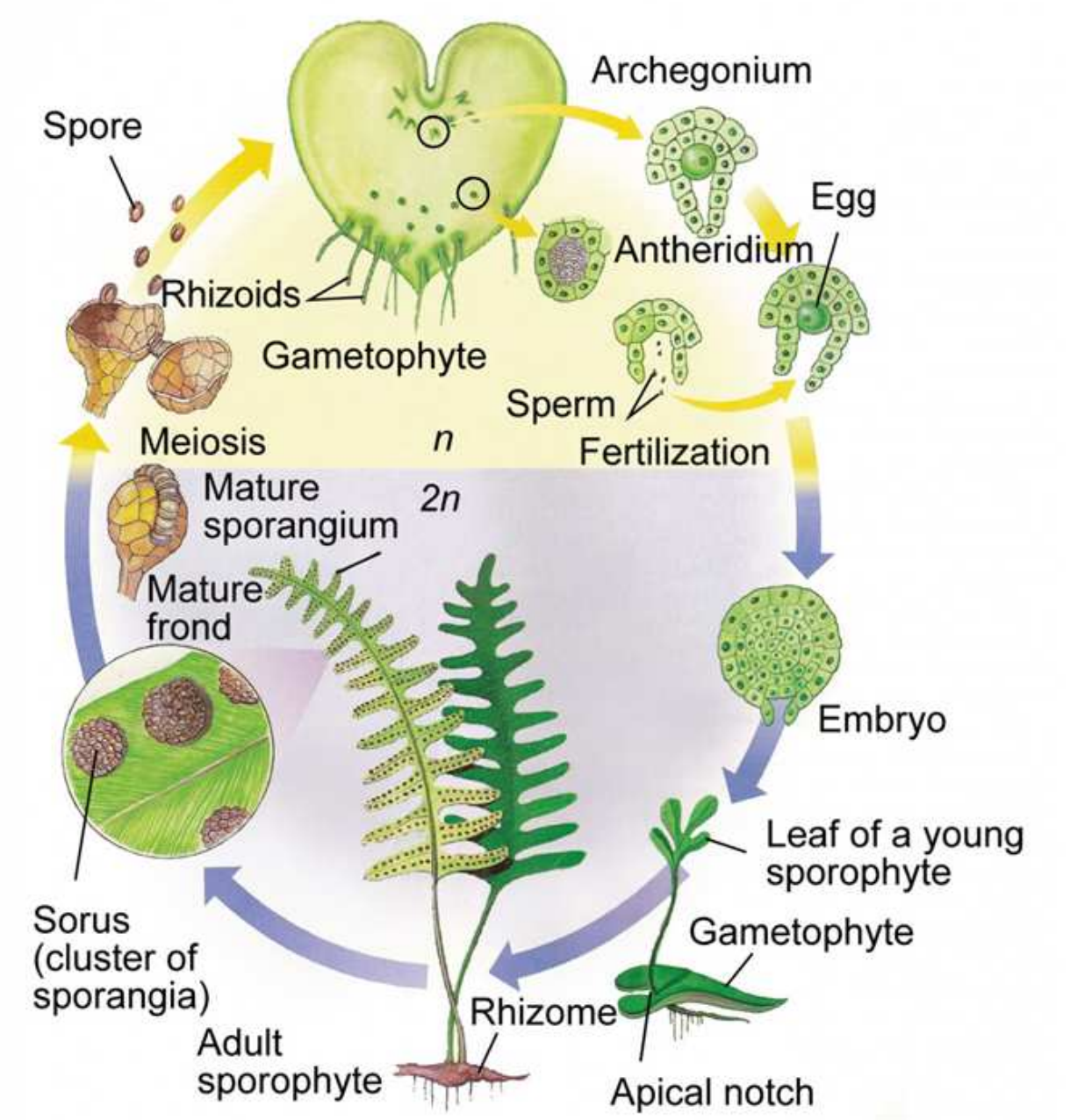
3. Make a wet-mount slide of the cross-section of a horsetail stem and stain with phloroglucinol. Note the epidermis, the big air spaces in the cortex, the ring of vascular bundles and the hollow pith.

Put your observation into your Plant Forms table.

PHYLUM POLYPODIOPHYTA - FERNS

Unlike most other non-seed vascular plants, the phylum Polypodiophyta (ferns) are much more common, with more than 12,000 living fern species worldwide. They occupy many habitats from desert to tropical rain forests, although they are most abundant in moist temperate habitats (like ours in the Pacific NW). We have in lab and outside several representative genera.

Although large tree ferns are found in tropical areas, most species of ferns are relatively small plants that have rhizomes (underground stems) and roots. However, unlike the other seedless vascular plants, ferns have rather large true leaves called **fronds** that can be quite elaborate. In many fern genera only the leaves are aerial, while stems grow underground (underground stems are called **rhizomes**). Sporangia (spore sacks) are formed on fertile leaves called **sporophylls** ("spore-barring leaves"). The location of sporangia on leaves however, is species variable within the Polypodiophyta.



The above figure illustrates alternation of generation in fern. Circle parts of cycle identified as you proceed through the lab.

A. The Sporophyte Generation Of Ferns

PROCEDURE-Observation and descriptions
1. Examine the mature sporophyte of the fern species available. Locate the stem. The stem usually grows horizontally. If the fern is epiphytic (growing on another plant) the stem often grows along the host branch. If the fern is terrestrial the stem will grow at or below the soil surface. What is this type of stem called?

⇨ _____

Examine the microscope slide Fern Combination [Fern "Wood"]. Compare and contrast the tissues with those seen in angiosperms. Put your observations in the Plant Forms Table.

2. Note the large leaves or fronds. On the undersurface of a fertile leaf locate small yellowish-brown spots called sori (sing. sorus) (not all fern species have reproductive structure in sori). Each sorus contains many **sporangia**. A leaf that holds reproductive structures is termed a **sporophyll** ("spore leaf"). Not all fronds are fertile. Some ferns have fertile fronds separate from vegetative fronds, some are fertile only during certain periods of their live cycle.

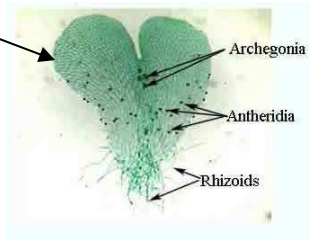
⇨ 3. Examine a sorus with a dissecting microscope. Covering the sori is a shield shaped **indusium**. Scrape the contents of a sorus into a drop of water on a slide and make a wet mount with a coverslip. Examine under the low power of the microscope.

4. Demo: examine the fern sporophylls under the dissection microscope. Note what happens to the sporangia as they dry. Describe your observation.

⇨

B. The Gametophyte Generation Of Ferns

Upon germination, the fern spore (1n) develops into a short filament of cells that differentiates into flattened structures called prothallia (sing. **prothallium**). The mature heart-shaped prothallium is the multicellular haploid gametophyte.



PROCEDURE- Drawing of fern gametophyte
1. With a dissecting microscope examine living fern gametophytes if available (otherwise examine a prepared slide). Locate rhizoids on the ventral surface. Rhizoids are root-hair-like projections that help take up water.

2. Identify among the rhizoids of a mature gametophyte the numerous globe-shaped **antheridia** (containing many sperm). Locate vase-shaped **archegonia** (each containing a single egg) just below the apical notch. Only the neck of the archegonium is visible (most of the archegonium is embedded within the gametophytic tissue).

⇨ 3. Draw and label rhizoids, the prothallium, archegonium and antheridia. Examine the archegonium and antheridia under higher magnification to highlight details. Try to identify egg in the archegonia, and sperm in the antheridia.

Questions: Remember to put morphological and anatomical differences of the groups of plants we have examined into your Plant Form Table.

1. Is the fern prothallium haploid or diploid?

2. Is the fern prothallium sporophyte or gametophyte?

3. Does each of the four phyla of non-seed vascular plants illustrate alternation of generations? What forms the basis of your answer?

4. What is the major difference between the alteration of generations of seed plants and non-seed vascular plants?

5. Once dispersed, do the spores found in these four plant phyla produce gametophytes or sporophytes?

6. How do spores differ from seeds?

7. What is the difference between a rhizome and a rhizoid?