SESSION OBJECTIVES

Students will be able to...

… site identify any of the pteridophyte groups
… describe the fern life cycle, indicating meiosis and fertilization
… understand the similarities and differences between club-mosses and ferns
… explain how pteridophytes are different from all other land plants

PTERIDOPHYTES, are a paraphyletic collection of spore-bearing, vascular plants

• “Vascular” means that they possess water-conducting cells called xylem, and sugar-conducting cells called phloem, in their roots, stems, leaves, and sporangia
• They are spore-bearing plants with sporangia on leaves or stems
• Pteridophytes are the oldest vascular plants on Earth
  o Sporophyte stage (2n): pteridophytes have dominant sporophyte stage
    • Sporophyte is multicellular and free-living, with roots, stems, and leaves
  o Gametophyte stage (1n): Gametophyte is also free-living, but much smaller than sporophyte
    • Archegonium with an egg, and antheridia with sperm, are created on the gametophyte
    • Fertilization is facilitated by water, allowing sperm to swim to eggs

**The above features pertain to all pteridophytes; below are specifics for each pteridophyte group**

TRACHEOPHYTES, are the monophyletic clade of vascular plants

• Defining feature is true vascular tissue (i.e. xylem and phloem)
  o Xylem has cell walls thickened with lignin
  o All vascular plants, by definition, are tracheophytes
• Evidence of the oldest vascular plants comes from over 425 million years ago
• Origin of vascular tissue allowed plants to grow taller, and more inland
• There are two monophyletic groups of tracheophytes
  1. **Euphyllophytes** (page 2): Ferns, Horsetails, and Seed plants
  2. **Lycopods** (page 4): Ground pines, Spike-mosses, and Quillworts

“-phyte”=plant; “-phyll”=leaf; “eu-“=true; “pro-“=early; “mega“=large; “micro“=small; “sporo“=sporangium
Branching Patterns: the division of an apical cell(s) during growth
- Pteridophytes have an apical cell that bifurcates to create various dichotomous branching patterns
- When the apical cell bifurcates, the resultant stems can vary in size and angle creating different forms
  - Isotomous: new branches are equal in size and angle (e.g. *Psilotum*)
  - Anisomotous: new branches are unequal in angle, and sometimes size (e.g. *Selaginella*)
  - Pseudomonopodial: a type of anisotomous branching in which one larger axis continues a main upright axis, and the other is smaller and greatly deflected (e.g. *Equisetum*)

Terminology
- Microphylls: small leaves with one unbranched vein; found only in the lycopods (see below)
- Megaphylls: larger "true" leaves with multiple branching veins; found in the euphyllophytes (see below)
- Homosporous: all spores are the same size and shape
- Heterosporous: plant produce two types of spores, in separate sporangia
  - Large spores, called megaspores, are created in megasporangia and germinate into female gametophytes
  - Small spores, called microspores, are created in microsporangia and germinate into male gametophytes
- Sporophyll: specialized leaf that bears and protects sporangia
  - A megasporophyll is a specialized leaf that protects a megasporangium

Euphyllophytes are a monophyletic grouping of plants with true leaves, which are called megaphylls.
- Defining feature is megaphylls: leaves that have branching veins of xylem and phloem
- These plants also have upright, three-dimensional branching of stems.
- Evidence of the oldest euphyllophytes comes from 410 mya (Devonian Period)
- Origin of large leaves allowed plants to absorb more light and carbon dioxide
- There are two monophyletic groups of euphyllophytes
  1. Monilophytes (page 3): Ferns (*sensu lato*) and Horsetails
  2. Spermatophytes (next week): Seed plants (next week)

*sensu lato* (s.l.) means “in the loose sense” or a general definition of this group;
*sensu stricto* (s.s.) means “in the strict sense” or a specific definition of this group
**MONILOPHYTES** are a *monophyletic* clade of spore-bearing plants with true leaves
- This group is defined by a *siphonostele* vascular arrangement in stems
- There are five monophyletic groups of monilophytes that we will cover
  1. **True Ferns** s.s.: Subclass Polypodiidae
  2. **Horsetails**: Order Equisetales
  3. **Whisk ferns †**: Order Psilotales
  4. **Marattioid ferns †**: Order Marattiales (not covered)
  5. **Ophioglossoid ferns †**: Order Ophioglossales (not covered)

**True Ferns** in the subclass *Polypodiidae*, are the most commonly recognized pteridophytes
- Comprise over 80% of living ferns e.g. *Osmunda, Polytrichum, Polypodium*
- Ferns are diversifying and dominate the understory in many areas
- Most successful spore-bearing plants; diverse habit with herbs, “trees” and vines
- Usually rhizomatous; tree ferns have an upright rhizome
- Large compound leaves, called fronds or megaphylls
  - Leaves develop as fiddlehead, and then uncurl
- Sporangia are born on bottom (=abaxial) of leaves
  - Sporangia are clustered, called a *sorus* (plural=sori)
- Each sporangium has thickened cells, called an *annulus*, which aids in spore dispersal

**Horsetails**, in the order *Equisetales*, are bamboo-like pteridophytes
- Temperate and tropical forms, 1 genus (*Equisetum*), 15 species
- Live in wetland environments: rivers, ponds/lakes, bogs
- Bamboo-like stems, distinct nodes and internodes
  - Whorled, photosynthetic stems/branches
- Leaves black and non-functional, but whorled
- Sporangia in cones at apex of plant
  - Each sporangium is on a curved stalk, arranged in a whorled pattern inside cone
  - Spores have wings, called elaters, that respond to humidity
- Plants absorb silica and other macromolecules from soil, and use in support tissues

**Whisk ferns**: Order *Psilotales*, are leafless/rootless pteridophytes
- Tropical only, 2 genera (*Psilotum, Tmesipteris*), 14 species
- Herbaceous plants with isomorphous branching
- No leaves; possess leaf-like scales
- No roots; possess rhizoids for anchorage
- Simple, large sporangia along stems

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LYCOPODS, phylum Lycopsidophyta, are a monophyletic grouping of small-leaved, ancient pteridophytes

- Lycopods are defined by having microphylls: small leaves with one unbranched vein
- There are three monophyletic groups of clubmosses
  1. **Ground pines**: Order Lycopodiales
  2. **Spike-mosses**: Order Selaginellales
  3. **Quillworts**: Order Isoetales (not covered)
- Evidence of the oldest lycopods comes from over 415 million years ago
- Lycophytes were the dominant vegetation on Earth of 100 million years
- They are the main source of coal on the Earth
- Lycopods have small leaves with a single vein called microphylls
- Sporangia are born on top (=adaxial) of special leaves called sporophylls
- Sometimes called “club-mosses”, because their leaves make them appear moss-like, and their cones are club-like in appearance

**Ground pines**, in the order Lycopodiales, are the most ancestral vascular plants

- 13 living genera, 500 species: *e.g.* Lycopodium, Huperzia
- Isotomous and anisotomous branching in stems
- Spirally-arranged microphylls
- Sporophylls sometimes form a cone-like structures
  - Ground pines are homosporous
- Adventitious roots from a rhizome
- Gametophytes are small, free-living, and photosynthetic
- Stems used for Xmas wreaths; spores used for flash powder

**Spike-mosses** in the order Selaginellales, appear fern-like from a distance

- 1 living genus (*Selaginella*), 700 species:
- Herbaceous plants with anisotomous branching
- Also possess microphylls, but more planated, to appear frond-like
- Adventitious roots, called rhizophores, appear from leafless stems
- Sporophylls create a cone-like structure
  - *Selaginella* is heterosporous
- Gametophytes are small and remain inside spores (seed-like)
  - Male gametophyte releases sperm from inside microspore
  - Sperm swim to and fertilize egg on female gametophyte inside megaspore
- Several species are used in horticulture cultivation, such as terrariums
- A few species exist in deserts, and are known as resurrection ferns, since they curl up during drought, and open when the rain returns
SESSION TAXONOMY

**Archaeplastida** - contains red & green algae and plants
- **Streptophytes** - Land plants and Charophyte green algae
- **Embryophytes** - Land Plants

**Tracheophytes**: Vascular plants
- **Lycopsids**: Ground pines, Spike-mosses, Quillworts
  - **Lycopodiales**: Ground pines
  - **Selaginellales**: Spike-mosses
- **Euphyllophytes**: “Ferns, Horsetails, Seed plants
  - **Monilophytes**: True Ferns, Horsetails, Eusporangiate Ferns
    - **Polypodiidae**: True ferns
    - **Equisetales**: Horsetails
    - **Psilotales**: Whisk ferns

LABORATORY DRAWINGS
- Fern sorus (slide): **sporangia, annulus, spores, indusium, pinna/leaflet**
- Fern gametophyte (slide): **gametophyte, archegonia, antheridia, rhizoids**
- Horsetail, *Equisetum* (living): **node, internode, leaves, cones, note pseudomonopodial branching**
- Whisk fern, *Psilotum* (living): **stems, enations, sporangium, note isotomous branching**
- Spike-moss, *Selaginella* (living): **microphylls, stems, cone, sporophylls, sporangium, megaspores or microspores, note anisotomous branching**

QUESTIONS FOR THOUGHT:
- Where does meiosis occur on a true fern or spike-moss?
- Where does fertilization occur on a true fern or spike-moss?
- What is a "pteridophyte" and why is this a useful educational term?
- How is the life cycle of a pteridophyte different from a bryophyte?
- What does the gametophyte of a true fern look like?
- What does the sporophyte horsetail look like?
- What aspects of the morphology of *Psilotum* are considered ancestral?
- What is a synapomorphy for the lycophytes?