Domain Eukarya
Kingdom Plantae

DIVISION PTEROPHYTA

ferns and allied divisions

As you look at the materials of the pterophytes, keep in mind the comparison of ferns with *Marchantia* in terms of alternation of generations and the various structures. Ferns have both xylem and phloem, the transport tissues for water and nutrients that are characteristic of all upstanding land plants. The gametophyte generation is small but still depends on water for gamete fertilization. Ferns are tough colonists of disturbed environments.

Other divisions of primitive vascular plants include:

- Division Sphenophyta (horsetails): preserved *Equisetum*.
- Division Lycophyta (club mosses): preserved *Lycopodium* and *Selaginella*
- Division Psilophyta (whisk ferns): preserved *Psilotum* and slide.

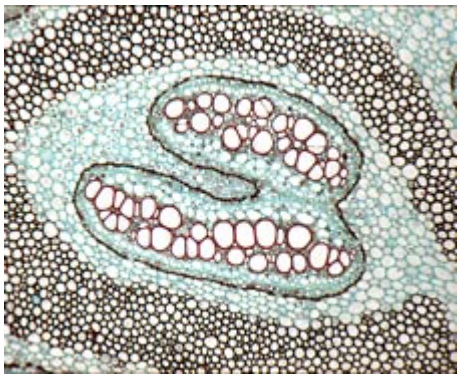
Alternation of generations (sporophyte/gametophyte)

Sporophyte. The diploid sporophyte (2n) is the plant that you call a fern. There are several live examples in pots in the room. One of them has many runners, each of which would root in moist soil; this is a means of asexual reproduction.

The sporophyte consists of a root and a shoot with upright leaves called **fronds**. Some ferns have a **rhizome**, a horizontal stem from which the true roots extend. Most ferns are much taller than either liverworts or mosses because fern plants are sporophtyes, which have **vascular tissue**; mosses and liverworts are gemetophytes, which lack vascular tissue. Vascular tissue consists of

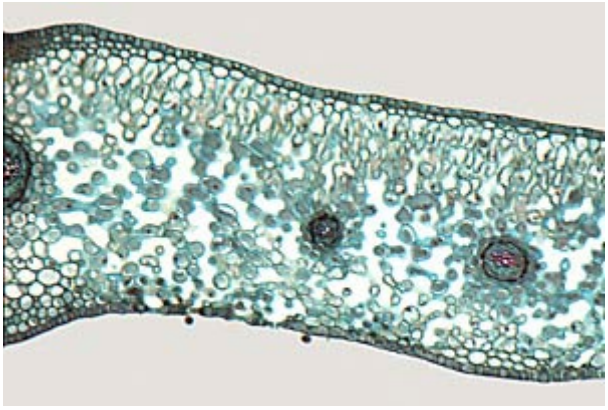
two kinds of cells. **Xylem** vessels transport water up from the roots; **phloem** sieve-tube members transport nutrients made in the leaves to other parts of the plant.

Slide: *Pteris* rhizome x.s. Several oval **vascular bundles** encircle a central pair. Large, thick-walled cells in the center of each bundle are **xylem** tubes; they are probably stained pink. Surrounding them are small, thin-walled **phloem** cells, also tubular; they are probably stained green. Outside the bundles are zones of brown cells called **sclerenchyma**, a strengthening tissue.

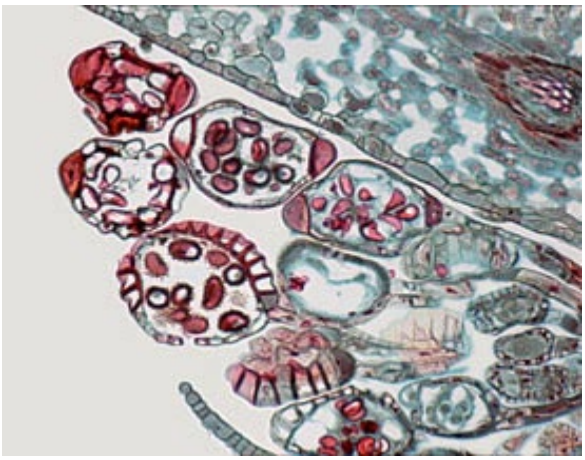


The mature sporophyte forms **sporangia**, and within them **meiosis** occurs to produce haploid **spores** (n). The sporangia are grouped together in clusters called **sori** (sorus, singular) on the undersides of the leaves. They look like rusty brown rosettes.

Look at the cross section of the leaf itself. The top and bottom are defined by cellular layers called **upper** and **lower epidermis**. The inside of the leaf is called **mesophyll**; it is divided into two parts, closely packed tall cells above that maximize light collection for photosynthesis--**palisade mesophyll**--and a meshwork of cells with open spaces below for gas exchange--**spongy mesophyll**. Openings into the air spaces are through stomata in the lower epidermis. Recall that the pores and air spaces in *Marchantia* were at the top, because that plant lies on the ground.

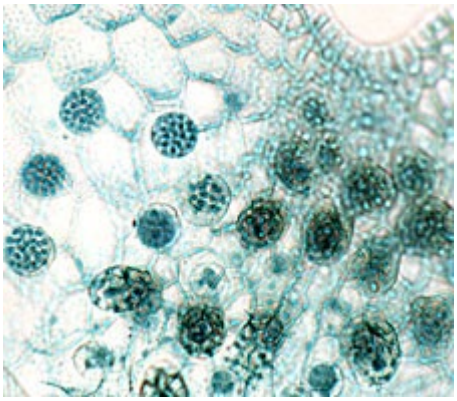


Slide: *Cyrtomium falcatum*: sorus on leaf, median l.s. You can see that each sorus has a central axis to which the sporangia are attached; in this example there is a common covering underneath the sporangia, and it is called an **indusium**. Each sporangium is encircled by a thick-walled ring of cells called the **annulus**. The annulus is hygroscopic (readily absorbs and retains water); as the annulus dries out, tension develops until the structure bursts open and the spores are flung out as if by a catapult. This aids in dispersal of the tiny haploid spores so ferns can take over the world.

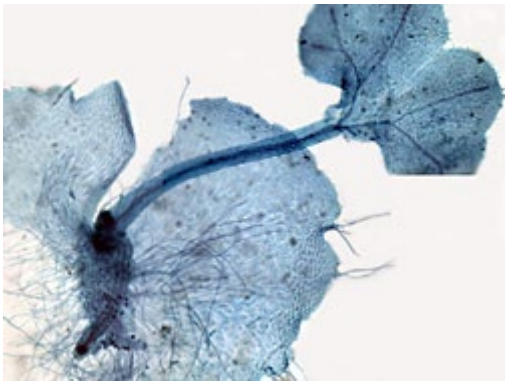


Gametophyte: The haploid spores germinate into a haploid **prothallus** (n), the **gametophyte**. It is a small, heart shaped plant which is photosynthetic. There are preserved examples; living specimens are on the soil in the terrarium.

Slide: Fern prothalium, male & female. **Rhizoids** extend from the underside into the soil. Antheridia are scattered toward the edge of the underside; these appear as multi-celled spheres and produce flagellated sperm. When it rains, sperm swim to the eggs in **archegonia** that are located near the cleft of the heart shape. Each archegonium contains one egg.



Slide: Fern prothalium, young sporophyte. When fertilization takes place, a diploid zygote (2n) forms. The zygote germinates and divides by **mitosis** to produce a new sporophyte plant. The young sporophyte consists of a primary root pointing down and a primary leaf pointing up. The bifurcating vascular bundle, a characteristic of sporophytes, is visible in the leaf. The sporophyte grows on the site of the archegonium as in *Marchantia*, but it is an independent plant, because it forms roots and photosynthetic green leaves.



Ferns are plants with independent haploid gametophyte and diploid sporophyte stages. Suppose that a fern sporophyte is heterozygous for a lethal recessive allele which prevents synthesis of chlorophyll.

A. What percent of the gametophytes of the next stage in the life cycle will die?
B. What percent of the next sporophyte generation will still carry the lethal recessive allele?

Last updated 22 September 2007 (JHW)