FILICOPHYTA LECTURE HELPER

Comparative Biology of Plants 50-222

Bloomsburg University of PA

- (= Pterophyta, Pteridophyta)
- ca. 10,000 spp.
- no strobili
- most are homosporous
- megaphylls
- stem steles: ectophloic siphonostele, amphiphloic siphonostele, or dictyostele

EUSPORANGIATE CLASSES

Ophioglossopsida

- homosporous
- gametophytes subterranean, fleshy, cylindrical, associated with endophytic fungus
- *Ophioglossum*, *Botrychium*

Marattiopsida

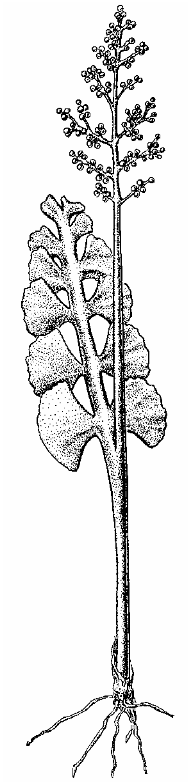
- homosporous
- gametophytes, epiterranean, photosynthetic *and* associated with endophytic fungus
- *Angiopteris, Marattia* (tropical, subtropical tree ferns)
- ancient tree ferns were prevalent in Late Carboniferous through the Triassic

LEPTOSPORANGIATE CLASS

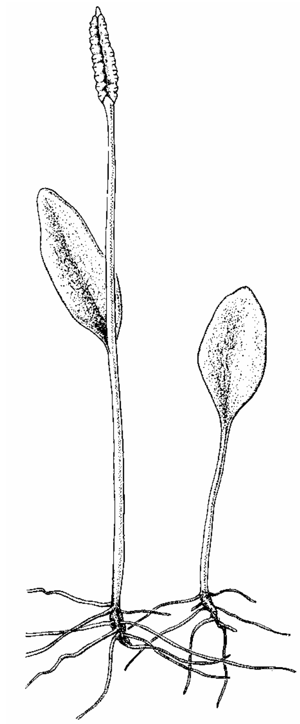
Filicopsida

- homosporous and heterosporous orders
- gametophytes epiterranean, photosynthetic, not associated with fungi
- three orders:
    - Filicales – homosporous - many examples, *Adiantum*, *Polypodium*
    - Marsiliales – heterosporous – *Marsilea*, *Pilularia*
    - Salviniales – heterosporous – *Azolla*, *Salvinia*

Botrychium

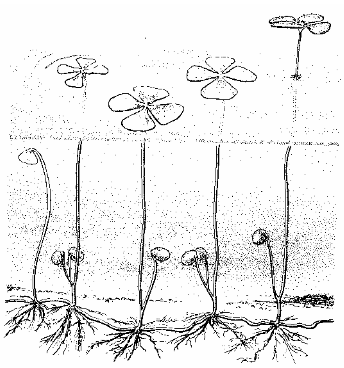


Ophioglossum

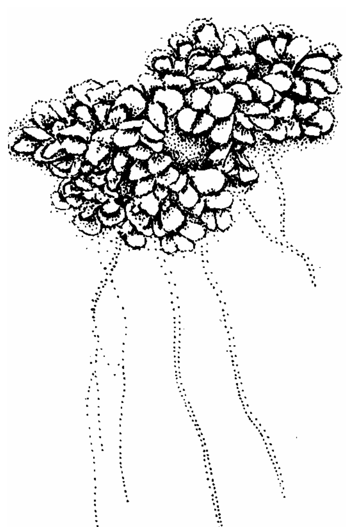


Angiopteris

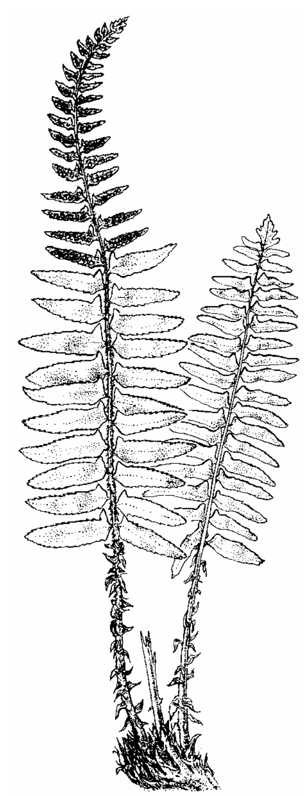
Marsilea



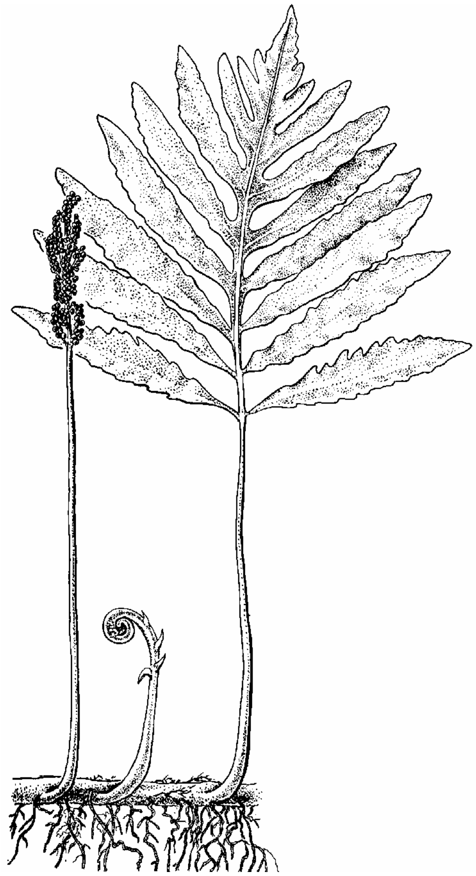
Azolla



Polystichum



BASIC SPOROPHYTE BODY PLAN



Aerial Stem – Marattiopsida only

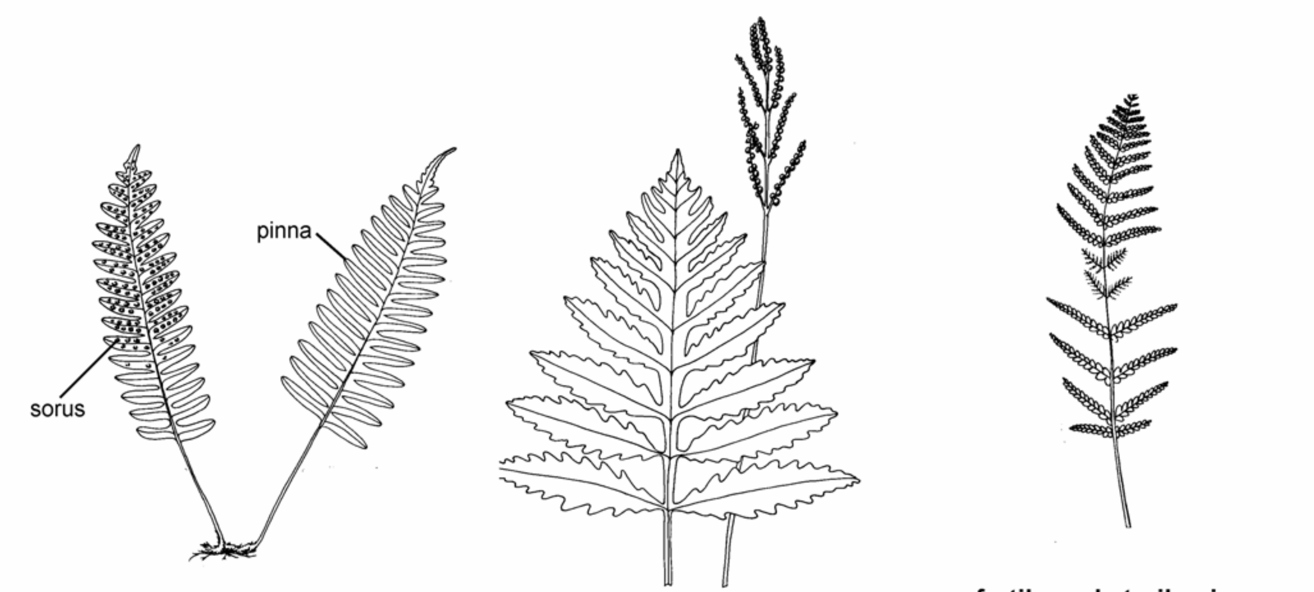
Rhizome with adventitious roots – all taxa

Leaves – called fronds

- conspicuous
- photosynthetic, at least initially
- emerge with circinate vernation (called a “fiddle-head”)

Sporangia

- borne on frond (technically sporophylls)
- in clumps called sori (pl. sorus)



fertile and sterile fronds similar **fertile and sterile fronds different** **fertile and sterile pinnae different, on the same frond**

FILICOPSIDA

- leptosporangiate (usually a definite number of spores/sporangium; 48 – 64 (-512))
- ca. 300 genera and 9,000 species

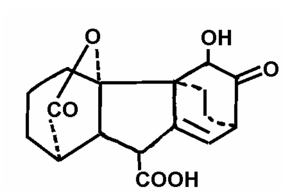
FOCUS ON FILICALES

- most of our familiar ferns
- homosporous
- exosporic gametophyte development

- spore germination
  - influenced by light quality – red/far-red - phytochrome
  - influenced by chemicals – e.g. thelypterin – ALLELOPATHY

- gametophytes
  - monœcious
  - potentially bisexual
  - gametangia on ventral surface, need liquid water for antheridial dehiscence, releasing multiflagellate sperm
  - all male or protandrous (antheridia first, then archegonia)

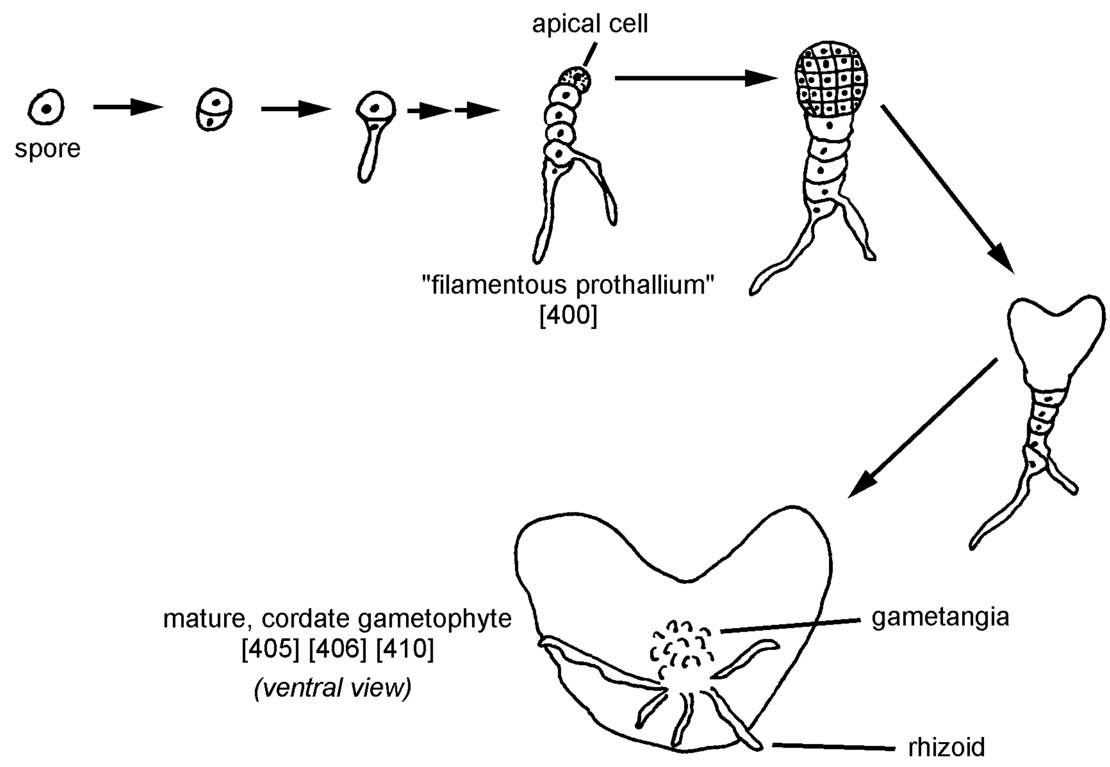
- sexual development of gametophytes related to chemical messengers released into the environment called ANTHERIDIOGENS (related to gibberellic acids 4 and 7)



antheridiogen

  - cordate gametophytes produce and release
  - stimulate younger (pre-cordate) gametophytes to produce antheridia
  - as gametophytes become cordate, they become insensitive to antheridiogen, then they form archegonia and secrete antheridiogen themselves

Common developmental pattern:

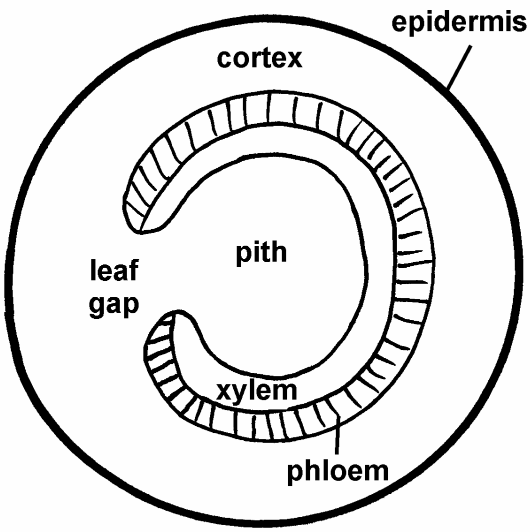


SPOROPHYTE of Filicales

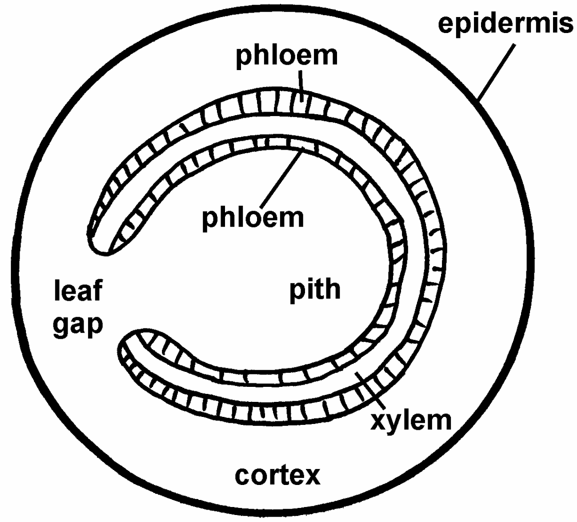
Stem

- tissues are primary, even extinct and extant tree ferns; high development of sclerenchyma
- xylem development is exrach or mesarch
- a few have vessels
- stele types
    - protostele in a few primitive taxa
    - siphonosteles
        - ectophloic, e.g. *Osmunda*
        - amphiphloic (solenostele), e.g. *Dennstaedtia*
    - dictyostele, e.g. *Pteridium* and *Polypodium*

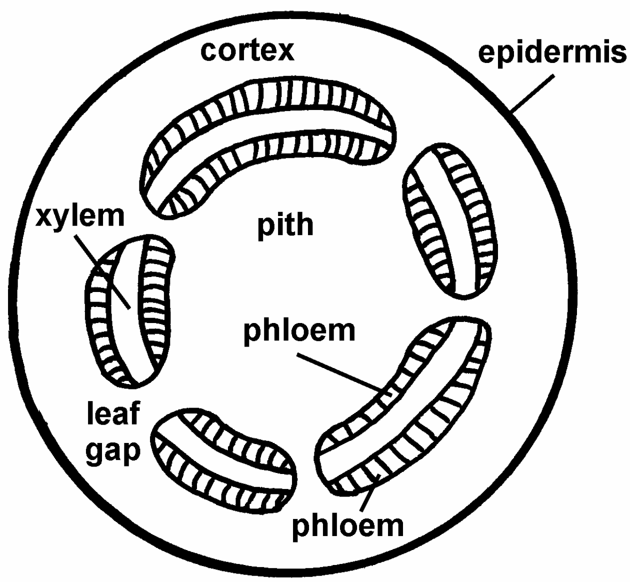
ECTOPHLOIC SIPHONOSTELE



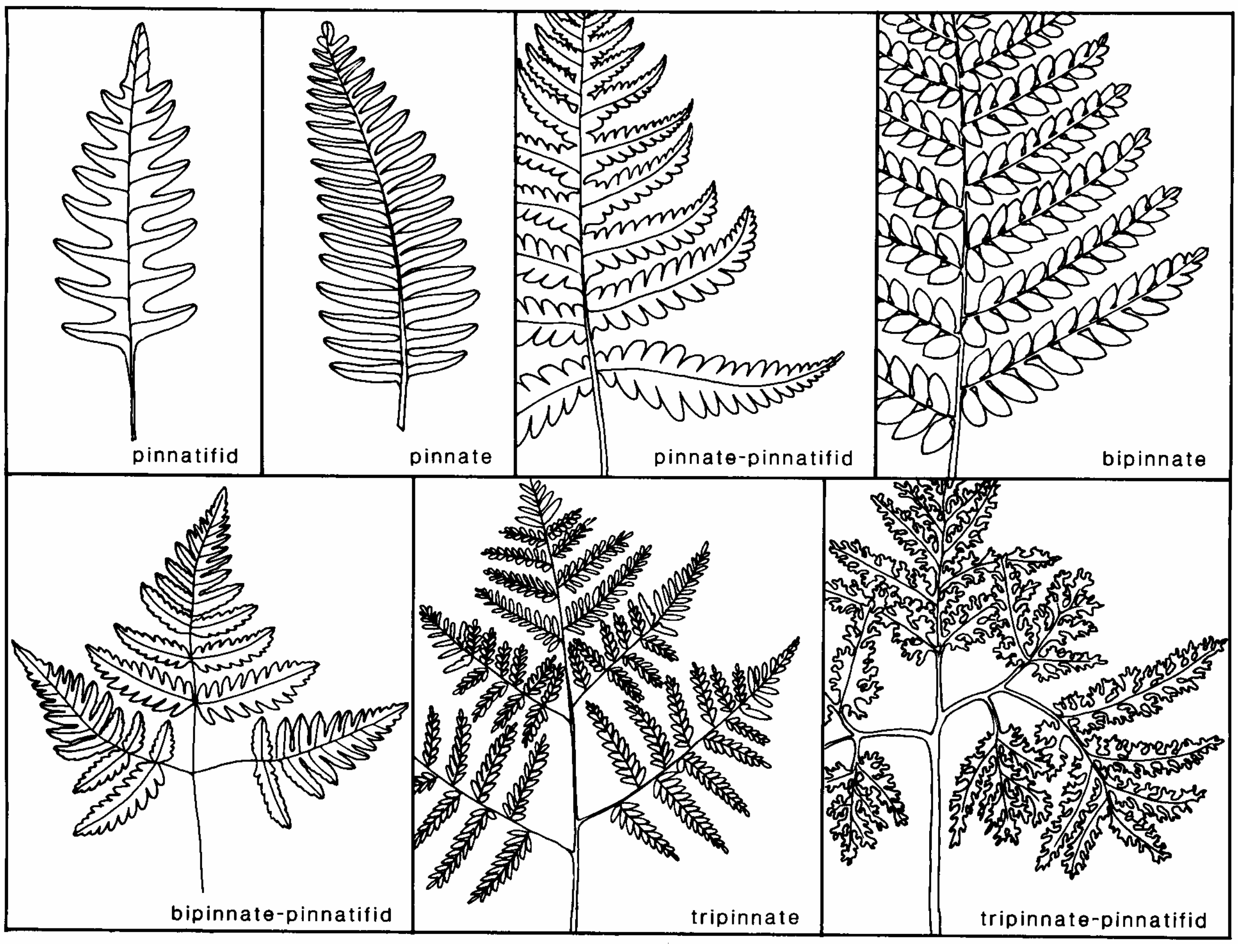
AMPHIPHLOIC SIPHONSTELE (SOLENOSTELE)



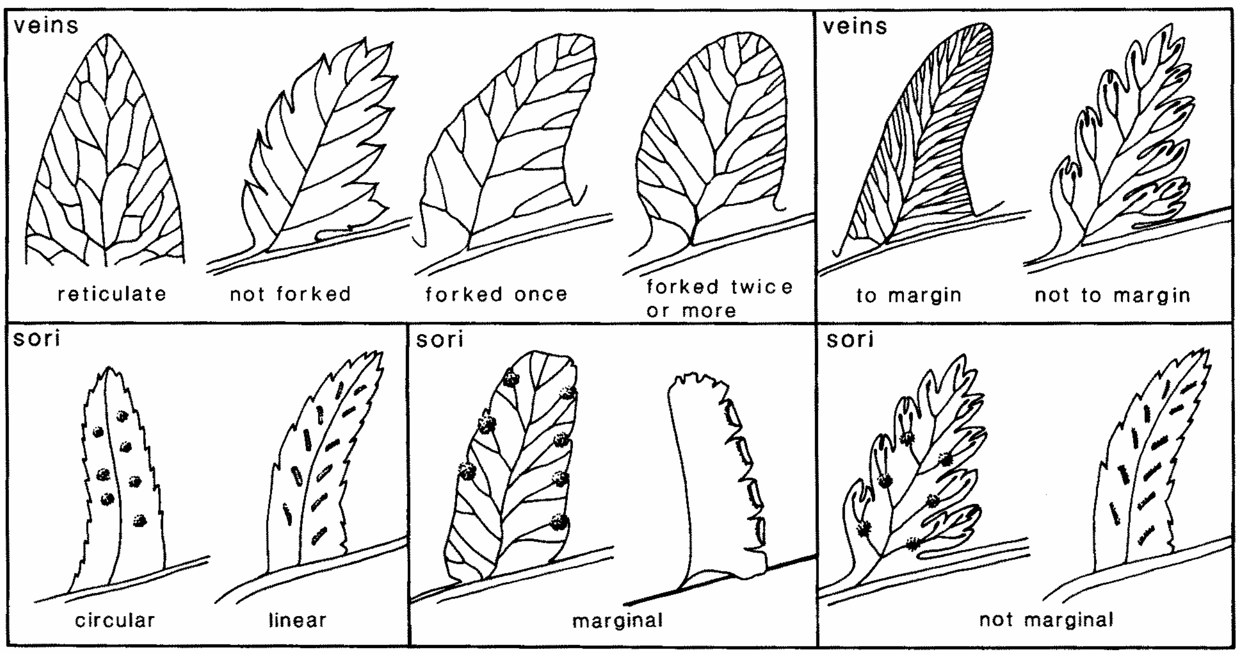
DICTYOSTELE



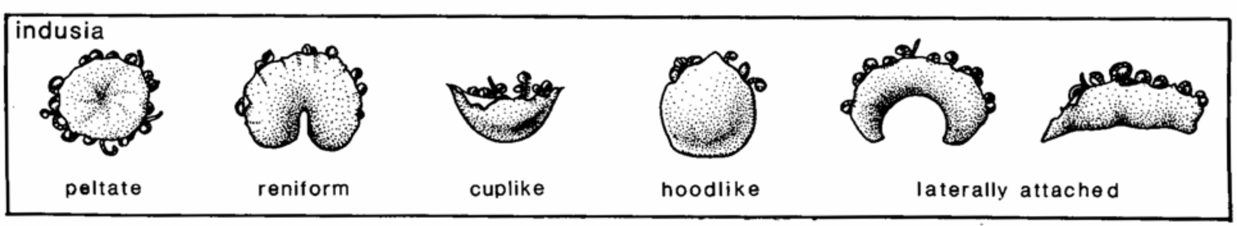
Frond Dissection

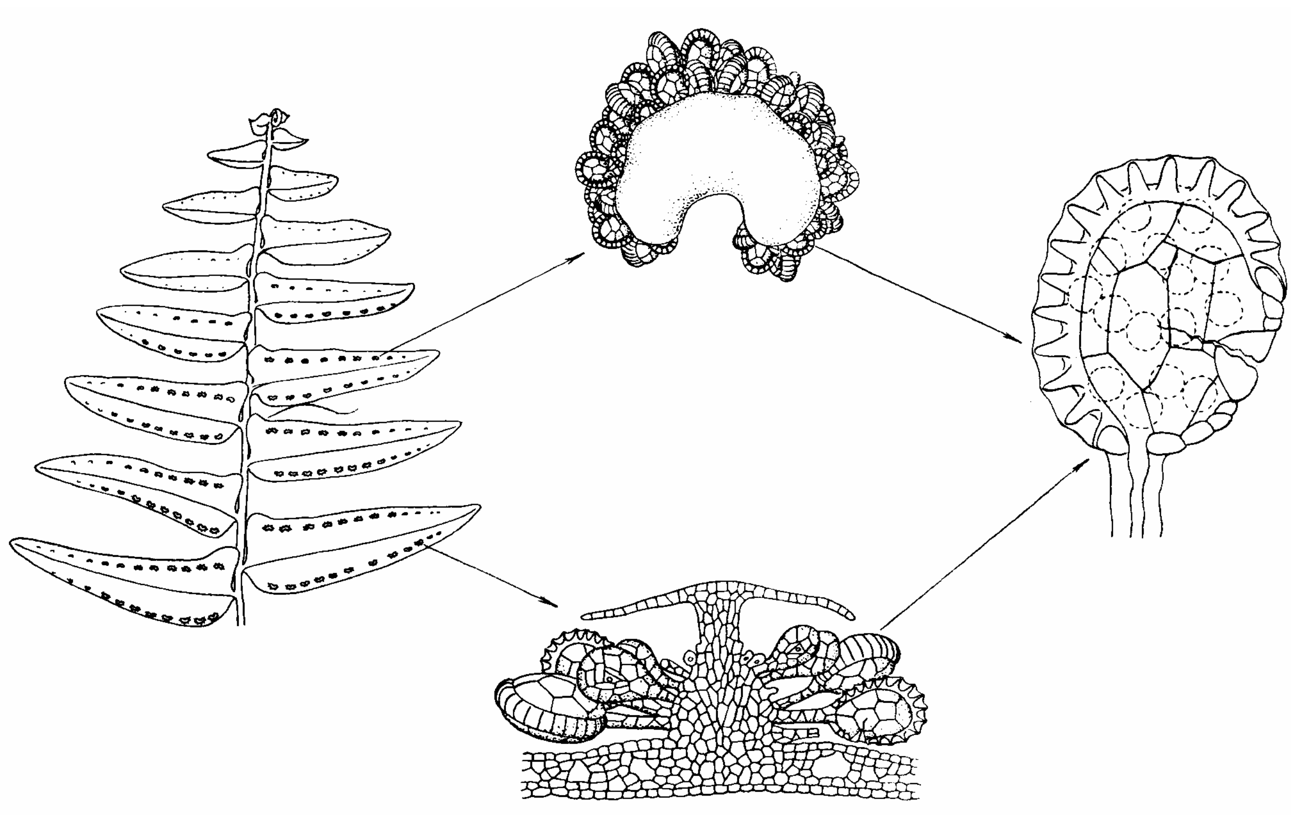


Leaf Venation and Position of Sori



Sori, Sporangia and Indusia





APOGAMY and APOSPORY

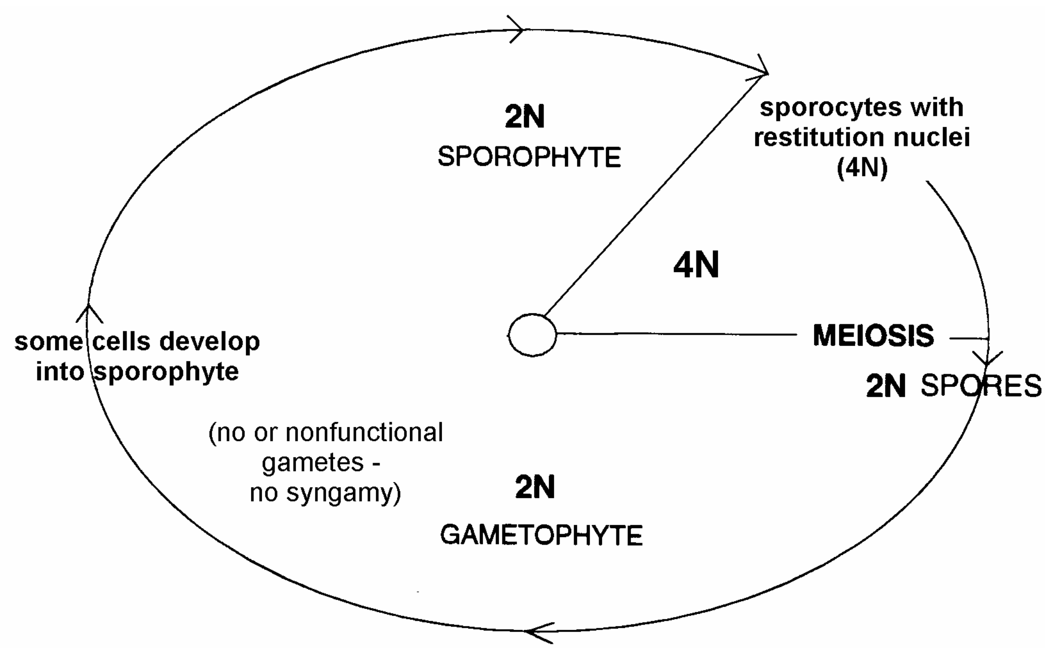
Apospory ≡ formation of a 2N gametophyte from a vegetative cell or cells of a sporophyte (mostly an in vitro phenomenon)

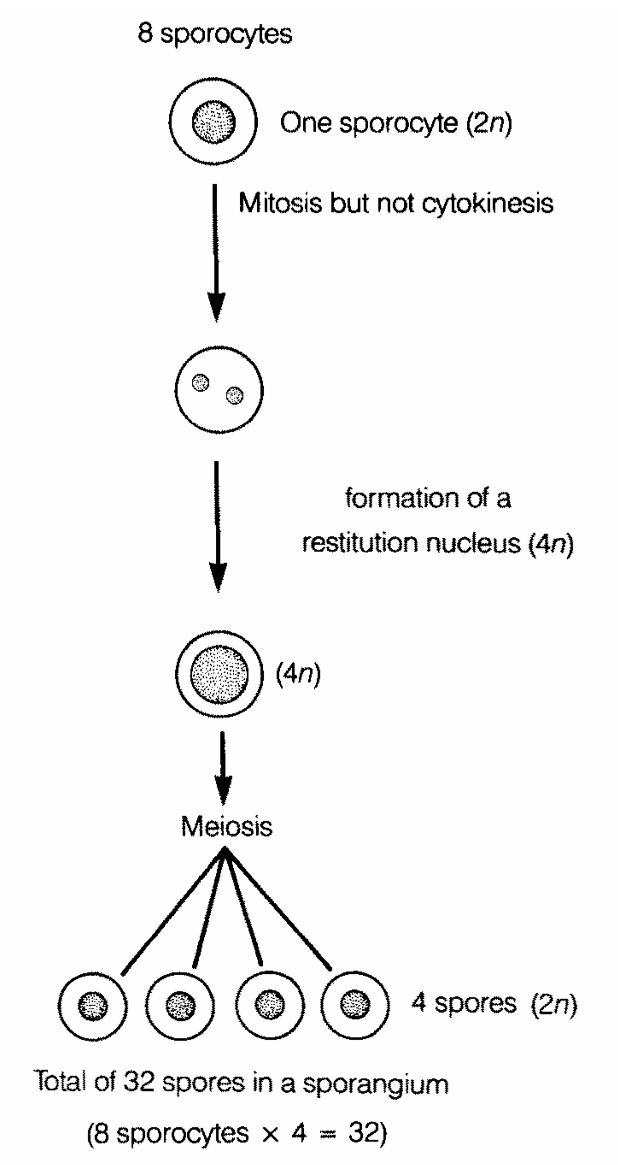
E.g. *Adiantum pedatum* – Morel showed that juvenile leaves of young sporophytes will proliferate into gametophytes in culture.

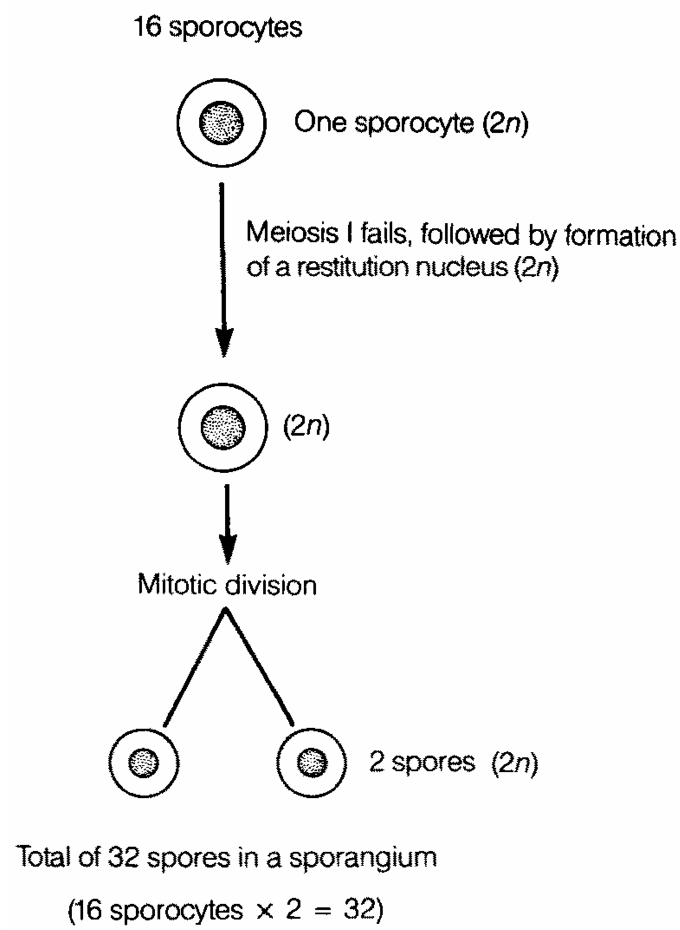
Morel, G. 1963. Leaf regeneration in *Adiantum pedatum*. Journal of the Linnean Society of London, Botany 58:381-383.

Apogamy ≡ development of a sporophyte from somatic tissue of a gametophyte (just behind the apical notch).

- Antheridia and archegonia may be present, but nonfunctional.
- Gametophyte and derived sporophyte have same chromosome number.
- Sensitive to nutritient levels (sugars) in the environment, and to growth regulators such as GA and ethylene.
- In obligate apogamy, sporangial development is altered – need a compensating mechanism.




8 sporocytes
One sporocyte (2n)
Mitosis but not cytokinesis
formation of a
restitution nucleus (4n)
(4n)
Meiosis
4 spores (2n)
Total of 32 spores in a sporangium
(8 sporocytes × 4 = 32)


16 sporocytes
One sporocyte (2n)
Meiosis I fails, followed by formation
of a restitution nucleus (2n)
(2n)
Mitotic division
2 spores (2n)
Total of 32 spores in a sporangium
(16 sporocytes × 2 = 32)

Ferns have high chromosome numbers. Are they polyploid?

Soltis, D.E., and P.S. Soltis. 1987. Polyploidy and breeding systems in homosporous Pteridophyta: a reevaluation. *American Naturalist* 130:219-232.

- homosporous ferns have th highest chromosome numbers known for any organism
  - typical, average fern - - 2N ≈ 100
  - highest fern - - 2N = 1260
  - typical, average flowering plant - - 2N ≈ 32

- it was assumed for a long time that ferns were polypoid, and that the large number of chromosomes reflected chromosomal doubling in the evolutionary history of ferns
- Analyses of genes coding for isozymes indicate that of the 652 loci surveyed for over 30 homosporous ferns, only 6 could have arisen through polyploidy. (Side note, primitive magnoliophytes with high chromosome numbers are of ancient polyploid numbers).
- Explanation? One explanation is chromosomal fission.

Are homosporous ferns, with monœcious and potentially bisexual gametophytes intragametophytic selfers?

Soltis, D.E., and P.S. Soltis. 1992. The distribution of selfing rates in homosporous ferns. *American Journal of Botany* 79:97-100.

16 species had intragametophytic selfing rates 0 – 0.2

2 species had intragametophytic selfing rates 0.21 – 0.4

2 species had intragametophytic selfing rates 0.81 – 1.0 (*Botrychium* spp.)

- Inbreeders had much genetic structure (partitioned population)
  - Dry, patchy environments favor inbreeding.