All About Ferns: A Resource Guide

Compiled by Audrey Bowe

What Makes a Fern a Fern?

Ferns can come in all shapes and sizes, from the towering tree ferns of Australia to the delicate cliff ferns of North America. There are, however, a number of general traits you can look for to determine if a plant is a fern.

Fiddleheads

First, there's the distinct way in which many fronds, or fern leaves, unfurl. Young fronds, called fiddleheads because of their striking resemblance to the head of a violin, start out tightly curled at the base of the root. They then slowly unroll themselves much like a scroll unrolls as they grow. This special way of growing is a response to light. The cells in the fiddlehead that are exposed to light will get bigger and grow, causing the frond to lengthen and unfurl.

Spores

Another way to tell if a plant is a fern is to look at its reproductive structures. If it has a flower, fruit, or seed- it's not a fern! All ferns, and many fern relatives, reproduce using spores, or tiny living single cells. Typically, reproductive fronds will produce sori, or spore dots on the undersides of their leaflets. Within these sori, hundreds of thousands of spores are developed in little packets known as sporangia, and released when mature.

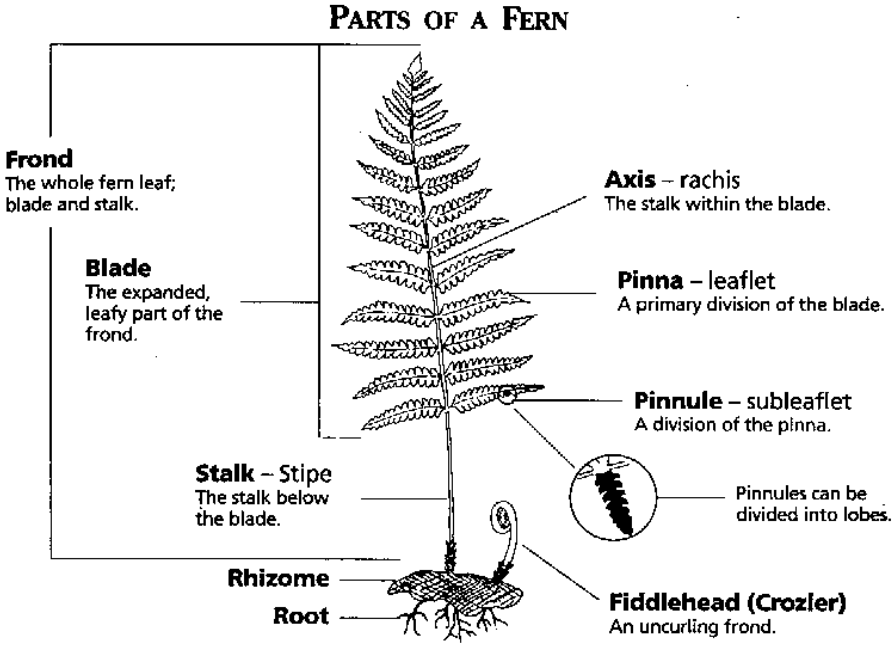
The shape of these sori varies a great deal between species. Many species have circular or kidney-shaped spore dots, such as the Marginal Woodfern (pictured below middle), however some have more interesting shapes. In the Purple-stemmed Cliffbrake (below left), the edges of the fern's leaflets fold over to form a

border around the leaflet that holds spores. The Lady Fern (above right) has eyebrow-shaped spore dots.

Some kinds of ferns grow their spores on modified leaves, that look very different from their other fronds. These structures are typically referred to as fertile fronds. Good examples of this are found in the form of the local Royal Fern and Sensitive Fern. Pictured on the left is the fertile frond of a Royal Fern, so named for its "crown" of spore-holding fronds, which develop on the tips of the fern fronds, making it appear as though they wear crowns.

Fern Anatomy

Just like other plants, ferns have roots, stems, and leaves. These parts, however, have names that are specific to ferns. These terms are important to know when identifying ferns.



Rhizome, or Rootstock: This part of the plant is responsible for producing roots, which take up nutrients and water from the soil. Fern rhizomes can be very thin and creeping, or thick and stocky. Often times the shape of the rhizome is indicative of the growth form of the fern. Ferns that grow in a crown formation, with all fronds emerging from a single central point, tend to have stockier rhizomes, whereas ferns that send up single fronds from multiple places tend to have creeping rhizomes.

Stalk, Stipe, or Stem: This is the part of the fern that connects the root of the plant to the blade, or the leafy part of the plant. Its function is almost entirely support, however it may also be photosynthetic.

Frond, Leaf, or Blade: This is the part of the frond which bears leaflets or pinnae. This part of the plant is responsible for performing photosynthesis. Spores are also typically produced on the underside of the blade.

Leaflets or Pinnae: These are the parts of the frond that are fully divided from the stalk of the frond. Some but not all fern fronds are divided into pinnae. Further divisions in the frond are called **pinnules**, where the leaflets are further divided into smaller leaves that are connected to the branched stem of the pinna**.**

Axis or Rachis: This is the part of the fern stem that is touching the fern's leaflets. Essentially, it's the part of the stem that touches the leafy portion of the frond.

Fern Allies

Largely due to having a similar appearance and way of reproducing themselves, a group called the "fern allies" is classified with the ferns. These allies are a diverse group of interesting plants, although more recent research has shown that these plants are not as closely related to ferns as scientists previously thought.

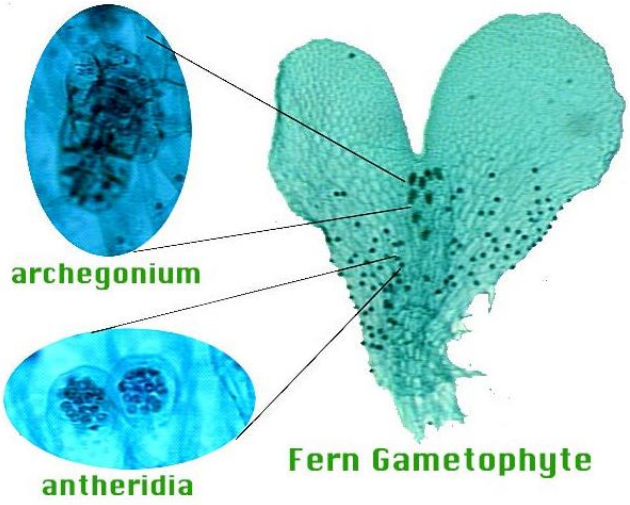
Club mosses: Low growing, creeping, and typically green year-round, these plants are commonly called "ground cedar" or "princess pine" because they look so similar to young evergreen trees. Club mosses only ever grow to be a few inches in height, however, and are found most commonly in richly wooded areas.

Horsetails: Found only around water, these plants have hollow stems that will pop off into segments if pulled. These plants have a great deal of silica, a hard chemical compound that is in rocks such as quartz and sand, in their tissues, which makes them rough. Because of this quality, they were once used to scrub dishes and clothing, earning them the nickname "scouring rush."

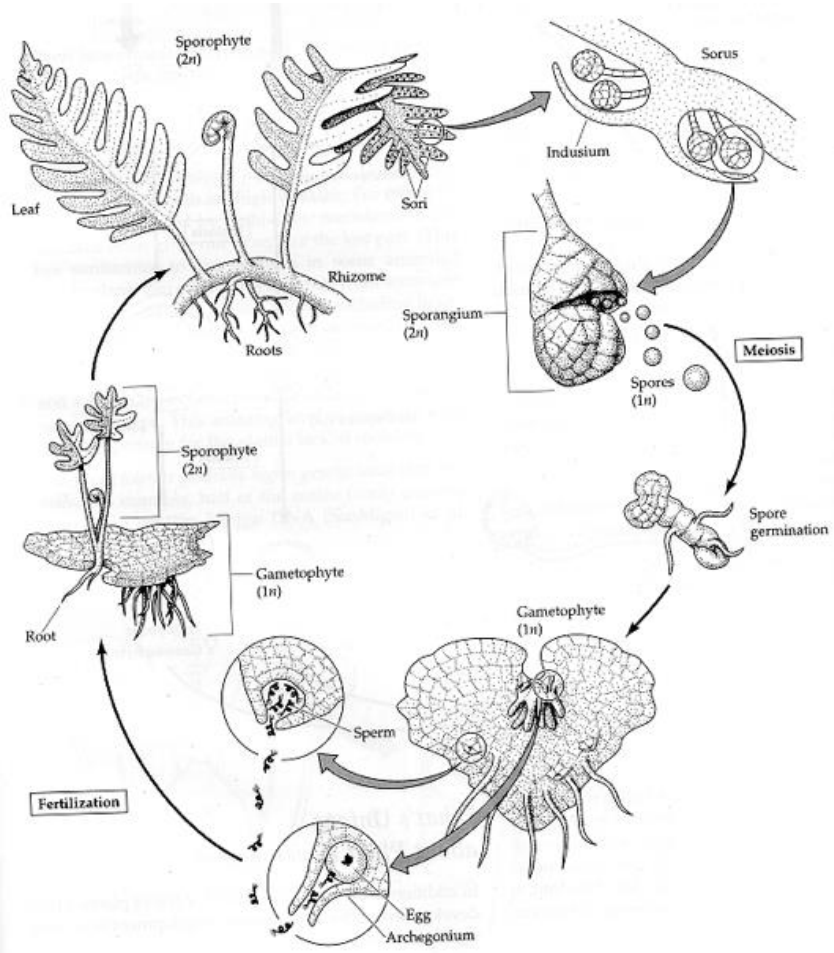
Quillworts: Mostly aquatic, and typically fully submerged in water, these plants have leaves which are hollow and resemble porcupine quills. These plants are small, and look a lot like small onion or chive plants. Many species of quillwort are very rare, although quillworts can be found all across the world.

Spikemosses: Found almost exclusively in the tropics, spikemosses resemble mosses more than they do ferns. Plants of this grouping can be brilliantly iridescent, or shiny in the sunlight, and also have incredible drought resistance.

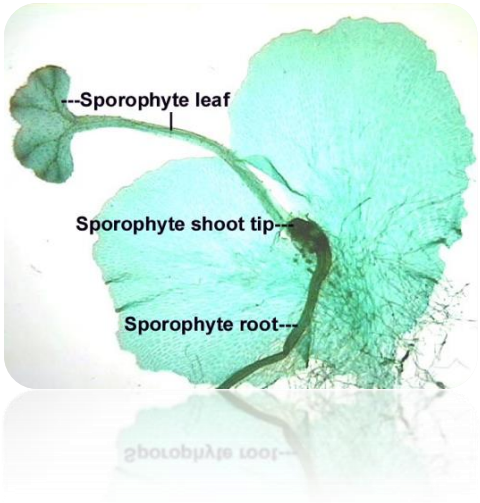
Fern Life History



The lifecycle of ferns and their allies is totally unique from other plants. When seed plants produce seeds, flowers are pollinated on the plant, and develop into fruits, which then are dispersed. Imagine an apple flower being pollinated by a passing honeybee and then developing into a fruit. This fruit (and its seed!) is eaten by a passing animal, and released far from the mother tree. This is how reproduction and seed dispersal works in most plants. In the fern life cycle, however, fertilization doesn't happen until *after* the spore, or living single cell by which ferns reproduce, has left the plant. This is the equivalent of a flower bud falling off of the tree, blooming, and then being pollinated, or fertilized, well away from the tree it came from.



For fertilization to occur in ferns, this spore has to first settle into a suitable site. Once it finds itself in an environment with enough water and light, the spore will develop into a small, heart-shaped, photosynthetic structure called a prothallus. The prothallus, which is typically a few millimeters in diameter, is known as a fern gametophyte because it produces the fern's gametes, or sex cells. On the underside of the prothallus, two reproductive organs develop: the archegonia and antheridia. These organs, which lie on the underside of the prothallus, or gametophyte, produce the sperm and eggs. The sperm come from an organ known as the antheridia, and the eggs are produced in the archegonia (pictured above in blue). These organs are found



on opposite sides of the prothallus, and the sperm must swim from the antheridia, where it is produced, to the archegonia where the egg is. Because the sperm can only reach the egg if there is water, ferns are dependent on water for reproduction. While ferns can self fertilize, nearby gametophytes can also fertilize each other, thereby increasing genetic variety in the offspring.

After fertilization occurs, the gametophyte begins growing into a sporophyte (see left picture), the vegetative phase in which the spores are produced, and what is commonly referred to as a fern. This growth will eventually turn into a new fern frond and the cycle begins again.

The Magnificent Spore

For the longest time, early botanists searched for a fern seed. Scientists at the time knew only how seed plants reproduced, and therefore assumed ferns also used seeds to reproduce themselves. Because the actual fern seed could not be found, some were convinced that the seed was actually invisible. In fact, they just weren't looking close enough. Ferns reproduce using spores, which appear as fine dust when released. Individual spores are tiny- typically only several microns across, and can only be seen with the naked eye when in large quantities. In fact, seeing individual spores in any detail requires an electron microscope!

Spores are predominantly wind-dispersed, which is quite effective, given that spores easily become airborne because of their size. Once in the air, spores are so tiny that they can remain suspended for long periods of time and travel great distances. Experiments have shown that these spores can survive long periods of time in the atmosphere, and germinate even after being exposed to a great deal of heat and light. Because spores are able to travel so well, ferns are some of the first plants to grow on islands that are far away from any other source of plants.

Spores are typically brown or black in color when mature. Certain species of fern, however, produce green spores. These spores are green because they contain chloroplasts, or small energy-producing organelles, that perform photosynthesis. While being able to produce energy and develop quickly is an advantage, these spores also must find a place to develop within a few days, or they will die. Darker

colored spores, which have thicker cell walls, are able to persist in a dormant, or inactive, state for much longer.

Classroom Activity: Make a Spore Print

While individual spores can't be seen, spore dust is easy to see and collect.

Materials Needed:

White, or light colored paper
Fresh ferns bearing ripe or almost ripe spores

To make the print, lay down paper on a flat surface, and place the fern fronds so that spore dots are facing the paper. Within 24 hours, if the spores are ready to disperse, they will fall off of the frond and onto the paper, leaving a print of spores in the shape of a fern.

Ferns, Ferns, Everywhere!

Ferns like tropical environments. In fact, only 15% of the world's species live in temperate areas. However, there are an estimated 12,000 species of fern across the globe, which leaves almost 2,000 species that occur elsewhere.

Though their life cycle requires water for the sperm to swim to the egg in the gametophyte phase, and many ferns are highly adapted for living in moist environments, ferns have adapted many ingenious methods that allow them to live in all kinds of environments. Different species can inhabit a huge variety of habitats all over the world. One species of fern, the Bracken Fern, is found on all continents except for Antarctica! From forest floors, to deserts, to cliff faces, ferns can be found worldwide. Some ferns even live underwater, in caves, and on other plants.

There are about 100 species of fern that inhabit the Northeastern United States. This means that with a little effort, one can easily become familiar with most of the common ferns found in the Northeast. Great places to start looking for ferns include swamps or wooded areas.

Additional Resources

http://www.ct-botanical-society.org/ferns/index.html
This website has a comprehensive list of native Northeastern US ferns, and includes picture guides on how to identify them.

http://www.sciencelearn.org.nz/Contexts/Ferns/Sci-Media/Animations-and-Interactives/Fern-life-cycle
A great interactive guide to the fern life cycle.

http://www.britannica.com/EBchecked/topic/204819/fern
A good overview of ferns, with lots of additional information on natural history and classification.

Images from:

Fern Gametophyte diagram:
http://www.geog.ucsb.edu/img/news/2012/f

Spore print:
http://forums.gardenweb.com/forums/load/crypto/msg0610240431912.html

Sword fern spores:
http://www.microlabgallery.com/gallery/SwordFernSpores.aspx

Developing sporophyte:
http://www.angelfire.com/de/nestsite/iscidiversity2.html

Fern Life cycle diagram:
http://www.esu.edu/~milewski/intro_biol_two/lab_2_moss_ferns/Fern_life_cycle.html

Club Moss:
http://www.plant.photos.net/images/7/74/Ground_cedar.jpg

Horsetail:
http://www.gardenadvice.co.uk/howto/gardenplants/weeds/pics/horsetail.jpg

Quillworts:
http://www.maine.gov/doc/nrimc/mnap/images/isopro_3.jpg

Spikemoss:
http://science.halleyhosting.com/nature/gorge/moss/sel/douglasii.html