

Topic 20. Protista II: The Stramenopiles

The Stramenopiles (heterokonts) are a phylogenetic group within the kingdom, Protista. These organisms were derived from an ancestor with two dissimilar flagella, hence, the name *heterokonts*. The group includes both photosynthetic and non-photosynthetic phyla. It is uncertain whether the original ancestor was heterotrophic or photosynthetic. The photosynthetic members all have chlorophylls a and c, and the accessory pigment, fucoxanthin, which imparts a golden-brown color. The chloroplasts of these members are associated with four membranes which indicates that these were derived from a secondary endosymbiotic event with a red alga.

Domain: Eukarya - Organisms with nucleated cells

Kingdom: Protista

The Stramenopiles (heterokonts)

The Water Molds

Genus: *Saprolegnia*

The Diatoms

Centric Diatoms

Pennate Diatoms

The Brown Algae

Genus: *Sargassum*

Genus: *Fucus*

Kelps

Web Lesson@ http://botit.botany.wisc.edu/botany_130/diversity/heterokonts

I. Water Molds.

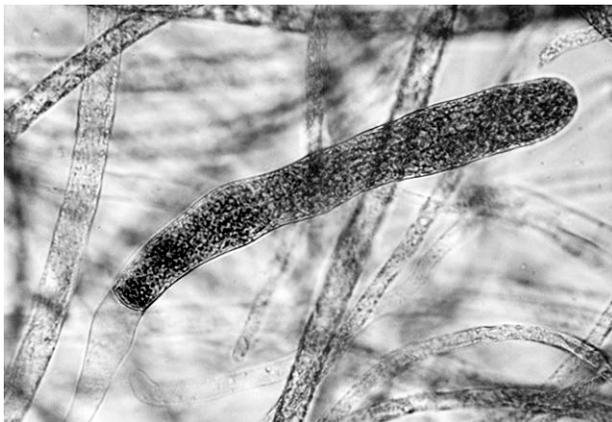
Water molds are superficially similar to the fungi and, in the past, were grouped in the fungi. They are **heterotrophic**, and their bodies consist of **hyphae**. These hyphae are **coenocytic**. Unlike the fungi, their hyphae are diploid and produce gametes by meiosis; their cell walls are made of **cellulose** (not chitin), and their flagellated cells have two dissimilar flagella. This last character firmly associates the group with the heterokonts and not with the fungi. The water molds include species responsible for several important plant diseases. These organisms reproduce asexually via zoosporangia, and sexually. They have sexual structures called **gametangia** bearing either eggs (**oogonia**) or sperm nuclei (**antheridia**).

Objectives: Know the genus *Saprolegnia* and recognize the following: **coenocytic hyphae, zoosporangia, oogonia, antheridia, zygotes.**

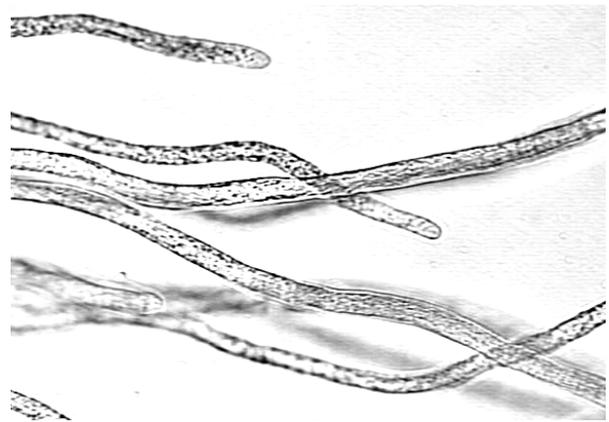
Procedure: *Saprolegnia* growing on cucumber seeds are in petri dishes at the front. *Saprolegnia* is a saprophyte that can turn parasitic (see the interesting article on mouth fungus at the front). The petri plates are numbered: the oldest dishes are labelled with the lower numbers. Younger cultures have better zoosporangia, the older ones have better gametangia.

- 1. Zoosporangia:** Take a petri dish and view with the 4x objective of an Olympus microscope with the cover of the petri plate off. Look for hyphae with dense cytoplasm in the new growth at the periphery of the mycelium. After locating hyphae with dense cytoplasm, carefully switch to the 10x objective and look for a septation cutting off the area of dense cytoplasm from the coenocytic mycelium. Typically zoosporangia are sausage-shaped. Once identified look for evidence of maturing zoospores in the zoosporangium. If you can identify maturing zoospores, share your slide with your TA.

Observe the figures below and use them for reference while viewing your culture.



Zoosporangium



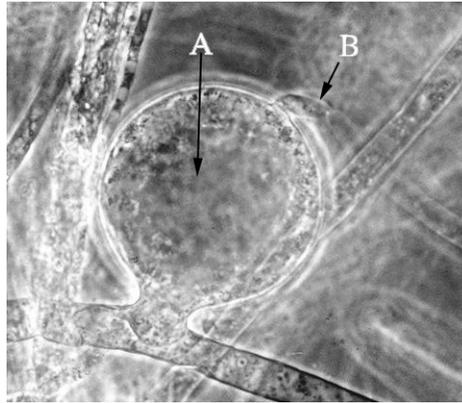
Coenocytic Hyphae

- 2. Gametangia:** In the Water Molds the gametes are never flagellated. Spherical hyphae called oogonia produce eggs by meiosis. In *Saprolegnia*, other hyphae from the same mycelium will grow through the oogonium and will undergo plasmogamy with the eggs to deliver sperm nuclei. These hyphae are antheridia. Observe a number of different cultures. Older cultures will have oogonia with dense zygotes. Antheridia will still be visible attached to these oogonia. Younger cultures should have abundant zoosporangia.

Label the figure of the gametangia below.

A. _____

B. _____

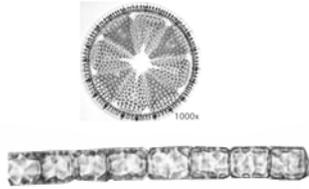


Draw an oogonium with zygotes from an older culture.

II. The Diatoms.

While diatoms can form loose colonies and filaments, they are essentially unicellular. They have cell walls that are made of silica which can be strikingly ornate. This has geologic consequences as the levels of silicon in the world's oceans never becomes high enough to allow for the precipitation of chert as it did before diatoms evolved. The diatoms are among the most important primary producers in both freshwater and marine environments. The cell walls consists of two parts called **valves** that are constructed somewhat like the two parts of a petri plate, with the top part overlapping the bottom. During cell division one daughter cell receives the bottom valve and the other the top. A new bottom then develops in each. One of the daughter is the same size as the mother and one will be smaller

Because of the structure of the cell walls, diatoms have two distinctive profiles. The **valve** view is the view seen when we look face on at one of the valves. The **girdle** view is the profile seen when the junction of the two valves faces the viewer. Based on the symmetry of the valves, two groups of diatoms are recognized. **Pennate** diatoms have valves that are bilaterally symmetrical, and **centric** diatoms which have valves that are radially symmetrical. Note that in each case the girdle views are rectangular.



Centric Diatoms: Valve view on top, bottom shows eight cells in a filament all in girdle view.



Valve View

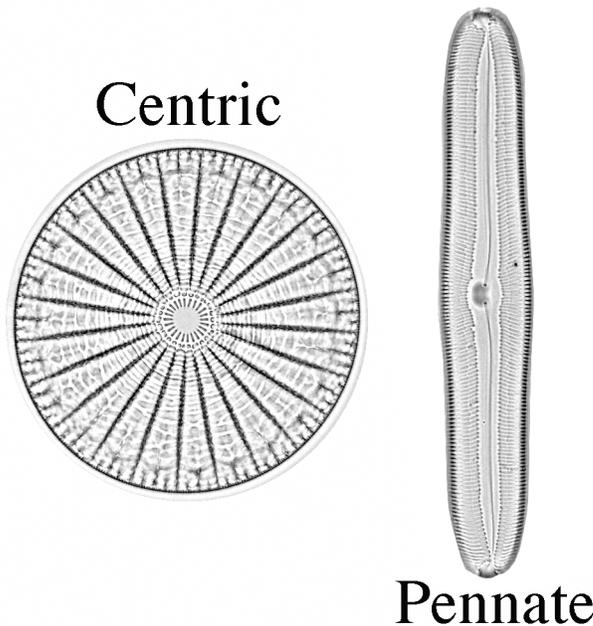


Girdle View

Pennate Diatom: Valve view on the top, and the girdle view of the same cell on the bottom

Objectives: Recognize diatoms. Also be able to identify diatoms as pennate or centric, and know the difference between a valve view and a girdle view of a cell.

IIa. Centric vs. Pennate Diatoms: Observe the demonstration slide of pennate and centric diatoms. These are displayed in the *valve* view.



IIb. Freshly collected diatoms.

Sample material from the bottom of the bowl of the freshly collected diatoms and make a wet mount. Note any filaments of the centric diatom *Melosira* (pictured at the top of the page on the left)). These, like all centric diatoms, have disk shaped chloroplasts.

Draw cells of *Melosira*. Label a cell with disc-shaped chloroplasts.

Look for motile pennate diatoms. How many different forms can you count while viewing for five minutes?

Identify girdle views and valve views in one form. Note that pennate diatoms have two elongated chloroplasts. In valve view, you will see them side by side. In girdle view, they will overlap and you will only see one yellow brown line.

Draw cells in girdle and valve views.

Valve

Girdle

Phototropism in Pennate Diatoms:

While viewing *diatoms* in a wet mount with your 10x objective, close down your field iris to generate a vignetted area of light surrounded by a halo of dark.

Choose a random area on your slide and count the number of cells present. Do not move your stage while leaving your microscope light on for three minutes. Then again count the number of cells in the illuminated area. Do this procedure twice and record your data below, then share your data with your class by reporting it on the board.

	Number of Cells -Start	Number of Cells - Finish
I.		
II.		

Record the average numbers of each from your entire class below:

Average number of cells - start _____

Average number of cells - finish _____

IIc. Diatomaceous Earth.

Marine deposits exist of accumulated planktonic diatom walls called diatomite. These can be commercially harvested as diatomaceous earth used commercially as an abrasives or as filter media. Diatomite deposits can be thousands of feet deep. Diatomaceous earth is an excellent source of cell walls of planktonic centric diatoms.

Procedure: Add a drop of water to a blank slide; wet a teasing needle in the water; and place the moist needle tip into the diatomaceous earth at the front bench. Stir the coated tip in the drop and add a cover slip. Look for a non-filamentous centric diatoms typical of marine phytoplankton.

Draw an example of a centric diatom in valve view.

III. The Brown Algae.

This is a group of multicellular seaweeds. The name “brown” algae is derived from their color, which is due to the accessory pigment **fucoxanthin**. Also, like the diatoms, their plastids contain **chlorophylls a and c**. **Algin**, a commercially important emulsifier, is produced from the kelps. Along with animals and plants, the **kelps** (order **Laminariales**) have independently evolved complex morphologies and cellular structure. Their bodies can be categorized into three parts: **holdfast** (anchoring the organism), **blade** (the primary photosynthetic structure) and **stipe** (the part connecting the blade to the holdfast). Some kelps have cells that function and look like the cells in the phloem of higher plants that serve to move photosynthate through the organism.

IIIa. *Fucus* - (Rockweed). If you frequent the rocky coastline of New England, this is the one brown alga you are most likely to encounter. It grows in dense populations attached to rocks at the shore line.

Carefully observe the living material at the front of each bench. Note the holdfast. Examine the opposite extremities of the organism. Growth in *Fucus* is like that in plants. It occurs at an apical meristem.

See if you can identify a region of cell division (an apical meristem).

Observe the pattern of branching.

Based on your observations how does branching occur in *Fucus*?

While *Fucus* is not related to plants, its external morphology is very much like two plants you will study next week, *Marchantia* and *Psilotum*. These similarities are due to convergent evolution.

Draw *Fucus*. label **holdfast** and clearly illustrate the pattern of branching

IIIb. *Sargassum*: If you frequent the beaches of the southeast, this is the one brown alga you are most likely to encounter. It is morphologically complex. It has obvious parts which can be described as blade and other parts which can be described as stipe, as well as having air bladders. Some *Sargassum* is found in floating masses at sea (The Sargasso sea gets its name from *Sargassum*). Other material from the same species are anchored by holdfasts. Interestingly, only the material that is anchored reproduces sexually. The masses adrift at sea reproduce vegetatively only by fragmentation. These floating masses support a rich community of organisms in areas that would otherwise be sterile.

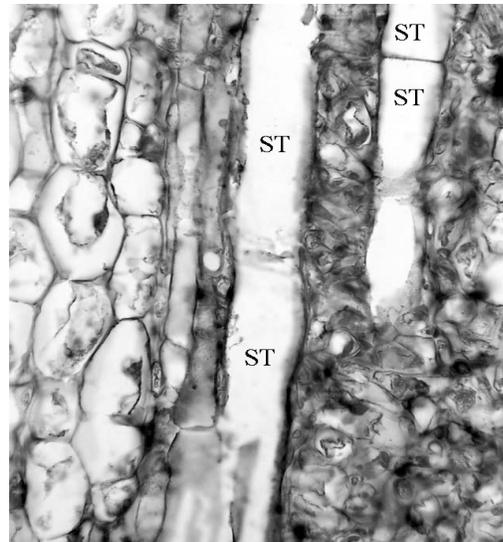
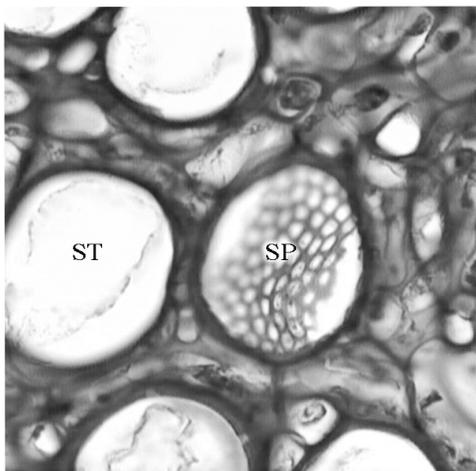
Draw *Sargassum*. label the **bladders**.

IIIc. Kelps (order Laminariales): Structurally, the most complex protists are the kelps. All the kelps have body parts that can be divided into **stipe, blade, and holdfast**. Some members of the group also have **specialized cells to conduct photosynthate**. Since some kelps can grow hundreds of meters long, it is not surprising that they evolved cells that allow photosynthate to move from the illuminated upper blades to the shaded stipes and holdfast.

Observe the examples of preserved kelps on the side bench.

Draw a kelp. label **blade, stipe, and holdfast.**

Observe the demonstration of a sieve-tube member in *Macrocystis*.



Phloem in *Macrocystis*. Sections of a stipe: Cross Section on the left;
Longitudinal Section on the right:

ST = Sieve-Tube Element. **SP** = Sieve Plate

Take some time on your own to observe the various examples of kelps illustrated through our web page:

<http://botit.botany.wisc.edu/Resources/Botany/Heterokonts/Phaeophyta/Kelps>