Lab 04: **Cyanobacteria & Algae**

A. Introduction

Plants are not the only organisms that are photosynthetic. In fact, photosynthetic lineages have popped up here and there throughout the tree of life (see the 7 groups in the phylogenetic tree below). In fact, there are even bacteria that are photosynthetic!!

Organisms called algae are photosynthetic, but are usually morphologically simpler than higher plants such as mosses, ferns, or angiosperms. Some algae are unicellular, but others are large, multicellular organisms like the kelps. Within the algae you can see the major trend in the evolutionary development of multicellularity reflected in the diversity of organismal forms: i.e., unicellular >> one-dimensional multicellular growth (1D) >> two-dimensional multicellular growth (2D) >> three-dimensional multicellular growth (3D).

Algae have been divided into groups based mainly on distinctive plastid accessory pigments. Because of these pigments, many groups of algae have been known by their color: hence red, green, brown, etc. Modern classifications delimit them with many other characters such as cell wall components, reproductive structures, and distinctive food storage molecules.

Algae are the dominant producers in aquatic environments, so they are very important ecologically. The materials available in lab today represent the major algal divisions, along with the cyanobacteria.

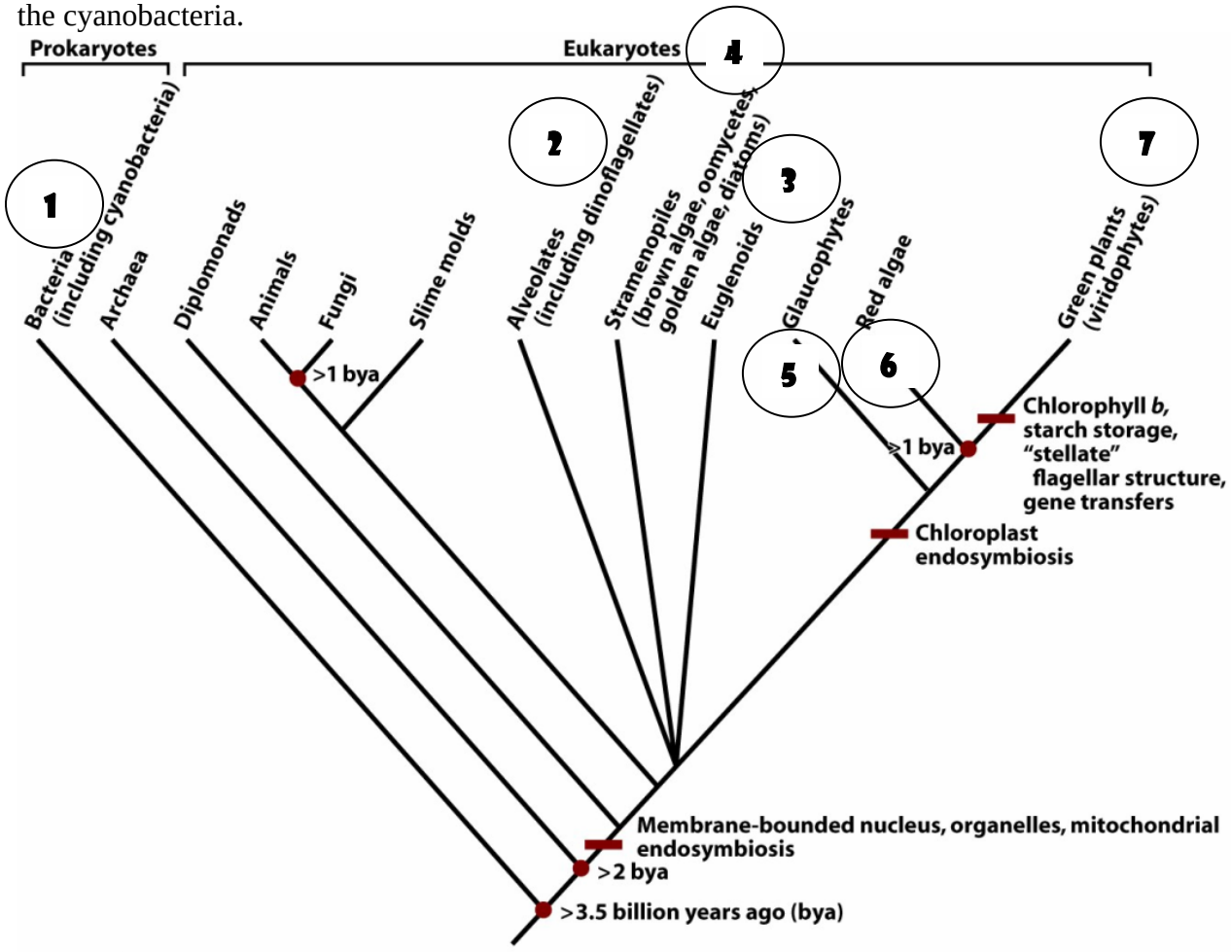

Figure 15-3
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Adapted from Fig. 15-3 in your book. A phylogenetic tree based on DNA sequences, showing 7 major groups of photosynthetic organisms.

B. Group 1: Cyanobacteria .

Also known as "blue-green algae", although they are actually bacteria. Like algae, these have chlorophyll.

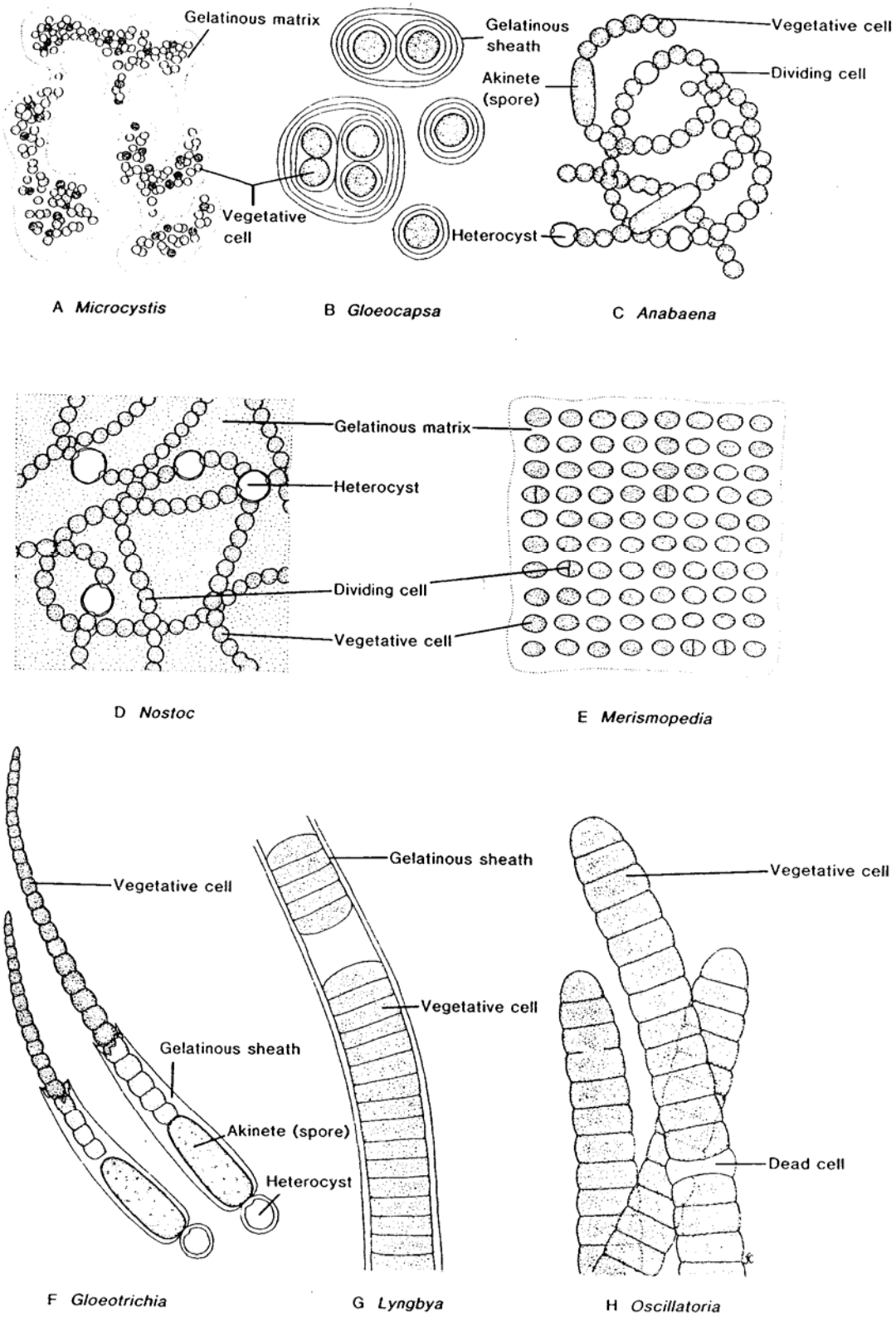
Many are unicellular, others are filamentous, while others are colonial.

1. If you were to have a unicellular cyanobacterium and a unicellular alga, how would you tell them apart?

Observations:
Make drawings of specimens representing the genera *Oscillatoria* and *Anabaena* at various magnifications. You should be able to recognize these.

2. Was Oscillatoria unicellular, filamentous, or colonial?

3. Was Anabaena unicellular, filamentous, or colonial?



Above, some cyanobacteria (blue-green algae)

C. Group 2: Dinoflagellates .

Dinoflagellates are not bacteria but protists. *What does that mean?*

How many cells is each dinoflagellate?

How many flagella do these have and how is each arranged to help them move?

Read in your book about the "armor" or "plates". Is this a cell wall? Are the plates inside or outside the cell(s)?

IF MATERIAL IS AVAILABLE, make observations.

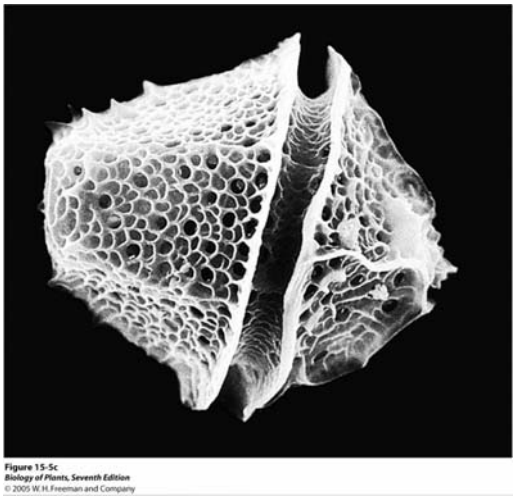


Figure 15-5c
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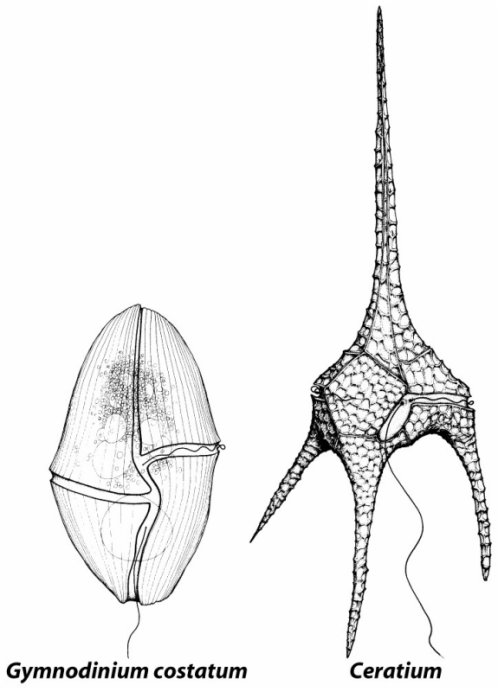

Figure 15-6
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D. Group 3: Euglenoids .

Euglena and other similar genera are small organisms called protists. *Euglena gracilis* is just one of many (ca. 800-900) species. They do not have common names like birds or trees, so we have to refer to them by their scientific name.

Euglenoids are interesting because they combine superficial characteristics of both plants and animals. They can make their own food like a plant, but they can also eat other things, like an animal. They can also swim and move. Scientists argued for years about which Kingdom to put them in, Animal or Plant? Right now they are in neither; according to some classifications they are in the Kingdom Protista with other simple (often microscopic) eukaryotes, such as amoeba and paramecium.

Observations: Euglena gracilis and other euglena are green because they have chloroplasts.

A euglena's body is only one cell, so they are very small and you must use a microscope to see them. Sometimes, since they live in water, if there are millions of euglena together, they form a mat on the surface of a pond or marsh that you can see. It looks slimy, a lot like algae. Some people say it looks like "pea soup". It gets in swimming pools too, if they are not cleaned regularly. If you've ever seen water in a marsh that looks red, it's from many euglena. Some species have chemicals in them that make them red. *Euglena gracilis* is not one of those species.

Euglena gracilis has a long hair-like thing that stretches from its body (see top picture). You need a very powerful microscope to see it. This is called a flagellum, and the euglena uses it to swim. It also has a red eyespot. *Euglena gracilis* uses its eyespot to locate light. Without light, it cannot use its chloroplasts to make itself food.

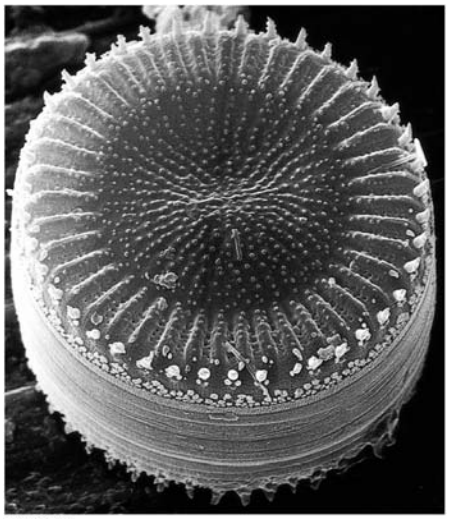
Drawing of *Euglena gracilis* from monoculture.

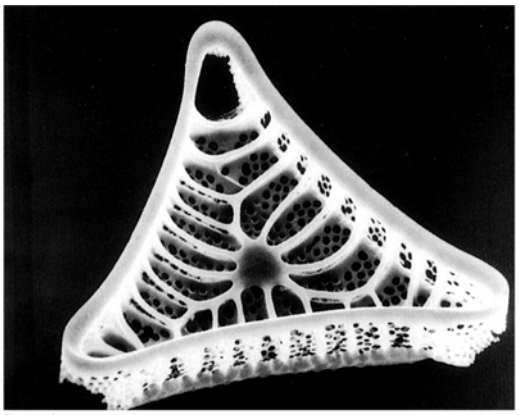
E. Group 4: Brown or Golden-brown Algae .

E1. Diatoms

Diatoms are unicellular or colonial organisms that are exceedingly important components of phytoplankton of both marine and freshwater systems.

The walls of diatoms consist of two halves: known as frustules, the walls are made of opaline silica and consist of two halves that fit together like a Petri dish. These frustules are very ornate and these ornamentations are used to distinguish species.





Above, scanning electron micrographs of a whole diatom (left) and the half of a frustule, showing the inside face (right).

Navicula observations.

Make observations of *Navicula* (from the latin *navicula*, meaning boat-shaped) with the light microscope. Draw *Navicula* below .

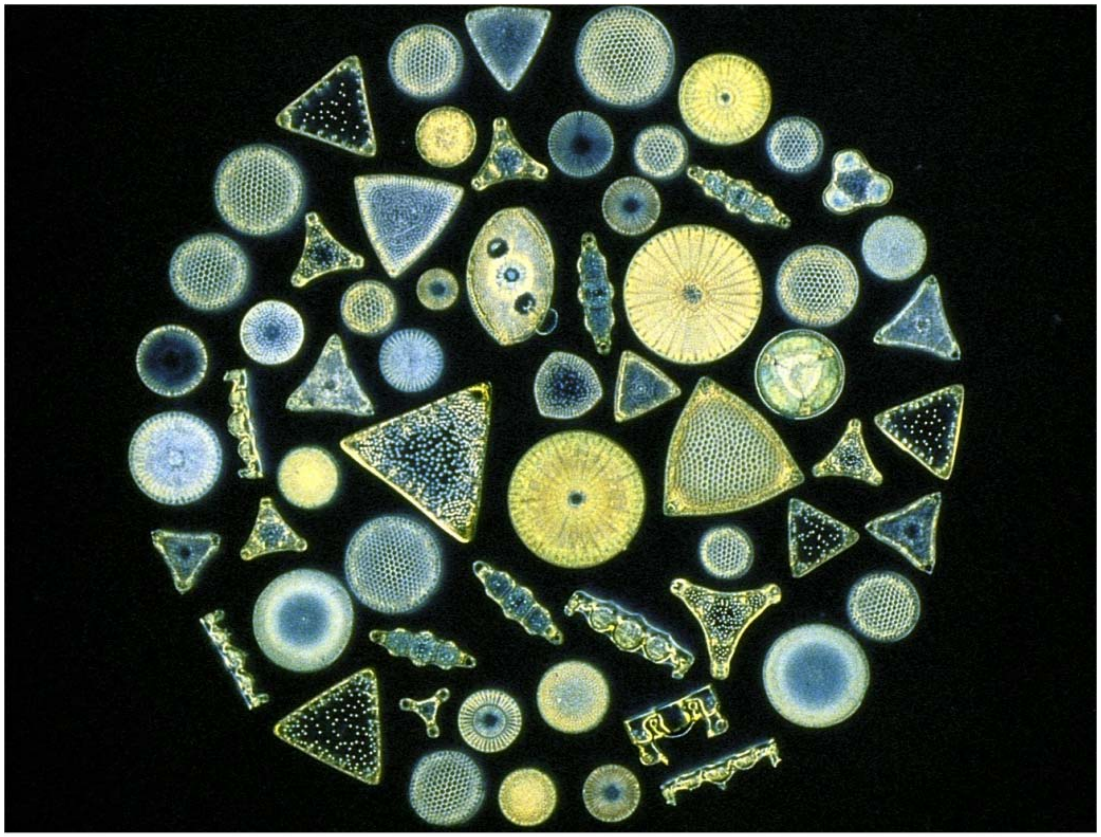


Figure 15-20a
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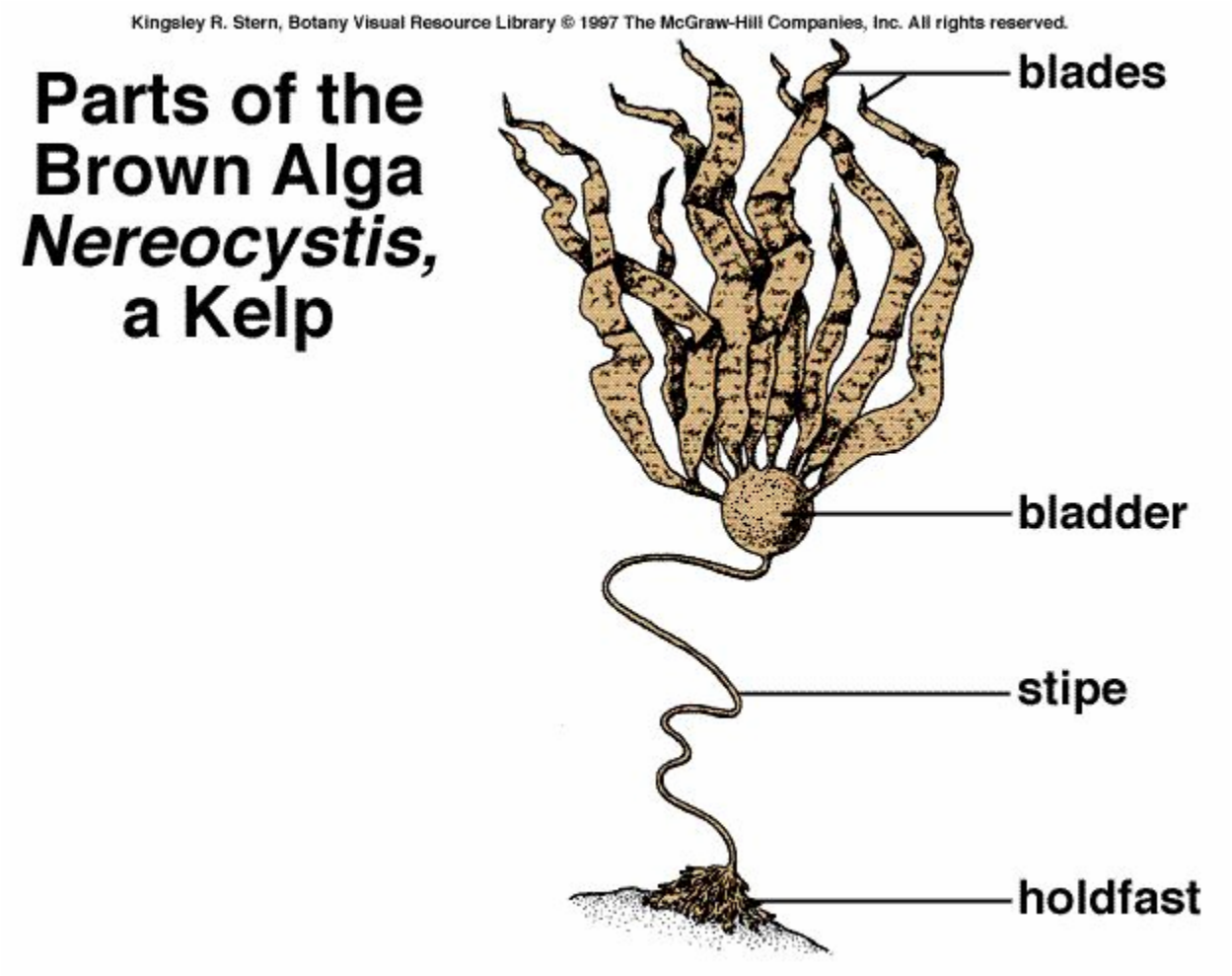
Fig. 15-20a from your book. An artful representation of many different types of diatoms.

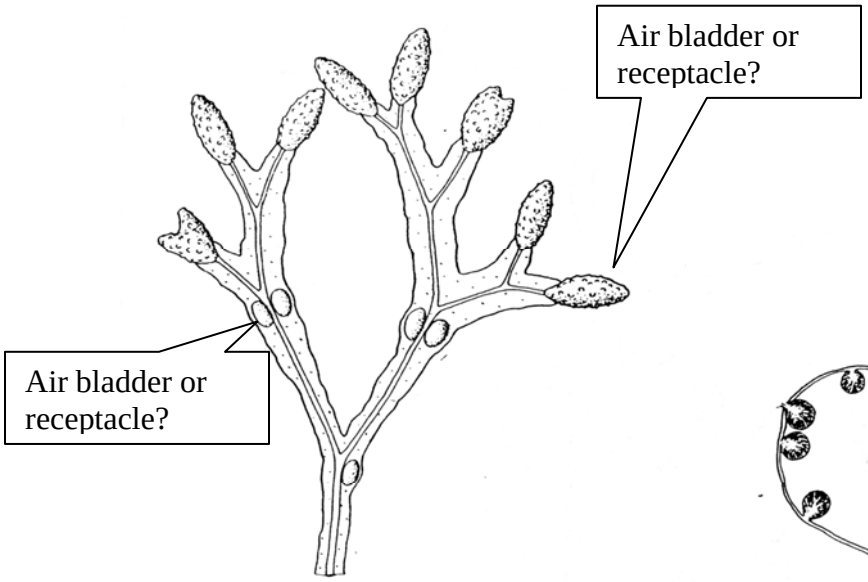
E2. Brown Algae

When marine algae get big (macroscopic), they are called seaweeds. Brown algae are the first macroscopic group that we will see today. Although they have chlorophyll, their special carotenoid fucoxanthin (which they share with diatoms) impart a brown color to them.

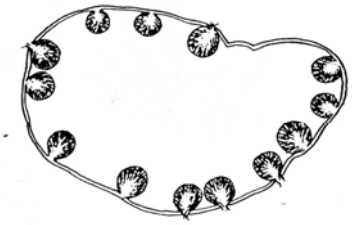
Well known members include *Fucus* (rockweed) and *Laminaria* and *Macrocystis* (the kelps).

Common structures will include a hold fast, a stipe, bladder (for buoyancy), and blades to function like "leaves".

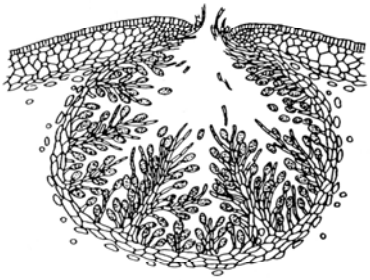




A. *Fucus*, plant with receptacles and air bladders.

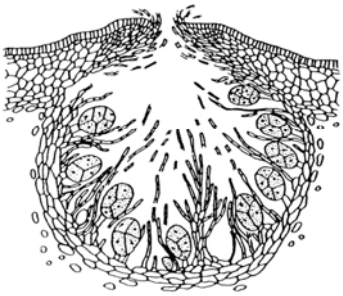


B. x-section of receptacle and smaller conceptacles.

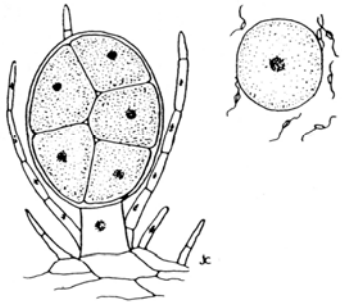


C. Male conceptacle with antheridia.

D. Antheridia with sperm.



E. Female conceptacle with oogonia.



F. Oogonium with eggs.

Above: *Fucus*, illustrations of the plant, as well as the reproductive parts. From your microscopic observations, label the plant illustration above as to which arrow box points to a receptacle, and which points to an air bladder.

F. Group 5: Glaucophytes .

Extremely small group of algae closely related to red and green algae. Will not be covered in lab.

G. Group 6: Red Algae .

The red algae are largely marine and multicellular "seaweeds". A class of accessory pigments (phycobilins) makes them reddish.

Make macroscopic and microscopic observations of the red algae available in lab.

H. Group 7: Green Algae .

The Green Algae are a very large and diverse group. They range from unicellular organisms such as *Chlamydomonas* or *Chlorella* to colonial organisms such as *Volvox*, to mulicellular organisms such as *Ulva* (sea-lettuce).

There are unlabeled monocultures of algae in the lab. Working in groups of 4, make wet-mounts of each, label the slide appropriately so you don't forget the identity, and use the dichotomous key on the last page of this document to identify all of the different kinds and place their drawings over the appropriate labels below.

H1. Unicellular forms

Chlamydomonas

Chlorella

Closterium (this unicell is bilaterally symmetric, with two equal halves and a single chloroplast; it's known as a "desmid")

H2. Colonial form

Volvox

H3. Filamentous forms

Spirogyra *Oedogonium*

Why is this genus called Spirogyra?

H4. Multicellular (seaweed) forms (IF AVAILABLE)

Macroscopic microscopic (paradermal and x-sections; whole many cells thick is *Ulva*?).

Ulva (sea-lettuce) and other species in *Ulva*

H5. Life-cycles of some green algal species.

Below is that of *Chlamydomonas*. Next page is that of *Oedogonium*.

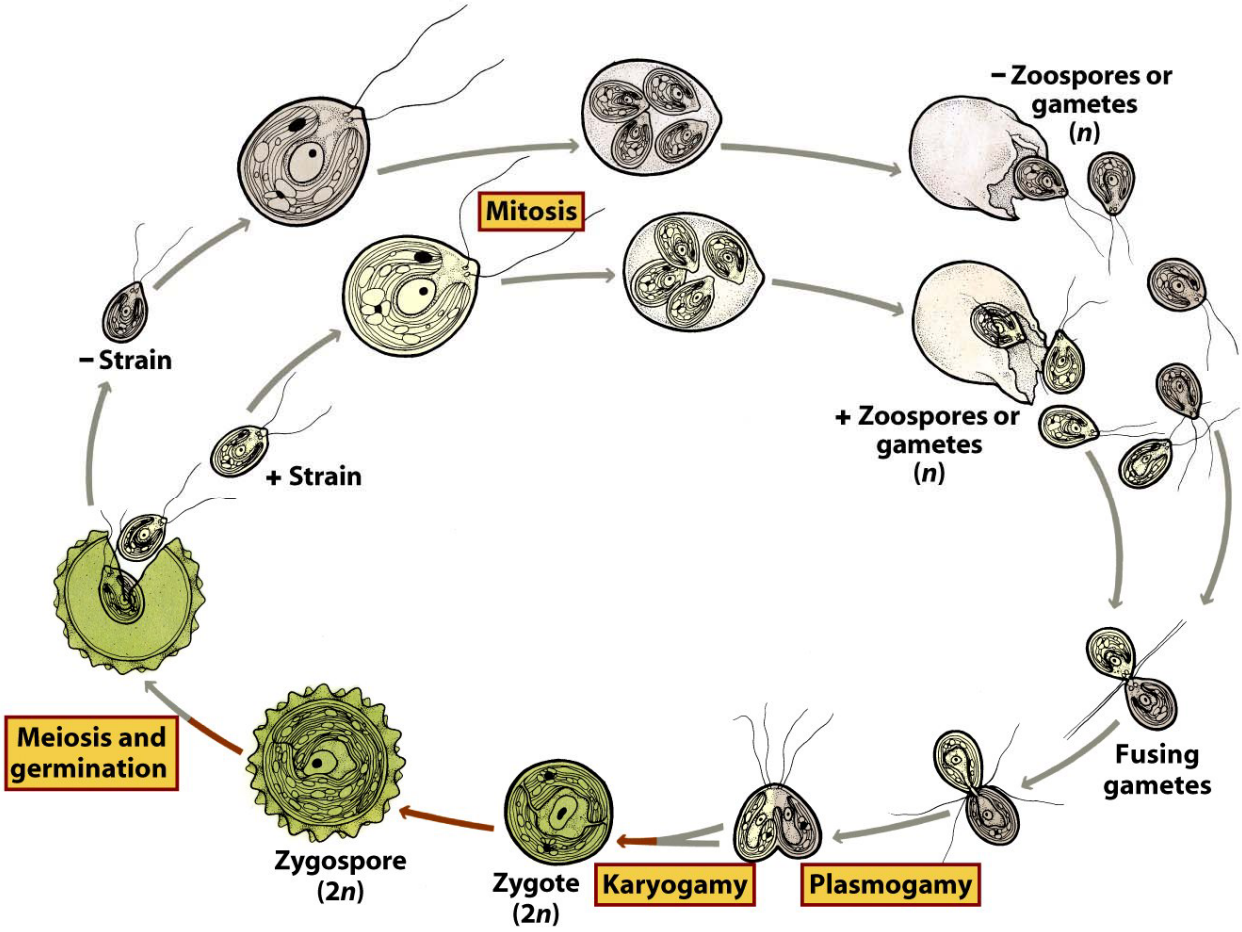


Figure 15-41
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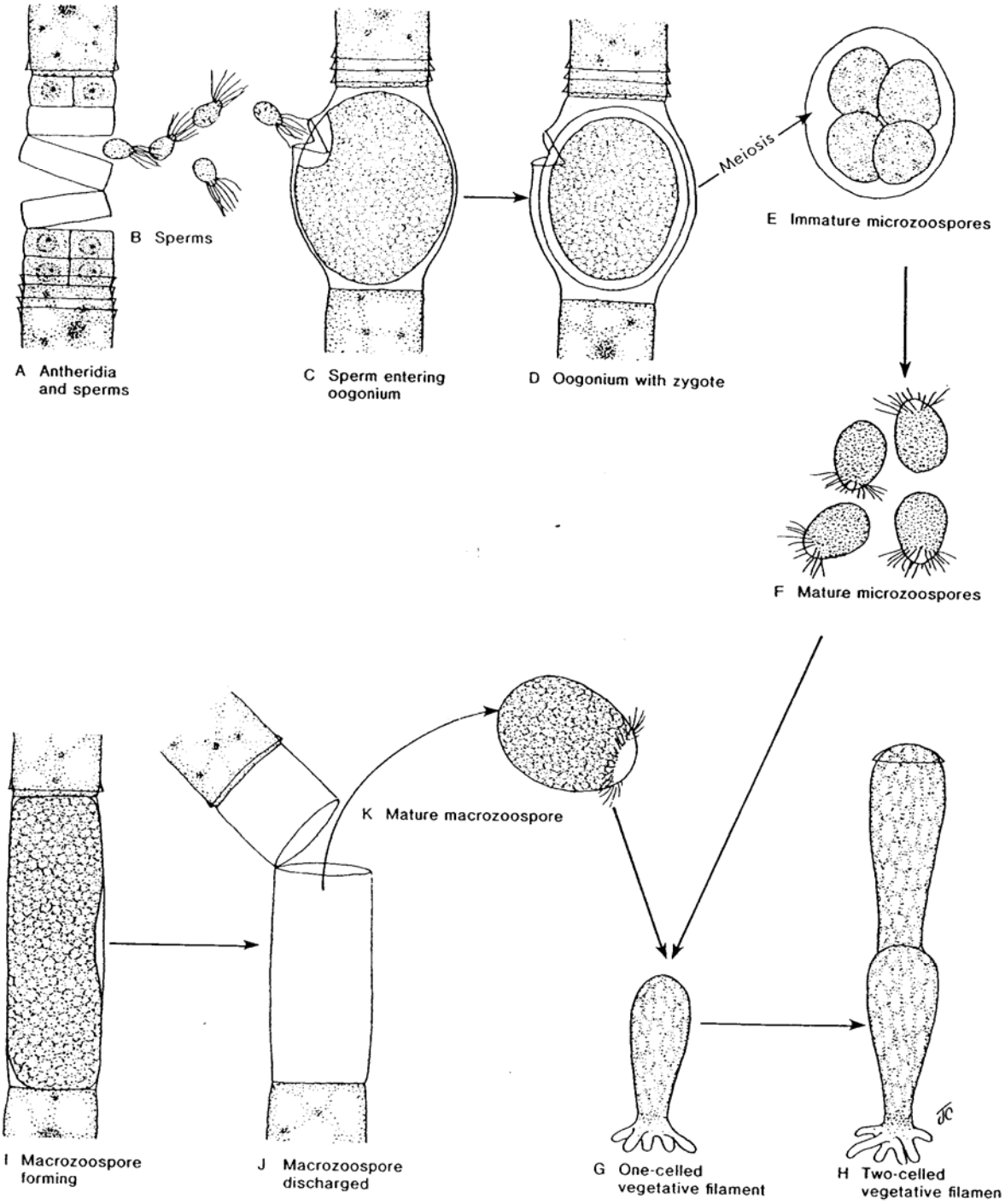
Above: Life cycle of *Chlamydomonas*, a unicellular green-alga.

Figure 23.2 *Oedogonium*



Above, life-cycle of the green alga *Oedogonium*.

Dichotomous Key to 10 Algae (prepared by MU botany faculty)

1. Cells single; not grouped in a colony or filament..... 2
1. Cells grouped in colony or end to end in a long filament..... 6

2. Cells golden-brown, elliptic (football shaped), from the top view the tips taper to rounded points, while from the side the tips are blunted and squared..... Navicula (Diatom)
2. Cells bright-green and shaped otherwise..... 3

3. Cells narrow (longer than wide)..... 4
3. Cells round or ovoid..... 5

4. Cells apparently not motile; very long and slightly crescent-shaped; round vacuoles at each tip may be filled with granules; a row of doughnut-shaped bodies (pyrenoids) runs from the tip to a central clear area..... Closterium (Desmid)
4. Cells motile (1-flagellate)..... Euglena (Euglenoid)

5. Cells ovoid, rather motile, with a groove on the narrower end where two flagella insert; red eye-spot present..... Chlamydomonas (Green Alga)
5. Cells round, not apparently motile (not flagellate)..... Chlorella (Green Alga)

6. Cells grouped into round colonies, bright-green..... Volvox (Green Alga)
6. Cells grouped into filaments, bright-green or blue-green..... 7

7. Cells blue-green (Cyanobacteria)..... 8
7. Cells bright-green..... 9

8. Filament with constrictions between the cells..... Anabaena (Cyanobacterium)
8. Filament without constrictions between the cells; moving..... Oscillatoria (Cyanobacterium)

9. Cells of filament cylindrical, chloroplast(s) round ..... Oedogonium (Green Alga)
9. Cells of filament cylindrical, chloroplast(s) spiral or curved..... Spirogyra (Green Alga)