Lab 10
The Protists

Lab Goals:
- Survey the diversity of Protista
- Review the diversity of lifecycles
- Identify structures in live mounts and prepared slides that distinguish the phyla
- Key out members of the Phylum Chlorophyta, class Chlorophyceae

A list of phyla and classes you should know:

<table>
<thead>
<tr>
<th>KINGDOM: Protista (~115,000)</th>
<th>See Table 18.1 page 386</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unicellular and Colonial</strong></td>
<td></td>
</tr>
<tr>
<td>PHYLA: Euglenophyta</td>
<td>euglenoids (800)</td>
</tr>
<tr>
<td>Dinophyta</td>
<td>dinoflagellates (3,000)</td>
</tr>
<tr>
<td>Bacillariophyta</td>
<td>diatoms (5,600)</td>
</tr>
<tr>
<td>Xanthophyta</td>
<td>yellow-green algae (600)</td>
</tr>
<tr>
<td>Chrysophyta</td>
<td>golden-brown algae (1,000)</td>
</tr>
<tr>
<td>Cryptophyta</td>
<td>cryptomonads (200)</td>
</tr>
<tr>
<td>Prymnesiophyta</td>
<td>haptophytes (300)</td>
</tr>
<tr>
<td><strong>Multicellular (some unicellular too)</strong></td>
<td></td>
</tr>
<tr>
<td>PHYLA: Phaeophyta</td>
<td>brown algae (1,500)</td>
</tr>
<tr>
<td>Rhodophyta</td>
<td>red algae (5,000)</td>
</tr>
<tr>
<td>Chlorophyta</td>
<td>green algae (7,500)</td>
</tr>
<tr>
<td>CLASSES:</td>
<td></td>
</tr>
<tr>
<td>Chlorophyceae</td>
<td></td>
</tr>
<tr>
<td>Ulvophyceae</td>
<td></td>
</tr>
<tr>
<td>Charophyceae</td>
<td></td>
</tr>
</tbody>
</table>

The Kingdom “Protista” is not a monophyletic group. It contains organisms which are more closely related to members of other kingdoms (plants, animals and fungi) than they are to other protists. It's also defined on the absence of characters (i.e. no complex development from embryos, no extensive cell differentiation, etc.), which is not considered to be a sound basis for classification. Recent studies of protist DNA and ultrastructure has shown that the protists are far more diverse than had been previously expected. In the future, protista will likely be classified in several kingdom-level taxa. We retain the word "protist" as a convenient term to mean "eukaryote that isn't a plant, animal, or fungus."

The first seven phyla are not necessarily related to each other but all have unicellular and colonial forms. Most of them are phytoplankton which are organisms that float near the surface of lakes and the oceans and are responsible for half of all of the world's photosynthesis.
Unicellular or Colonial

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Common name</th>
<th>Euglenophyta</th>
<th>Euglenoids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>800 species</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Earliest species were phagocytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/3 modern species have chloroplasts</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Photosynthetic species have chlorophyll a, b and carotenoids</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mostly freshwater</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flagellated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elaborate single-celled organisms</td>
<td></td>
</tr>
</tbody>
</table>

Examine: live mount
See page 388 in text

Look for:
- Flagella
- Pellicle
- Eyespot
- Contractile vacuole

Draw what you see and label the parts that are discernable:
<table>
<thead>
<tr>
<th>Phylum</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dinophyta</td>
<td>Dinoflagellates</td>
</tr>
</tbody>
</table>

- 3,000 species
- Closely related to ciliate protozoa
- Chlorophylls a and c masked by carotenoid pigments including peridinin similar to fucoxanthin of Chrysophytes
- Most unicellular
- Flagella beat in two grooves causing rotation as it moves
- Highly derived - permanently condensed chromosomes
- ½ are photosynthetic
- Some produce nerve toxins

See Fig. 18.3 in text

View the prepared slide of *Ceratium*. Draw what you see. Label the theca.

At some point, your instructor will turn off the lights and let you poke a bag of bioluminescent dinoflagellates. What are two adaptive hypotheses for bioluminescence?

1) 

2)
Phylum | Common name
---|---
Bacillariophyta | Diatoms

- 5,600 species
- Marine and freshwater phytoplankton in cool waters but some terrestrial species
- Responsible for 25% of total primary production on earth
- Compose most of biomass and species diversity in polar waters
- Unicellular or colonial
- Gametic meiosis
- Two shapes:
  - Centric diatoms are oogamous
  - Pennate diatoms are isogamous
- Chlorophylls a, c and fucoxanthin
- Chrysolaminarin is storage molecule
- Almost all are autotrophic, some are also heterotrophic
- Cell walls made of silica

Fig. 18.6 in text
Review the life cycle handout

View the prepared slides of mixed diatoms.
Draw what you see:

Make a wet mount of diatoms (if available) view under the microscope and draw what you see:

What triggers sexual reproduction in diatoms?
Phylum: Xanthophyta
Common name: Yellow-green algae

- 600 species
- Chlorophyll a, c and carotenoids
- Mostly freshwater phytoplankton (some in ocean or damp soil)
- Flagellated – tinsel and whiplash
- Mostly asexual reproduction

See Fig. 18.7 in text
View the slide of filamentous *Vaucheria*. Is this a sexual or asexual species? What makes you think so? Draw what you see:

Phylum: Chrysophyta
Common name: Chrysophytes

- 1,000 species
- Primarily unicellular or colonial although some are filamentous
- Abundant in cold waters of either marine or freshwater environments
- Some colorless – some with chlorophylls a and c masked by fucoxanthin
- Energy storage molecule = chrysolaminarin
- Mostly asexual reproduction
- Two flagella of unequal size
- Statospheres are silica-encased dormant life stage

See Fig. 18.8 in text
Examine the prepared slide of this colonial golden-brown algae (if available). Draw what you see.

[Image of filamentous *Vaucheria*]

[Image of colonial golden-brown algae]

http://www.plantbio.ohiou.edu/epb/faculty/research/Synura.jpg
<table>
<thead>
<tr>
<th>Phylum</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptophyta</td>
<td>Cryptomonads</td>
</tr>
</tbody>
</table>

- Marine and freshwater in cold waters
- Very small
- Dominant in plankton community when diatoms and dinoflagellates are less abundant
- Some photosynthetic – some not
- Chlorophyll a, c and phycobiliproteins
- Use ejectisomes for escape
- Flagellated

See Fig. 18.9
Examine the prepared whole mounts of *Chilomonas*
Draw what you see:

---

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prymnesiophyta</td>
<td>Haptophytes</td>
</tr>
</tbody>
</table>

- 300 species
- Mostly marine phytoplankton in warm waters (few freshwater and terrestrial)
- Chlorophyll a and c and caratonoids
- Account for 50% of photosynthesis in the mid-Atlantic
- Extremely small
- Important for transporting carbon to deep ocean
- Flagellated

No specimen to view. See Fig. 18.10 in text.
Multicellular (some unicellular too)

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phaeophyta</td>
<td>Brown algae</td>
</tr>
</tbody>
</table>

- 1,500 species
- Almost entirely marine
- Temperate and boreal seas
  - Rockweeds – Fucales – no meristem
  - Kelp – Laminariales – meristematic region between stipe and blade – phloem-like tissues
- Tropics – immense floating masses of Sargassum
- Basic form is thallus – relatively simple structure
- Classified according to thallus structure – not a good indicator of evolutionary relationships.
- Chlorophylls a and c, carotenoids xanthophylls and fucoxanthin – give dark green or olive color
- Laminarin stored in vacuoles
- Flagellated
- Produce spores and gametes

Review life cycle in Fig. 18.12
View the mounted specimen of *Laminaria* and draw what you see.

Look at the prepared slides of *Laminaria* sporangia. Draw what you see and locate structures on the lifecycle diagram.

View the whole plant in a jar of *Fucus*. See diagram on center bench. What body structures can you see?
View the prepared slides of the following *Fucus* structures and draw what you see:

1. female conceptacle

2. male conceptacle

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhodophyta</td>
<td>Red algae</td>
</tr>
<tr>
<td></td>
<td>5,000 species; &lt; 100 freshwater</td>
</tr>
<tr>
<td></td>
<td>Chlorophyll a, d and phycobiliproteins</td>
</tr>
<tr>
<td></td>
<td>Structurally complex – only a few are unicellular</td>
</tr>
<tr>
<td></td>
<td>Red color from phycobilins that mask the color of chlorophyll a</td>
</tr>
<tr>
<td></td>
<td>Storage molecule = floridean starch – more like glycogen</td>
</tr>
<tr>
<td></td>
<td>Calcified red algae confer strength to color reefs</td>
</tr>
<tr>
<td></td>
<td>No flagellated cells in life cycles</td>
</tr>
</tbody>
</table>

View mounted specimen to carpogonia under dissecting microscope.

Draw what you see:

View the prepared slides of reproductive structures and try to find and draw the following three structures on *Polysiphonia*.

1. Antheridia – what is the function of this structure?
2. carpogonia (called “cystocarp” on slide) – what is the function of this structure?

3. tetraspores – what is the function of this structure?

View the plastic bag with coralline algae in it (if available). Where would you find this kind of red algae?

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorophyta</td>
<td>Green algae</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum</td>
<td>Class</td>
</tr>
<tr>
<td>Chlorophyta</td>
<td>Chlorophyceae</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

One evolutionary trend seen among the green algae is that of increasingly larger colonies of simple, flagella-bearing cells. *Gonium* is a little raft of typically 16 cells, and represents the smaller colony size of this continuum. *Volvox* is at the opposite end of
the spectrum. It is a huge colony of hundreds of cells. It moves by the coordinated action of its flagella action which cause it to “tumble” as it swims. *Volvox* reproduces both asexually (you may see daughter colonies within the main *Volvox* body) and sexually (you may see macrogametes and microgametes inside some colonies; these stain darker). See life cycle diagram of *Volvox* on the center bench.

View the prepared slides of the evolutionary series. Draw the organisms and comment on the changes in complexity that you can observe.

1. *Chlamydomonas*
   Review life cycle Fig. 18.14

2. *Gonium*

3. *Pandorina*

4. *Eudorina*

5. *Volvox*

Examine the prepared slides and draw what you see (diagrams on center bench):

1. *Oedogonium* nannandrous: with epiphytic dwarf males:

2. *Oedogonium* macrandrous: with oogonia and antheridia

3. *Hydrodictyon*
### Phylum Chlorophyta

**Common name**: Green algae

#### Class Ulvophyceae
- Mostly marine – a few important freshwater
- Filamentous or sheets of cells
- Macroscopic and multinucleate
- Closed mitosis – nuclear envelope persists
- Spindle persistent through cytokinesis
- Marine have alternation of generation although freshwater do not – lost during transition to freshwater

**Review the life cycle Fig. 18.16**

**View the prepared slides and draw what you see:**
1. *Ulva*

2. *Ulothrix* (Life cycle diagram on center bench)

---

### Phylum Chlorophyta

**Common name**: Green algae

#### Classes Charophyceae
- Most closely resemble plants
- Biochemical, structural, and genetic similarities
- Unicellular, colonial, filamentous and parenchymatous genera
- Asymmetrical flagellated cells with multilayered structures
- Breakdown of nuclear envelope at mitosis
- Persistent spindles or phragmoplasts at cytokinesis
- Presence of phytochrome

**View the prepared slides and draw what you see:**
1. *Chara* with sex organs (see picture on center bench)

2. *Spyrogyra*
KEY THE FRESHWATER GREEN ALGAE

There are three mixes of freshwater green algae on the center bench. Each of these mixes contains five species. As a group, key down all five organisms to genera using the attached two-page key. Check your answers on the laptop in a PowerPoint file called “Species in Mix 1 (2 or 3)”. By keying down all five species, you will be introduced to the diversity of form in the Chlorophyta. You can do the other two mixes for extra credit – 5 points each.

<table>
<thead>
<tr>
<th>Species in Mix 1</th>
<th>Species in Mix 2</th>
<th>Species in Mix 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>3.</td>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
<td>4.</td>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
<td>5.</td>
<td>5.</td>
</tr>
</tbody>
</table>