

LOOKING BACK: Having studied the Prokaryotic Autotrophs, we now move to Eukaryotic Autotrophs, beginning with the Autotrophic Protists, known as “Algae.” Looking back to the prokaryotic *Anabaena* and *Prochloron* which have the photosynthetic pigments, Chl a, b, and carotenoids found in “higher plants,” we should ask what additional complexity justifies placing the “Algae” in a separate taxonomic kingdom – Protista? Watch for answers to this question as you study.

READING: Read **Chapter 18** pp. 317-338. We will not include “Heterotrophic Protists,” p. 339ff. Our main focus will be upon the Chlorophyta, or “Green Algae”. Study the Chapter Outline, Overview, and Summary, for overview. Use the EMPHASIS and Study Outline below for orientation. You are referred to **Chapter 12** as relates to mitosis, meiosis, and plant life cycles.

EMPHASIS: This Study Assignment in Chapter 12 and 18 will examine the following themes:

1. Distinguish Autotrophic Protista from Kingdoms Bacteria and Archaea.
2. What forms of morphology, nutrition and reproduction are represented in the algae?
3. Evaluate the claim the Chlorophyta are nearest the ancestral stock for the Plant Kingdom.
4. How do plant life cycles compare to typical animal cycles? Memorize the generalized cycle, Figure 12-6.

STUDY

QUESTIONS:

1. What distinguishes the Protista (Protoctista) from Kingdom Monera?
2. Prepare to briefly discuss representatives and distinguishing features of the major phyla of algae:
 - a. Unicellular → Phylum EUGLENOPHYTA – *Euglena*
 > Phylum DINOPHYTA (or Pyrrophyta) – Dinoflagellates
 - b. Both Unicellular and Multicellular:
 - > Phylum CHROMOPHYTA: Diatoms, and Brown Algae (formerly Phaeophyta)
 - > Phylum CHLOROPHYTA: *Spirogyra*, *Oedogonium*, *Chara*, *Volvox*, *Ulva*, *Chlamydomonas* – unicellular
 - c. Multicellular > Phylum RHODOPHYTA – red algae (seaweed)
3. Learn to write out the typical life cycle of plants (Fig. 12.6), then modify it to represent animals.
4. Distinguish zygotic meiosis (e.g. *Oedogonium*) from gametic (e.g. *Fucus*) and sporic meiosis (e.g. *Polysiphonia*).
 - a. Which is most animal-like?
 - b. Which has the most obvious diploid generation in the cycle? The least?
 - c. Which has the most mitotic activity in the $2n$ phase? The least? How do b. and c. relate?
5. Why are Chlorophyta and the Rhodophyta viewed as major phylogenetic links between prokaryotic life and the “higher plants?”

STUDY OUTLINE: ALGAE

I. PROTISTA -- The "Miscellaneous" Kingdom

- A. Includes autotrophic, plant-like ALGAE; and heterotrophic, animal-like PROTOZOA, and SLIME MOLDS (latter two sometimes classed in Kingdom Fungi)
- B. CONCLUDE: Kingdom Protista largely an A _____ taxonomic group (taxon) that encompasses quite varied and unique species
1. Evolution view admits that Protista (or Protoctista) as well as its taxonomic divisions are polyphyletic (*i.e.* contain genera and species that appear similar but evolved from different ancestral types—as if the phylogenetic tree branches have grafted back together to form this group—inconsistent with evolution’s presuppositions, therefore, not a natural classification.
 2. Creation view would agree that Protista is artificial and composed of many "kinds".
- C. Only consistent characteristic among all protists--their cells are E _____, that is, they have nuclear envelope and plastids
- D. “Heterotrophic Autotrophs” ? Indeed, protists such as Euglena are autotrophic in light, and switch to heterotrophic (dependence upon absorbed organic molecules) in darkness
- E. SEE INTERNET WEBLINKS (from top center of BIO 2500 Schedule Web Page) for color images of the various algal phyla. Scroll down to “Algae: Autotrophic Protists”

II. CHARACTERISTICS OF ALGAE:

- A. HABITAT -- nearly ubiquitous: freshwater, marine, on plants, soil, pools, drains
- B. CELLULAR ORGANIZATION:

1. Unicellular -- e.g. *C hlamydomonas* 3. Filamentous -- e.g. _____
2. Colonial -- e.g. _____ 4. Thalloid -- e.g. _____

QUESTION: Why aren't algae in plant kingdom ?

- > Less Differentiation -- e.g. no true leaves, stems, roots [but *kelps* have vascular tissue in *stipes*]
- > Cellular Layer protecting gametes is *not* present -- Except in C _____

C. PIGMENTS - Distinguishing feature among algal divisions: (TABLE 18.1)

1. Photosynthetic Pigments

- a. All algal divisions have *chlorophyll* ___ and *carotenoids* in plastids
- b. Chlorophyta and Euglenophyta are most *similar to Plantae* in having *chlorophyll* ___
- c. Rhodophyta - like Cyanobacteria, have red P _____ (absorb deep-penetrating blue light)

2. Photo-sensitive Pigment -- for *phototaxis*

- > *Stigma* (eyespot) -- photo-sensitive organelles with pigment R _____
- > Found in motile forms: e.g *Euglena*, *Chlamydomonas*, in zoospores; and in Dinoflagellates

D. ENERGY RESERVES:

1. LIPIDS (oils) -- in **D** _____ (Chromophyta); source of petroleum deposits
2. STARCH -- in **C** _____ and **D** _____ (or Pyrrophyta)
 - > *Pyrenoid* -- structure on chloroplast containing enzymes of CO₂ fixation and starch synthesis
 - > Found in *Chlamydomonas*, *Spirogyra*, *Oedogonium*

E. FLAGELLA

1. Provide motility in unicellular and colonial forms, and in *gametes*
2. Dinophyta -- 2 flagella (*dino* = two); one *rudder* and one *spinner*
 - > RED TIDE - bioluminescent dinoflagellates; toxins released to shellfish
 - > *Pfiesteria* – “the Cell From Hell”; along Atlantic coast, it causes lesions on fish; memory loss, fatigue and sores on humans

F. CELL SUPPORT / PROTECTION

1. Chromophyta (diatoms) - cell walls of **S** _____; cytoplasmic strands protrude thru holes
 - > Shapes: *pennate* (bilateral) and *centric* (radial)
 - > Other protist or animal phyla with mineral coats – _____
2. Dinophyta (Pyrrophyta) - "armor" plates of **C** _____ inside plasma membrane
3. Euglenophyta - has a flexible proteinaceous *pellicle* (or *periplast*)
4. Marine algae - cellulose and gelatinous components:
 - a. Rhodophyta - source of **A** _____ – used in culture media
 - b. Phaeophyta (kelps) – **A** _____ – emulsifier in creamy foods, desserts, cosmetics

G. BODILY SUPPORT

1. Land plants -- cell turgidity and woody tissues
2. Algae -- _____

QUESTION: Where on Earth are the largest plant and animal species?

III. EVOLUTIONARY RELATIONSHIPS -- explain linkage inferred from each of the following:

- A. Chlorophyll *b* --
- B. Phycoerythrin (phycobilin) --
- C. Energy storage as *starch* --
- D. *Phragmoplast* and *cell plate*
- E. *Flavinoid* biosynthesis and *multicellular layer* around gametangia --

IV REPRODUCTION IN ALGAE

- A. ASEXUAL REPRODUCTION -- cell division involving M _____ and C _____

> Major mode of algal reproduction; filament *fragmentation*; production of *zoospores*

- B. SEXUAL REPRODUCTION -- perform M _____ and F _____

C. LIFE CYCLES

1. Models to show alternating *haploid* and *diploid* stages
2. Three variations based upon role of *meiosis*: – the life cycles below are of most importance:
 - a. *Zygotic Meiosis* -- only $2n$ phase is *zygote*; undergoes meiosis > zoospores; like fungi
> Examples: *Syriogyra*, *Oedogonium*, and *Chlamydomonas*
 - b. *Sporic Meiosis* -- multicellular $2n$ phase undergoes meiosis --> spores; like land plants
> Examples: *Polysiphonia*
 - c. *Gametic Meiosis* -- multicellular $2n$ phase undergoes meiosis -> gametes; like animals
> Example: *Fucus* (rockweed)
2. Variation in *gametes*:
 - a. *Isogamous* -- flagellated gametes that appear identical; + or -
> Example: *Chlamydomonas*
 - b. *Oogamous* -- motile (male) and larger, nonmotile (female) gametes
> Example: *Oedogonium*, *Chara*