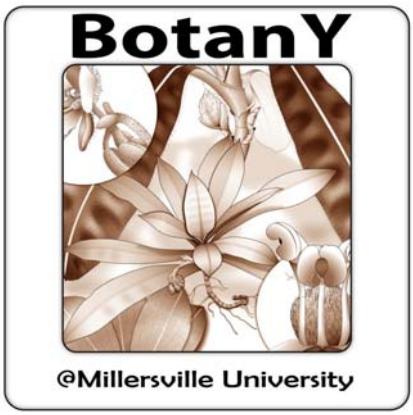
Topic 14



Algae

Raven Chap. 12 regarding Cyanobacteria (pp. 263-266), Chap 15 regarding algae (pp. 317-358)

I. What is an alga?

A. Any* photoautotroph not in Kingdom Plantae.
   1. Green algae
   2. Red algae
   3. Brown algae & Diatoms
   4. Blue-green algae* (Cyanobacteria)

I. What is an alga?

B. Characteristics of

- Photosynthetic
- Aquatic (terrestrial)
- No cuticle
- Nonvascular
- Most lack 2n multicellular form
- Fertilization (when present) via external water

- Base of aquatic food chains; 90% of marine and freshwater biomass.

I. What is an alga?

C. Where do you find them?

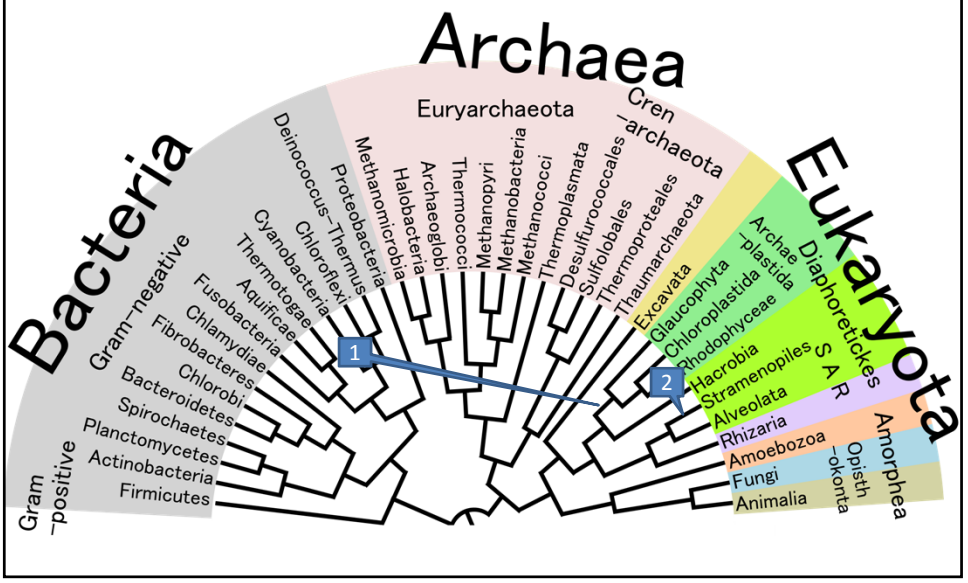
Regularly moist areas, fresh or marine

but most capable of regular, extreme dessication (e.g., intertidal zones, N face of houses or trees).

I. What is an alga?

D. Evolution?

Polyphyletic (not monophyletic)

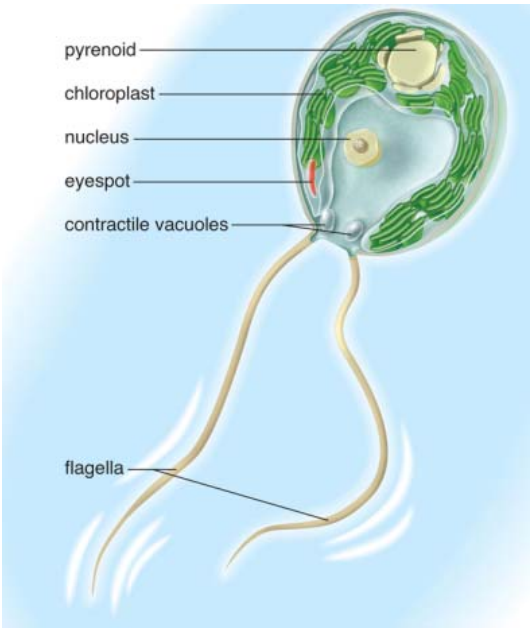


II. Green algae

- 17,000 spp. (sensu Raven)
- All habitats (incl. endosymbiotically)
- Microscopics important as plankton
- Typically haploid phase dominant & zygotic meiosis
- **Pigments:** chl. a, b, carotenoids (same as plants)
- **Storage CH_2O:** starch
- **Cell wall:** cellulosic

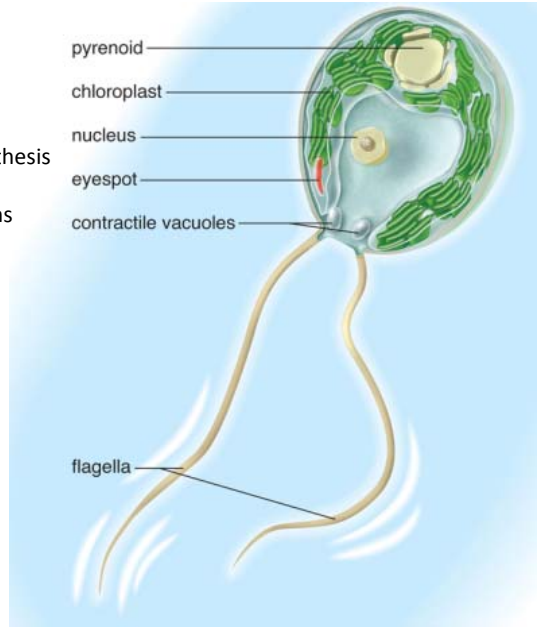
A. Unicellular

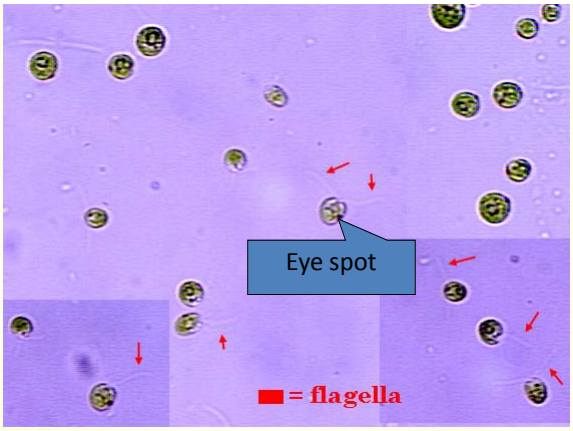
1. *Chlamydomonas*
   - •quiet freshwater
   - •motile
   - •1n (zygotic meiosis)



A. Unicellular

Pyrenoid:
- In chloroplast
- Center of CO_2 fixation or starch synthesis
- Visible due to enzyme density
- Typically surrounded by starch grains





Chlamydomonas

A. Unicellular

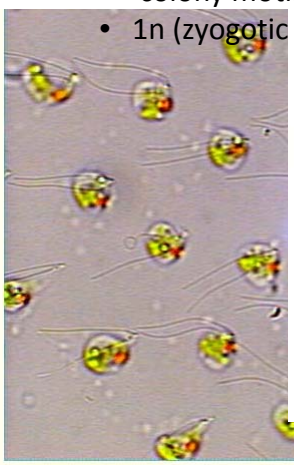
2. Acetabularia (Mermaid's wineglass)

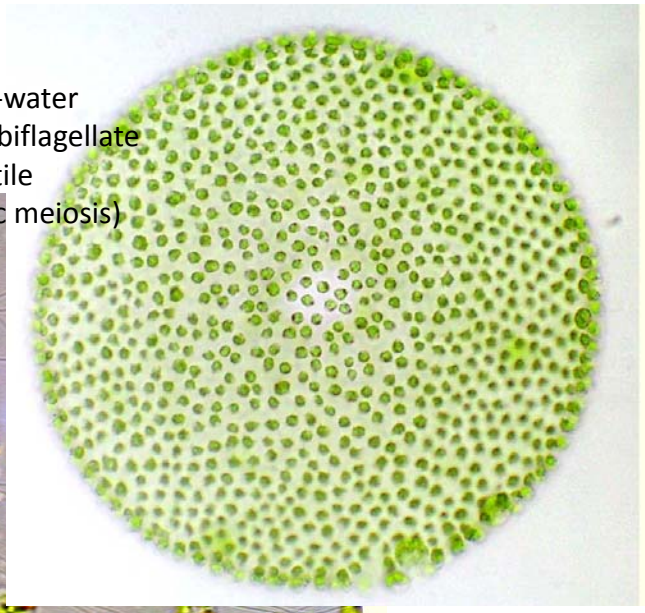
- Marine seaweed
- Typically subtropical
- Coenocytic
- Rhizoid, stalk, cap
- Non-motile
- 2n (1n = gametes)

5 cm

B. Colonial

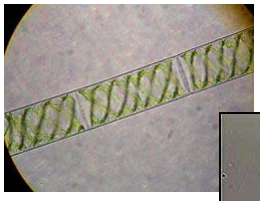
1. *Volvox*
   - quiet fresh-water
   - eyespot & biflagellate
   - colony motile
   - 1n (zyogotic meiosis)

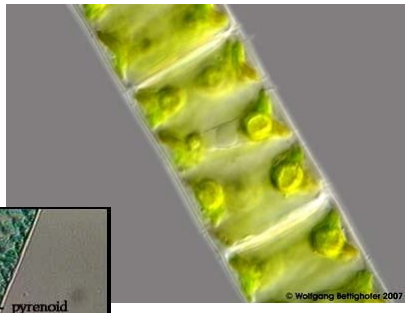


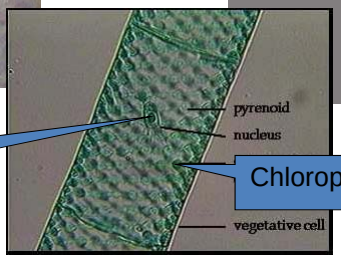


C. Filamentous (1D)

1. *Spirogyra* (watersilk)
   - quiet freshwater
   - Non-motile
   - 1n (zygotic meiosis)





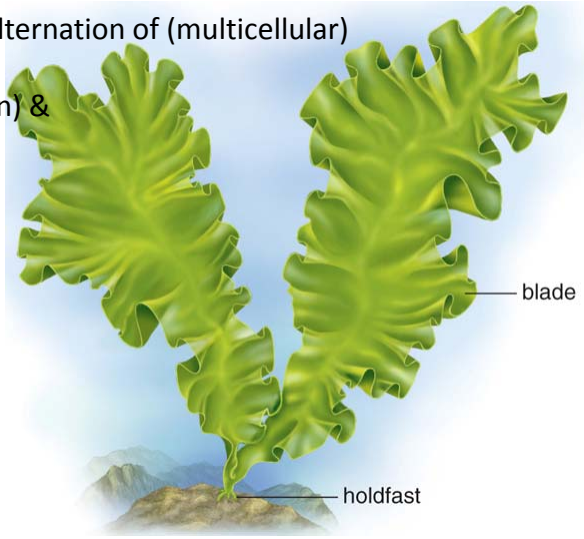


Nucleus

Chloroplast

D. Planar/thalloid (2D)

1. *Ulva* (sea-lettuce)
   - Marine seaweed
   - Homomorhpic Alternation of (multicellular) Generations: Gametophyte (1n) & Sporophyte (2n) (therefore no zygotic meiosis)



D. Planar/thalloid (2D)

1. *Ulva* (sea-lettuce)

III. Red algae

- 6000 spp. (Raven)
- Mostly marine
- Mostly seaweeds w/ holdfast (unicellular)
- Among the deepest (269+ m depth)
- **Pigments:** chl. a, d, red phycobilins, carotenoids
- **Storage CH_2O:** floridean starch
- **Cell wall:** Inner = cellulosic; Outer = pectic substances
  (coralline algae w/ calcium carbonate too)

III. Red algae

a. Economic Botany

-carrageenan

a polysaccharide used as stabilizing agent in foods such as chocolate milk, ice cream, pudding, etc.

-agar

a polysaccharide used as a solidifying agent. Found in many food products as well as laboratory culture plates and in agarose used to make gels for electrophoretic separation of DNA molecules.

-edibles

outer wrapping on sushi is the seaweed *Porphyra.*

IV. Brown algae & Diatoms

- 7600 spp.
- Marine, Fresh (terrestrial)
- Most abundant in cold waters
- **Pigments:** chl. a, c, carotenoids (mainly fucoxanthin)
- **Storage CH_2O:** laminarin
- **Cell wall:** cellulose & alginic acids or silica

IV. Brown algae & Diatoms

A. Browns

- 1500 spp.
- Marine
- Most seaweeds (some reach 100 m in length)
- **Cell wall:** cellulose & alginic acids

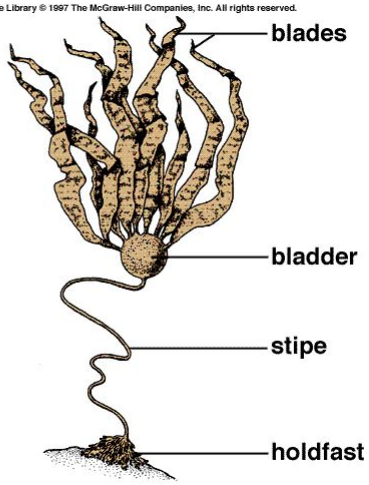
IV. Brown algae & Diatoms

A. Browns

1. General Morphology

Kingsley R. Stern, Botany Visual Resource Library © 1997 The McGraw-Hill Companies, Inc. All rights reserved.

Parts of the Brown Alga *Nereocystis*, a Kelp



IV. Brown algae & Diatoms

A. Browns

1. General Morphology

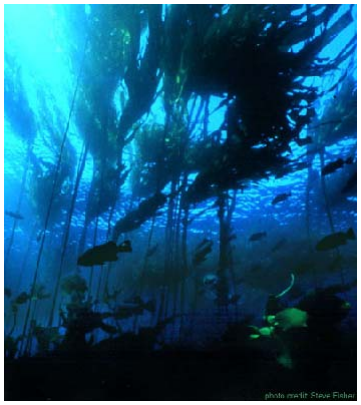
Macrocystis **(giant kelp)**

IV. Brown algae & Diatoms

A. Browns

1. General Morphology

Macrocystis sp. (kelp)



Nereocystis sp. (kelp)

IV. Brown algae & Diatoms

A. Browns

1. General Morphology

Macrocystis (giant kelp)

IV. Brown algae & Diatoms

A. Browns

Sargassum

IV. Brown algae & Diatoms

A. Browns

Rockweed

IV. Brown algae & Diatoms

A. Browns

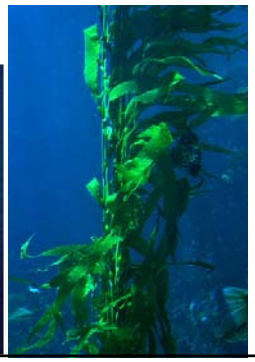
2. Economic Botany

a. algin (alginic acid)

Uses similar to “carrageenan” of red algae.
a carbohydrate used as stabilizing agent in foods such as chocolate milk, ice cream, pudding, etc.

b. Asian cuisine

many species eaten.



IV. Brown algae & Diatoms

A kelp mower off California coast.
Algin will be extracted from this.

Laminaria sp.

V. Cyanobacteria

(bluegreen bacteria, bluegreen algae)

- >1500 spp.
- Prokaryotic
- **Cell wall:** peptidoglycan (gram -)
- **Storage CH_2O:** cyanophycean starch

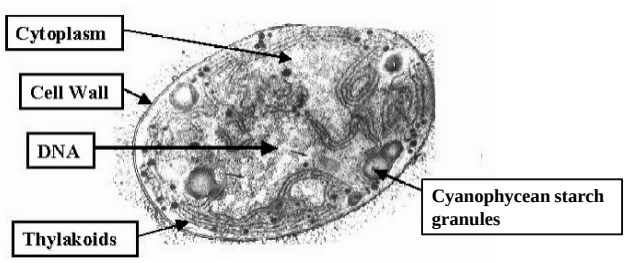
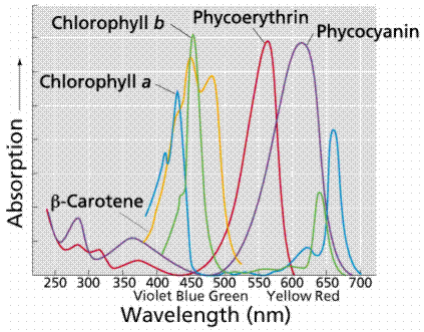


Figure by Frank Jochem,
Florida International University

V. Cyanobacteria

- **Pigments:** Chl. a, Chl. b, carotenoids, phycobilins called phycocyanin (blue) and phycoerythrin (red)



V. Cyanobacteria

- Unicellular, filamentous, colonial packets in mucilage

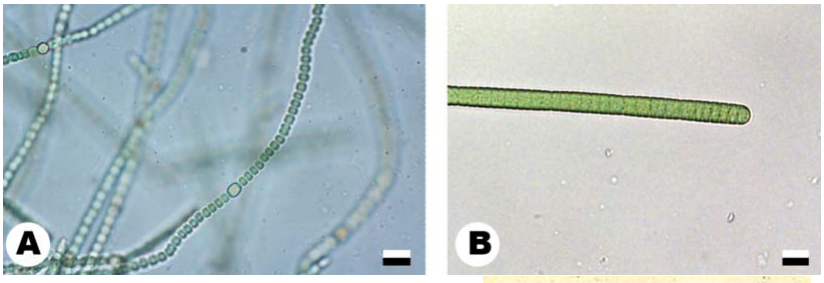


Figure 9.2A (*Anabaena*) and B (*Oscillatoria*)

Scale bar = 20 µm

from Hardy CR, JR Wallace. 2012. Algae in forensic investigations. Chapter 9 in D Hall, JH Byrd (eds) *Forensic Botany: A Practical Guide*. John Wiley & Sons, Ltd. London.

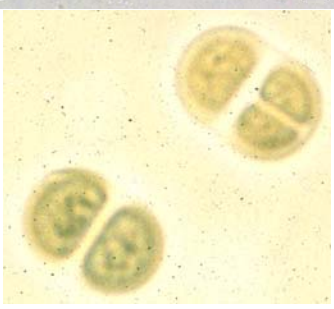


Figure 9.6 (*Anacystis*)

V. Cyanobacteria

- Marine or freshwater (terrestrial), some in lichens, some in hot springs @ 85 C
- Planktonic (important in marine) or Mat-forming

V. Cyanobacteria

- N-fixing
- Some motility via gliding or oscillation via gas vessicles

V. Cyanobacteria

Ethnobotany

Good

- Food for commercial fish
- N-fixing species in rice fields
- Asian Cuisine: e.g., *Nostoc* (below)

V. Cyanobacteria

Ethnobotany

Good

- *Spirulina*
  1) eaten in Africa (Lake Chad region) and Mexico City region
  2) sold as vitamin-rich health supplement

V. Cyanobacteria

Ethnobotany

Bad

- *Some impart bad odors and tastes to drinking water*
- *Cyanotoxins: Some produce harmful, toxic algal blooms that can kill domestic animals (even humans in 1 known case); also implicated in Guam ALS-PDC*

e.g., Brazil, 1996: 26 of 130 dialysis patients died over several days due to liver failure, 96 more severely ill due to use of water from *Microcystis*-infected reservoir.

Jochimsen et al. 1998. New England Journal of Medicine 338: 873-878.

e.g., Wisconsin, 2002: 17 year old dies after swim in *Anacystis*-infected golf course pond from cardiac arrest and other preceding problems.

Behm. 2003. *Milwalkee Journal Sentinel*, 6 Sep 2003.