Topic 10
Algae

Chap. 17 (pp. 305-309)
Chap. 18 (Protista; pp. 319-341)

I. What is an alga?

A. Any photoautotroph not in Kingdom Plantae.
   1. Green algae
   2. Red algae
   3. Brown algae & Diatoms
   4. Dinoflagellates
   5. Euglenoids
   6. Cyanobacteria & Prochlorobacteria

I. What is an alga?

B. Characteristics of

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

- Base of aquatic food chains

I. What is an alga?

C. Where do you find them?

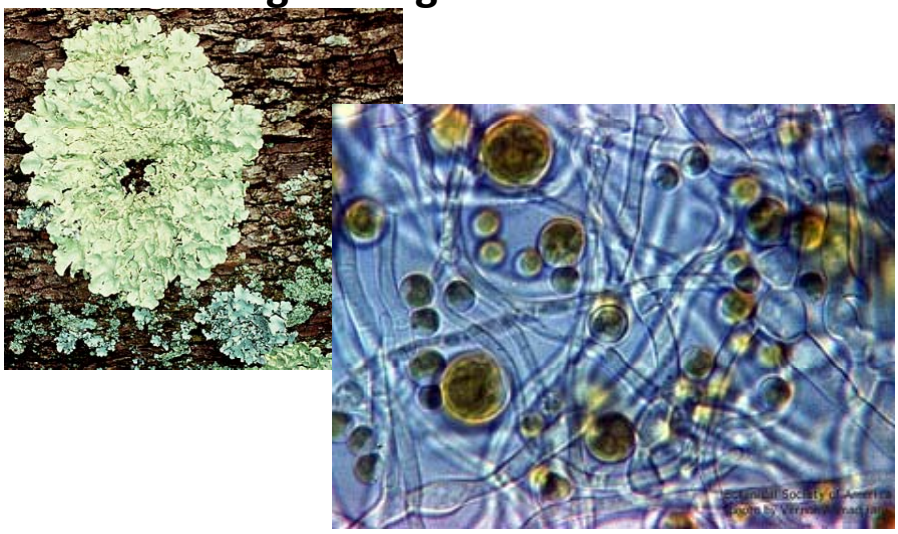
Regularly moist areas, fresh or marine

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

II. Green algae

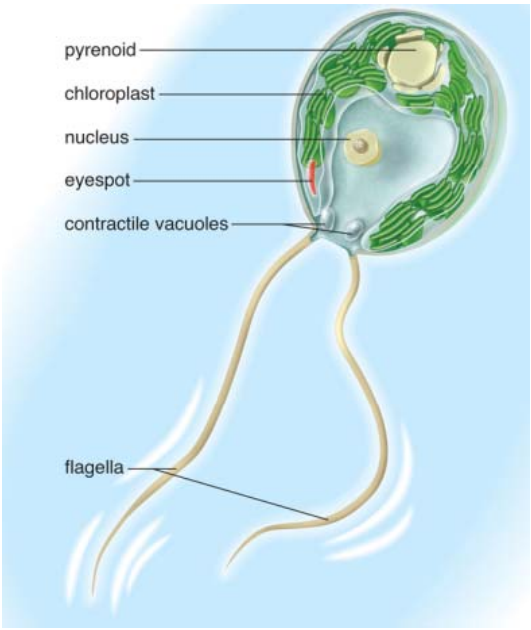
- 7500 spp.
- All habitats (incl. endosymbiotically)
- Microscopics important as plankton
- Typically haploid phase dominant & zygotic meiosis
- **Pigments:** chl. a, b, carotenoids
- **Storage:** starch
- **Cell wall:** cellulosic

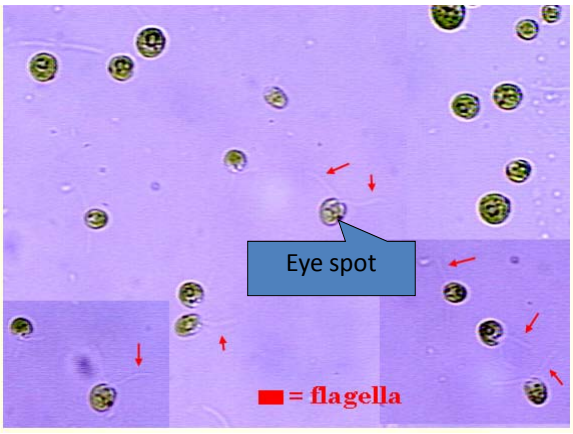
Lichens = fungus + alga



A. Unicellular

1. *Chlamydomonas*
   - quiet fresh-water





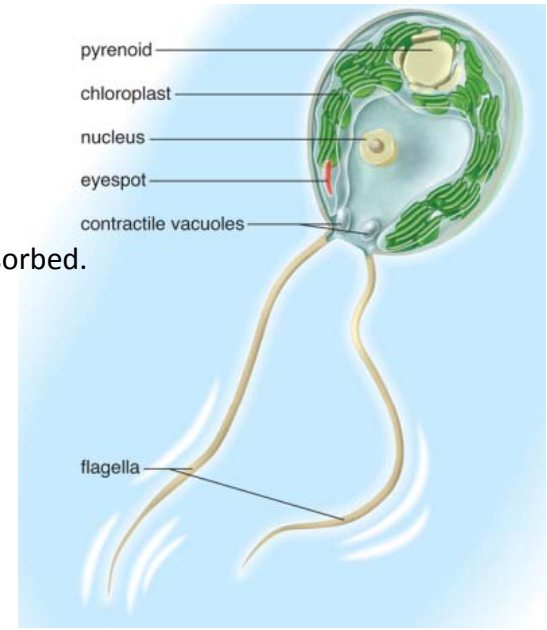
Chlamydomonas

A. Unicellular

1. *Chlamydomonas*

   a.Asexual repro.

   1)Flagella fall/reabsorbed.
   2)Mitosis
   3)Flagella reform.

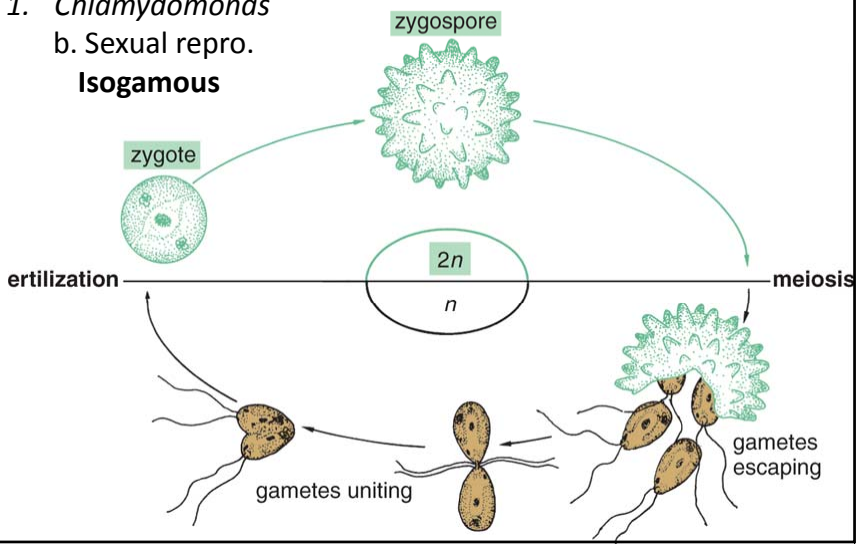


A. Unicellular

1. *Chlamydomonas*

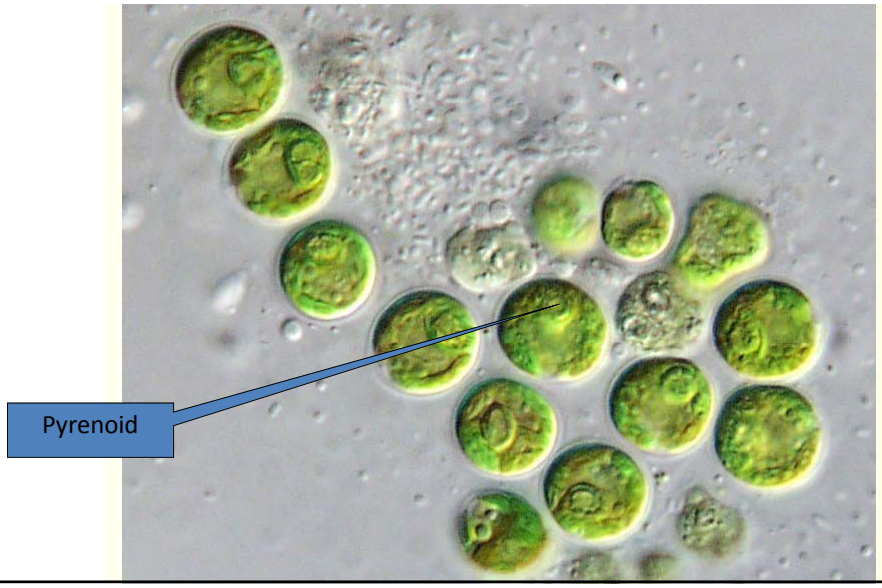
   b. Sexual repro.

   Isogamous



A. Unicellular

2. Chlorella



A. Unicellular

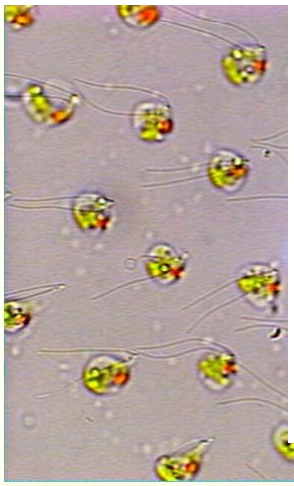
3. Acetabularia (Mermaid's wineglass)

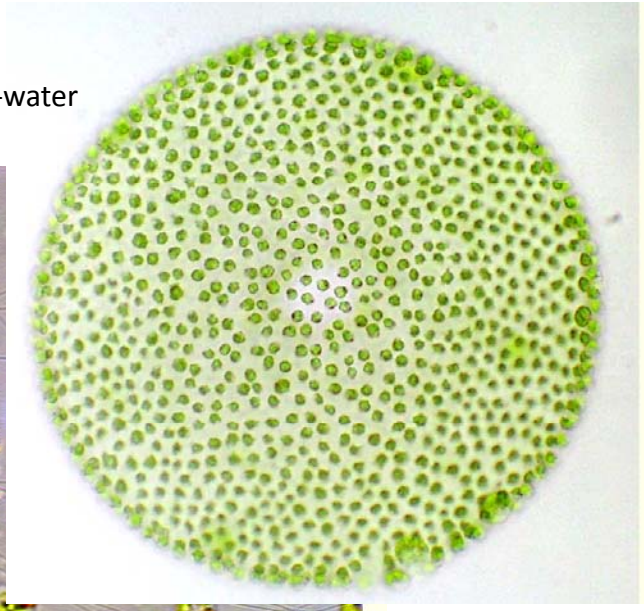
- Marine seaweed

5 cm

B. Colonial

1. Volvox
- quiet fresh-water

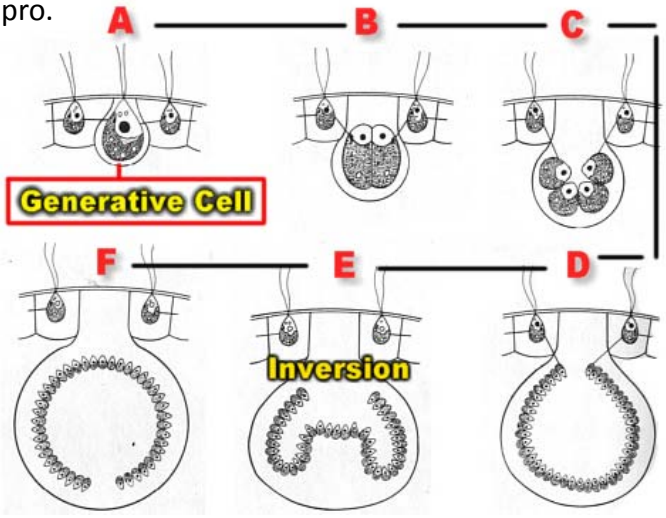




B. Colonial

1. Volvox

a. Asexual repro.

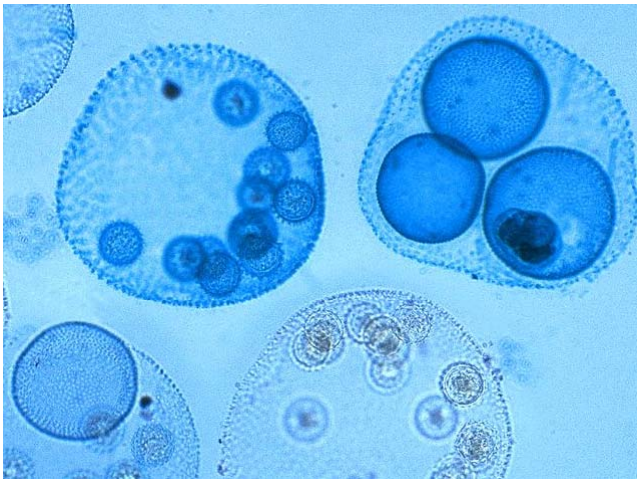


www.botany.hawaii.edu/.../Chlorophyta-4-00.htm

B. Colonial

1. Volvox

a. Asexual repro.



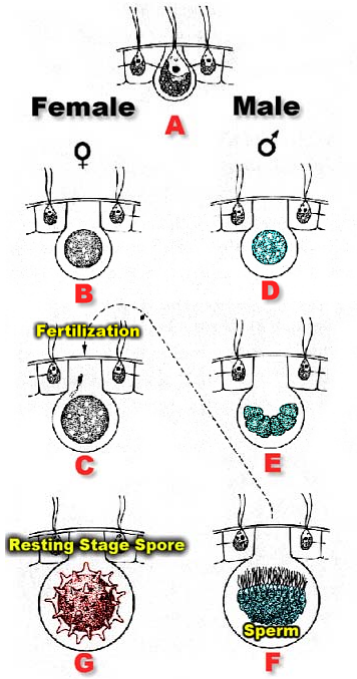
B. Colonial

1. Volvox

b. Sexual repro.

Oogamous

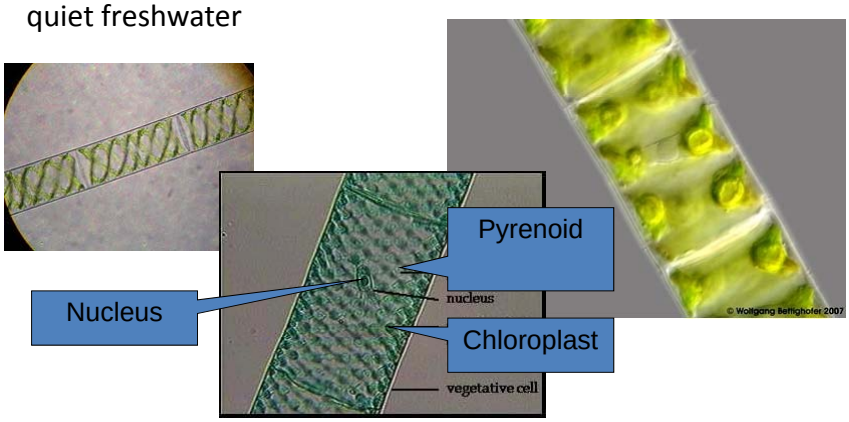
1. Fertilization
2. Zygospore
3. Meiosis
4. Zoospores
5. New *Volvox*



www.botany.hawaii.edu/.../Chlorophyta-4-00.htm

C. Filamentous (1D)

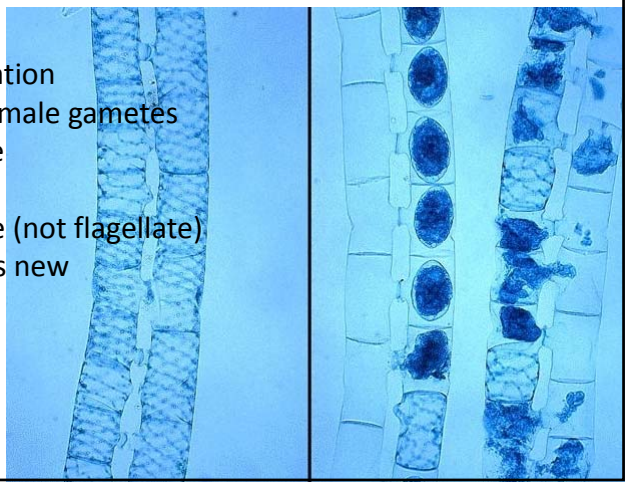
1. *Spirogyra* (watersilk)
   quiet freshwater



C. Filamentous

1. *Spirogyra* (watersilk)
   a. Asexual repro.
      Via fragmentation.

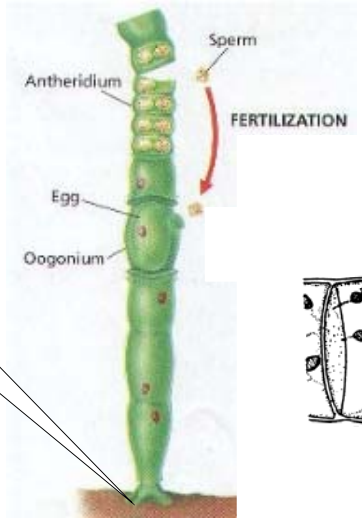
   b. Sexual repro.
      Via conjungation
      1) male & female gametes
      2) Zygospore
      3) Meiosis
      4) One spore (not flagellate) cell becomes new filament.



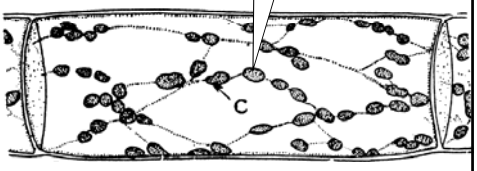
C. Filamentous

2. Oedogonium

Epiphyte on plants/surfaces in fresh water.



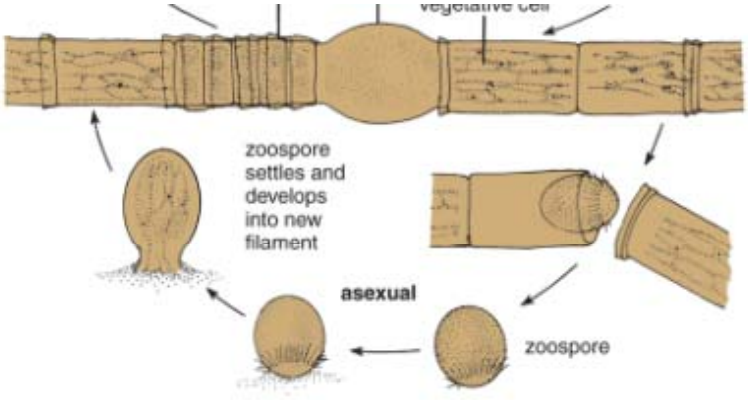
Tubular, net-like CP w/ pyrenoids



C. Filamentous

2. Oedogonium

a. Asexual repro.
   Via cloned "zoospore" formation or fragmentation.

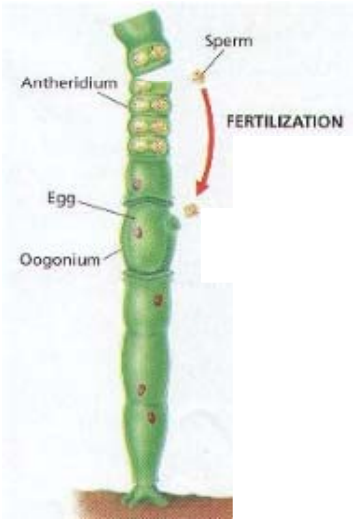


C. Filamentous

2. Oedogonium

b. Sexual repro.
Via **oogamy**, "antheridia", & oogonia.

1. Fertilization
2. Zygospore
3. Meiosis
4. Zoospores

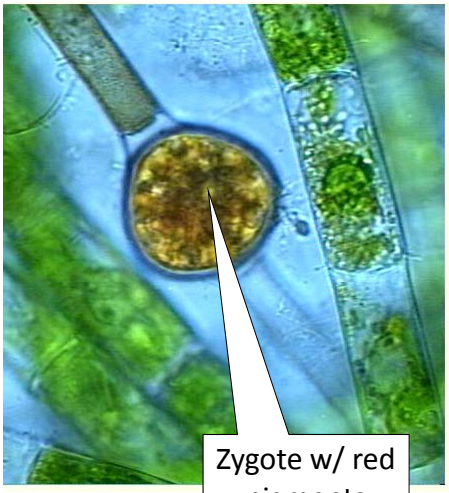


C. Filamentous

2. Oedogonium

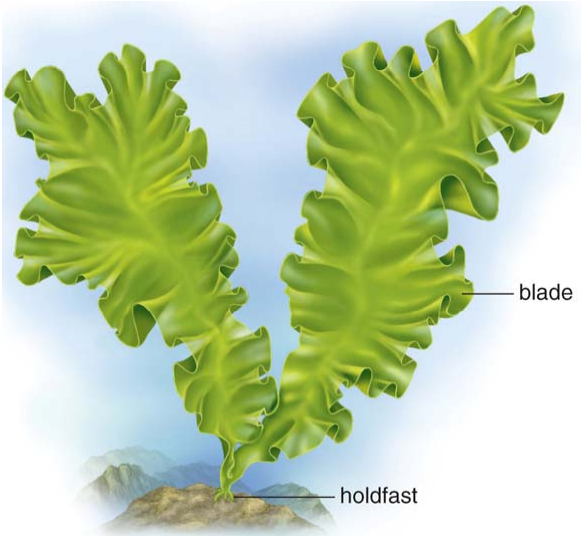
b. Sexual repro.
Via **oogamy**, "antheridia", & oogonia.

1. Fertilization
2. Zygospore
3. Meiosis
4. Zoospores



D. Planar/thalloid (2D)

1. *Ulva* (sea-lettuce)
   - Marine seaweed
   - Gametophyte & Sporophyte (therefore no zygotic meiosis)



D. 2D (planar, thalloid)

1. *Ulva* (sea-lettuce)

III. Red algae

- 5000 spp.
- Mostly marine
- Mostly filamentous seaweeds w/ holdfast (unicellular)
- Among the deepest (269+ m depth)
- **Pigments:** chl. a, d, phycobilins
- **Storage:** 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, fucoxanthin xanthophylls
- **Storage:** laminarin
- **Cell wall:** cellulose & alginic acids or silica

IV. Brown algae & Diatoms

A. Browns

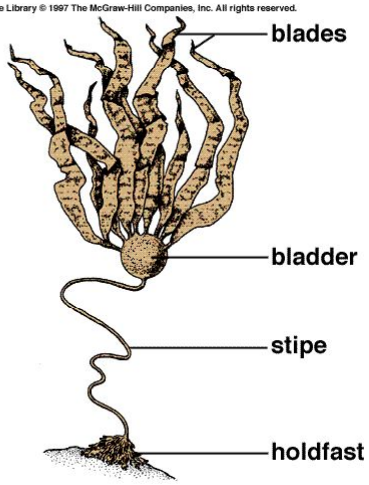
- 1500 spp.
- Marine
- Most seaweeds (some reach 100 m in length)
- **Cell wall:** cellulose & alginic acids

IV. Brown algae & Diatoms

A. Browns

1. General Morphology

Parts of the Brown Alga *Nereocystis*, a Kelp



IV. Brown algae & Diatoms

A. Browns

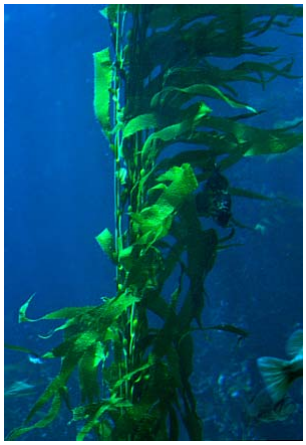
1. General Morphology

Macrocystis **(giant kelp)**

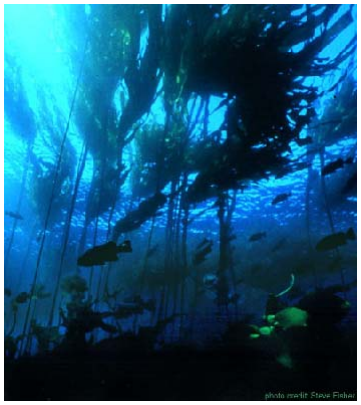
IV. Brown algae & Diatoms

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

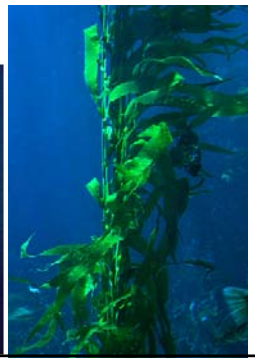
2. Economic Botany

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.

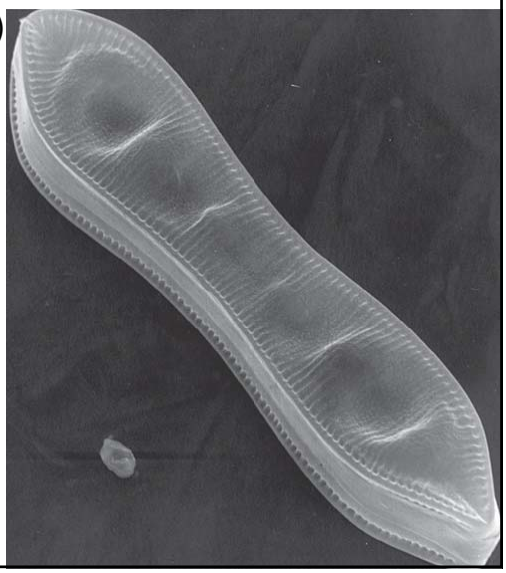
Laminaria sp.

IV. Brown algae & Diatoms

B. Diatoms

- >=5000 spp.
- Fresh or Marine (terrestrial)
- Unicellular (colonial)
- **Cell wall:** silicaceous, in 2 frustrules

Major component of phytoplankton, esp. marine



IV. Brown algae & Diatoms

B. Diatoms

1. General Morphology
   a. symmetry
- Polysymmetric
- Disymmetric
- Monosymmetric

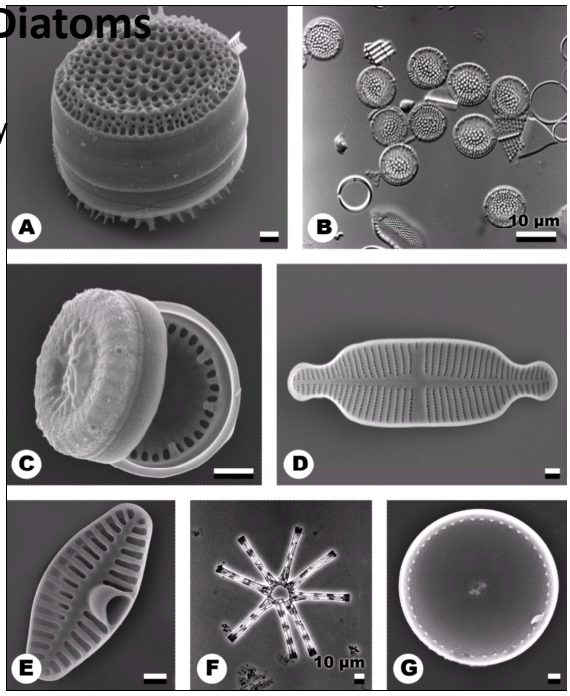


Figure 9.4 from Hardy CR, JR Wallace. 2012. Algae in forensic investigations. Chapter 9 in D Hall, JH Byrd (eds) *Forensic Botany: A Practical Guide*. John Wiley & Sons, Ltd. London.

Scale bar = 1 µm except where otherwise indicated.

IV. Brown algae & Diatoms

B. Diatoms

1. General Morphology
   b. color

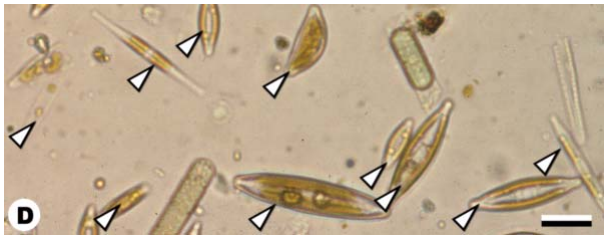


Figure 9.1D from Hardy CR, JR Wallace. 2012. Algae in forensic investigations. Chapter 9 in D Hall, JH Byrd (eds) *Forensic Botany: A Practical Guide*. John Wiley & Sons, Ltd. London.

Scale bar = 10µm

IV. Brown algae & Diatoms

B. Diatoms

2. Ethnobotany

- Diatomaceous earth
- Oil

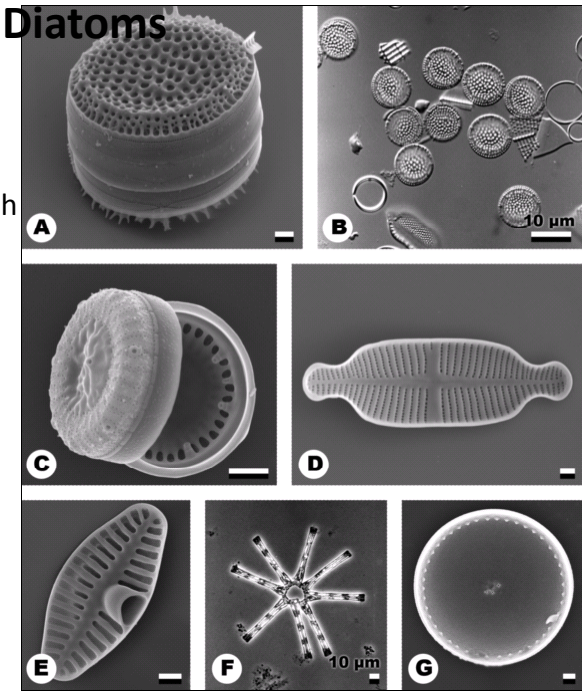


Figure 9.4 from Hardy CR, JR Wallace. 2012. Algae in forensic investigations. Chapter 9 in D Hall, JH Byrd (eds) *Forensic Botany: A Practical Guide*. John Wiley & Sons, Ltd. London.

Scale bar = 1 µm except where otherwise indicated.

IV. Brown algae & Diatoms

B. Diatoms

2. Ethnobotany

- Diatom Test for Drowning

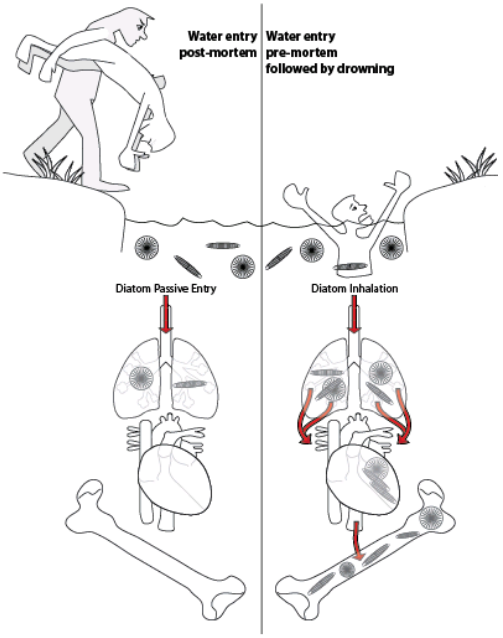


Figure 9.7 from Hardy CR, JR Wallace. 2012. Algae in forensic investigations. Chapter 9 in D Hall, JH Byrd (eds) *Forensic Botany: A Practical Guide*. John Wiley & Sons, Ltd. London.

V. Dinoflagellates

- >5000 spp.
- Unicellular
- Marine or freshwater (more species in the former)
- Planktonic
- **Pigments:** Chl. a, Chl. c, peridinin (a brownish xanthophyll sensu Stern)
- **Cell wall:** cellulosic, internal
- **Storage:** starch

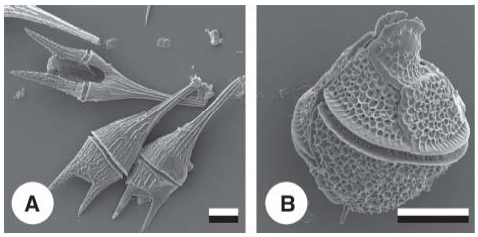


Figure 9.5A,B

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.

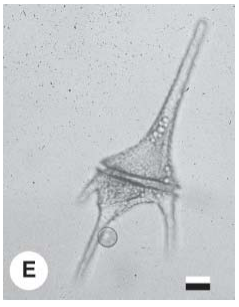


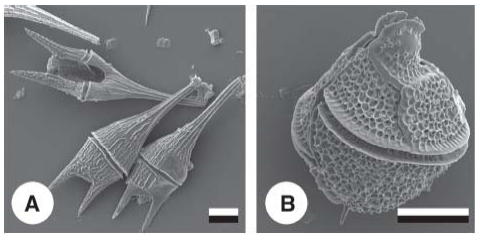
Figure 9.1E

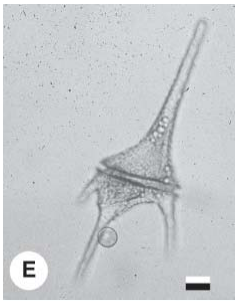
Scale bar = 20 µm except where otherwise indicated.

V. Dinoflagellates

Some responsible for

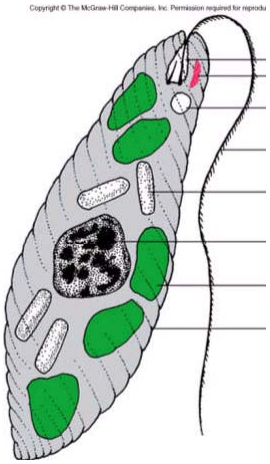
- Bioluminescence
- Red Tides
- Dinotoxins (e.g., saxitoxin)
- Paralytic Shellfish Poisoning





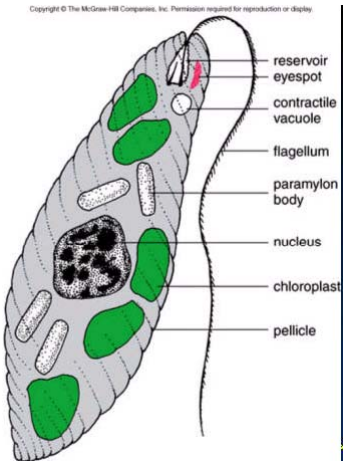
VI. Euglenoids

- 800-900 spp.
- Unicellular
- Freshwater
- Motile
- Planktonic



VI. Euglenoids

- 800-900 spp.
- Unicellular
- Freshwater
- Motile
- Planktonic
- **Pigments:** Chl. a, Chl. b, carotenoids
- **Cell wall:** none
- **Storage:** paramylon (similar to starch
- **Special Feature:** flexible pellicle (plasma membrane underlain by flexible, spiraling protein bands)



VII. Cyanobacteria

(bluegreen bacteria, bluegreen algae)

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

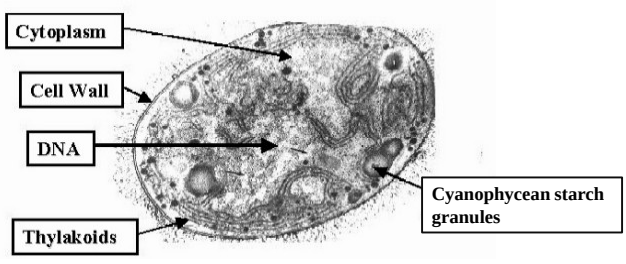


Figure by Frank Jochem, Florida International University

VII. Cyanobacteria

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

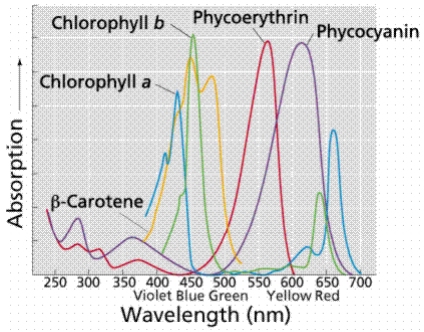


Figure by Frank Jochem,
Florida International University

VII. Cyanobacteria

- Unicellular, filamentous, colonial packets in mucilage

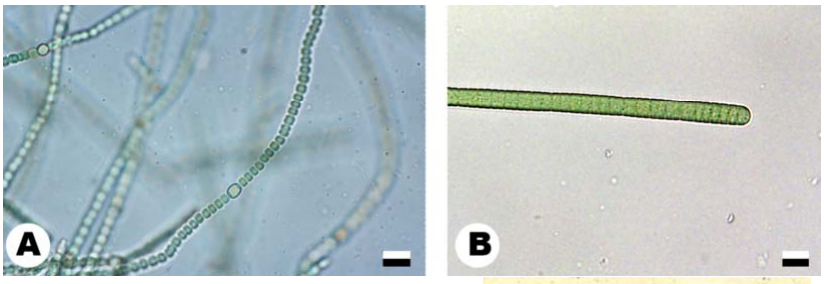


Figure 9.2A (*Anabaena*) and B (*Oscillatoria*)

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.

Scale bar = 20 µm

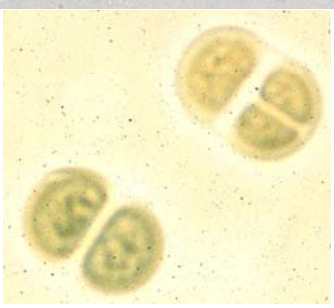


Figure 9.6 (*Anacystis*)

VII. Cyanobacteria

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

VII. Cyanobacteria

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

VII. Cyanobacteria

Ethnobotany

Good

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

VII. Cyanobacteria

Ethnobotany

Good

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

VII. 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)*

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.