Division: Chlorophyta

The mean Greens

I. Taxonomy

II. Unifying Characteristics

III. Distinguishing Classes

IV. Classes in Detail

Easiest division of Chlorophyta from other algae:
- usually bright green, grassy color

Exceptions:
Essential Members of the Phytoplankton

I. Algal Taxonomy

Hierarchical system of classification:
Level: Suffix: Example:
Domain
Kingdom Eukaryote
Phylum/Division Plantae
Class Chlorophyta
Genus Ulvophyceae
Species Ulva
Species lactuca
Evolution of structural complexity
- Primitive unicells evolved structural complexity over time
- Morphological divergence distinguishes groups
Making taxonomic distinctions (classes) based on morphology can easily lead to mistakes. **Prasinophyceans** are unicells but.....
II. Unifying features of the Chlorophyta

1. Flagellate cells = typically possess 2 flagellae, equal length

- multiples of two
- arrangement at flagellar base

Flagellar Phototaxis

1. light sensation (stigma)
2. Ca2+ influx
3. 1 more active, 1 less
4. orientation to light
2. Mitochondria

![Mitochondrial Diagram]

flattened cristae
advantages?

3. Plastids

A. all contain at least 1 plastid
   multiple, discoid plastids

   green algae = variety of chloroplast forms

   synthesize and store starch

   main photopigments = chlorophyll a and b, β-carotene

A Chlamydomonas, B Chlorella, C Asterochloris, D Acrochaete, E Spirogyra, F Enteromorpha, G Pseudocodium
4. Pyrenoids

sites of carbon fixation often within the chloroplast of algal cells

concentration of carbon dioxide

III. Bases for distinction between classes

1. Cell division
   A. Mitotic spindle

   nucleus = dumbbell shaped

   closed
   metacentric centrioles
   open

   Chlorophyceae
   Trebouxiophyceae
   Ulvophyceae
   Prasinophyceae
   Charophytes
   Land Plants

   Prasinophyceae
   Trebouxiophyceae
1. Cell division
   B. phycoplast vs phragmoplast

<table>
<thead>
<tr>
<th>Phycoplast: tubules parallel to plane</th>
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<tbody>
<tr>
<td>Phragmoplast: tubules perpendicular to plane</td>
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</table>

   Chlorophyceae
   Trebouxiophyceae
   Ulvophyceae
   Prasinophyceae
   Charophytes
   Land Plants

   unclear in Prasinophyceae & Trebouxiophyceae

1. Cell division
   C. furrowing vs cell plate formation

   Furrowing: most algae
   Cell plate formation = Charophytes and land plants
2. **ONE** basal body per flagellum, located at the flagellar base, anchoring into the cell
- basal body pairing may vary

<table>
<thead>
<tr>
<th>parallel</th>
<th>opposed</th>
<th>clockwise</th>
<th>counter clockwise</th>
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3. **Cell covering**

- **Scales** - made of complex polysaccharides
- **Cell wall** - usually cellulose

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<tr>
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Some new concepts and review of old ones

1. Levels of Complexity – Chlorophyta are most diverse in growth forms, some microscopic (unicellular), some up to 8m long

A. Unicellular forms
   *Chlamydomonas, Chlorella, Dunaliella, desmids*

B. Colonial forms
   Unicells form large interconnected groups
   *Pandorina, Pediastrum, Volvox*

C. Filamentous forms
   Colonial form where single algal cells form long visible chains, threads, *Cladophora, Ulothrix*

D. Thallous forms
   Composed of plates or cells arranged into tree-like forms, *Ulva*

E. Coenocytic forms
   A multinucleate mass enclosed in a single cell wall
   *Caulerpa, Codium*
2. Sexual Fusion

Isogamy –

Anisogamy –

Oogamy –

3. Generations

Sporophyte – diploid (2n), multicellular, produces spores through meiosis

Gametophyte – haploid (n), multicellular, may be microscopic, produces gametes through mitosis
IV. Classes in Detail - The Chlorophyte Diversity
Class Prasinophyceae

Unicellular, may be flagellar or lack flagellae

Open or closed cell division
Phycoplast or phragmoplast
Division by furrowing

Basal bodies opposite
Large golgi body b/w basal bodies

Cell covering = 1-5 layers of polysaccharide scales

Chlorophyceae
Trebouxiophyceae
Ulvophyceae
Prasinophyceae
Charophytes
Land Plants
extrusomes –

Reproduction mainly asexual - may produce resting stages or “cysts”

Mostly marine, some freshwater

one chloroplast (cup shaped), single pyrenoid
Class Chlorophyceae

Unicellular, colonies, filaments, coenocytes

- closed cell division
- phycoplast
- division by furrowing
- basal bodies clockwise
- cell wall out of cellulose
- mostly freshwater, some marine species
- anisogamous, isogamous and oogamous

Genus: Chlamydomonas

Unicellular, terrestrial, fw, marine, even in snow

can grow in total darkness = acetate

deprivation of nitrogen = diploid zygospore

haplontic = somatic cells
Genus: *Tetraspora*

Colonial, cell body spherical, 2 or more flagellae

Colony with gelatinous bag

Single chloroplast, cup-shaped with pyrenoid

Haplontic – sexual reproduction in unfavorable conditions only
Genus: *Dunaliella*

Unicellular, cells often ovoid, distinctly mucilaginous

Chloroplast single, generally cup shaped

Plastids packed with β carotene

Uses in cosmetics, food supplements, aquaculture

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**Tree of Life:**

- Chlorophyceae
  - Trebouxiophyceae
  - Ulvophyceae
  - Prasinophyceae
  - Charophytes
  - Land Plants
Class Trebouxiophyceae

Unicells, filaments, blades

- Metacentric cell division
- Phycoplast
- Division by furrowing
- Basal bodies counterclockwise
- Cell wall out of cellulose
- Mostly freshwater/terrestrial

Genus: Chlorella

Unicellular, generally spherical

- Endosymbiotic
- Ring-shaped or cup shaped chloroplast

Melvin Calvin = Nobel prize (Chemistry), CO₂ assimilation in plants

High in protein, minerals and vitamins = nutritional supplement
Class Ulvophyceae

Unicells, filaments, blades

closed cell division
phragmoplast
division by furrowing

basal bodies counterclockwise

cell wall out of cellulose

mostly marine macroalgae
Diverse Morphologies

unbranched filament
parenchymatous

branched filament
coenocytic/ siphonous

Thallus Composition

no organized “distinct” parts

some analogous structures to vascular plants

holdfast = anchor

stipe = support to the blades

blades = photosynthetic
Genus: *Ulva*

- Blade-like
- Ephemeral in intertidal
- Fast growing, tasty to herbivores
- Some euryhaline
- Cellular construction?

![Life Cycle of Ulva](image)

![Image of Ulva](image)
Genus: *Ulothrix*

Filamentous, unbranched uniserate

Cells closely adherent

Simple or rhizoidal basal cells

ring-shaped chloroplast, partially or completely encircling cell circumference

Pyrenoids single

Sexual reproduction by isogamous, biflagellate gametes

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Genus: *Codium*

Coenocytic/siphonous construction:

= Multinucleate

“clotting compounds” to quickly repair wounds
Bryopsis

Uniaxial and multiaxial construction

*Codium the size of an apple = ~30 km of siphons

Gametangium

Utricles
Codium Scallop Interactions

Attach and grow on scallops
Weigh them down and prevent escape from predators
Cast adrift in heavy storms
Results in high mortality

Kleptoplastids

- Sacoglossan radula adapted to host alga (length of tooth ~ thickness of siphon)
- Common in siphonous greens
- Pierce and suck out insides
- Stolen chloroplasts can last up to a month or so
Genus: **Caulerpa**

- uniaxial, but with trabeculae for support
- trabecula = ingrowth of wall material
- unicellular, coenocytic
- rhizoids with specific attachment mechanisms

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**The Caulerpa Invasion**

- native in Australia (non-native strains have invaded)
- 1st introduced as a non-native in Mediterranean (1984)
- introduced at 2 sites in S.California (Carlsbad, Huntington Harbor)
- genetics =

= listed as one of the top 100 invasive species in the world
Genus: *Halimeda*

anisogamous, dioecious = separate sexes

Holocarpic reproduction

Calcification as defense against herbivores

Calcification: CaCO4 precipitated from water column

(decalcify *Halimeda*, just a mass of enormous siphons)

Both chemical and structural defense common in tropical spp

*Elysiella*