Division: Heterokontophyta

Or

(Ochrophyta, Chromophyta, Phaeophyta)

~ 1,500 species
99% marine

Division: Heterokontophyta

Many classes……mostly unicellular or colony of unicells……..

- class: Chrysophyceae
- class: Synurophyceae
- class: Dictyochophyceae
- class: Pelagophyceae
- class: Raphidophyceae
- class: Xanthophyceae
- class: Eustigmatophyceae
- class: Tribophyceae
- class: Phaeothamniophyceae

** We will focus on marine macroalgae……
- class: Phaeophyceae

General Brown Characteristics……

1) Pigments: chl a,c
   carotenoids: B-carotene, violaxanthin, fucoxanthin

2) Chloroplast structure:
   - envelope:
   -
   - thylakoids:

3) Storage product:

4) Flagella:

Pigments……

Characteristic olive-brown color from:
1. a carotenoid pigment, fucoxanthin
2. tannins (a.k.a. polyphenolic compounds and terpines)

Fucoxanthin:

- protection from UV

Tannins:

- anti-endophyte, -epiphyte, and anti-herbivory
- stored in special vesicles called "physodes" in the cytoplasm

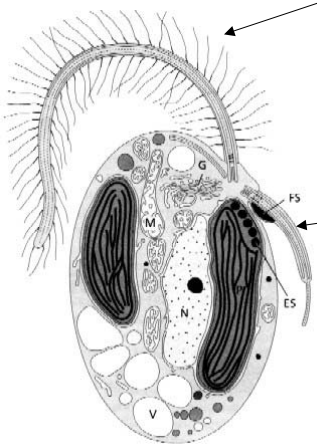
Storage products……

- Storage products in Phaeophycea: laminaran and mannitol are most abundant
- Always sugars, never starch
- Storage products found in cytoplasmic vacuoles (no special name); not associated with chloroplasts or pyrenoids
- Mannitol function→ is important in osmoregulation; transporting organic material to different parts of the thallus in large species; and lowers freezing point

Flagella……

Heterokont flagella:

Anterior "flimmer flagellum"
- long flagellum with two rows of stiff hairs ("mastigoneme")
- directed forward



Posterior "whiplash flagellum"
- short, smooth flagellum
- directed backward
- contains flavin which functions as a photoreceptor

- an eyespot acts a shading structure or light reflector

Flagella attached laterally not apically

Morphology……

-advanced forms: complex multicellular thalli

-no unicellular (except gametes) or colonial forms

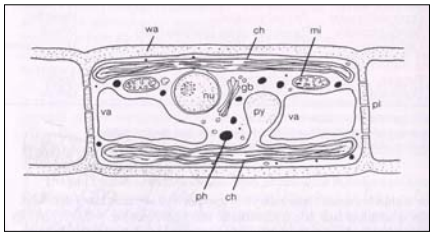
-simplest forms are branching filaments

-more complex forms are parenchymatous and pseudoparenchymatous

- differentiation of cortex (outer pigmented cells) and medulla (inner non-pigmented cells)

- medullary cells → primarily for storage or transport

- some browns quite large → over 40 meters long



Morphology……cell walls

Two components:

1. Cellulose → microfibrils (1-10% of thallus dry weight)
   Function: structural support

2. Alginic acid → surrounds the microfibrills (35% of thallus dry weight)
   Function: elasticity; flexibility; prevent desication; and ion exchange

Alginates……

Alginates = salt form of alginic acid; primarily in intercellular matrix

Human uses for alginates →

- ice-cream → prevents ice crystal formation

- frosting → water retaining properties; prevent drying

- paints → emulsifying agent; keeps pigments suspended and prevents brush streaking

- pharmaceuticals

- manure

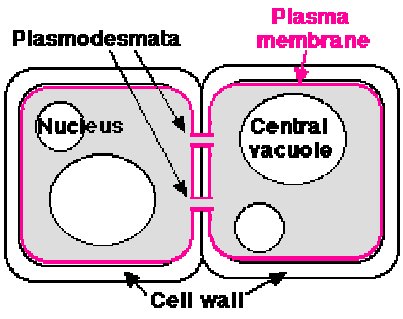
-food → "kombu" in Japan; dried and shredded laminarians

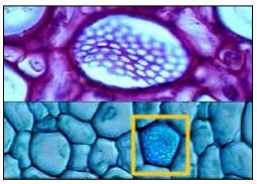
Morphology……..intercellular connections

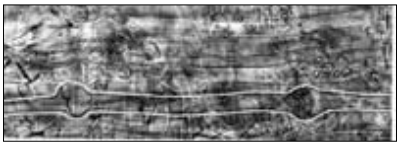
→ only alga to transport sugar/photosynthate in sieve elements

Plasmodesmata = connections between adjacent cells, formed during cell division

- used for cell-to-cell transport of photosynthetic products and cell communication



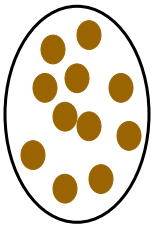




Reproduction……..

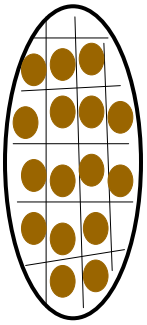
Gametangia = structure where gametes are formed

Sporangia = structure where spores are formed



Uninlocular = all spores/gametes are produced in a single compartment

"unangia"



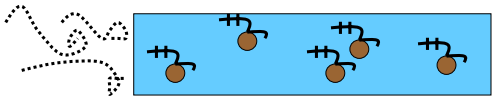
Plurilocular = divided into many small chambers (locules); one spore/gamete per chamber

"plurangia"

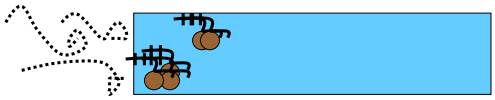
Reproduction……..

Physiological and Behavioral Anisogamy

How do the male gametes find the female ones?



"scent of a woman"



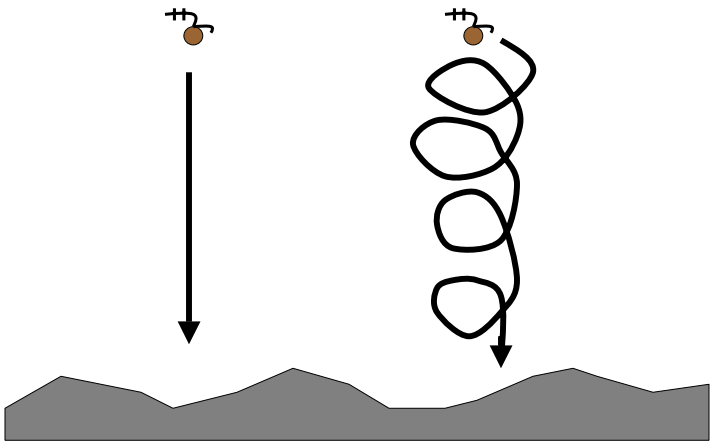
Pheromones = chemicals produced to elicit a specific behavioral or physiological response from another individual.

Many Phaeophyceans produce sexual pheromones, all are chemically similar (unsaturated hydrocarbons)

Male gametes are VERY sensitive to pheromones: very low concentration will elicit a response

Reproduction……..

Physiological and Behavioral Anisogamy



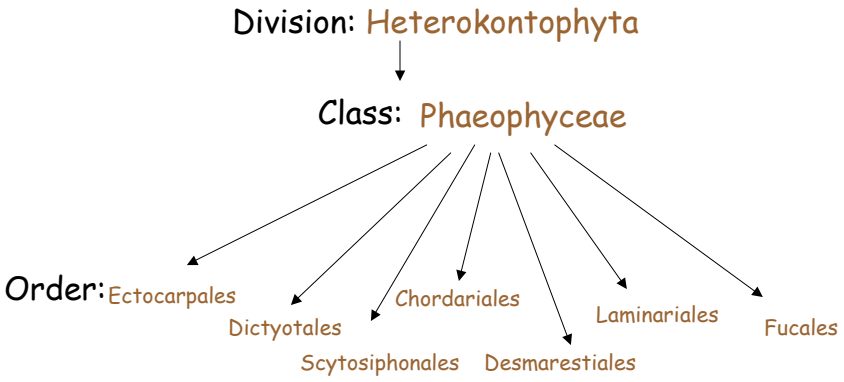
Brown algal habitat…

- mostly marine (or at least brackish water)
- intertidal and subtidal

- dominate colder waters
  - →Northern hemisphere:
  - # of red species > # of brown species
  - # of red ***individuals*** << # of brown ***individuals***

12 orders within……class: Phaeophyceae

Our focus will be on the following 7 orders:



Distinguishing among orders based on……

1. Life History and Reproduction
   - isomorphic/heteromorphic alt. of gen.; diplontic
   - isogamous, anisogamous, oogamous
2. Macrothallus Construction:
   - filamentous
   - parenchymatous
   - pseudoparenchymatous
3. Growth
   - diffuse
   - apical
   - intercalary
   - trichothallic
   - meristodermal

Division: Heterokontophyta

Class: Phaeophyceae

Order: **Ectocarpales** Dictyotales Scytosiphonales Chordariales Desmarestiales Laminariales Fucales

- saxicolous or epiphytic

- uniseriate filaments

- opportunistic spp, excellent colonizers

Celebrity genus: ***Ectocarpus***

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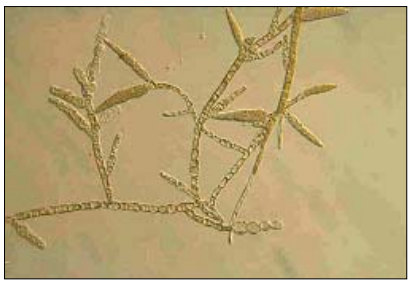
Order: Ectocapales……

1. Life History and Reproduction
   - isomorphic alternation of generations
   - physiological and behavioral anisogamy
2. Macrothallus Construction:
   - filamentous
   - pseudoparenchymatous
3. Growth
   - diffuse



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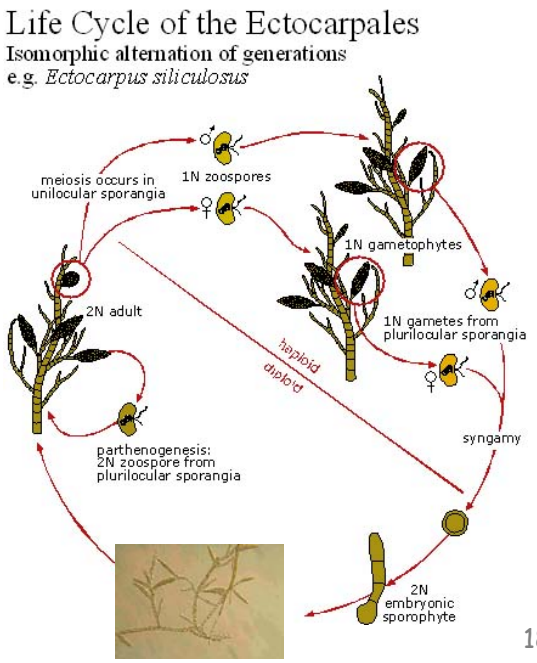
Sex determination:
•50% zoospores become male
•50% zoospores become female

Pheromone:
•Ectocarpene
•No pheromone→ males swim straight
•With pheromone→ males swim circular path decreasing in response to increasing ectocarpene concentrations



Division: Heterokontophyta

Class: Phaeophyceae

Order: Ectocarpales, **Dictyotales**, Chordariales, Scytosiphonales, Desmarestiales, Laminariales, Fucales

Celebrity genus: *Dictyota*

- saxicolous

- common in tropical waters; also found locally subtidal

Order: Dictyotales……

1. Life History and Reproduction
   - isomorphic alternation of generations
   - usually oogamous
2. Macrothallus Construction:
   - parenchymatous
3. Growth
   - apical

Life history of *Dictyota*

• reproductive structures in "sori" = cluster of gametangia or sporangia

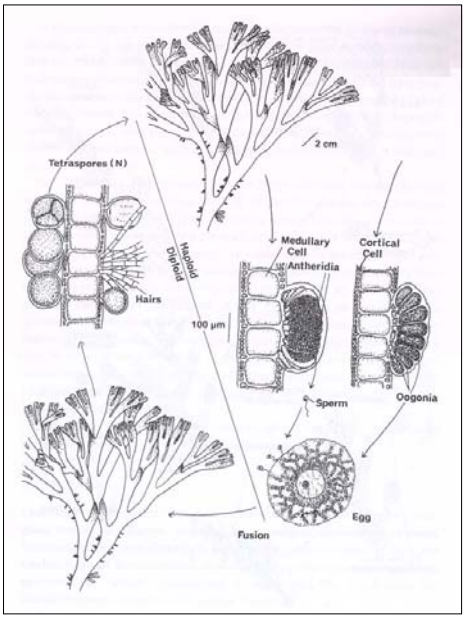
•pheromone= dictyotene

• tetraspores (non-flagellated) → 2 female / 2 male

•gametophyte dioecious

•large egg → one per "oogonium" = female reproductive structure containing one or more eggs

•sperm → single flagella but has second basal body



Only calcified phaeophycean……

…….in order Dictyotales

Padina

Division: Heterokontophyta

Class: Phaeophyceae

Order: Ectocarpales, Dictyotales, Chordariales, Laminariales, Fucales, **Scytosiphonales**, Desmarestiales

Celebrity genus: *Scytosiphon*

- saxicolous or epiphytic
- found locally in higher intertidal shallow pools
- plurangia always uniseriate (filament in single row)

Order: Scytosiphonales……

1. Life History and Reproduction
   - heteromorphic alternation of generations
   - isogamous or anisogamous
2. Macrothallus Construction:
   - filamentous (sporophyte)
   - parenchymatous (gametophyte)
3. Growth
   - diffuse

Order: Scytosiphonales……
….life history not fully understood

gametophyte

upright stage

crust stage (‘*Ralfsia*’-like)

sporophyte

Division: Heterokontophyta

Class: Phaeophyceae

Order: Ectocarpales, Dictyotales, **Chordariales**, Scytosiphonales, Desmarestiales, Laminariales, Fucales

Celebrity genera: *Analipus*.....*Leathesia*.....*Ralfsia*

- saxicolous or epiphytic

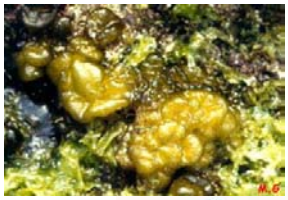
-common intertidally, tropics to poles

- plurangia could be uniseriate *or* multiseriate

Order: Chordariales……

1. Life History and Reproduction
   - heteromorphic alternation of generations (diplohaplontic)
   - physiological and behavioral anisogamy
2. Macrothallus Construction:
   - filamentous
   - pseudoparenchymatous
3. Growth
   - variable

convergent evolution of form…



Colpomenia =
parenchymatous;
O. Scytosiphonales

Leathesia =
psuedoparenchymatous;
O. Chordariales

both genera found locally…..do the crunch test!! ☺

Division: Heterokontophyta

Class: Phaeophyceae

Order: Ectocarpales, Dictyotales, Scytosiphonales, Chordariales, **Desmarestiales**, Laminariales, Fucales

- saxicolous
- low intertidal to subtidal
- "acid weed"

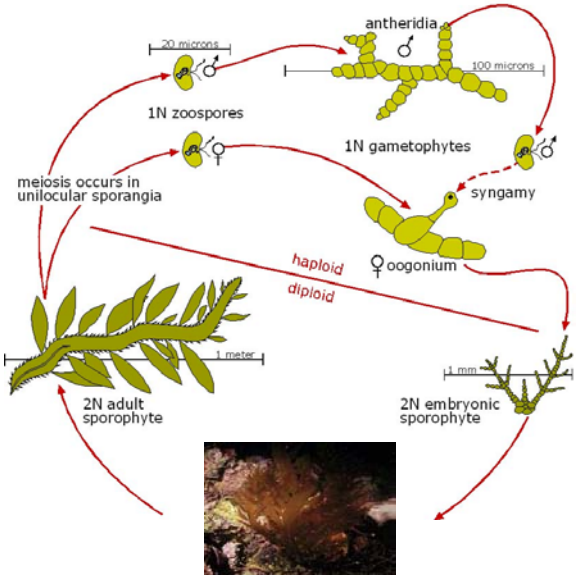
Celebrity genus: *Desmarestia*

Order: Desmarestiales……

1. Life History and Reproduction
   - heteromorphic alternation of generations (diplohaplontic)
   - oogamous
2. Macrothallus Construction:
   - filamentous
   - pseudoparenchymatous
3. Growth
   - trichothallic

Life Cycle of the Desmarestiales

Diplo-haplontic
e.g. *Desmarestia ligulata*



- subtidal, but grows well in high light (very abundant if disturbance has removed other plants or canopy, e.g. El Nino, or urchin grazing)

- Disappears with kelp growth due to canopy cover; shading

- "Acid weed": cells accumulate sulfate ions from seawater which reacts with water to produce sulfuric acid or malic acid, stored in vacuoles

=ANTIHERBIVORY, pH 0.8-1.8, bleaches other algae