

Domain: Eukarya

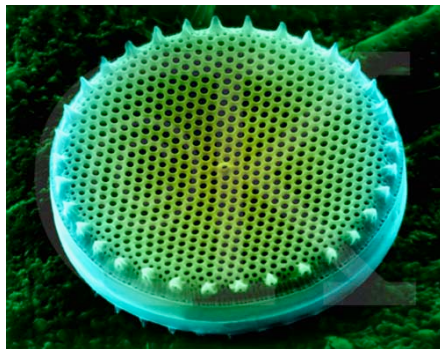
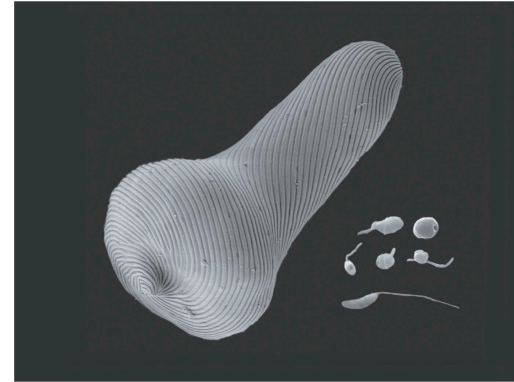
Kingdoms

Protista

Plantae

Fungi

Animalia



Kingdom: Protista

Protists were the first eukaryotes

Most protists are unicellular

Some algae are multicellular

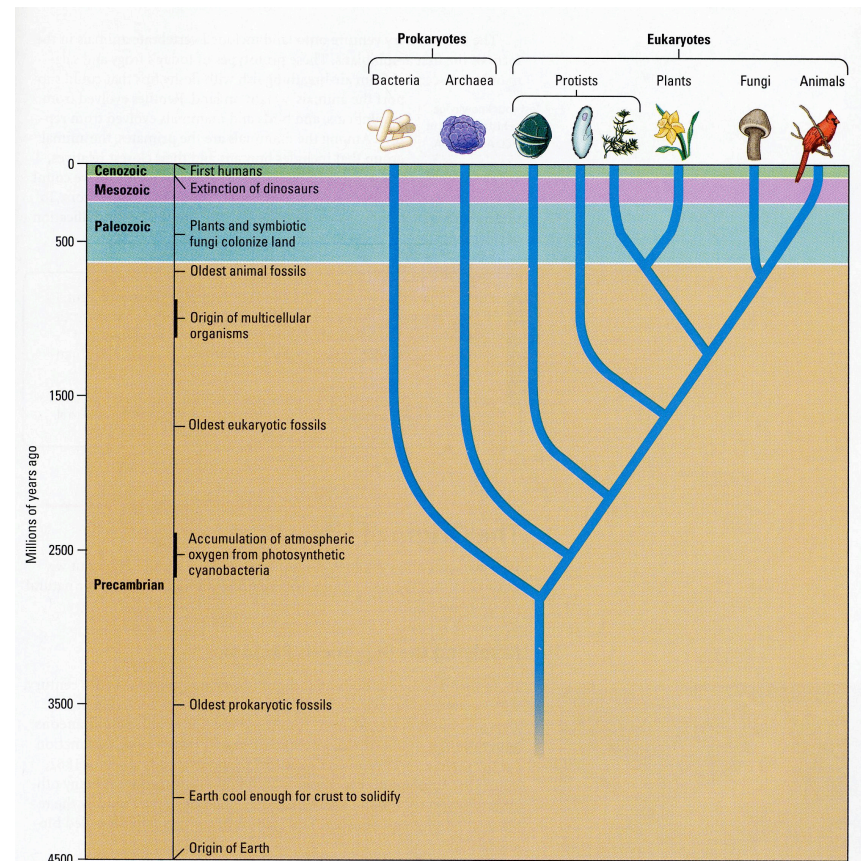
Origins

1.8 bya: Unicellular eukaryotes

1.2 bya: Multicellular algae

1.2 bya - 600 mya:

Protist diversification
- many new phyla



Endosymbiotic theory of eukaryotic origins

Eukaryotic cell originated as a
symbiotic mutualism

Aerobic heterotrophic bacterium

+

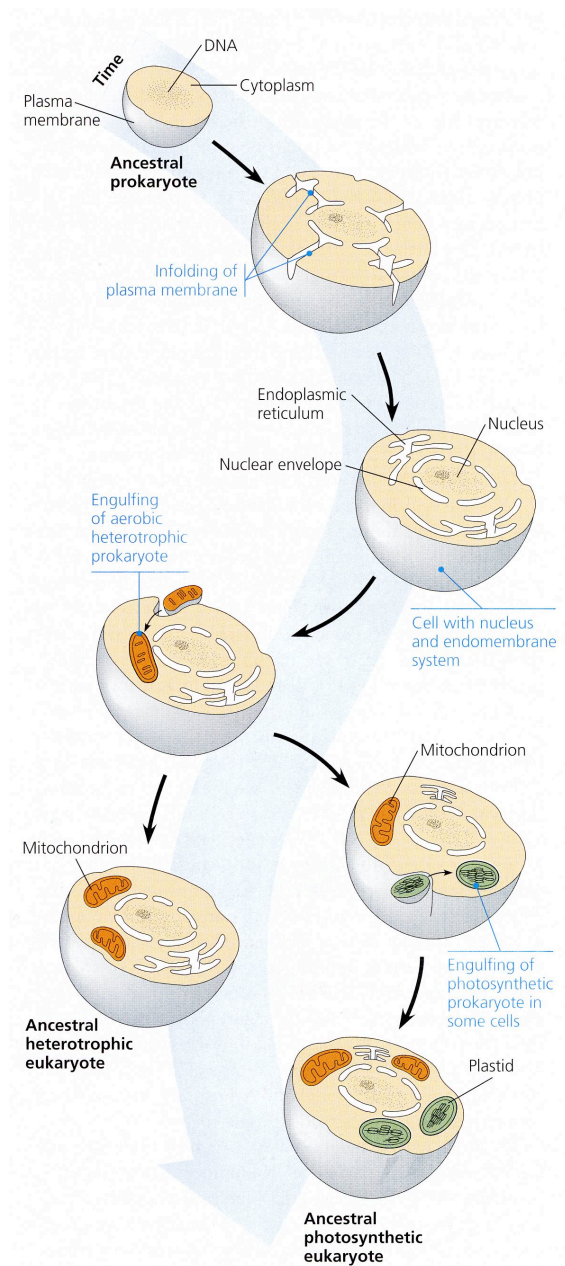
Bacteria became mitochondria

Anaerobic archaean cell

+

Autotrophic cyanobacterium

Bacteria became chloroplasts

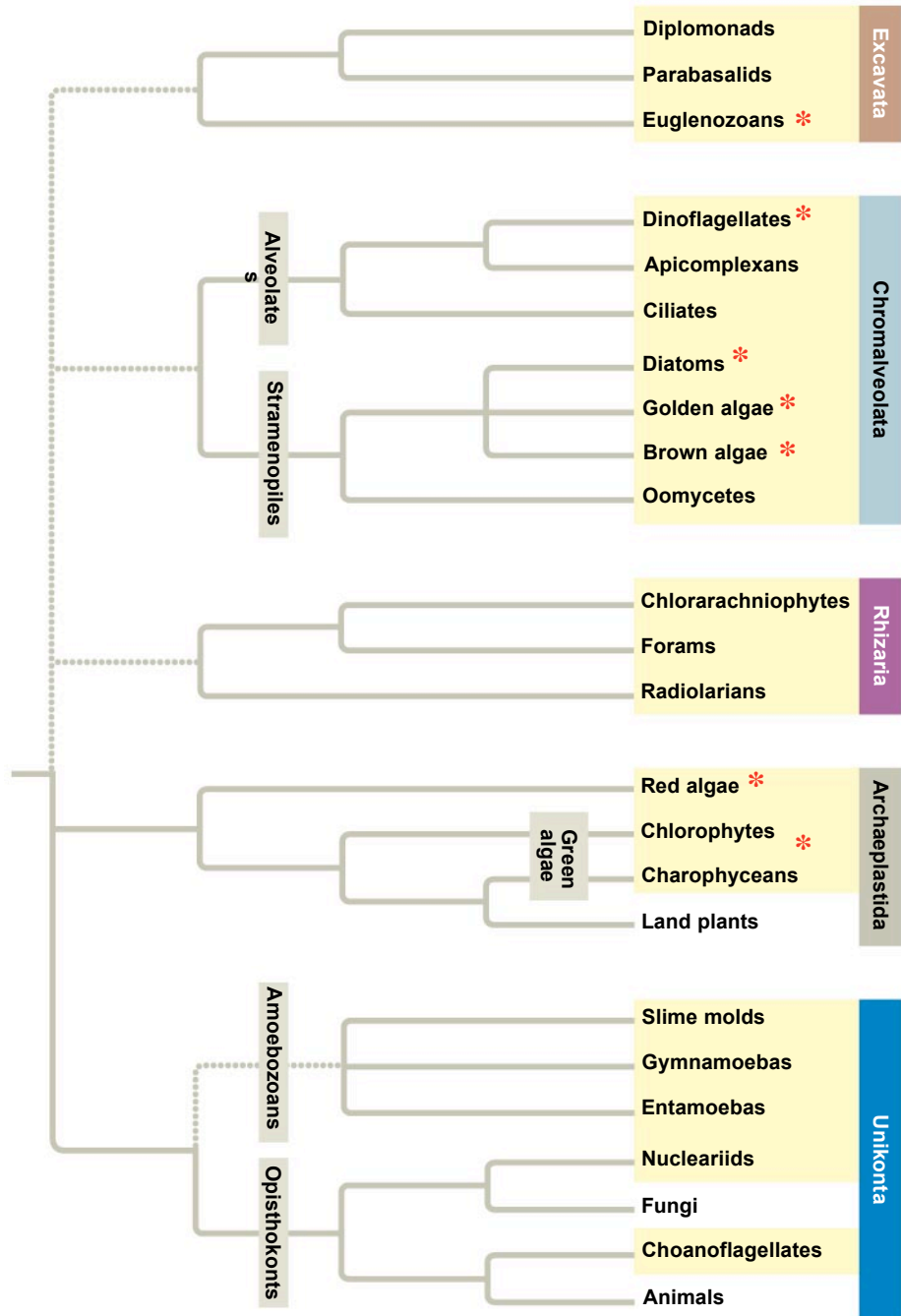


Phylogeny of Eukarya

5 “Supergroups” of protists represent 5 distinct lineages each with several clades

Clades \pm = Phyla

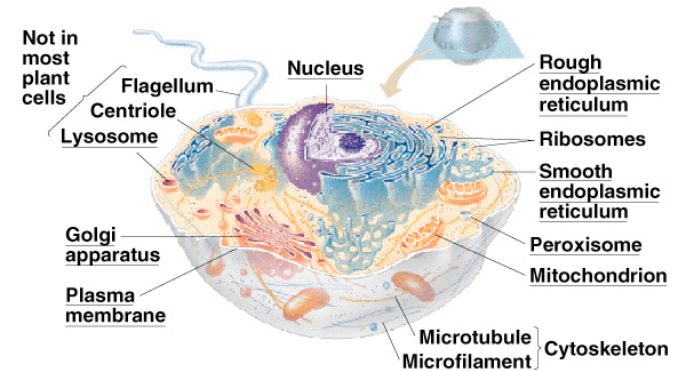
* Photosynthetic “Algae”



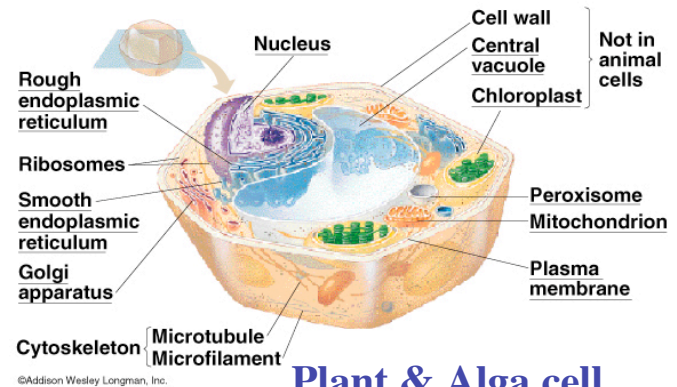
- Many different phyla of algae
- Not all in same supergroup
 - some more closely related than others
- Multicellular kingdoms evolved from different protist ancestors
- Archeoplastida:
 - Plants, Green algae & Red algae

Eukaryotic Cells

- Plasma membrane surrounds Cytoplasm
- Nuclear membrane
- Linear chromosomes
- Ribosomes
- Organelles (e.g. mitochondria)
- Cytoskeleton
- Cilia & flagella for movement (in some)



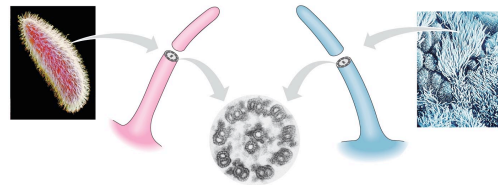
Animal & Protozoan cell



Plant & Alga cell

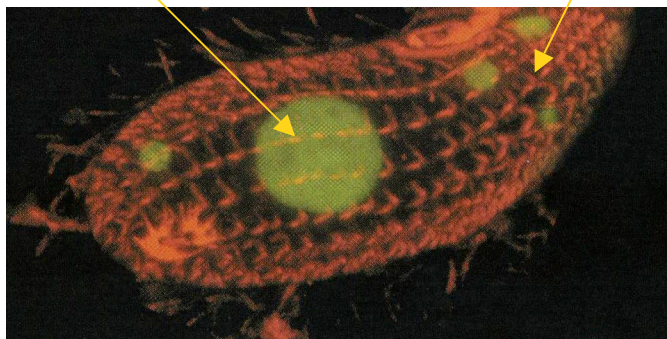
Cells reproduce by mitosis and meiosis.

Haploid cells (1N) have 1 copy of each chromosome
Diploid cells (2N) have 2 copies of each chromosome



Nucleus

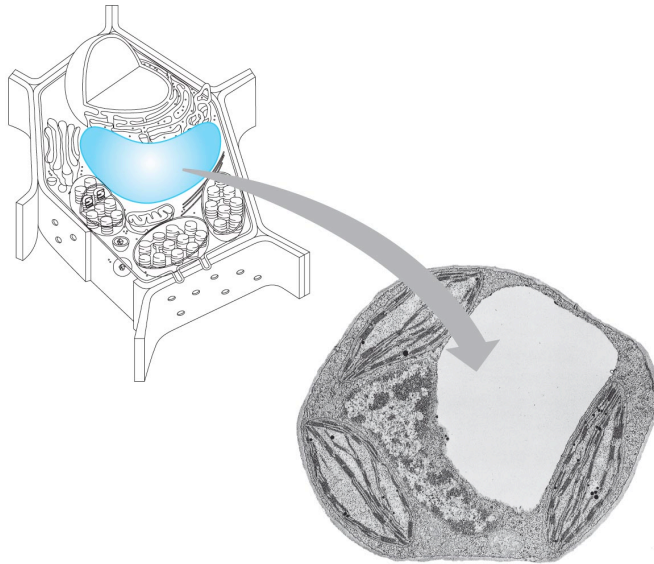
Cytoskeleton



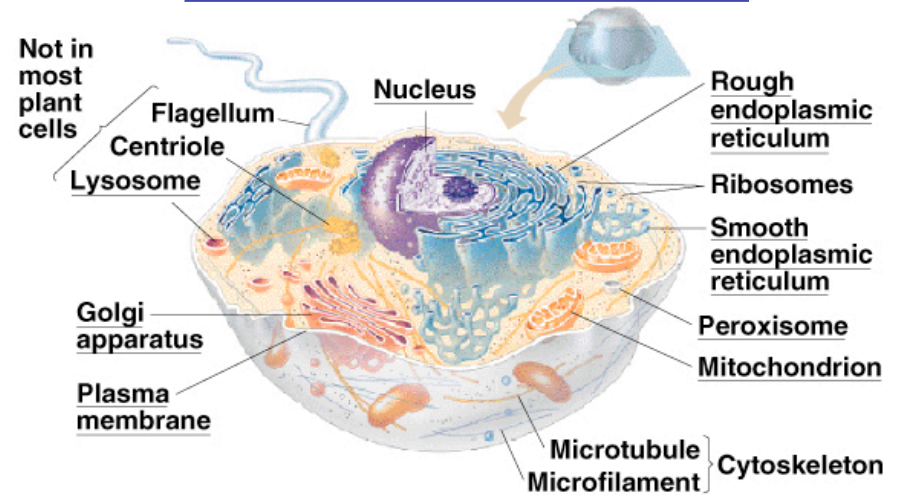
Plant & Algae Cells

Unique Features

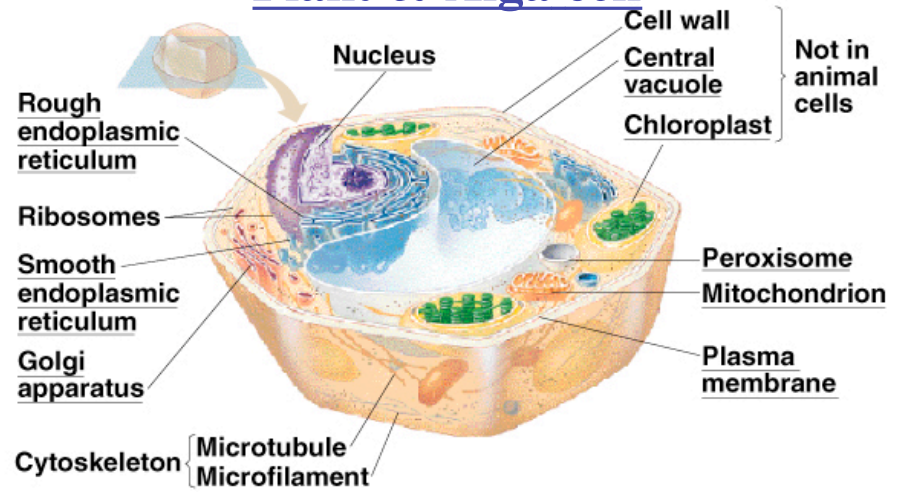
- *Cells walls (most of cellulose)*
- *Central vacuole*
- *Chloroplasts*
 & other Plastids (organelles)
 e.g. Amyloplasts store starch



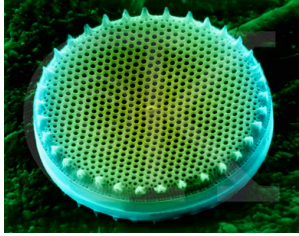
Animal & Protozoan cell



Plant & Alga cell



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“Kingdom”: Protista

- Eukaryotic
- Unicellular (most)
 - Seaweeds are Multicellular



Algae - producers
“plant-like protists”

Protozoans - consumers
“animal-like protists”



Protist Lifestyles

- **Free-living in Aquatic habitats:**

Marine (ocean) or Freshwater

- **Planktonic - surface water**

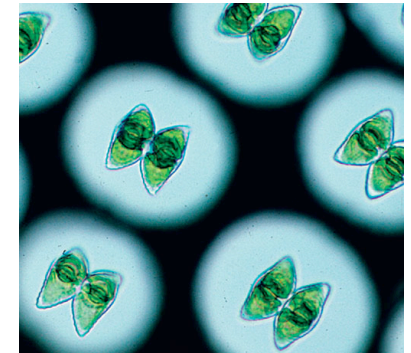
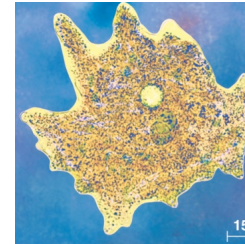
- **Phytoplankton - producers (algae)**

- **Zooplankton - consumers (protozoans)**

- **Benthic - on the bottom**

- **Parasites: consumers**

in cells or body fluids of host (protozoans)



Features of Protists

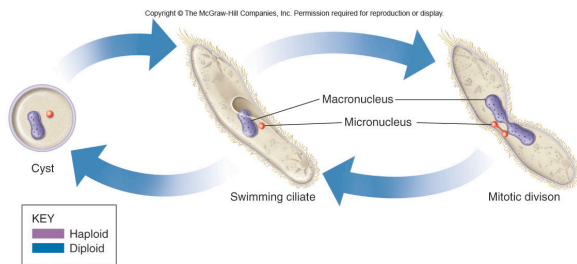
- **Mode of nutrition**
 - **Autotrophs** - algae
 - **Heterotrophs** - protozoans
 - **Mixotrophs** (autotrophs with facultative heterotrophy)
- **Movement** - swimming, crawling or none
 - some algae are motile & swim with flagella
 - other algae can't swim
- **Taxis (+/-)**: swim toward or away from stimulus
 - Phototactic (light)

Reproduction

the creation of a new individual organism

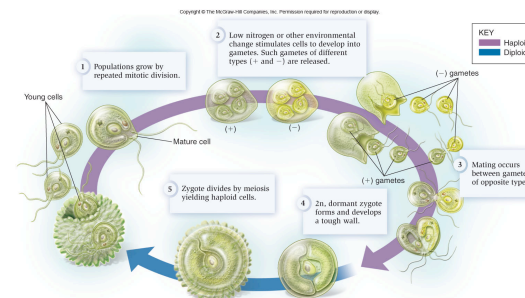
Asexual reproduction

- *Offspring from 1 parent*
- *Mitosis produces new cells*
- *New individuals genetically same*
- *Offspring are clones*
- *Offspring are same ploidy level*



Sexual reproduction

- *offspring from 2 parents*
- *Gametes = sperm & egg*
- **Gametes fuse to form zygote**
 - *Gametes are haploid (1N)*
 - *Zygote is diploid (2N)*
- *New individuals genetically different*



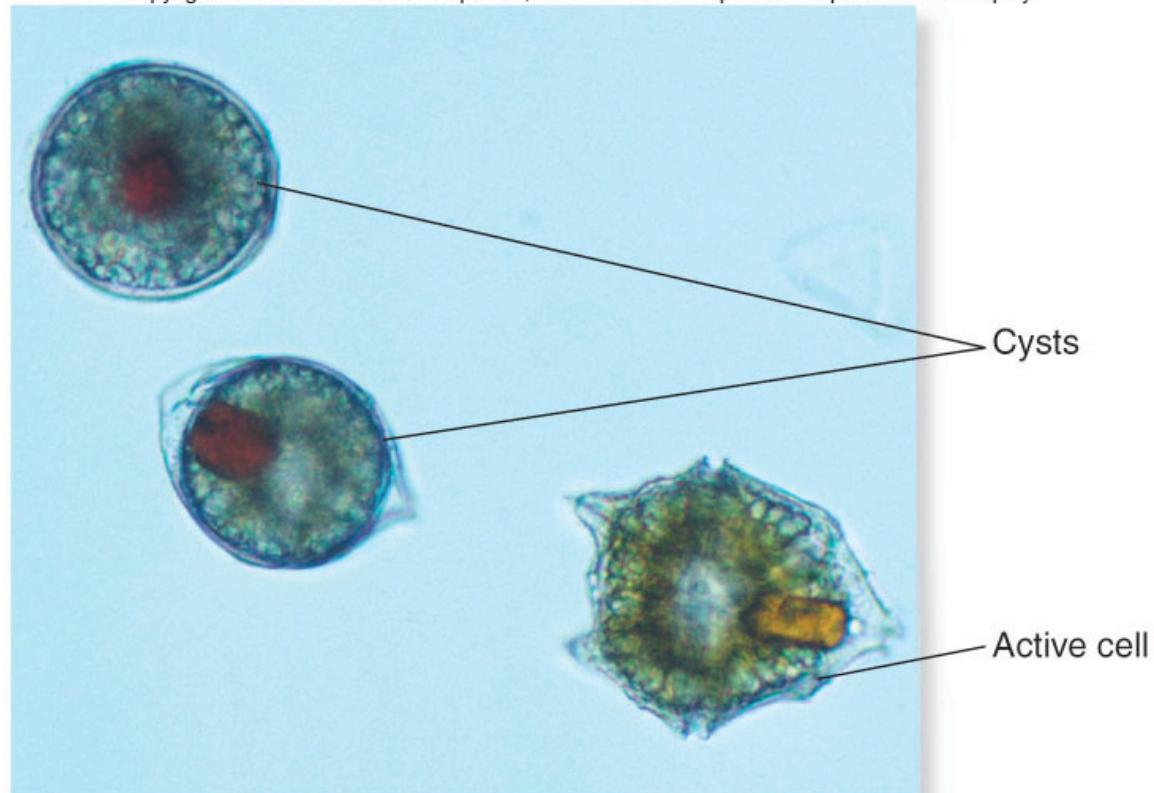
Meiosis produces haploid gametes or spores

- *Gametes in Animals, Protozoans & some Algae*
- *Spores in Plants, Algae & Fungi*
 - *spores cannot fuse, can divide by mitosis*

Cysts are dormant stage

Unicellular with thick wall

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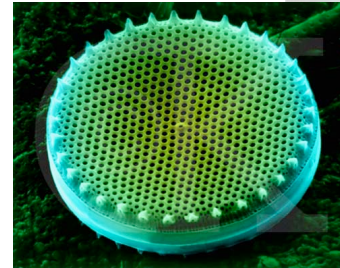


Linda E. Graham, OK

“Algae”

At least 7 different phyla

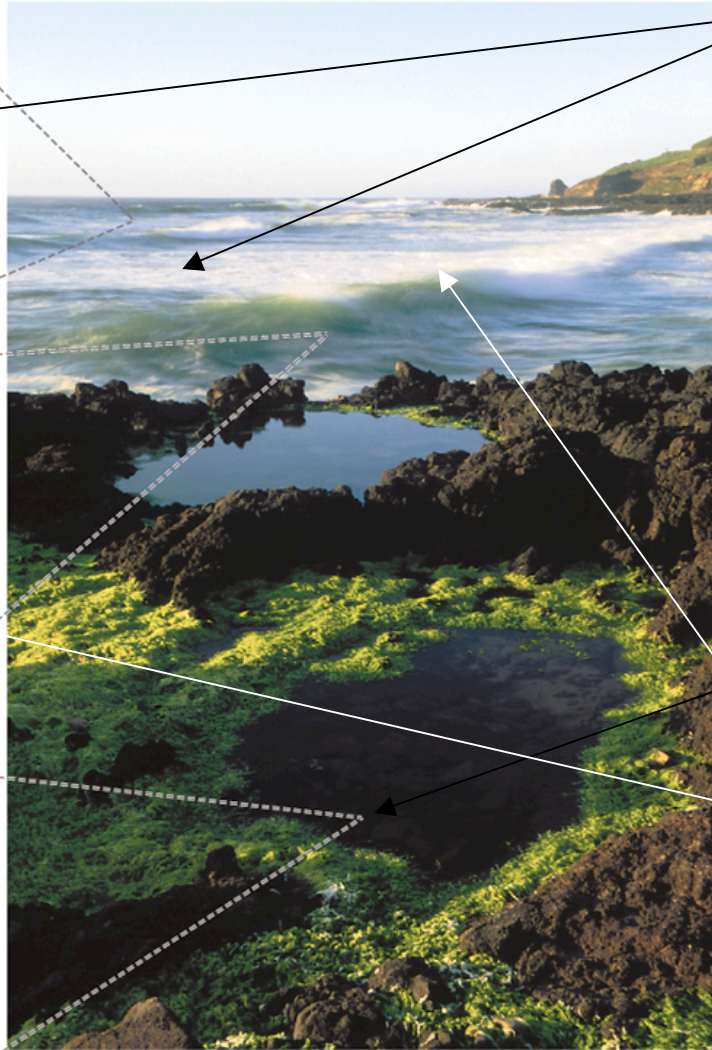
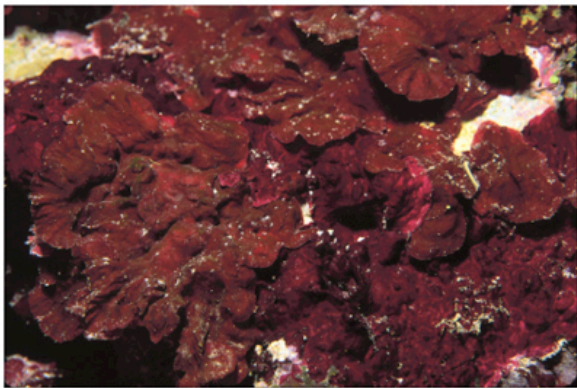
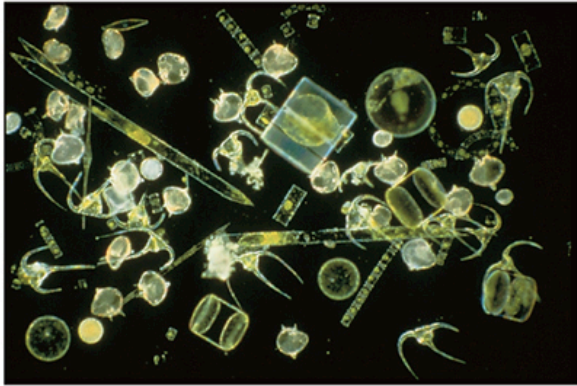
- **Photoautotrophs**
 - Chlorophyll A: main pigment
- **Phytoplankton**
 - Unicellular algae
 - Drift in sunlit surface waters
- **Seaweeds = Macroalgae**
 - Multicellular
 - Attached to rocks on bottom (benthic)



General Features of Algae

- **Aquatic: marine & freshwater**
- **Producers: Base of food chain in aquatic ecosystems**
- **Absorb nutrients (nitrogen)
& gases (carbon dioxide) from water**
- **Live in the photic zone**
 - **need light for photosynthesis**

Algae Dominate Aquatic Ecosystems

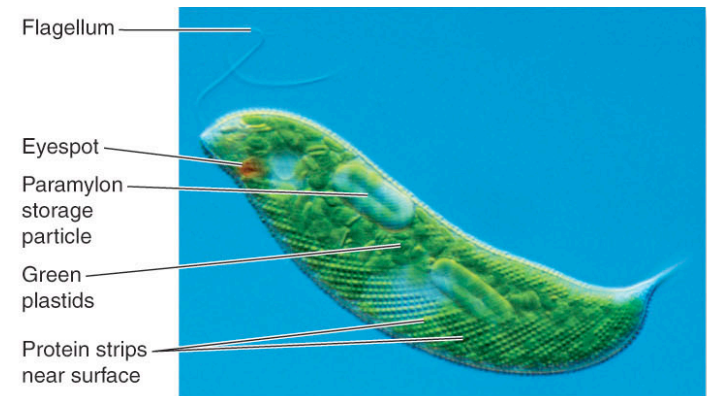
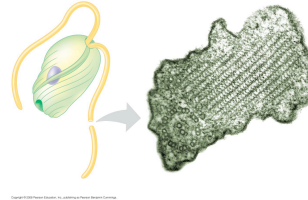


**Phytoplankton
are pelagic**

**Seaweeds
are benthic
in
Intertidal
&
Subtidal
habitats**

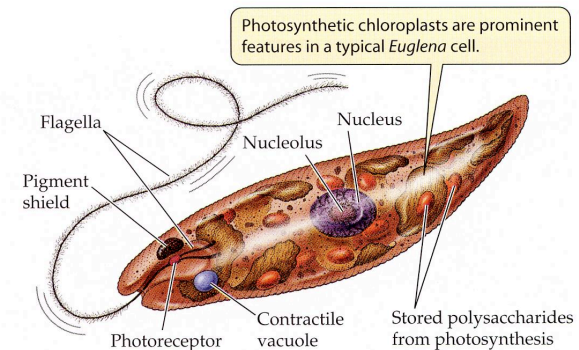
Euglenozoans: Euglenids

- **Unicellular**
- **Anterior flagella (often only 1)**
with photoreceptor & "eyespot"
- **Unique flagella structure - crystalline rods**
- **No cell walls**
- **Pellicle: flexible proteins**
under cell membrane



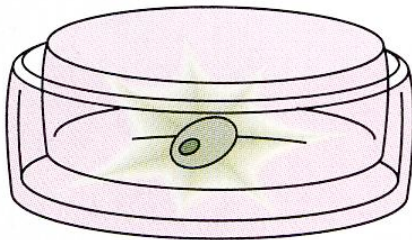
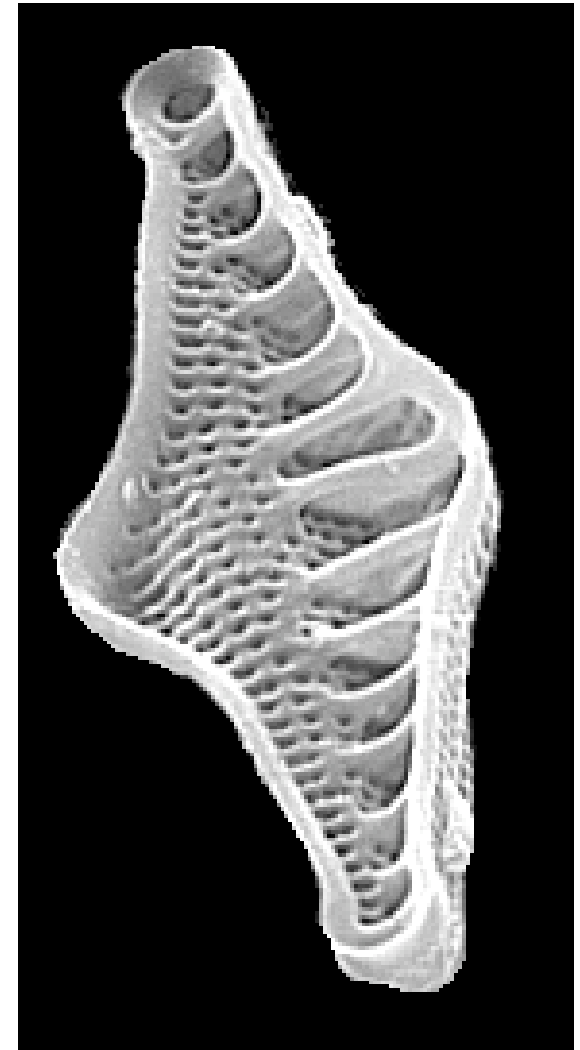
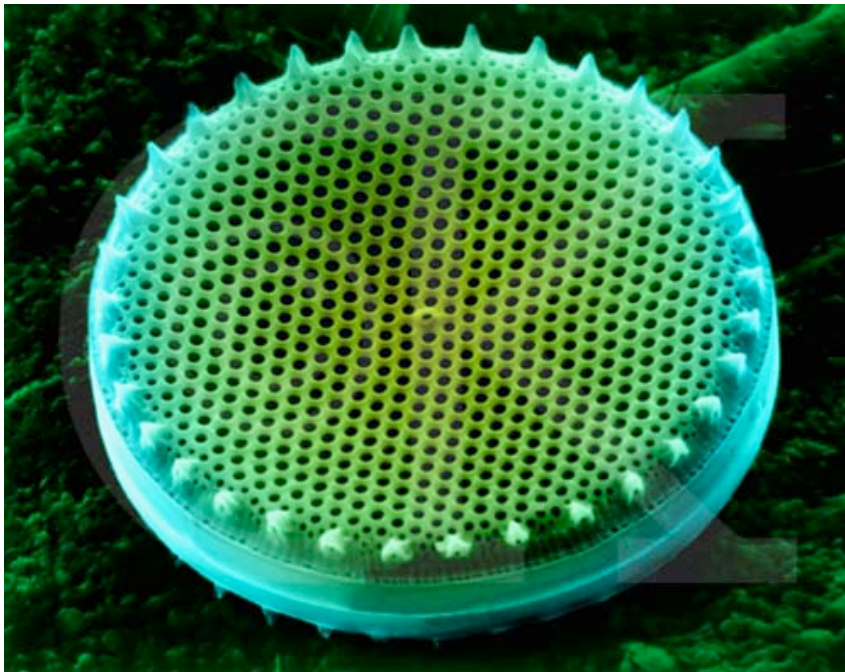
(a) *Euglena*

- **Mixotrophs**
 - **Autotrophic: photosynthesis by Chloroplasts**
 - **Heterotrophic**
- **Mostly freshwater**
 - **contractile vacuoles**
 - **release excess water**



Diatoms

Unicellular algae: 2 Cell walls of “glass” (SiO_2)

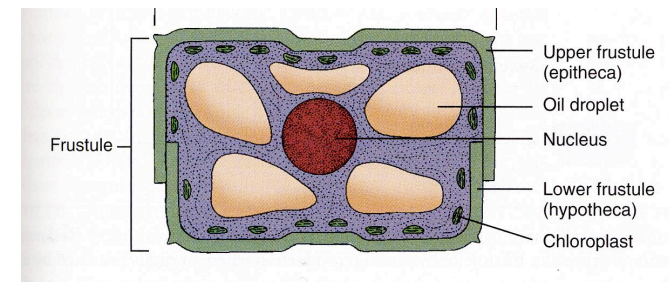
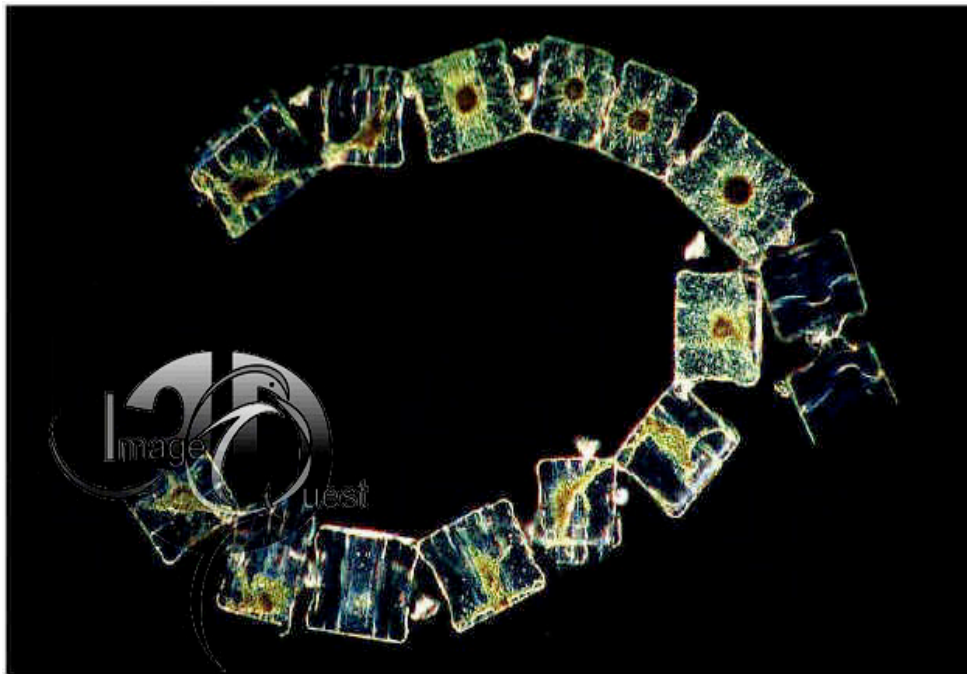
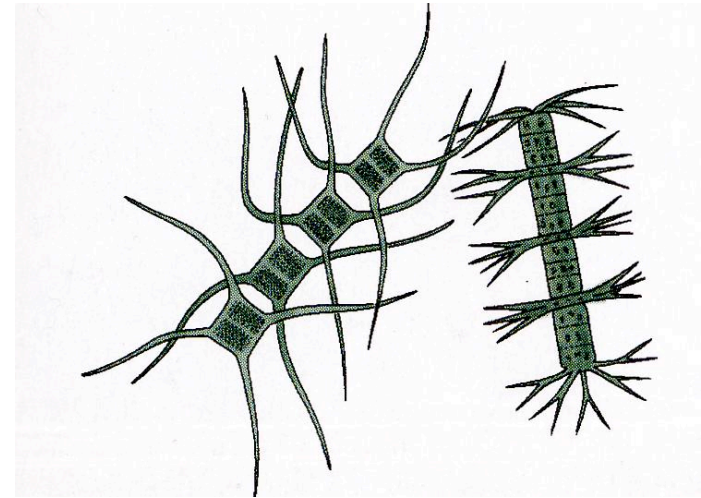


Diatom

Frustule:
a “glassy shell”

Diatoms

- Carotenoid pigments
- Non-motile:
Floats with oil droplet or spines

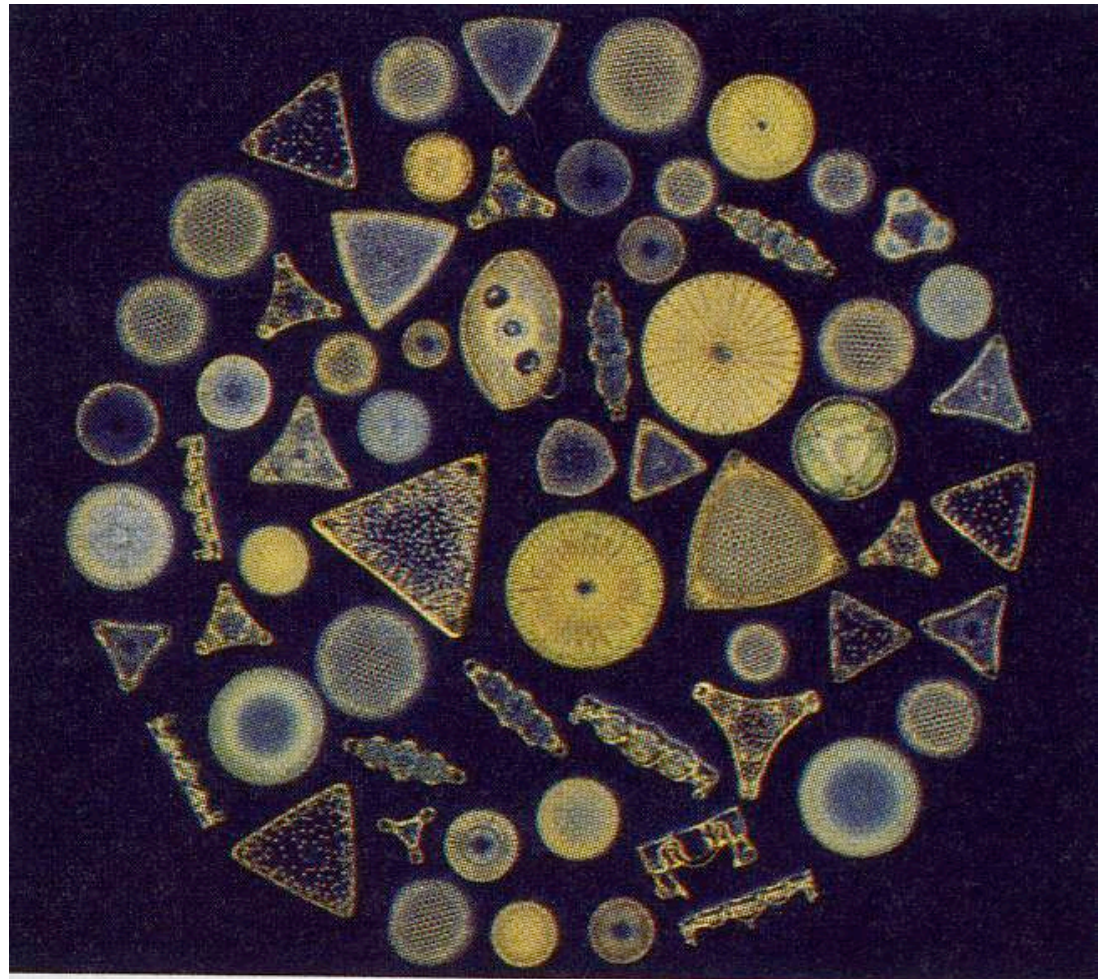


Diatoms

Common in cold
nutrient rich waters:

Temperate
&
Polar regions

Marine
&
Freshwater

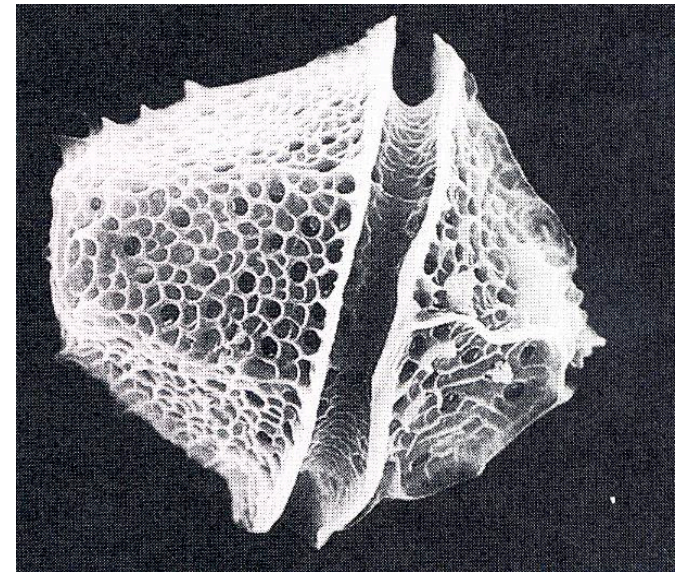
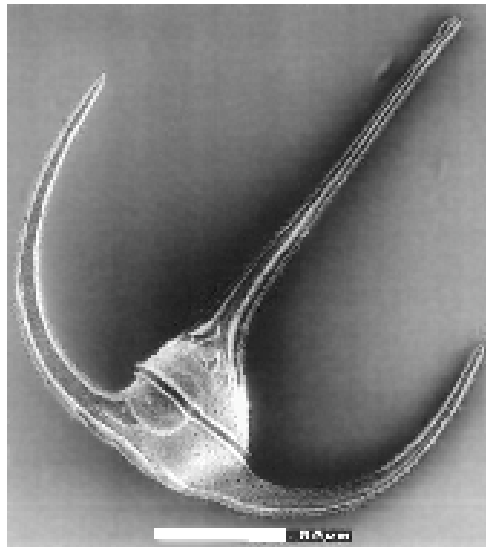
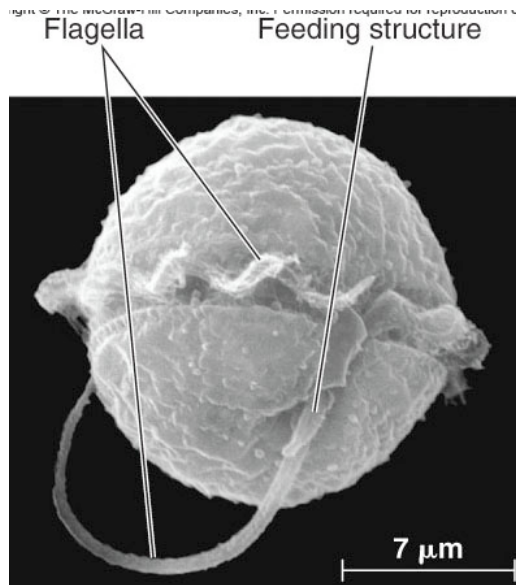


Dinoflagellates

Unicellular

Swim with 2 flagella

Cell wall made of
cellulose plates

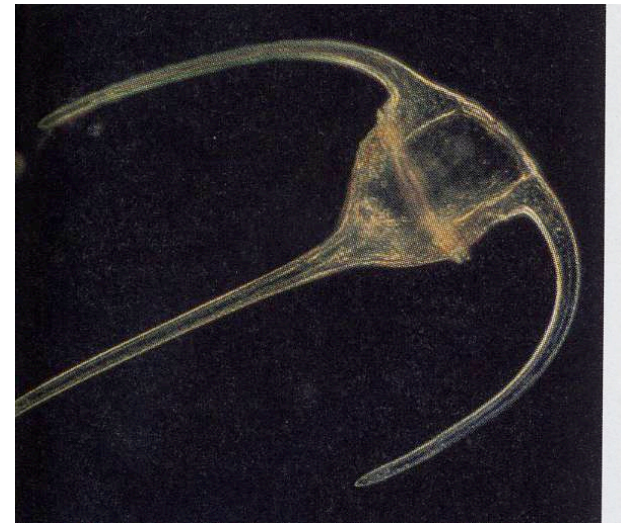


Dinoflagellates

- **Autotrophs & Heterotrophs**
 - carotenoid pigments
- **Warm waters in Temperate & Tropics**
- **Swims vertically in surface waters**

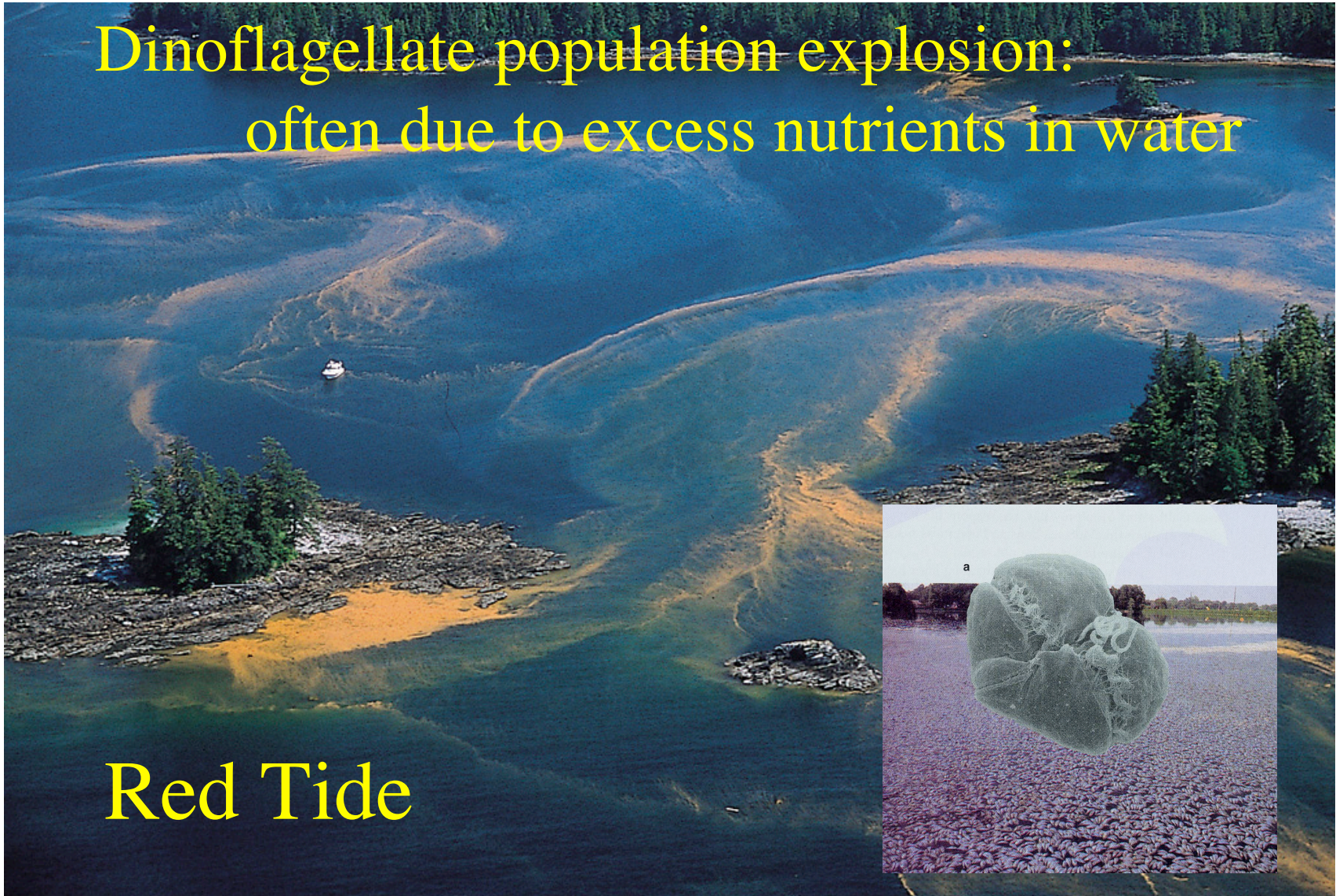


*Free living
or
Symbiotic mutualists
in animals*



Harmful Algal Blooms (HAB)

Dinoflagellate population explosion:
often due to excess nutrients in water



Red Tide

3 Seaweed Phyla

Multicellular algae

- **Brown Algae = Phaeophyta**
- **Red Algae = Rhodophyta**
- **Green Algae = Chlorophyta**

Life in the intertidal region

An area covered & uncovered by water twice each day

Environmental challenges

- **Resource acquisition**
 - light
 - nutrients
- **Wave shock**
- **Abrasion**
- **Drying out**

Adaptations

- **Thallus - Flat Body with Pigments for PSN**
 - Chlorophyll a
 - Accessory pigments
- **Flexible**
- **Mucus on surface**
 - protection

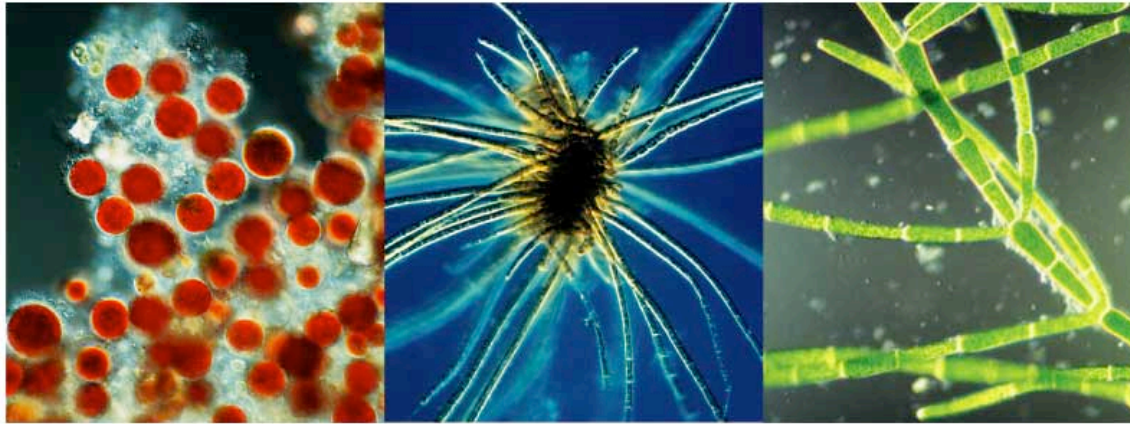
Algae phyla differ in their pigments

All have chlorophyll a

Red

Brown

Green



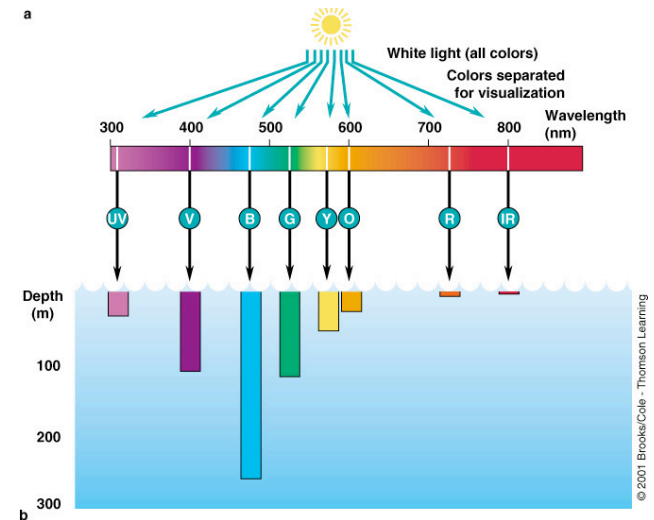
Phycobilins

Carotenoids

Chlorophyll "b"

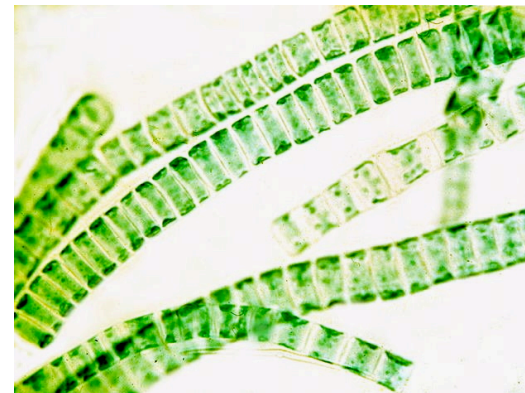
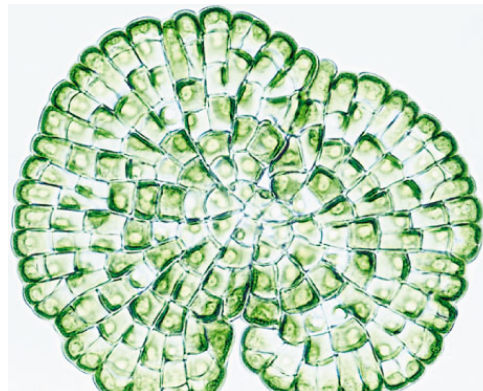
**Pigments capture light
&
impart color to cells**

*Each pigment captures different
wavelengths of light*



Chlorophyta: Green Algae

- Mostly freshwater, some marine
- Small Bodies
- Shallow water: use red light

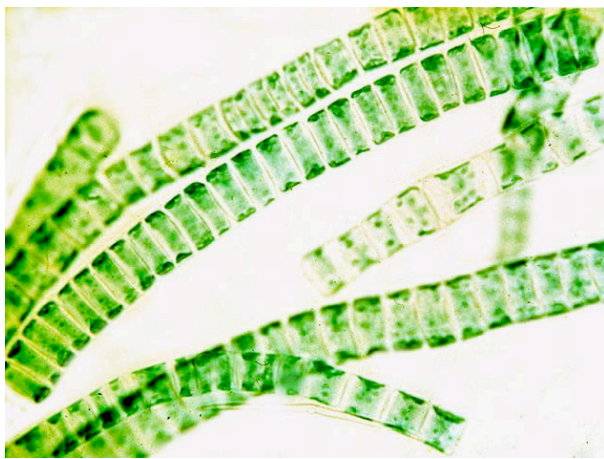


Unicellular algae - flagellated cells



Colonial Algae

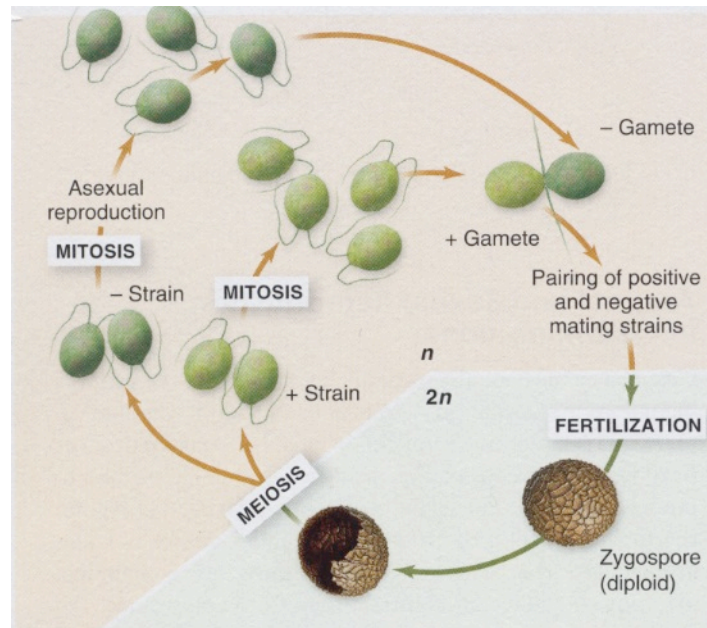
- **Multicellular algae - Filaments & Sheets (seaweed)**



Most unicellular protists have a

Zygotic Life Cycle

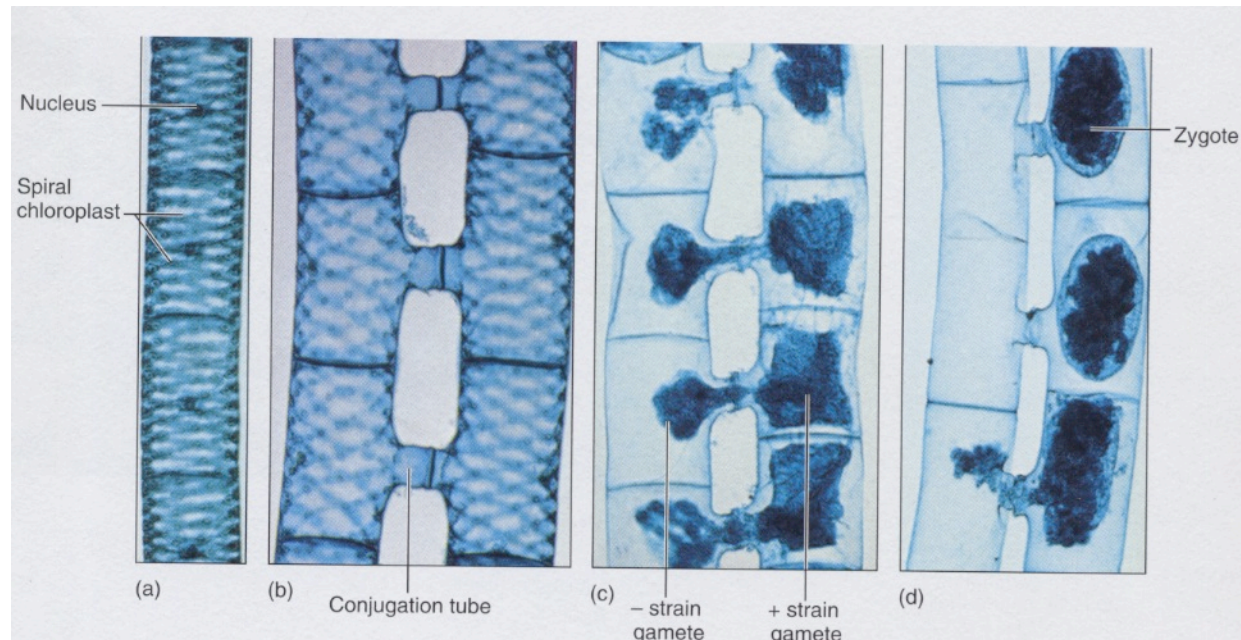
- Haploid “vegetative” cells
- Asexual reproduction by mitosis
- + & - Gametes (1N) produced & fuse to form zygote (2N)
- Zygote is “resting” stage (a “cyst” or zygospore)
- Zygote divides by meiosis to form haploid cells



Sexual reproduction in filamentous green algae

“Conjugation”

- Haploid “vegetative” cells in filament
- 2 filaments align & cells form conjugation tube
- 1 filament cell contents condenses to form a “gamete”
- Cell contents move from one filament to the other
- “Gametes” fuse to form a zygote inside
- Zygote undergoes meiosis to make 4 haploid cells
- A haploid cell can divide by mitosis to make new filament



Seaweeds

Alternation of Generations = Sporic Life Cycle

2 multicellular stages:

Sporophyte (2N)

Gametophyte (1N)

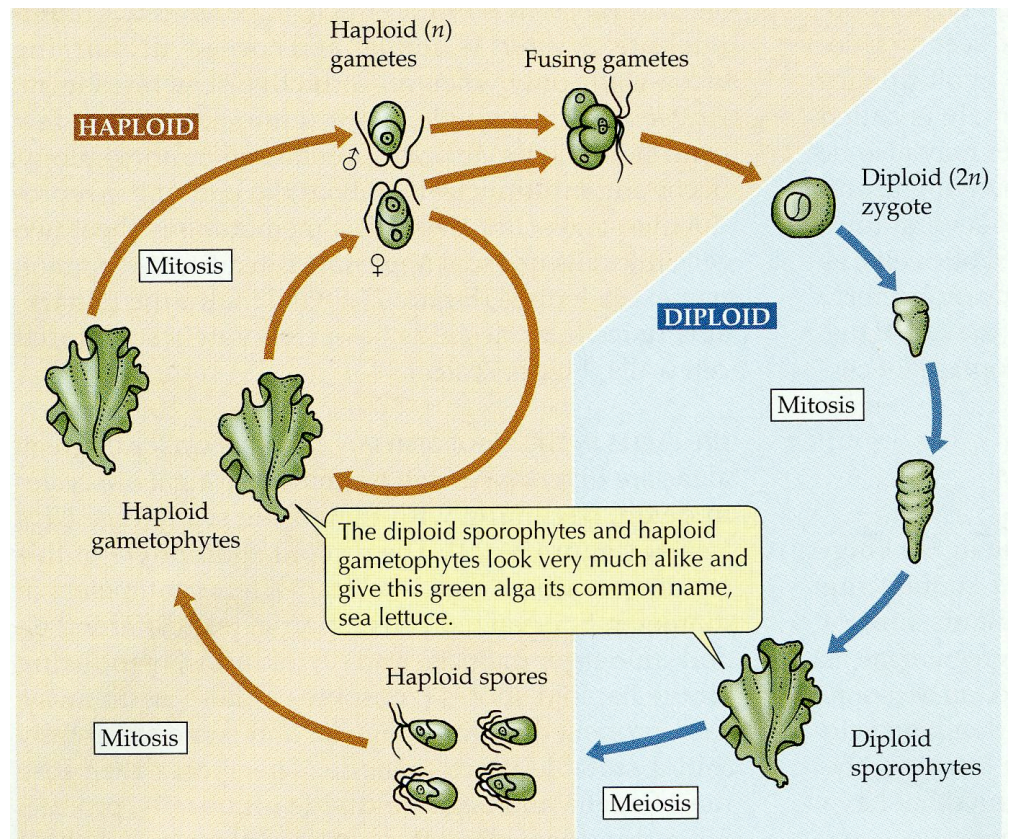
3 unicellular stages:

Spores (1N)

Gametes (1N)

Zygote (2N)

Haploid phase / Diploid phase



Example shows life cycle of Chlorophyta

Phaeophyta: Brown Algae

- **Large complex bodies**
- **All marine**
- **Intermediate depths**
 - (to 30m)
- **Cold waters**
- **Kelps form great “forests”**



Specialization of Thallus

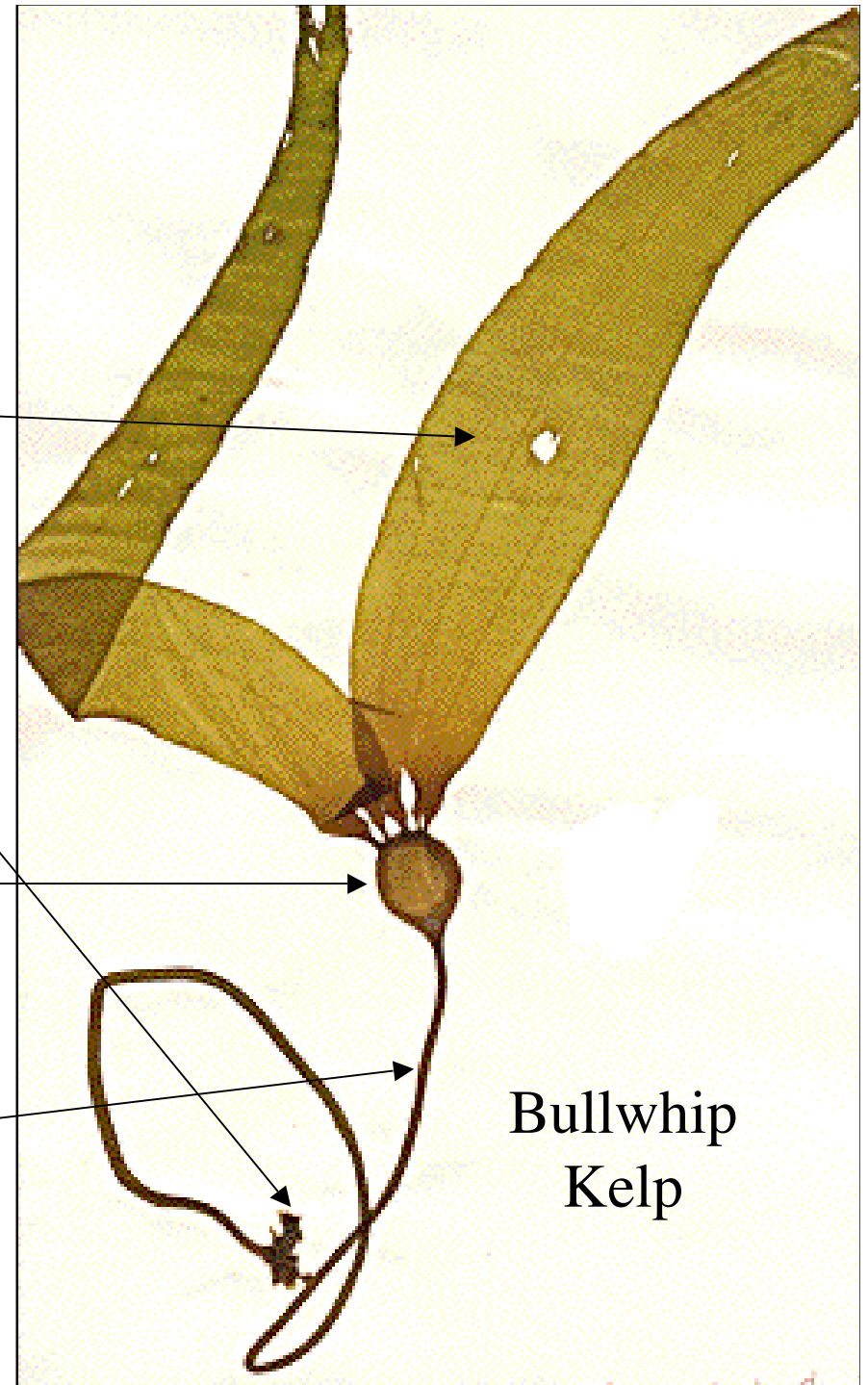
*Blade: catch light &
absorbs nutrients

*Holdfast: anchorage

Air bladder: floatation
keeps blades near surface

Stipe: allows blade to
reach up to light

** All algal thalli consist of these parts*



Rockweeds

- Intertidal Zone
- Shallow water
- Small body



Kelp

- Subtidal Zone
- Deeper water
- Large body



Giant Kelp

Macrocystis pyrifera

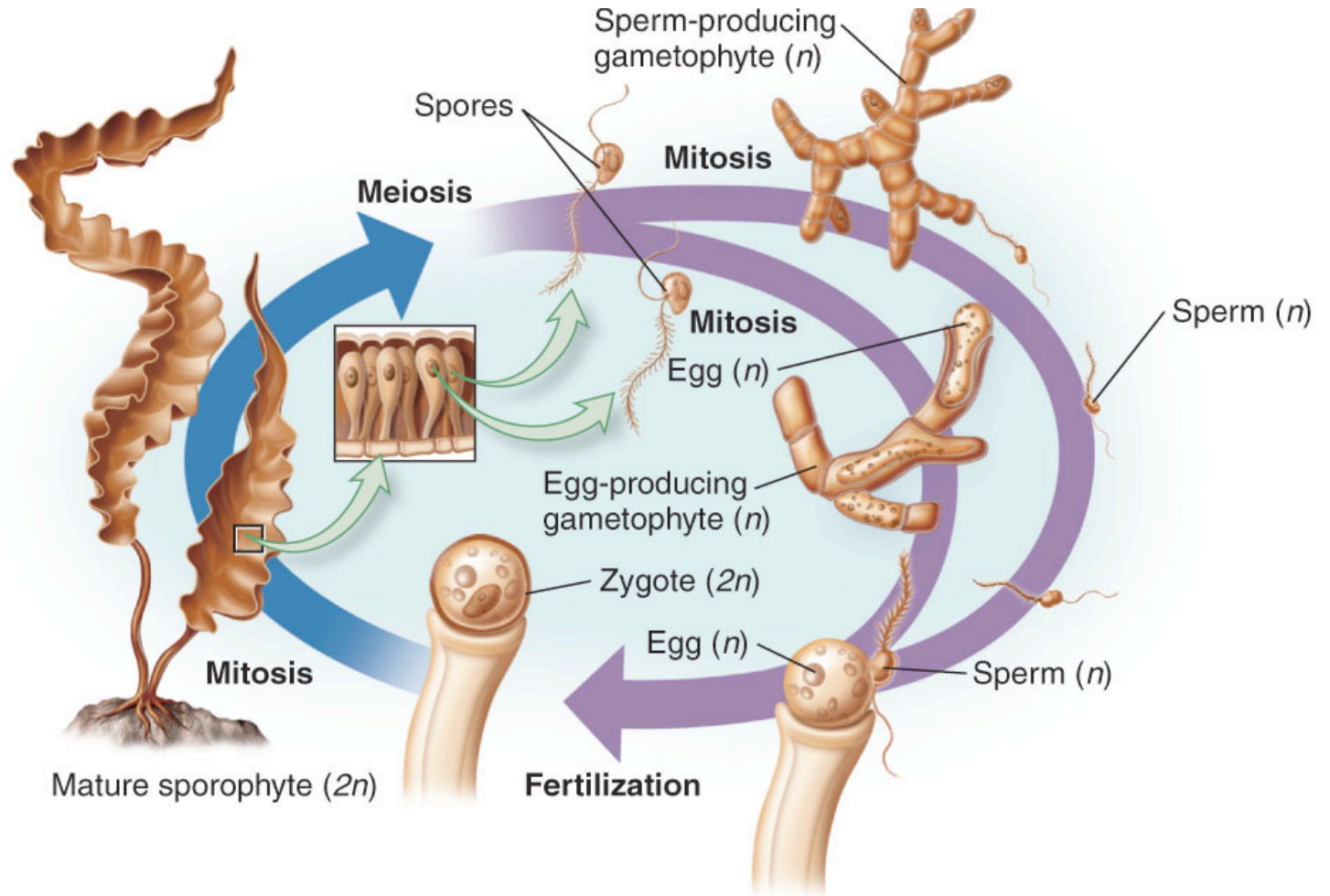
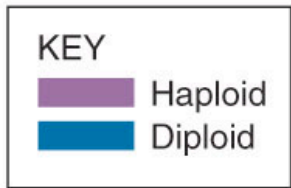
**Most common kelp
in CA**

Huge forests

Perennial



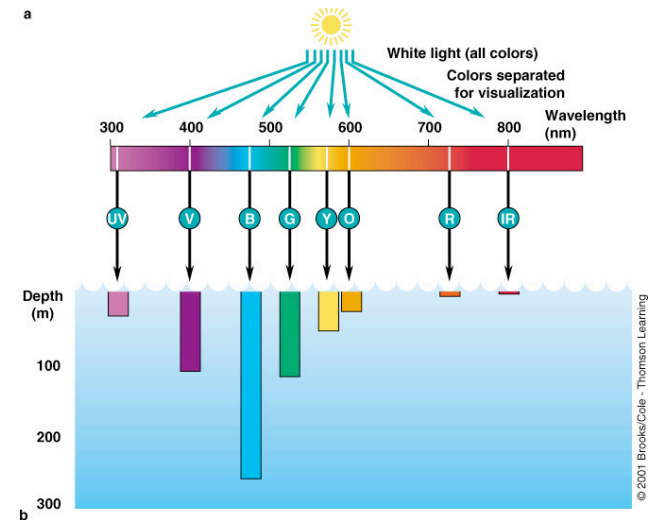
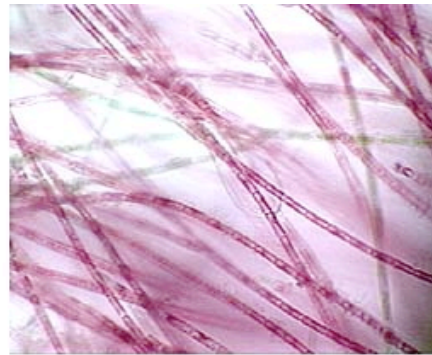
*Kelp have a dominant sporophyte generation (2N)
& small short lived gametophytes (1N)*



Red Algae

- **Small to Medium Size**
- **Use blue light**
- **Shallow to Deep Water**
- **Marine**

Rhodophyta



Red Algae

- **No flagellated cells**
- **Highest diversity in tropics**
- **Some are parasites on other algae**



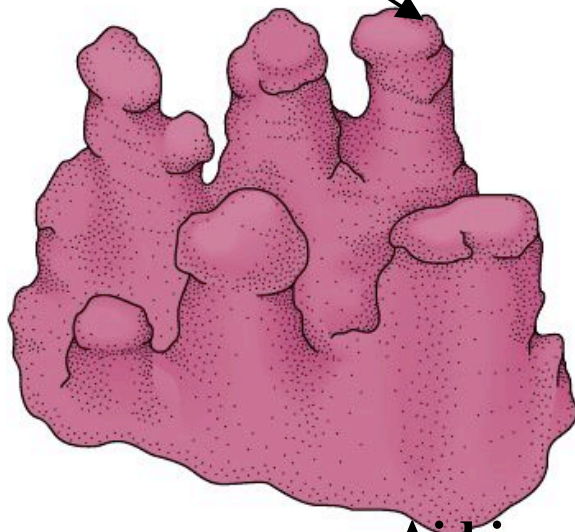
Red Algae

Some are calcareous (CaCO₃ in cell walls)

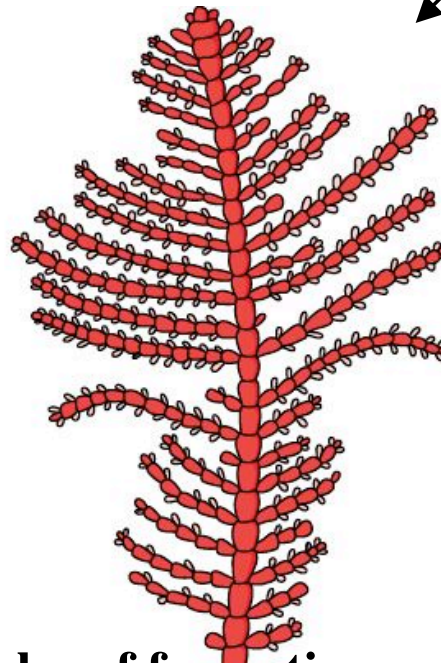
Coralline algae = upright

Encrusting = hard & flat

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a



b

Aid in coral reef formation

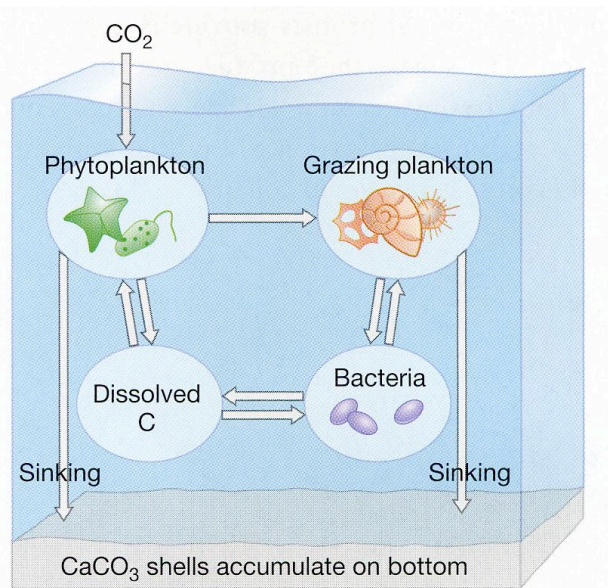
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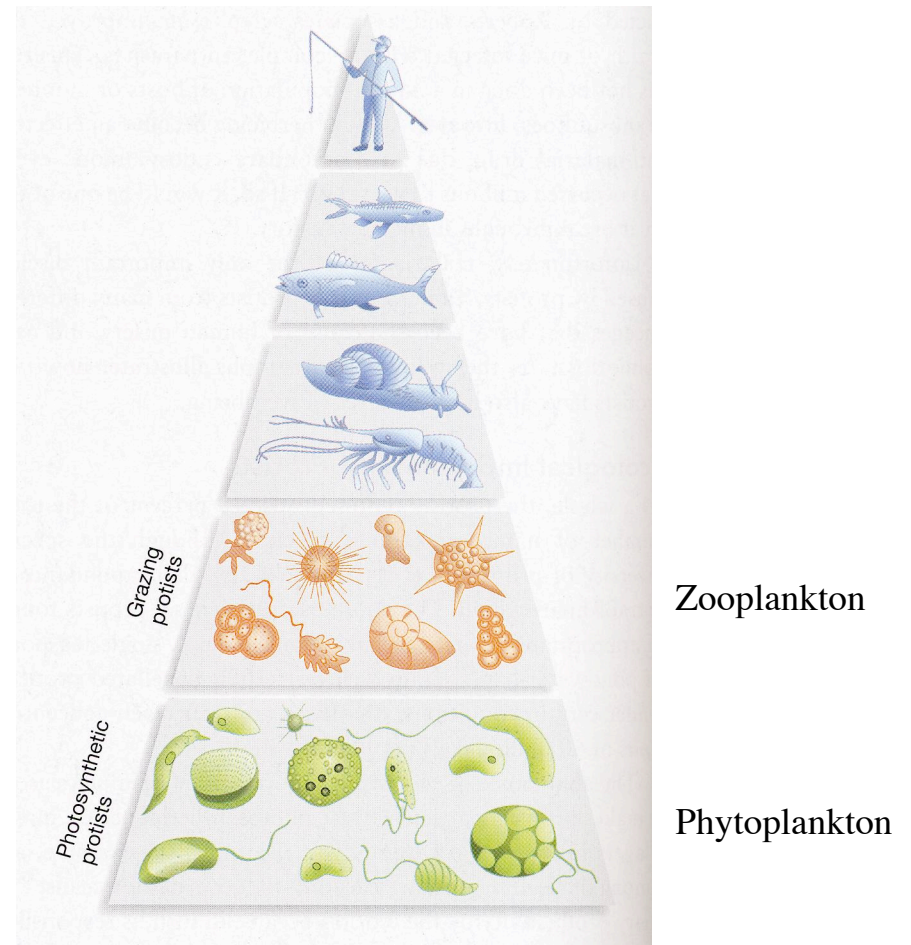
Ecological Importance of Protista

Biogeochemical cycling



Carbon up-take

Oxygen production



Base of food chain in aquatic ecosystems