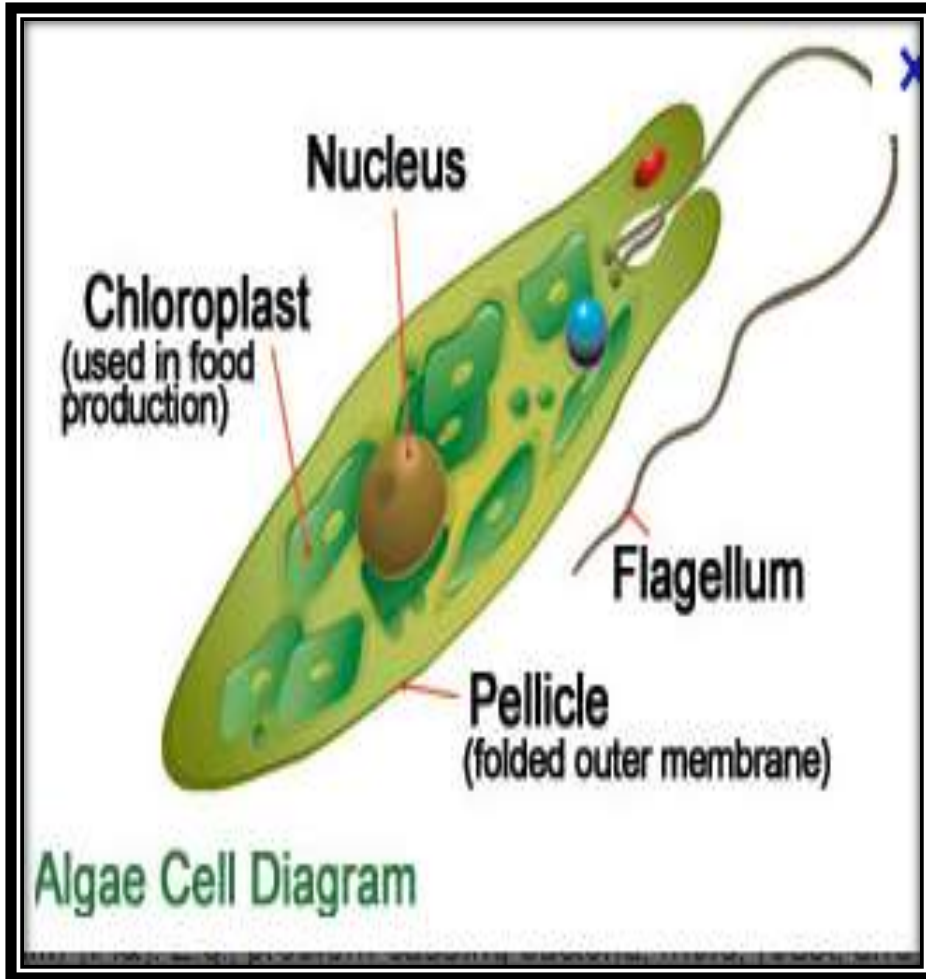


ALGAE





- They can be defined as the small autotrophs that fail to show any cellular differentiation & their sex organs are unicellular & if multicellular all cells are fertile



DISTINGUISHING FEATURES:

- They are photoautotrophs
- They primarily inhabit aquatic habitats
- The vegetative body does not show any differentiation into various tissue systems
- They show progressive complexity in reproduction
- They do not develop embryo after fusion of gametes during sexual reproduction
- Range in size from microscopic to single celled organisms to large seaweed
- Many species occur as single cells others as multicellular



- ❑ Algal cells are **eucaryotic**
- ❑ Study of algae is called **phycology**
- ❑ Cellwall is thin and rigid
- ❑ Motile algae such as euglena have flexible cell membrane called **periplasts**
- ❑ Cell walls of many algae are surrounded by a flexible gelatinous outer matrix
- ❑ A discrete nucleus is present
- ❑ Inclusions like starch granules, oil droplets and vacuoles are present
- ❑ Chlorophyll and other pigments are present
- ❑ **Chloroplasts** may occur one,two or many per cell they may be ribbon like ,bar like ,net like,or as discrete discs



GENERAL CHARACTERISTICS:

- Thallus organisation
- Cell structure
- Algal flagella
- Algal pigments
- Algal nutrition
- Food reserves
- Reproduction



1) THALLUS ORGANISATION:

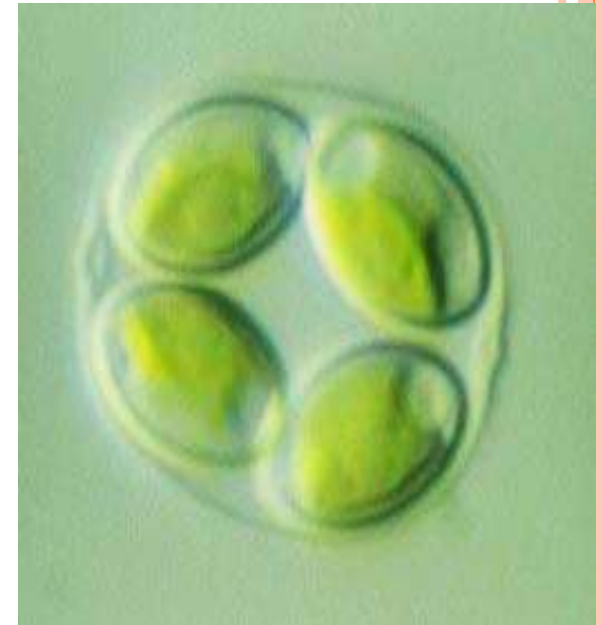
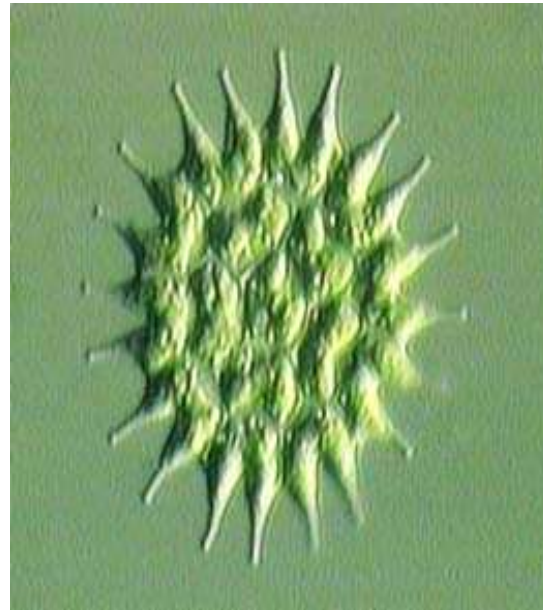
a) Unicellular algae:

- single cells, motile with flagellate (like *Chlamydomonas* and *Euglena*) or nonmotile (like *Diatoms*).
- Occor in all groups except carophycae of phylum chlorophyta and pheophyta.
 - ✓ Rhizopodial
 - ✓ Flagellate
 - ✓ Spiral fillamentous
 - ✓ Nonmotile



b) Colonial algae:

Motile or non motile algae may form a colony by aggregation of the products of cell division with in a mucillagenous mass.



- **Coenobial :**

The colony is formed with a definite shape, size and arrangement of cells.

Ex: *volvox*

- **Palmelloid :**

Irregular arrangement of cells varying in number ,shape and size.

Ex: *Chlamydomonas* , *Tetraspora*

- **Dendroid:**

Looks like microscopic tree due to union of mucilagenous threads present at base of each cell.

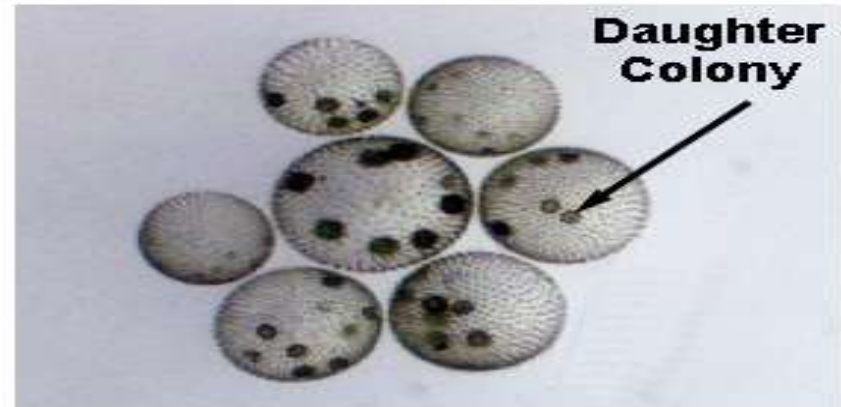
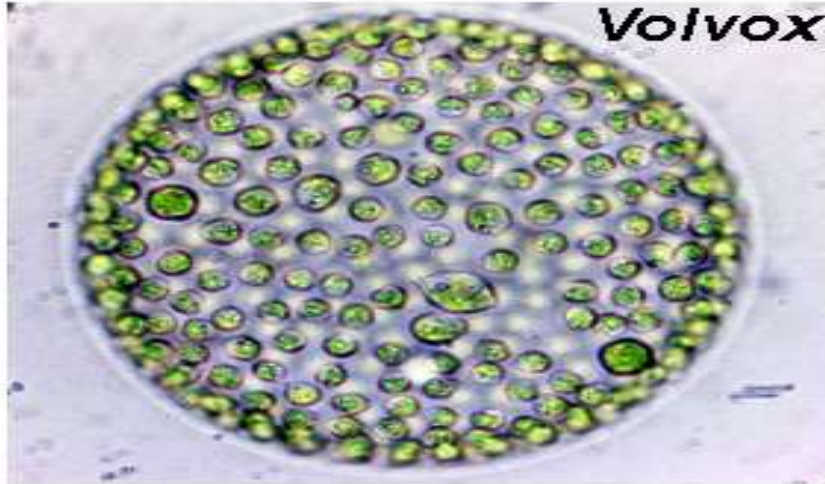
Ex: *Chrysodendron*

- **Rhizopodial colony:**

Cells are united through rhizopodia

Ex: *Chrysidiastrum*





c) Filaments algae:

- Daughter cells remain attached after cell division and form a cell chain
- Adjacent cells share cell wall (distinguish them from linear colonies!)
- May be unbranched (uniseriate such as *Zygnema* and *Ulthrix*) or branched (regular mutiseriate such as *Cladophora* or unregular mutiseriate such as *Pithophora*).



Pithophora



Chlorophyta
Zygnema sp

d) Coenocytic or siphonaceous:

one large, multinucleate cell without cross walls such as *Vaucheria*



e) Parenchymatous:

mostly macro-scopic algae with tissue of undifferentiated cells and growth originating from a meristem with cell division in three dimensions such as *Ulva*



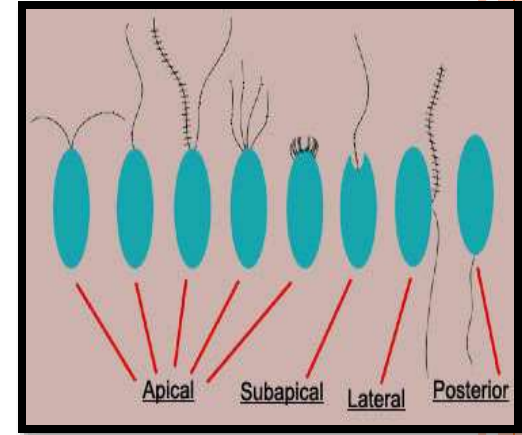
2) CELL STRUCTURE

- Eukaryotic characterised by presence of well organised nucleus and membrane bound organelles like plastids ,mitochondria and Golgi bodies
- An intermediate form called mesokaryotic occurs in **Dianophyceae** which shows both eukaryotic (nucleus with nuclear membrane & chromosomes) and prokaryotic characters(basic proteins are absent)
- Some do not has true cell wall Ex: euglena, gymnodinium & possess a membrane called **pellicle** around cytoplasm
- Motile flagella possess a pigmented spot known as **eye-spot or stigma**(swimming)
- Cell wall is with mixed carbohydrates and substances like alginic acid , fucoidin , fucin & hemicelluloses present
- Mitochondria, Golgi complex , Endoplasmic reticulum present.



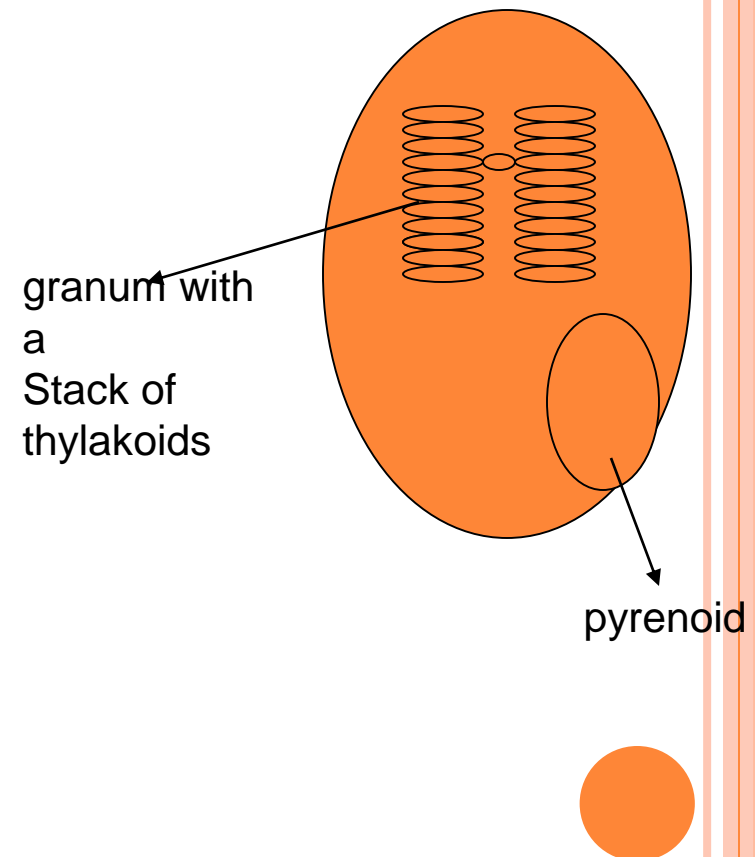
3) ALGAL FLAGELLA

- Found in all algae except **Rhotophyceae**
- The main function is **motility**
- They are of 2 types
- **Whiplash or acronematic**-possess smooth surface
- **Tinsel or pleuronematic**-covered by fine filamentous appendages called as mastigonemes or flimmers
- Tinsel is divided into 3 types
 - **Pantonematic**-mastigonemes arranged in two opposite rows or radially
 - **Pantocronematic**-Pantonematic flagellum with a terminal fibril
 - **Stichonematic**-mastigonemes develop only on one side of the flagellum



4) ALGAL PIGMENTS

- Distinct chloroplast, nuclear region and complex organelles.
- Thylakoids are grouped into grana
pyrenoids are centers of carbon dioxide fixation within the chloroplasts of algae. Pyrenoids are not membrane-bound organelles, but specialized areas of the plastid that contain high levels of ribulose-1,5-bisphosphate carboxylase / oxygenase



- The pigments are within membrane bound organelles called plastids
- May be **leucoplasts** (colourless plastids) or **chromoplasts** (coloured plastids)
- **Chromoplasts**- contain chlorophyll a and b
- **Chromatophores** -contain only chlorophyll a
- Types - Chlorophylls(5), xanthophylls(20), carotenes(5) and phycobillins (7)
- Chlorophyll a present in all
- Xanthophylls(yellow/brown) present in chlorophyceae and pheophyceae
- B carotene present in most algae
- Phycobillins are water soluble red(phycoerythrin) and blue(phycocyanin) confined to rhodophyceae



5) ALGAL NUTRITION

- Photo autotrophic and synthesis their own food from carbondioxide and water
- **Aquatic** forms obtain carbon dioxide and water by diffusion and osmosis
- **Aerials** obtain water from damp substratum and carbon dioxide from air
- They also synthesis oil and protiens from carbohydrates



6) FOOD RESERVES

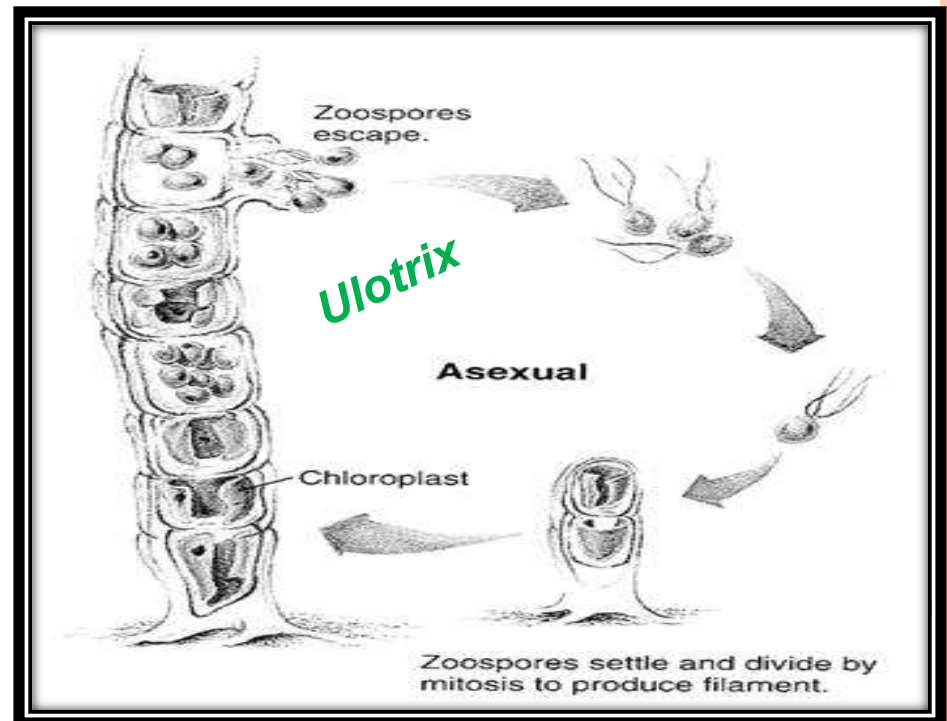
- Food materials accumulated as **polysaccharides**
- **True starch**-seen in two algal divisions chlorophyta and charophyta
- **Floridean starch**- found in rhodophyta
- **Laminarin**- found in brown algae
- **Paramylon**- found in euglenoids
- **Leucosin**-peculiar to xanthophyta , bacillariophyta & chrysophyta
- **Fats** occur as reserved food in appreciable amounts in the cells of xanthophyta , bacillariophyta & chrysophyta



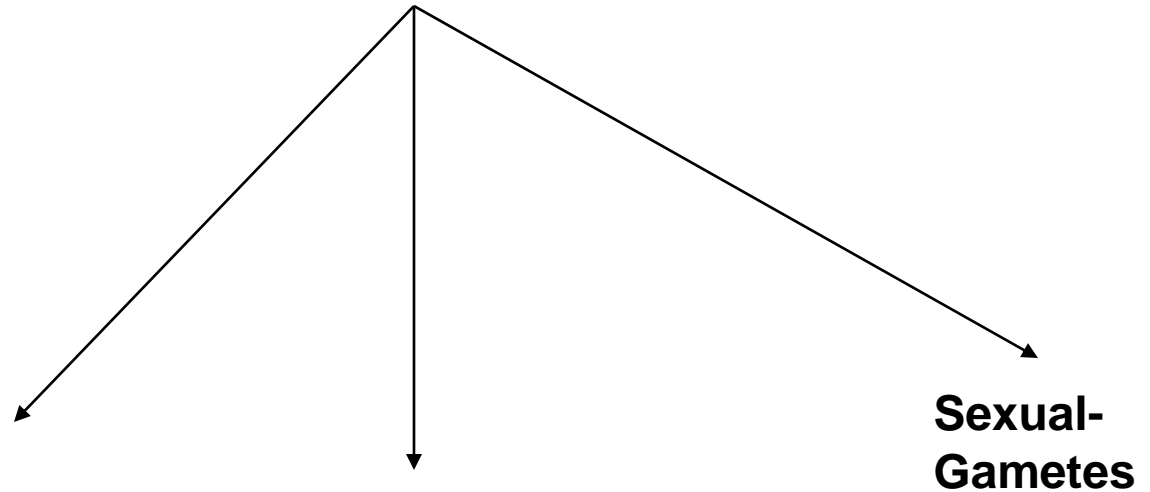
7) REPRODUCTION IN ALGAE

MOST REPRODUCE BOTH SEXUALLY AND ASEXUALLY

- Most sexual reproduction is triggered by environmental stress
- Asexual Reproduction
 - Mitosis
- Sexual Reproduction
 - Meiosis
 - Zoospores
 - Plus and minus gametes
 - Zygospore



REPRODUCTION IN ALGAE



**Vegetative
Cell
divisions/Fragmentation
=part of the filament
breaks off from the rest
and forms a new one.**

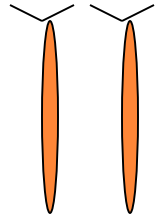
Asexual Reproduction

.

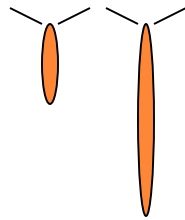


SEXUAL REPRODUCTION

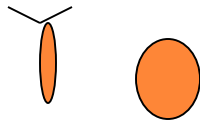
- **ISOGAMY**-Both gametes have flagella and similar in size and morphology.



- **ANISOGAMY**-Gametes have flagella but are dissimilar in shape and size. One gamete is distinctly smaller than the other one.



- **OOGAMY**-gamete with flagella (sperm) fuses with a larger, non flagellated gamete (egg).

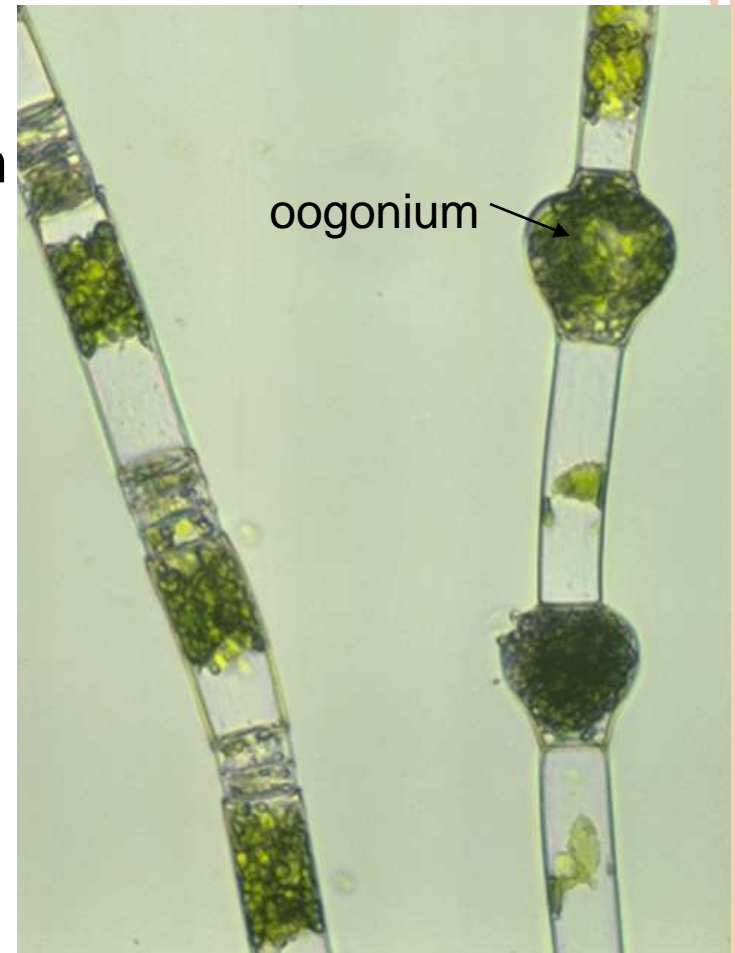


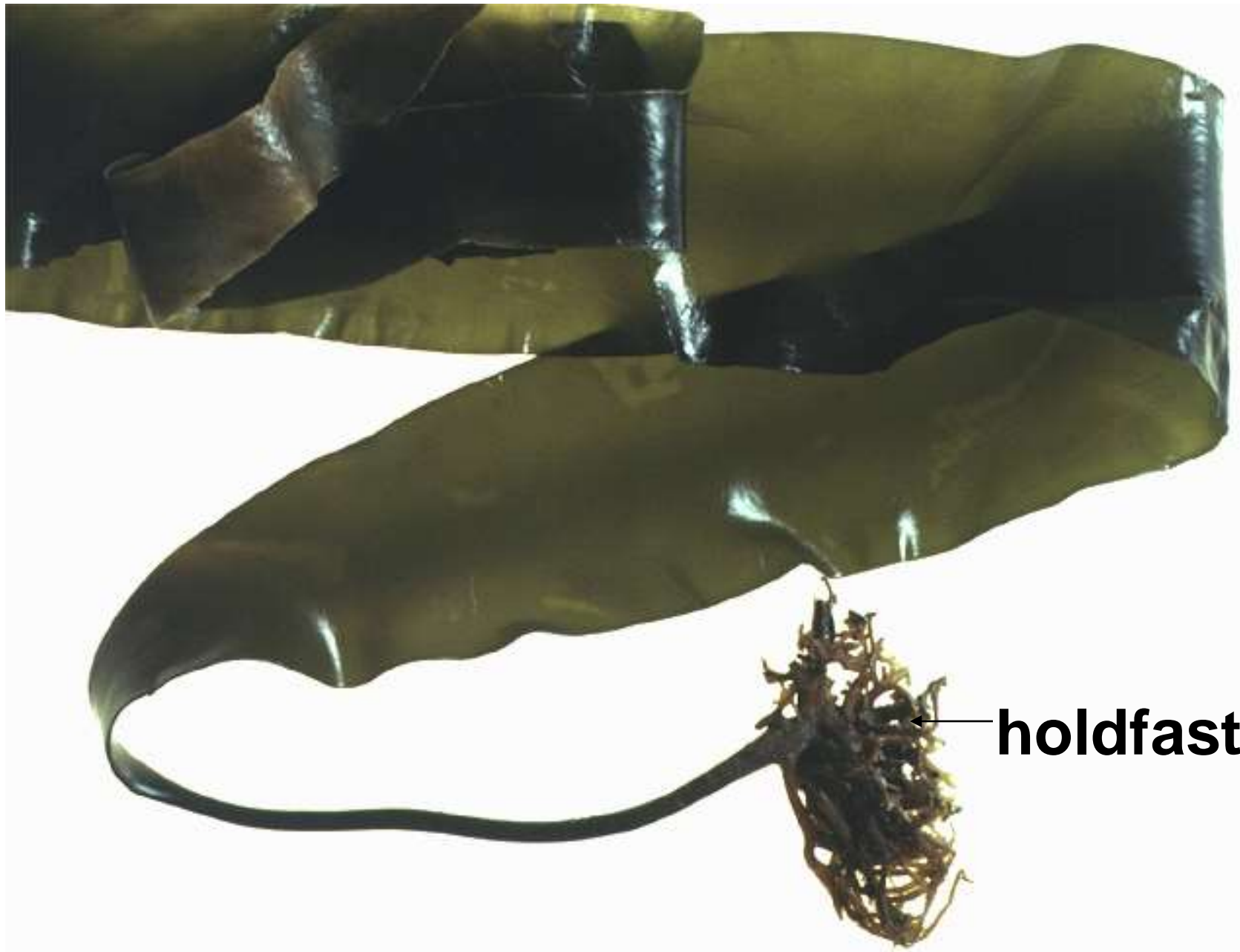
- **Monecious:** both gametes produced by the same individual
- **Diecious:** male and female gametes are produced by different individuals
- **Homothallic:** gametes from one individual can fuse (self-fertile)
- **Heterothallic** gametes from one individual cannot fuse (self-sterile)
- **Conjugation:** a special type of reproduction. The entire cell serve as a gametes and the cell content are transported passively between two cells taking part in sexual reproduction



REPRODUCTION IN MULTICELLULAR ALGAE

- Oedogonium reproduction
 - **Antheridium** -release flagellated sperm that swim to the oogonium
 - **Oogonium** - houses the zygote which is a diploid spore
 - The spore undergoes meiosis and produces 4 haploid zoospores. One of the four cells becomes a root like holdfast the others divide and become a new filament.





← holdfast

CLASSIFICATION OF ALGAE

○ **BASED ON SEVEN MAJOR DIVISIONS**

- 1) Nature and properties of pigments
- 2) Chemistry of reserve food products
- 3) Morphology of flagella
- 4) Morphology of cells and thalli
- 5) Life history reproductive structures and methods of reproduction
- 6) Food-storage substance
- 7) Cell wall composition



DIVIDED INTO 9 PHYLA

- **Phylum Rhodophycophyta**
- *Phylum Xanthophycophyta*
- **Phylum Chrysophycophyta**
- **Phylum Phaeophycophyta**
- **Phylum Bacillariophycophyta**
- **Phylum Euglenophycophyta**
- **Phylum Chlorophycophyta**
- **Phylum Cryptophycophyta**
- **Phylum Pyrrophyta**



PHYLUM RHODOPHYCOPHYTA

- + 4000 species of **RED Algae**
- Most are marine
- Smaller than brown algae and are often found at a depth of 200 meters.
- Contain chlorophyll **a** and rarely **d** as well as **phycobilins** which are important in absorbing light that can penetrate deep into the water
- Have cells coated in carageenan which is used in cosmetics, gelatin capsules and some cheeses
- Red algae **GELIDIUM** from which **AGAR** is made



Red Algae



Porphyra - nori use to wrap uncooked fish & other food items

Smithora naiadum - a epiphyte on eel and surf grass



Pikea robusta

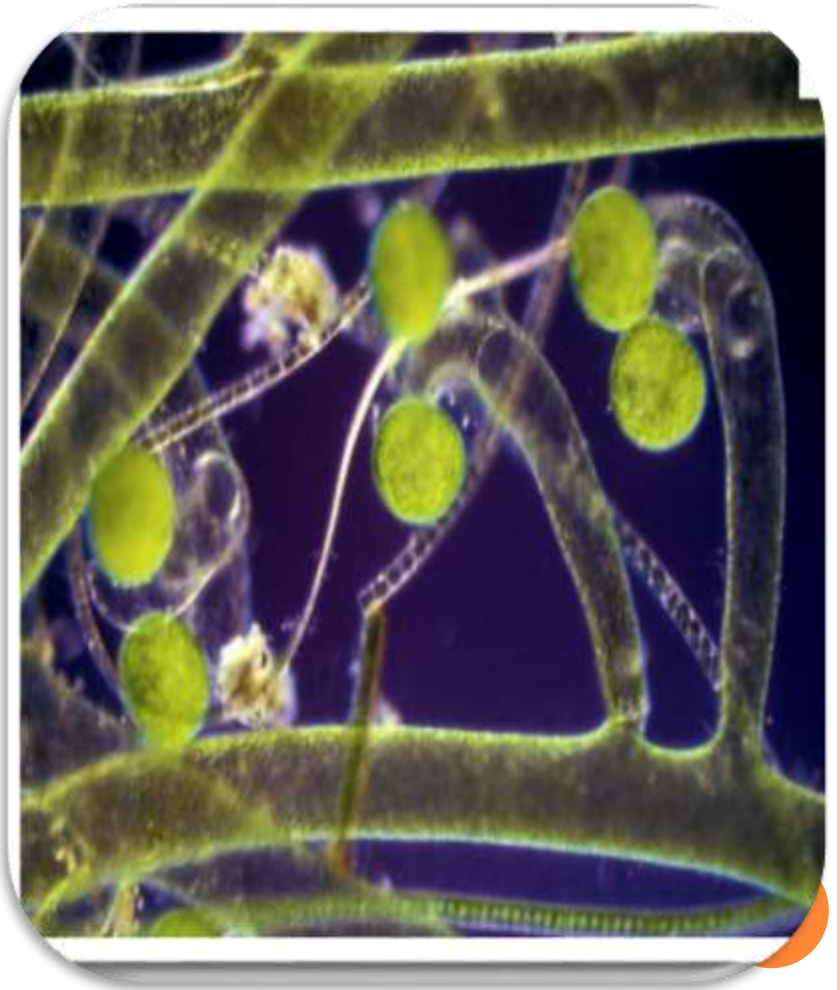


PHYLUM XANTHOPHYCOPHYTA

- Yellow Green Algae
- Xanthophytes walls with cellulose and pectin
- Chlorophyll a,c and rarely e are present
- Cellular storage product is chrysolaminarin
- Flagella unequal in length
- Asexual reproduction by cell division and fragmentation
- *Vaucheria* is a well known member of this division



VAUCHERIA



PHYLUM CHRYSOPHYCOPHYTA

□ Golden Algae

- ▶ **predominately flagellates some are amoeboid**
- ▶ **Chlorophyll **a** and **c** present**
- ▶ **Reserve food as chrysolaminarin and their frequent incorporation of **silica****
- ▶ **Characteristic color due to masking of their chlorophyll by brown pigments**
- ▶ **Reproduction is commonly asexual but at times isogamous**



GOLDEN ALGAE



PHYLUM PHAEOPHYCOPHYTA

- 1500 species of **Brown algae**
- Mostly marine and include seaweed
- All are multicellular and large (often reaching lengths of 147 feet)
- Individual alga may grow to a length of 100m with a holdfast, stipe and blade
- Chlorophyll **a** and **c** present
- Used in cosmetics and most ice creams
- Many of them have holdfasts and air bladders which give them buoyancy



Brown algae



Fucus sp.



Nereocystis luekeana



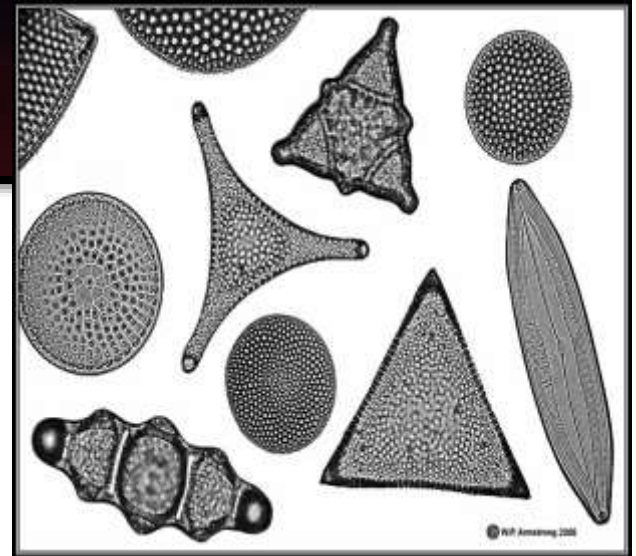
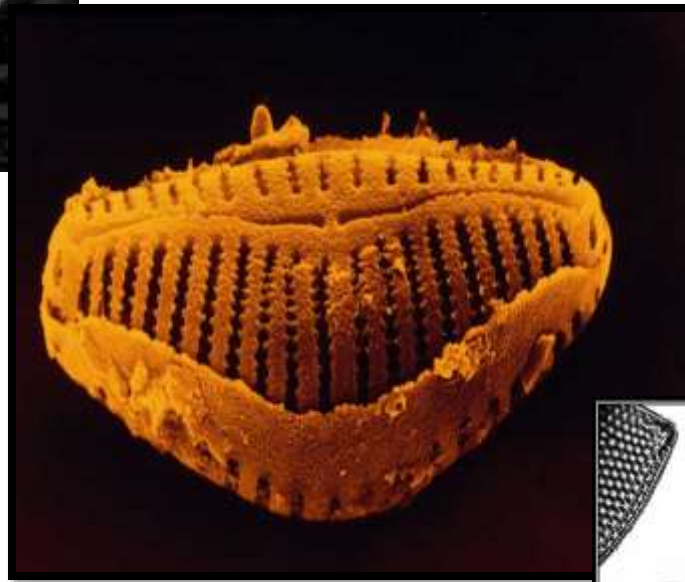
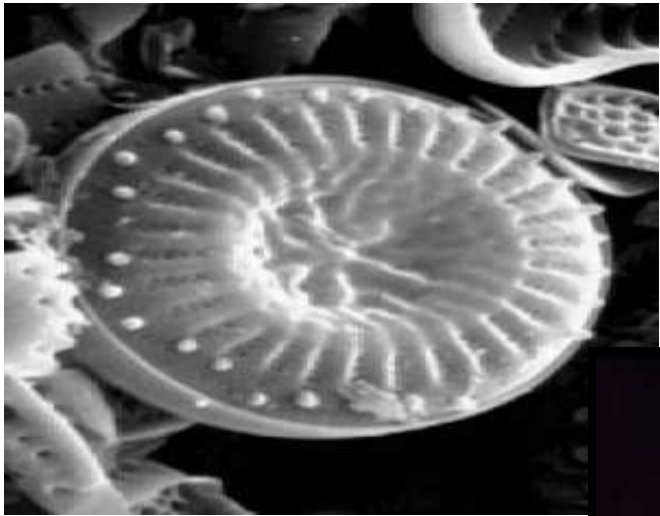
PHYLUM BACILLARIOPHYCOPHYTA

□ The Diatoms

- Diatoms provide abundant food supply for aquatic animals
- Chlorophyll **a** and **c** present
- Shells of diatoms are called frustules
- Deposits of these shells from centuries of growth are called **diatomite** or **diatomaceous earth**



DIATOMS

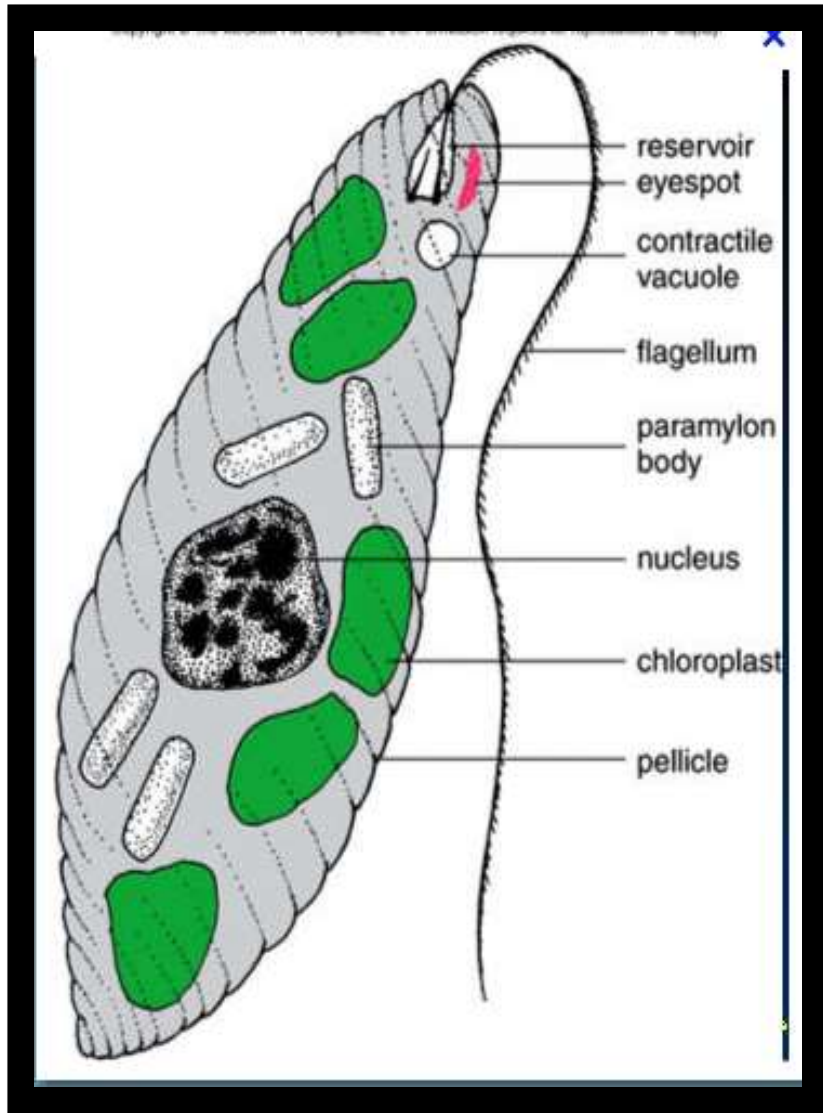


PHYLUM EUGLENOPHYCOPHYTA

- ✓ **Unicellular and motile by means of flagella**
- ✓ **Chl a & b present**
- ✓ **1000 species of Euglenoids**
- ✓ **Have both plantlike and animal-like characteristics**
- ✓ **Euglena cell with contractile vacuules and fibrils**
- ✓ **Carry out photosynthesis in chloroplast and is facultatively autotrophic**
- ✓ **Reproduction by longitudinal binary fission**
- ✓ **Dormant cysts are formed**



EUGLENA

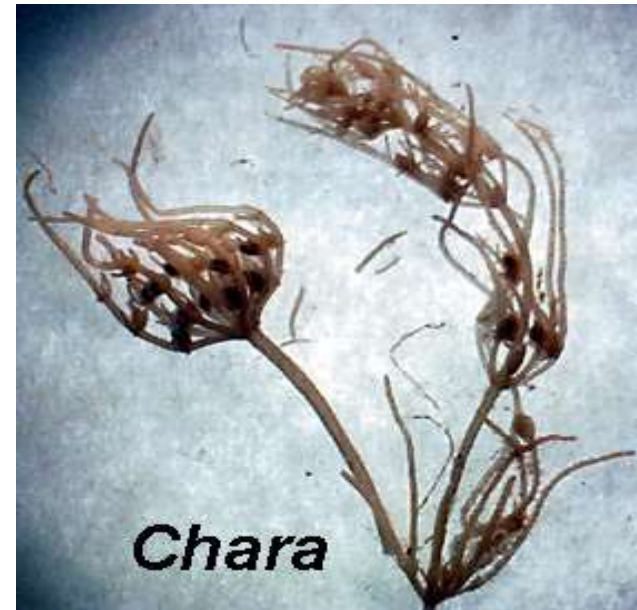


PHYLUM CHLOROPHYCOPHYTA

- **Green algae**
- **7000 diverse species**
- **green algae contain one chloroplast per cell which contain pyrenoids**
- **Both green algae and land plants have chlorophyll a and b as well as carotenoids and store food as starch**
- **Both have walls made of cellulose**
- **Reproduction by asexual methods or isogamous and heterogamous sexual means**



Green algae

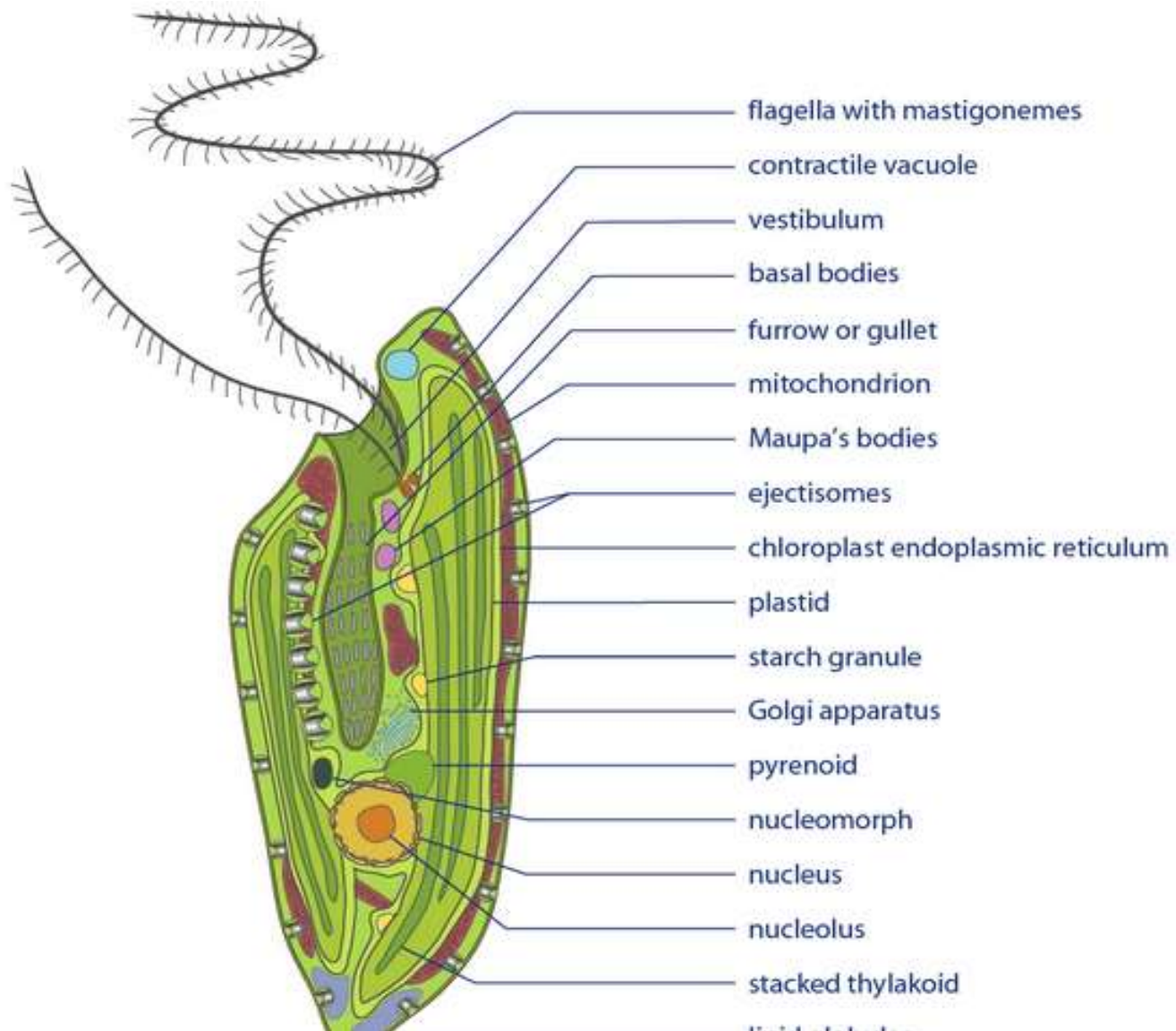


PHYLUM CRYPTOPHYCOPHYTA

- **Cryptomonads** are biflagellate organisms
- Cells are slipper shaped and flattened occur singly
- Some with cellulose wall others naked
- There are 1 or 2 plastids with or without pyrenoids
- Reproduction by longitudinal cell division or by zoospores or cysts



CRYPTOMONAS

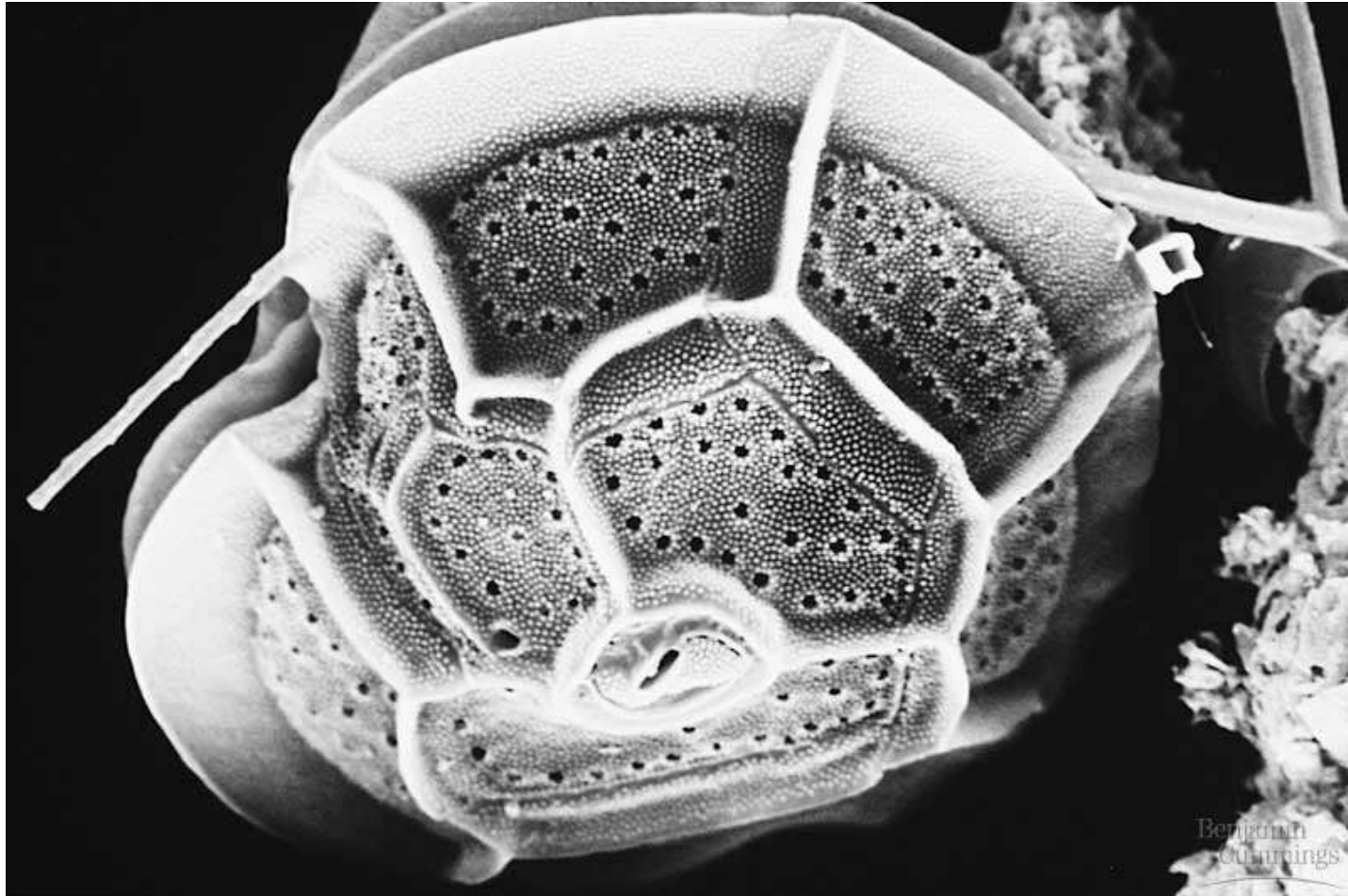


PHYLUM PYRRROPHYCOPHYTA

- ▶ **Flagella are inserted in the girdle and arranged with one encircling the cell and other trailing**
- ▶ **Many are covered only by plasmalemma and in some there is a wall made of cellulose**
- ▶ **Some have a series of cellulose plates with in plasmalemma termed thecal plates**
- ▶ **Dianoflagellates a diverse group of biflagellated uni cellular organisms present**



DIANO FLAGELLATES



Beneficial Aspects of Algae

- Food for humans
- Food for invertebrates and fishes in mariculture
- Animal feed
- Soil fertilizers and conditioners in agriculture
- Treatment of waste water
- Diatomaceous earth (= diatoms)
- Chalk deposits
- Phycocolloids (agar, carrageenan from red algae; alginates from brown algae)
- Drugs
- Model system for research
- Phycobiliproteins for fluorescence microscopy



ROLE OF ALGAE TO DETECT ENVIRONMENT POLLUTION

- Indicator of pollution - algae blooms can occur when too much nitrogen and phosphorus enter a waterway.
- Algae are ideally suited for water quality assessment because they have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts.



ALGAE USAGE IN SEWAGE TREATING PLANTS

- Algae can be used to treat both municipal and industrial wastewater.
- *Algae* play a major role in aerobic treatment of waste in the secondary treatment process.
- Algae - based municipal wastewater treatment systems are mainly used for *nutrient* removal (removal of nitrogen and phosphorous).
- Algae have the ability to accumulate the heavy metals and thereby remove toxic compounds from the wastewater. In some cases, *algae* also play a role in the removal of pathogens in the tertiary treatment stage.



ALGAE IN FILTER PLANTS

- An algae scrubber filters water by moving water rapidly over a rough, highly illuminated surface, which causes algae to start growing in large amounts.
- As the algae grow, they consume nutrients such as inorganic nitrate, inorganic phosphate, nitrite, ammonia, and ammonium from the water.



ALGAE ROLE IN TREATING HEALTH PROBLEMS

- Ulva Can be used to treat goiter; reduce fever, ease pain, induce urination
- Codium Can be used to treat urinary diseases, treat edema,
- Sargassum Can be used to treat cervical lymphadenitis, edema;
- Porphyra Can be used to treat goiter, bronchitis, tonsillitis and cough
- Gelidium Laxative; can be used to treat tracheitis, gastric diseases and hemorrhoids; can be used to extract agarinishes inflammation; reduces fever;



HARMFUL EFFECTS OF ALGAE

- ❑ Several species are parasitic on higher plants
- ❑ Green algae *Cephaleuros* attacks leaves of tea, coffee, pepper causing considerable damage
- ❑ Some algae live in the roots and fleshy parts of higher plants but not harmed
- ❑ Acrylic acid is produced by a unicellular algae in plankton act as extracellular inhibitors its shown by chemical analysis
- ❑ Some planktonic algae produce toxins which are lethal to fish and other animals these toxins are extracellular liberated from algae by bacterial decomposition of algal blooms





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