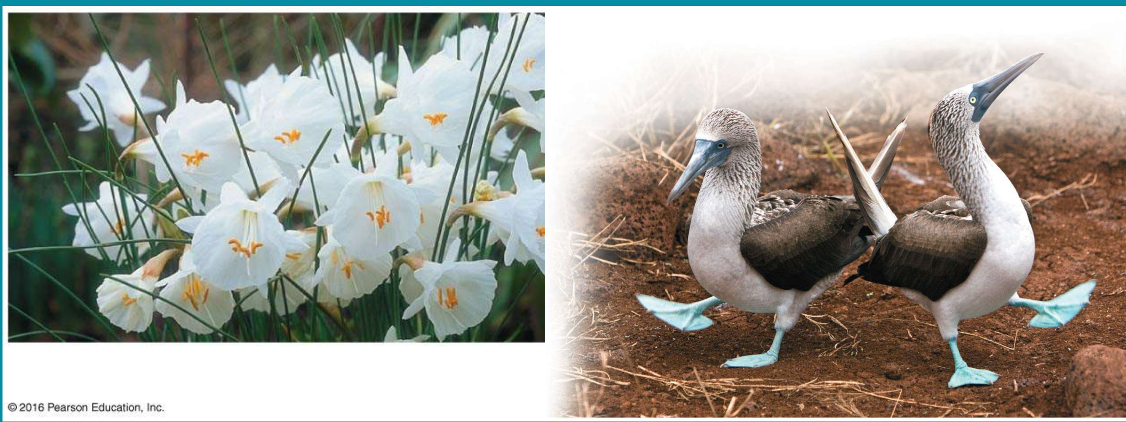
SLE 132 – Form and Function
Biological Clocks and Tropisms



Learning Outcomes

- Understand that tropisms orient the growth of plant organs toward or away from stimuli.
- Know that turgor movements are relatively rapid, reversible plant responses.
- Know biological clocks control circadian rhythms in plants and photoperiodism synchronizes many plant responses to change of season.

Tropisms

Tropism is a growth response resulting in curvatures of whole plant organs toward (positive) or away from (negative) stimuli

- **Phototropism** – light
  - towards is positive phototropism
  - away from is negative phototropism
- **Gravitropism** – gravity (+ Down, - Up)
- **Thigmotropism** – touch

Phototropism

- Result of differential cell elongation on opposite sides of stem
- Due to unequal distribution of auxin
- In grasses, auxin migrates across the tip from bright side to dark side

- As seen before in Darwin and others experiments

https://www.youtube.com/watch?v=DhITXtENPrU

Gravitropism

- Shoot shows negative gravitropism
- Root shows positive gravitropism
- This occurs in darkness

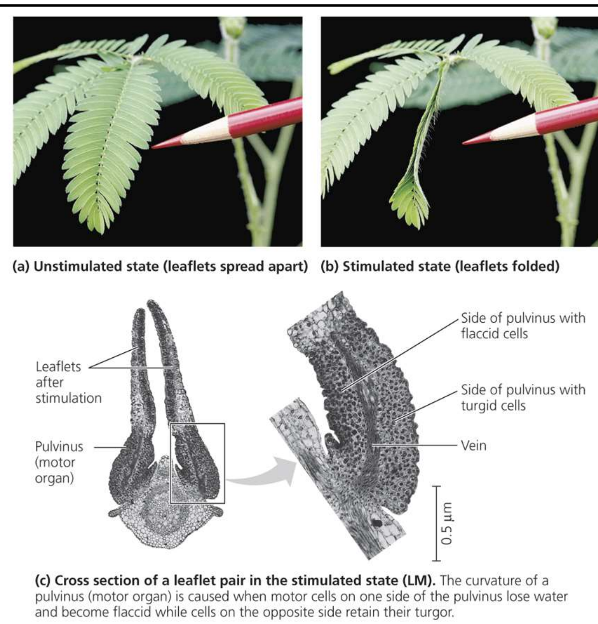
- How – not yet fully understood
  - Gravity pulls organelles with dense starch grains to low points in cells
  - cells signalled to redistribute auxin which controls direction of growth

https://www.youtube.com/watch?v=Rb55mj8xkxk

Thigmotropism – response to touch

- Contact stimulates differential growth
- Cells on opposite sides grow/engorge faster causing plants to coil or grasp
  - For example – climbers up side of a wall.

Touch-me-not plant
http://www.youtube.com/watch?v=BLTcVNyOhUc (4 min)
Time lapse vines
https://www.youtube.com/watch?v=dTljaIVseTc (1 min)



▲ **Figure 39.26** **Rapid turgor movements by the sensitive plant (*Mimosa pudica*).**

Biological Clocks

- Plants display **rhythmic behaviour** – for example stomata open in day, close at night
- Some flowers e.g. Daisy (dandelion) close flower at night, open flower during day
- Rhythm persists even when organism sheltered from environmental cues

Biological clocks

Many legumes lower their leaves in the evening and raise them in the morning, even when kept under constant light or dark conditions

Sleep movements of a bean plant occur at the same time intervals **whether kept in dark or light**

▲ **Figure 39.18 Sleep movements of a bean plant (*Phaseolus vulgaris*).** The movements are caused by reversible changes in the turgor pressure of cells on opposing sides of the pulvini, motor organs of the leaf.

Biological clocks

BUT – If kept in constant environment for prolonged periods **some deviation occurs**

- E.g. Bean plant will deviate to 26 hour cycle

▲ **Figure 39.18 Sleep movements of a bean plant (*Phaseolus vulgaris*).** The movements are caused by reversible changes in the turgor pressure of cells on opposing sides of the pulvini, motor organs of the leaf.

Biological clocks

- Some evidence that a molecular mechanism is located within the cell, involving feedback loops = **clock genes**!
- Affected little by temperature
  - This is different from most metabolic processes
- Useful considering changes occurring in environment can inhibit response but **biological clock continues**

https://ed.ted.com/lessons/how-plants-tell-time-dasha-savage

Photoperiod

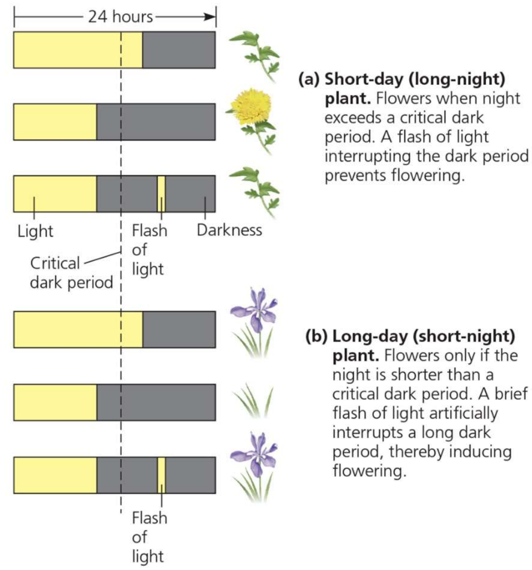
- Biological clock can be **diurnal (daily), seasonal, annual** etc.
- Time of year is determined by photoperiod
  - length of day and night
- Plants whose flowering is triggered by photoperiod
  - **short day** plants
  - **long day** plants

Photoperiod

- In 1940's – found that flowering plants actually **respond to night length** <u>not day length</u>
- scientists decided not to change terminology to avoid confusion
  - **short day plants =** long night plants
  - **long day plants =** short night plants
- Plants require a critical length of light/ darkness (often termed critical day length or **critical photoperiod**)

Photoperiod

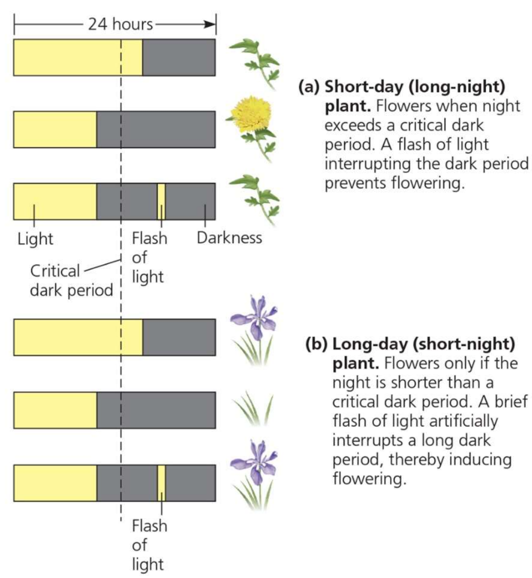
- **Continuity of darkness** is important
- **Short day plants** require a minimum number of hours (critical night length) of <u>uninterrupted darkness</u>
- If broken, flowering does not occur
- If daylight is interrupted by darkness there is no effect on flowering.



▲ **Figure 39.19** **Photoperiodic control of flowering.**

Photoperiod

- **Long day** (short night) plants flower only if the night is <u>shorter than a critical dark period</u>
- The night can be artificially shortened with a flash of light



▲ **Figure 39.19** **Photoperiodic control of flowering.**

SLE 132 – Form and Function
Introduction to Algae/Protists

DEAKIN COLLEGE in association with DEAKIN UNIVERSITY AUSTRALIA

Learning Outcomes

- Understand that the Protista is a diverse and artificial group of eukaryotes that has some very ancient members.
- Know that protists can cause many important diseases, such malaria and that photosynthetic protists (the algae) are responsible for most of the primary production on Earth.
- Learn microalgae (e.g. diatoms and golden algae) include a variety of freshwater and marine forms, some may cause algal blooms.
- Learn macroalgae (seaweeds) are multicellular algae and classified into three groups: red algae, brown algae and green algae.
- Understand that red and green algae are the closest relatives of plants.
- Understand the ecological and commercial importance of algae.

Protists

- Protists are **eukaryotes** that do not fit into Kingdom Animalia, Fungi or Plantae
- Most are unicellular, some colonial and multicellular species
- More structure and functional diversity that any other group of eukaryotes

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Protists

- Protists are nutritionally diverse and include:
  - **Photoautotrophs:** photosynthesize and contain chloroplasts
  - **Heterotrophs:** absorb organic molecules or ingest larger food particles
  - **Mixotrophs:** combine photosynthesis and heterotrophic nutrition
- Protists can reproduce <u>sexually or asexually</u>

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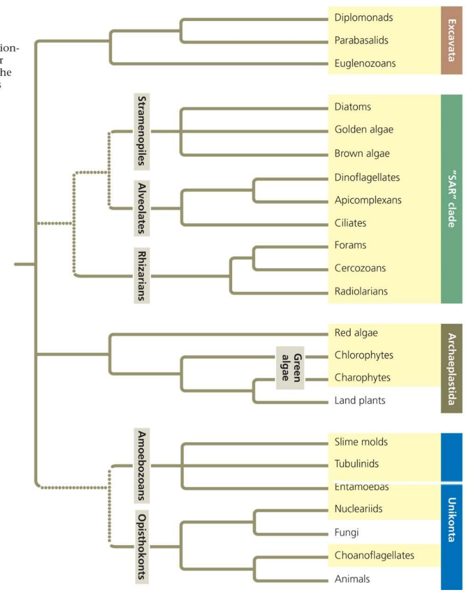
FYI

▼ Figure 28.2
Exploring Protistan Diversity

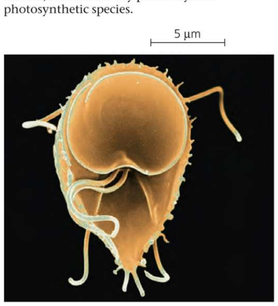
The tree below represents a phylogenetic hypothesis for the relationships among all the eukaryotes on Earth today. The eukaryotic groups at the branch tips are related in larger "supergroups", labelled vertically at the far right of the tree. Groups that were formerly classified in the kingdom Protista are highlighted in yellow. Dotted lines indicate evolutionary relationships that are uncertain and proposed clades that are under active debate. For clarity, this tree only includes representative clades from each supergroup. In addition, the recent discoveries of many new groups of eukaryotes indicate that eukaryotic diversity is much greater than shown here.



FYI

Excavata

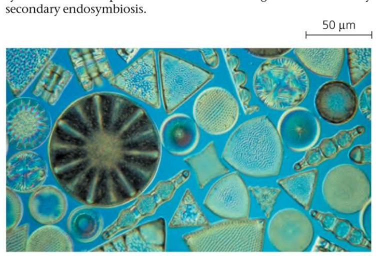
Some members of this supergroup have an "excavated" groove on one side of the cell body. Two major clades (the parabasalids and diplomonads) have modified mitochondria; others (the euglenozoans) have flagella that differ in structure from those of other organisms. Excavates include parasites such as *Giardia*, as well as many predatory and photosynthetic species.



***Giardia intestinalis*, a diplomonad parasite.** This diplomonad (colourised SEM), which lacks the characteristic surface groove of the Excavata, inhabits the intestines of mammals. It can infect people when they drink water contaminated with faeces containing *Giardia* cysts. Drinking such water—even from a seemingly pristine stream—can cause severe diarrhoea. Boiling the water kills the parasite.

"SAR" Clade

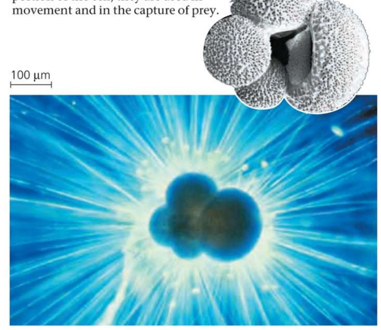
This supergroup contains (and is named after) three large and very diverse clades: Stramenopila, Alveolata, and Rhizaria. Stramenopiles include some of the most important photosynthetic organisms on Earth, such as the diatoms shown here. Alveolates also include many photosynthetic species as well as important pathogens, such as *Plasmodium*, which causes malaria. Many of the key groups of photosynthetic stramenopiles and alveolates are thought to have arisen by secondary endosymbiosis.



Diatom diversity. These beautiful single-celled protists are important photosynthetic organisms in aquatic communities (LM).

"SAR" Clade

The rhizarian subgroup of the SAR clade includes many species of amoebas, most of which have pseudopodia that are threadlike in shape. Pseudopodia are extensions that can bulge from any portion of the cell; they are used in movement and in the capture of prey.

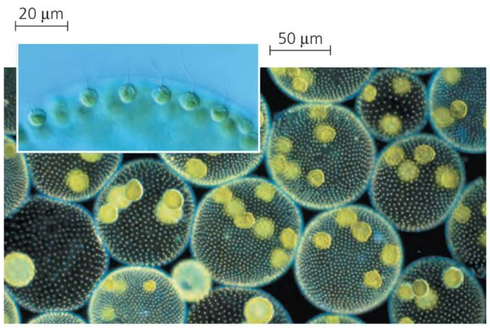


***Globigerina*, a rhizarian in the SAR clade.** This species is a foram, a group whose members have threadlike pseudopodia that extend through pores in the shell, or *test* (LM). The inset SEM shows a foram test, which is hardened by calcium carbonate.

FYI

Archaeplastida

This group of eukaryotes includes red algae and green algae, along with land plants (kingdom Plantae). Red algae and green algae include unicellular species, colonial species (such as the green alga *Volvox*), and multicellular species. Many of the large algae known informally as "seaweeds" are multicellular red or green algae. Protists in Archaeplastida include key photosynthetic species that form the base of the food web in some aquatic communities.



***Volvox*, a colonial freshwater green alga.** The colony is a hollow ball whose wall is composed of hundreds of biflagellated cells (see inset LM) embedded in a gelatinous matrix. The cells are usually connected by cytoplasmic strands; if isolated, these cells cannot reproduce. The large colonies seen here will eventually release the small "daughter" colonies within them (LM).

Unikonta

This group of eukaryotes includes amoebas that have lobe- or tube-shaped pseudopodia, as well as animals, fungi, and non-amoeba protists that are closely related to animals or fungi. According to one current hypothesis, the unikonts may have been the first group of eukaryotes to diverge from other eukaryotes; however, this hypothesis has yet to be widely accepted.

A unikont amoeba. This amoeba (*Amoeba proteus*) is using its pseudopodia to move.

Algae

- Algae were once considered 'plants' but are now placed in a <u>separate kingdom</u>
- Blue-green algae placed with bacteria – <u>cyanobacteria</u>
- Other groups of algae placed with <u>protists</u>
- Taxonomy is still being sorted out and the **number of algal divisions recognised varies** from authority to authority

Distinguishing features of algae

- Reproductive cells occur in unicellular or multicellular organs, in which every cell is fertile
- In most algae, both male and female gametes are shed from the parent and fertilisation occurs in the water
  - **embryos are not retained within the parental tissue**
    (that would characterise it as a plant)
- In some unicellular species the entire organism acts as a gamete in sexual reproduction

Distribution of Algae

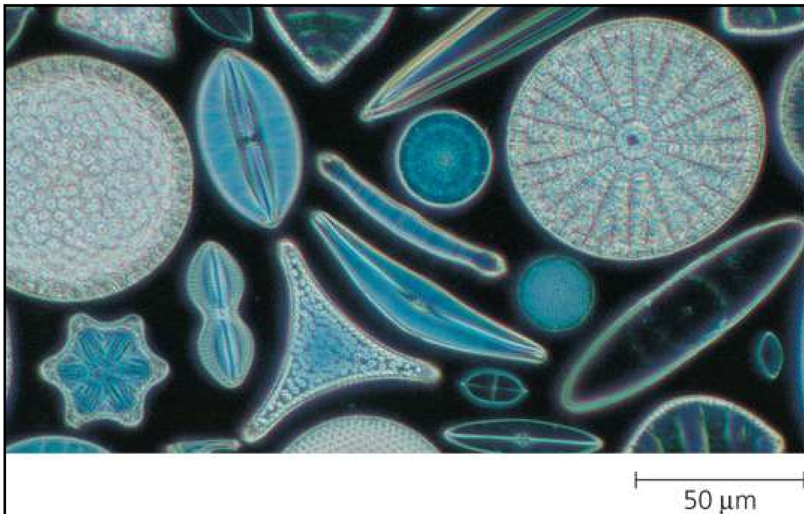
- Distribution of algae is affected by many factors
- Any one species has its own range of responses to any one environmental factor but **synergistic effects occur**
- Light and temperature are very important

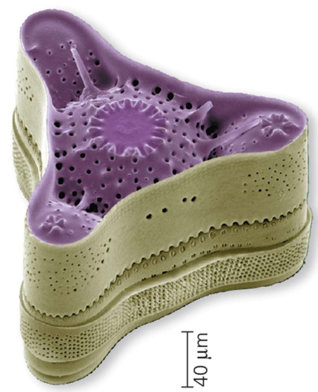
Micro-algae

- There are many different types of single cellular algae, which can be **marine or freshwater**
  - Golden brown algae
  - Green algae
  - Blue-green algae
  - Euglenoids
  - Diatoms
  - Dinoflagellates

Bacillariophyta – Diatoms

- Freshwater, estuarine or marine
- **Diatoms** are unicellular algae with a unique two-part, <u>glass-like wall of hydrated silica</u>
- Usually symmetrical
- Diatoms usually reproduce asexually, and occasionally sexually
- Diatoms are a major component of **phytoplankton** and are highly diverse





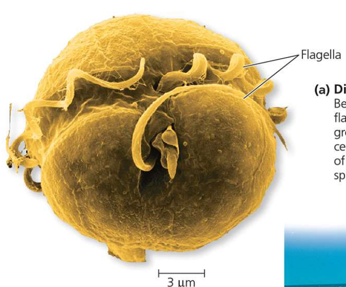
▶ **Figure 28.10** **The diatom *Triceratium morlandii* (colourised SEM).**

Dinoflagellates

- Cells frequently occur singularly but can be colonial
- Are **phytoplankton** that can bloom to <u>plague proportions</u> and kill fish and produce toxins dangerous to humans
- Each has a characteristic shape that in many species is reinforced by <u>internal plates of cellulose</u>
- **Two flagella** make them spin as they move through the water
- Dinoflagellate blooms are the cause of toxic "**red tides**" and red tide poisoning

Algal Blooms

- Refer to micro algae
- Increased in the last few years
- Increasing pollutants in water and also because of slow moving waters, high temps
- Some are known as red tides
- Various algae can cause blooms
- Causes odours, skin irritations, nervous conditions, death



(a) Dinoflagellate flagella. Beating of the spiral flagellum, which lies in a groove that encircles the cell, makes this specimen of *Pfiesteria shumwayae* spin (colourised SEM).

(b) Red tide in the Gulf of Carpentaria in northern Australia. The red colour is due to high concentrations of a carotenoid-containing dinoflagellate.

▲ **Figure 28.15** **Dinoflagellates.**

Bioluminescence – Dinoflagellates

https://www.youtube.com/watch?v=uqJbUKEPgXc

Red Tides

https://www.youtube.com/watch?v=35Jprh1VFug

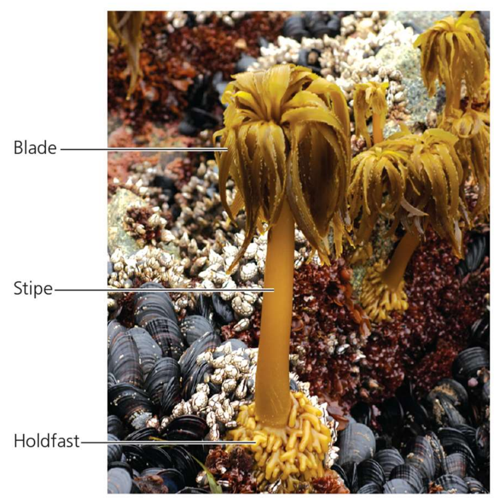
Brown Algae (Phaeophyta)

- Brown algae are the largest and most complex algae
- All are **multicellular**, and most are marine
- Brown algae include many species commonly called "seaweeds"
- Brown algae have the **most complex** multicellular anatomy of all algae

Brown Algae

- Giant seaweeds called **kelps** live in deep parts of the ocean
- The algal body is plantlike but lacks true roots, stems, and leaves and is called a thallus
- The root-like **holdfast** anchors the stem-like **stipe**, which in turn supports the leaf-like **blades**

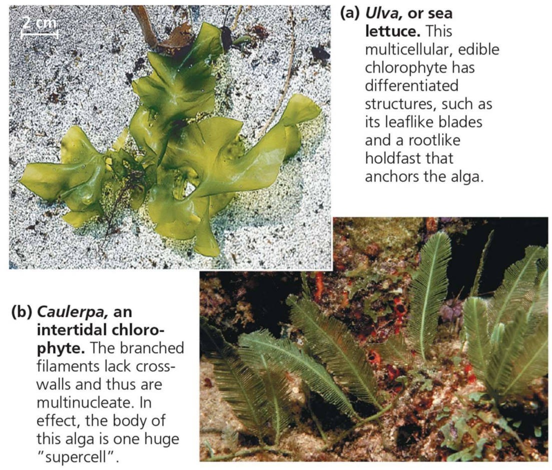
Tasmanian Kelp Forests
http://www.youtube.com/watch?v=eRfxFZ4ndlg



▲ **Figure 28.12 Seaweeds: adapted to life at the ocean's margins.** The sea palm (*Postelsia*) lives on rocks along the coast of the northwestern United States and western Canada. The body of this brown alga is well adapted to maintaining a firm foothold despite the crashing surf.

Green Algae (Chlorophyta)

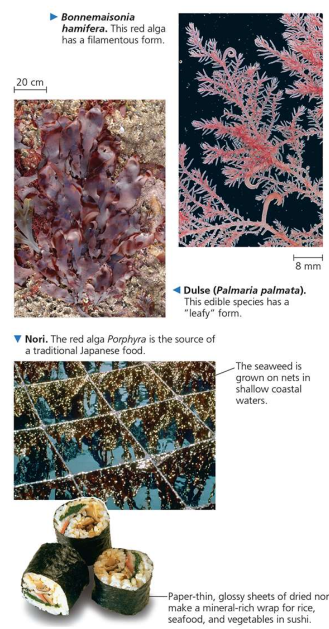
- Green algae are named for their green chloroplasts
- **Plants are descended from the green algae**
- Most chlorophytes live in fresh water, although many are marine
- Other chlorophytes live in damp soil, as symbionts in lichens, or in snow
- Chlorophyll *a* and *b*
- Notice how plant like some of the green algae are



▲ **Figure 28.22 Multicellular chlorophytes.**

Red Algae (Rhodophyta)

- Red algae are reddish in colour due to an accessory pigment call **phycoerythrin**, which masks the green of chlorophyll
- The colour varies from greenish-red in shallow water to dark red or almost black in deep water
- Red algae are usually multicellular;
  the largest are seaweeds
- Red algae are the most abundant large algae in coastal waters of the tropics



▲ **Figure 28.21 Red algae.**

Unicellular Symmetrical Hydrated silica wall Major component of phytoplankton	Unicellular Can cause toxic blooms called red tides Cell has two flagella that enable them to move	Multicellular, large and complex Mostly marine Many ‘seaweed’ are in this group. Can have plant-like structure with holdfast, stipe and blades.	Contains photosynthetic pigment phycoerythrin. Mostly multicellular ‘seaweeds’. Can appear greenish red to deep red/black.	Plants descended from this group. Fresh water and marine species. Unicellular and multicellular species. Contain chlorophyll *a* and *b*.