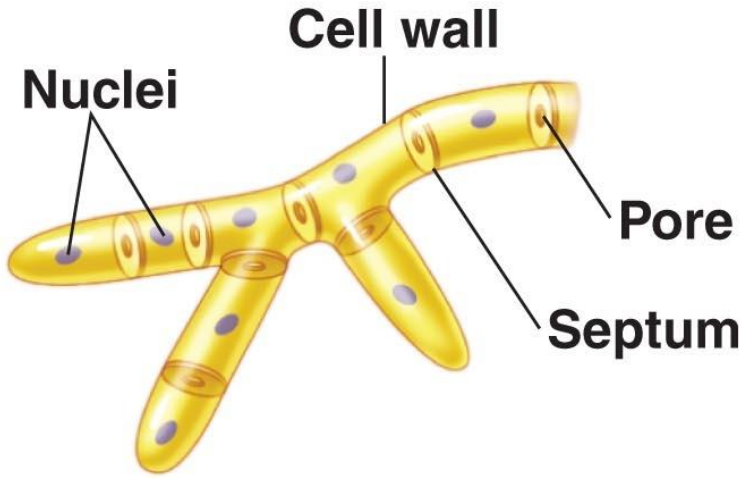
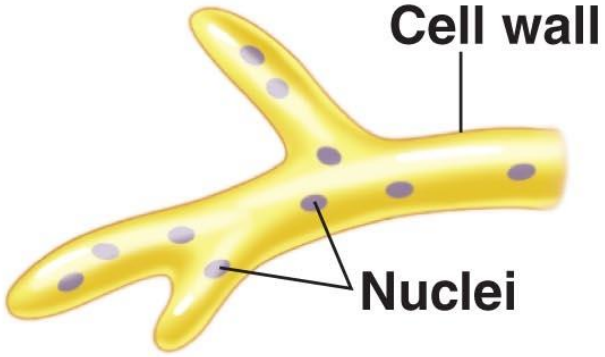
Fungi

Hyphal Types



(a) Septate hypha



(b) Coenocytic hypha

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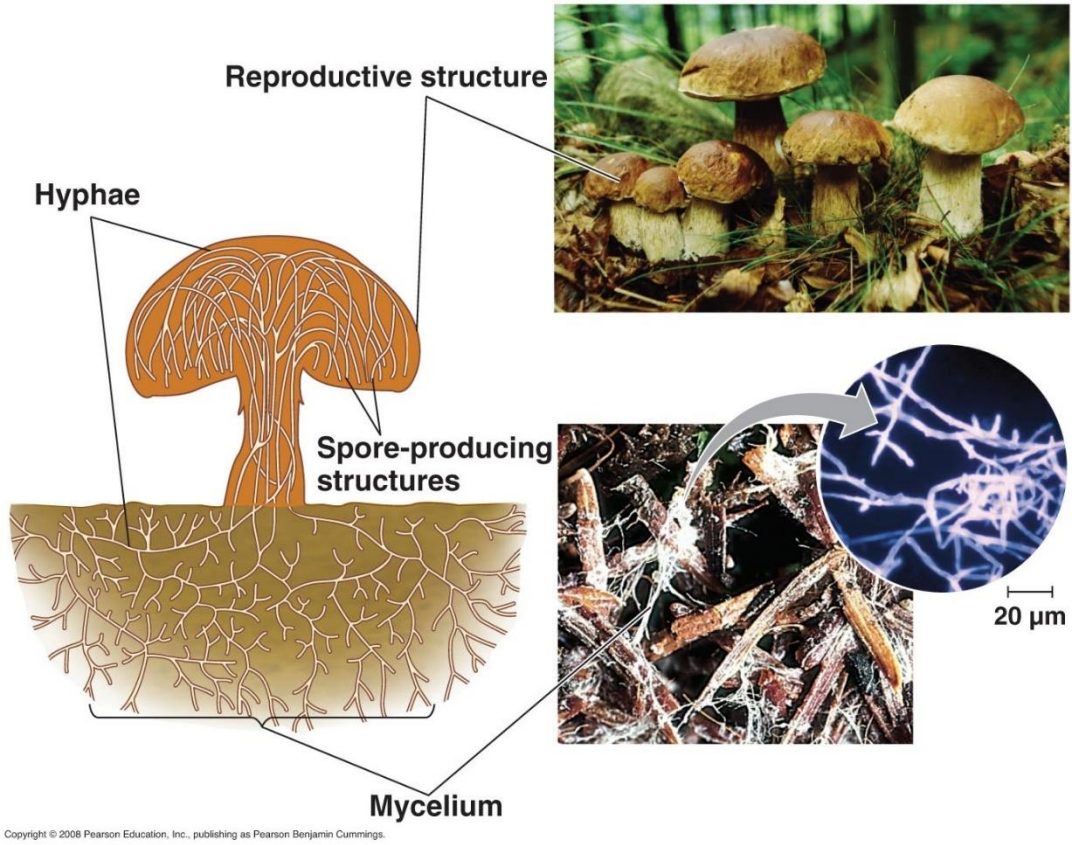
- Septate
- Coenocytic

Fungal Body

- Mycelium
- Loosely woven mat of hyphae
- Feeding structure



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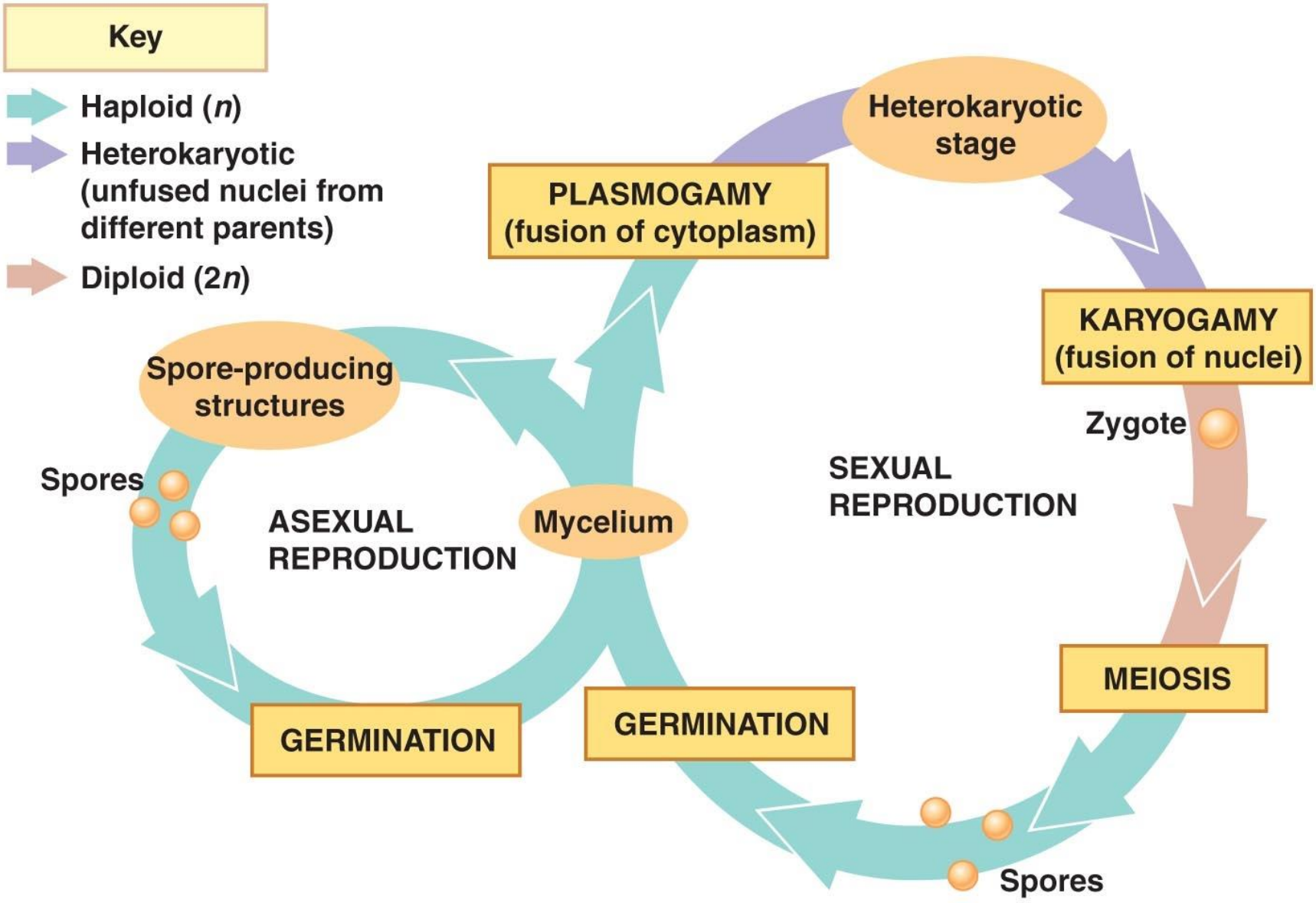

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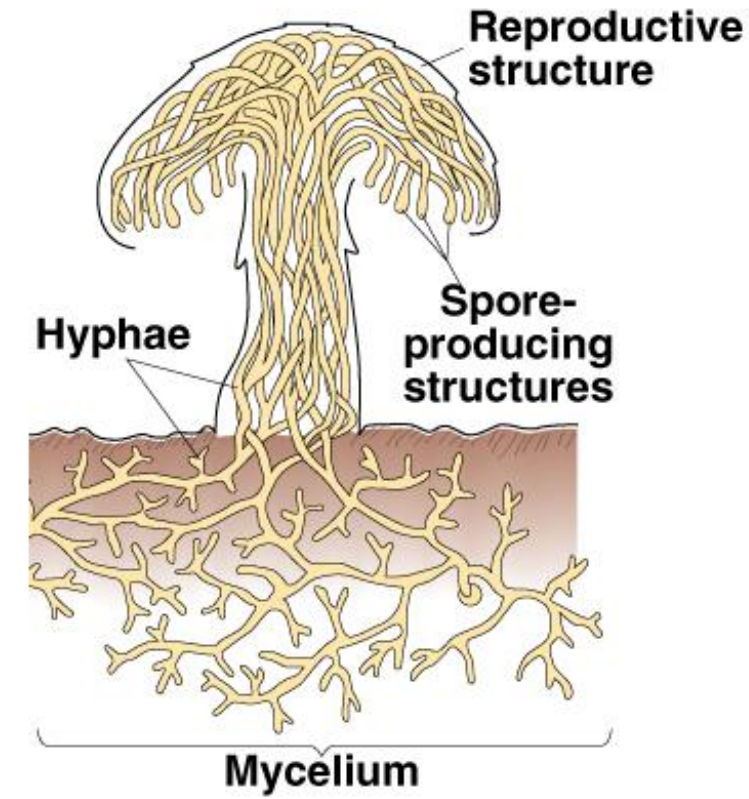
Introduction

- Fungi are eukaryotes
- Nearly all multicellular (yeasts are unicellular)
- Distinguished from other kingdoms by:
  - Nutrition
  - Structural organisation
  - Growth
  - Reproduction

Absorptive nutrition enables fungi to live as decomposers and symbionts

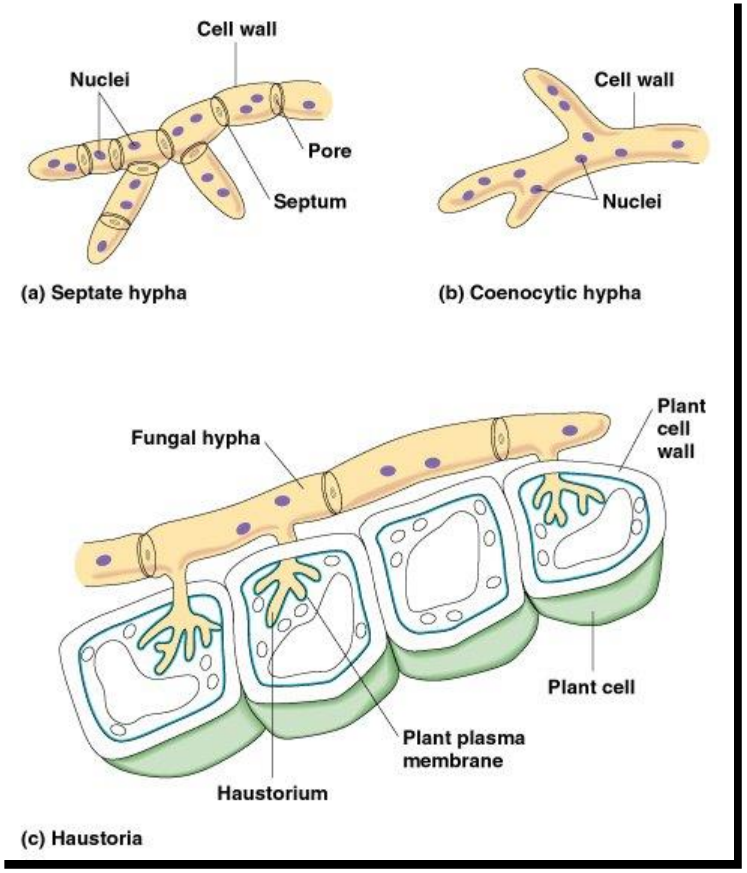
- **Fungi are heterotrophs that acquire nutrients by absorption**
- **Secrete hydrolytic enzymes and acids to decompose complex molecules into simpler ones that can be absorbed**
- **Specialised into three main types:**
  - **Saprobes - absorb nutrients from dead organic material**
  - **Parasitic fungi - absorb nutrients from cells of living hosts; some are pathogenic**
  - **Mutualistic fungi - absorb nutrients from a host, but reciprocate to benefit the host**

Extensive surface area and rapid growth adapt fungi for absorptive nutrition



- Basic structural unit of fungal vegetative body (mycelium) is the hypha
- Except for yeast, **hyphae** are organised around and within food source:
  - Composed of tubular walls containing chitin
  - Provide enormous surface area: 10cm^2 of soil may contain 1km of hyphae with 314cm^2 surface area

Fungal hyphae may be septate or aseptate

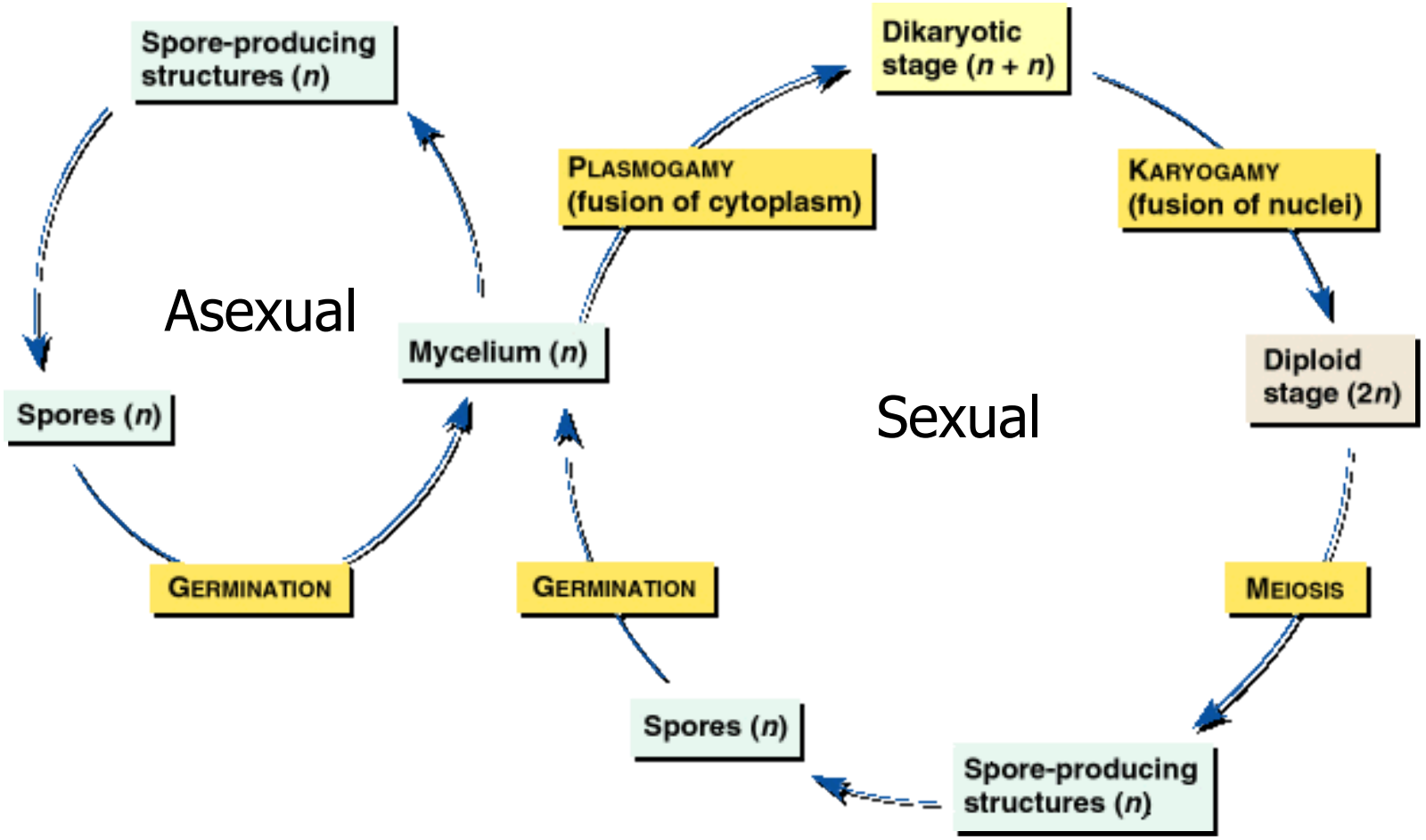


- Hyphae of **septate** fungi are divided into cells by crosswalls called septa
- Hyphae of **aseptate** fungi lack cross walls (**coenocytic**)
- Parasitic fungi have modified hyphae called **haustoria**, which penetrate the host tissue but remain outside cell membrane

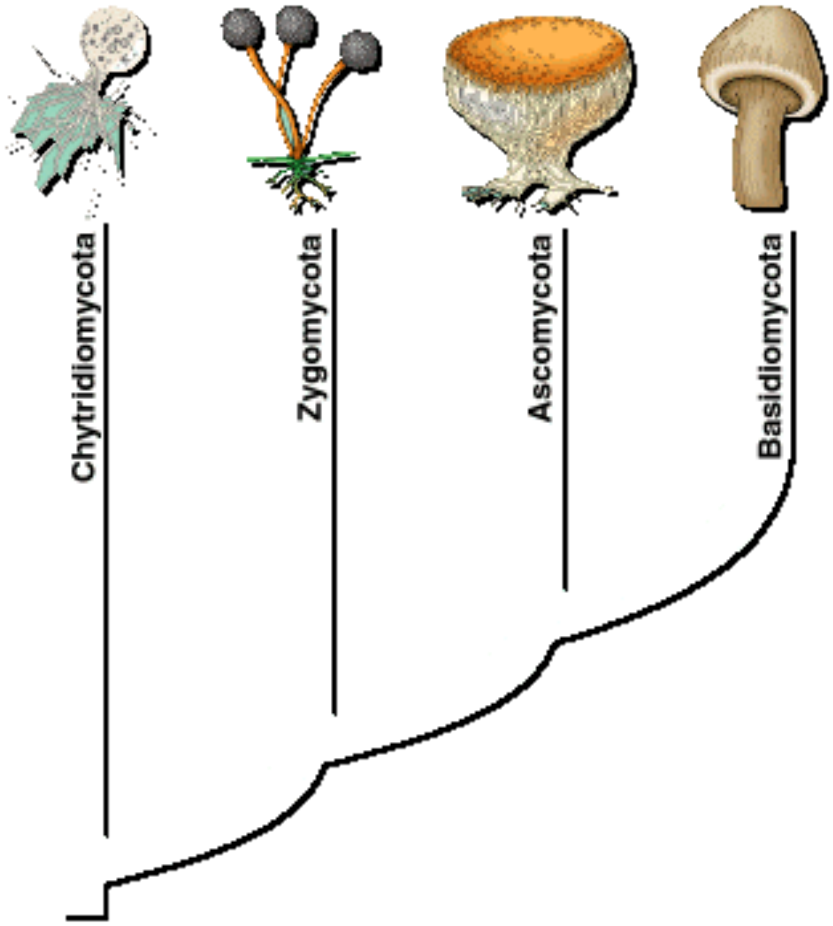
Fungi reproduce by releasing spores that are produced either sexually or asexually

- **Usually unicellular, haploid and of various shapes and sizes**
- **Produced either sexually (by meiosis) or asexually (by mitosis)**
  - **In favourable conditions, fungi generally clone themselves by producing enormous numbers of spores asexually**
- **Spores are the agent of dispersal responsible for geographic distribution of fungi:**
  - **Carried by wind or water**
  - **Germinate in moist places with appropriate substrata**

Generalised life cycle of fungi



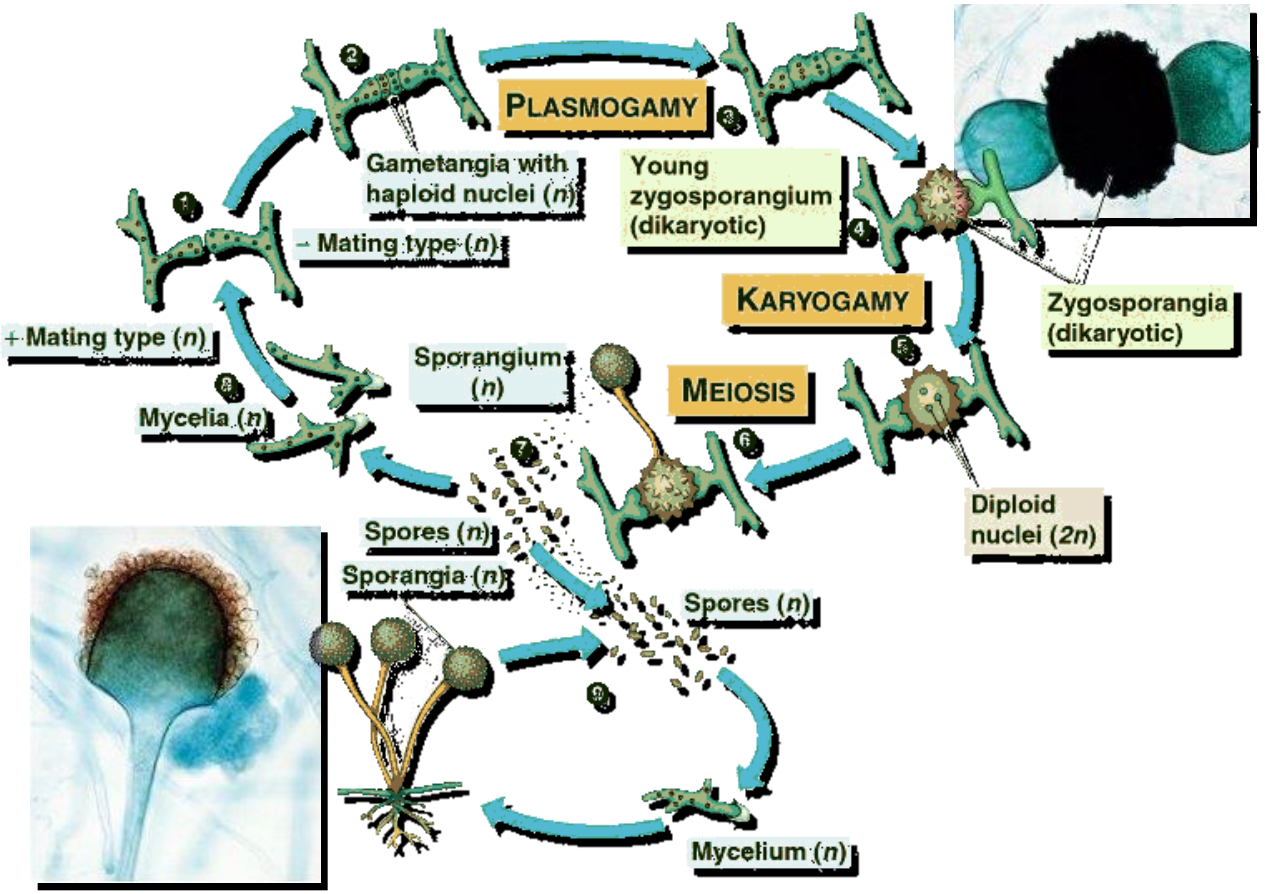
Phylogeny of fungi



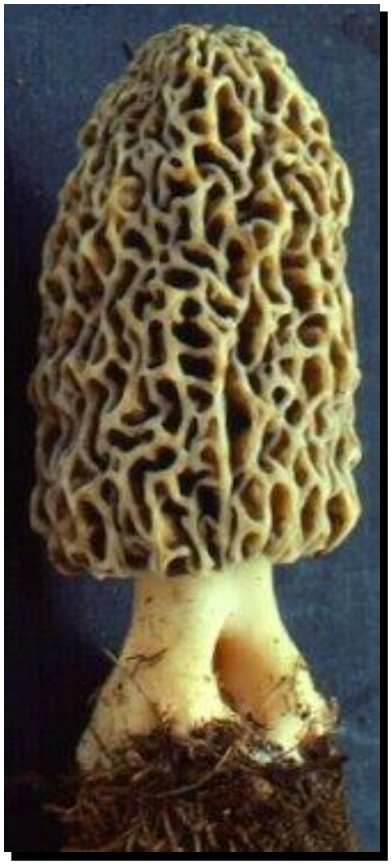
Division Zygomycota

- **Mostly terrestrial - live in soil or decaying material**
- **Some form mycorrhizae, mutualistic associations with plant roots**
- **Hyphae are <u>coenocytic</u>**
- **- septa only found in reproductive cells**

Life cycle of the zygomycete *Rhizopus stolonifer*, a common bread mould

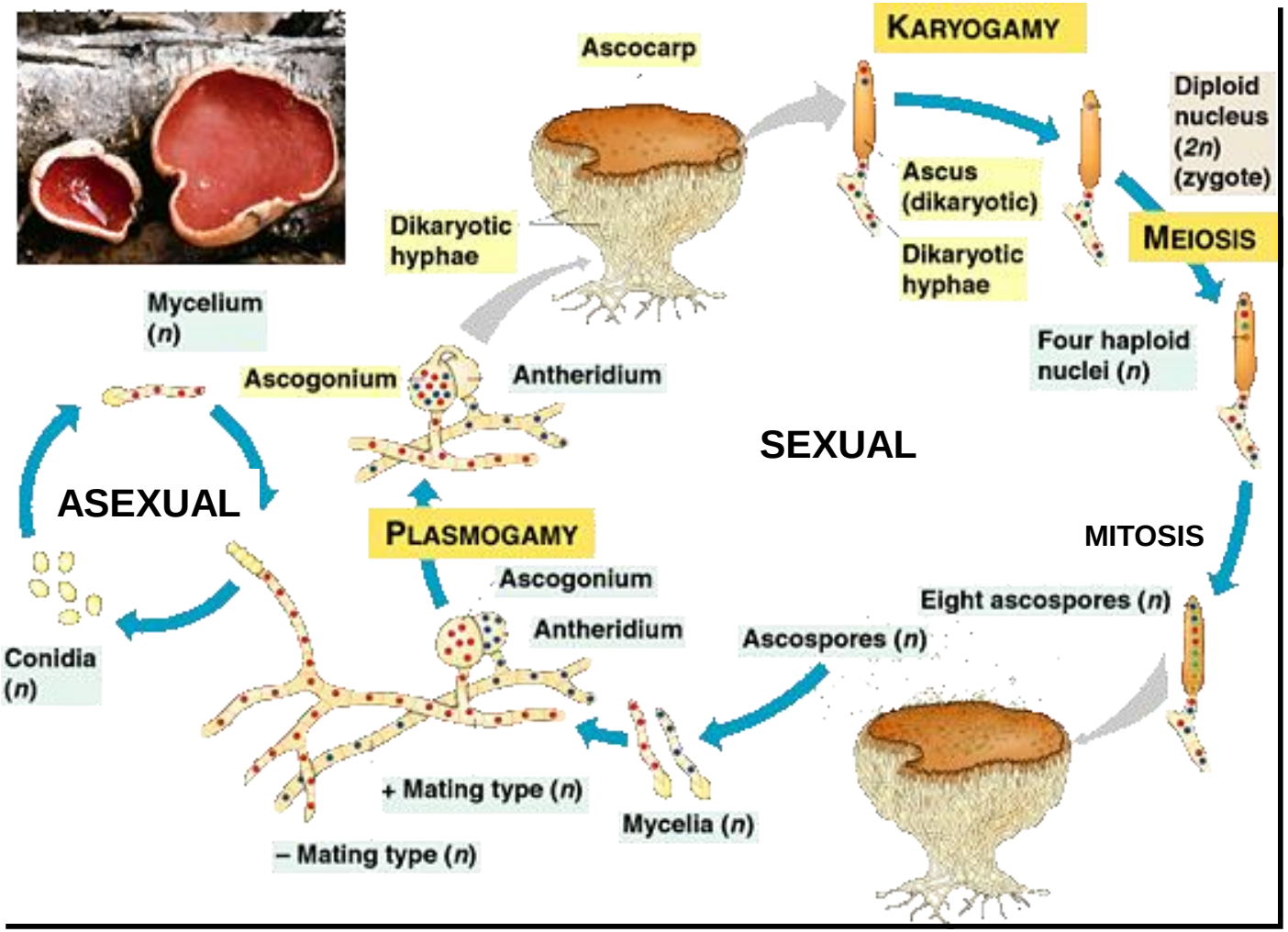


Division Ascomycota: sac fungi produce sexual spores in saclike asci



- Include unicellular yeasts and complex multicellular cup fungi
- Hyphae are septate
- In asexual reproduction, tips of specialised hyphae form conidia - chains of haploid asexual spores
- In sexual reproduction, haploid mycelia of opposite mating strains fuse

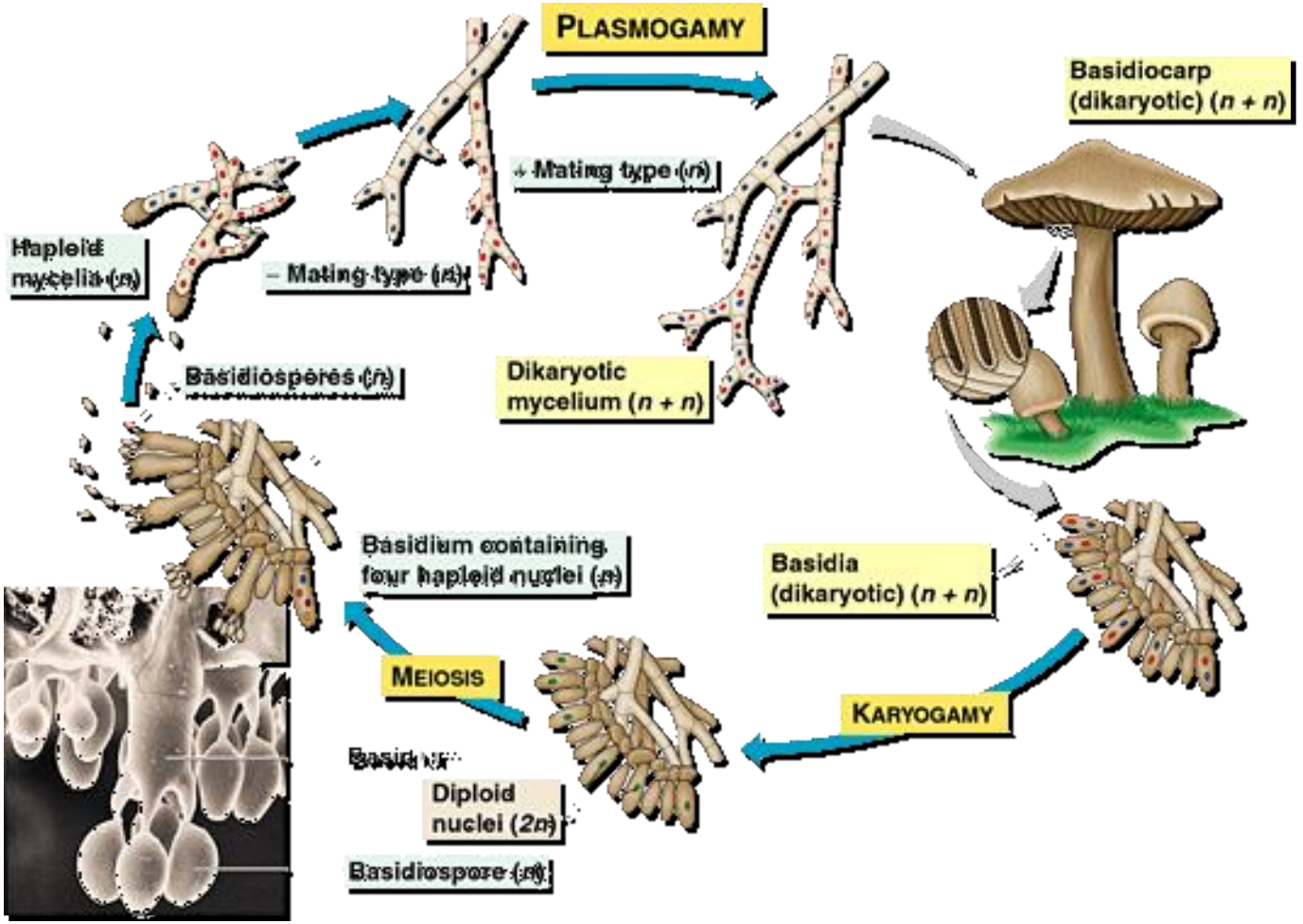
Life cycle of an ascomycete



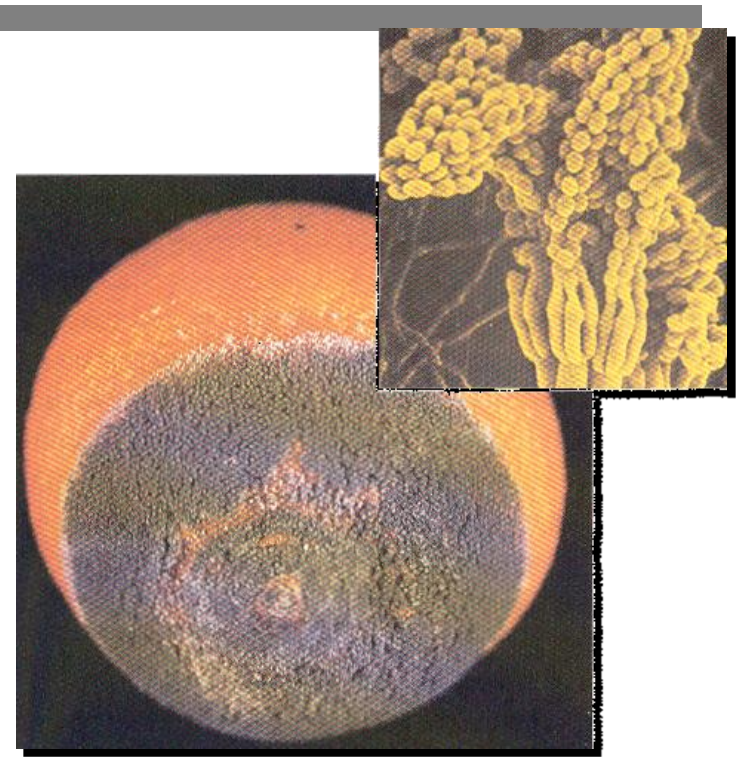
Division Basidiomycota: club fungi

- Named after transient diploid stage: basidium
- Important decomposers of wood / plant material
- Include:
  - Mycorrhiza-forming mutualists
  - Mushroom-forming fungi
  - Plant parasites e.g. rusts and smuts
- Characterised by dikaryotic mycelium that reproduces sexually via basidiocarps

Life cycle of a mushroom-forming basidiomycete

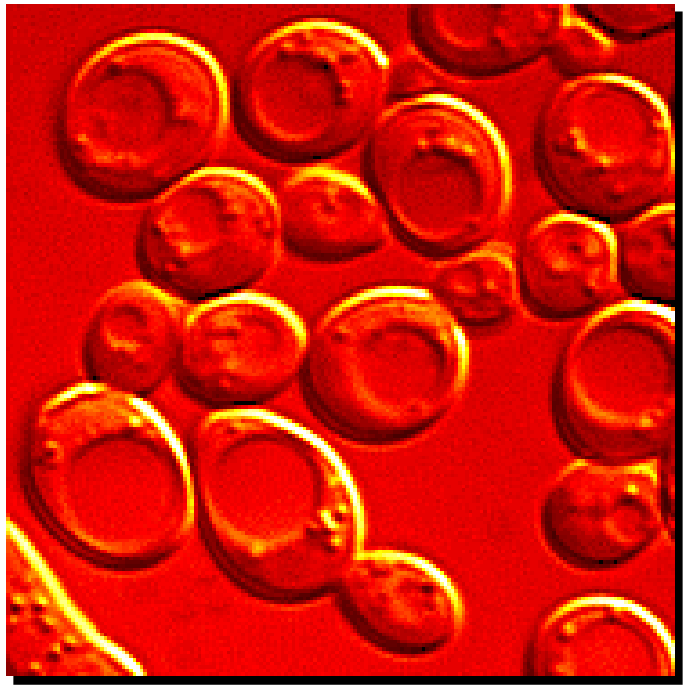


Moulds



- Rapidly growing fungus with no sexual stages
- May develop into a sexual fungus, producing zygosporangia, ascocarps or basidiocarps
- Moulds with no known sexual stage are known as **Deuteromycota** or imperfect fungi:
  - *Penicillium*
  - Flavour for blue cheeses

Yeasts



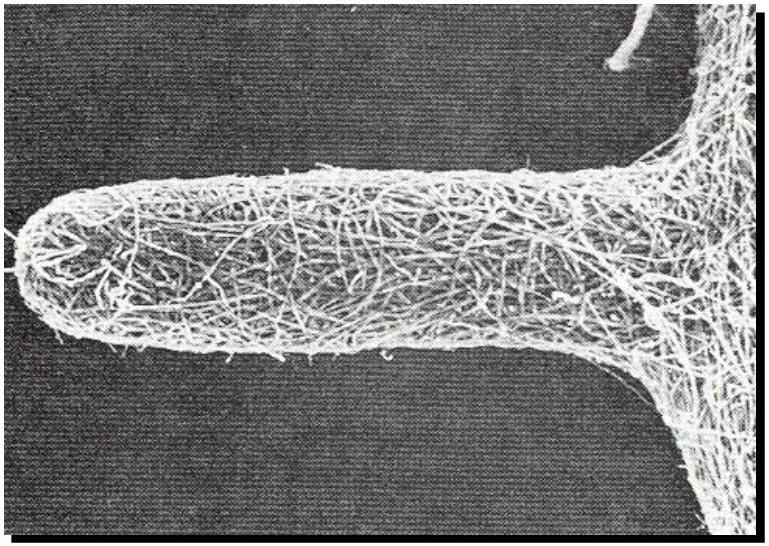
- **Unicellular: reproduce**
  - **Asexually by budding**
  - **Sexually by producing asci or basidia**
- ***Saccharomyces cerevisiae* is most important domesticated fungus:**
  - **Baking and brewing**
  - **Model organism**
- **Can cause problems:**
  - ***Candida*: "thrush"**

Lichens

- Symbiosis of algae with fungal hyphae

- The alga:
  - Provides fungus with food
  - May fix nitrogen
- Fungus provides good environment for growth:
  - Hyphal mass absorbs minerals and protects algae
  - Produces compounds that:
    - shield algae from sunlight
    - are toxic - prevents predation

Mycorrhizae



- Specific, mutualistic association of plant roots and fungi
- Fungi increase absorptive surface of roots and exchange soil minerals
- Found in 95% of vascular plants
- Necessary for optimal plant growth

Ecological impacts of fungi

- **Ecosystems depend on fungi as decomposers and symbionts: decompose food, wood and even plastics!**
- **Some fungi are pathogens e.g. athlete's foot, ringworm etc.**

- **Many animals, including humans, eat fungi:**
  - **In US, mushroom consumption restricted to *Agaricus***
  - **We eat a range of cultivated and wild mushrooms**
  - **Truffles are underground ascocarps of mycelia that are mycorrhizal on tree roots**

Algae

Introduction

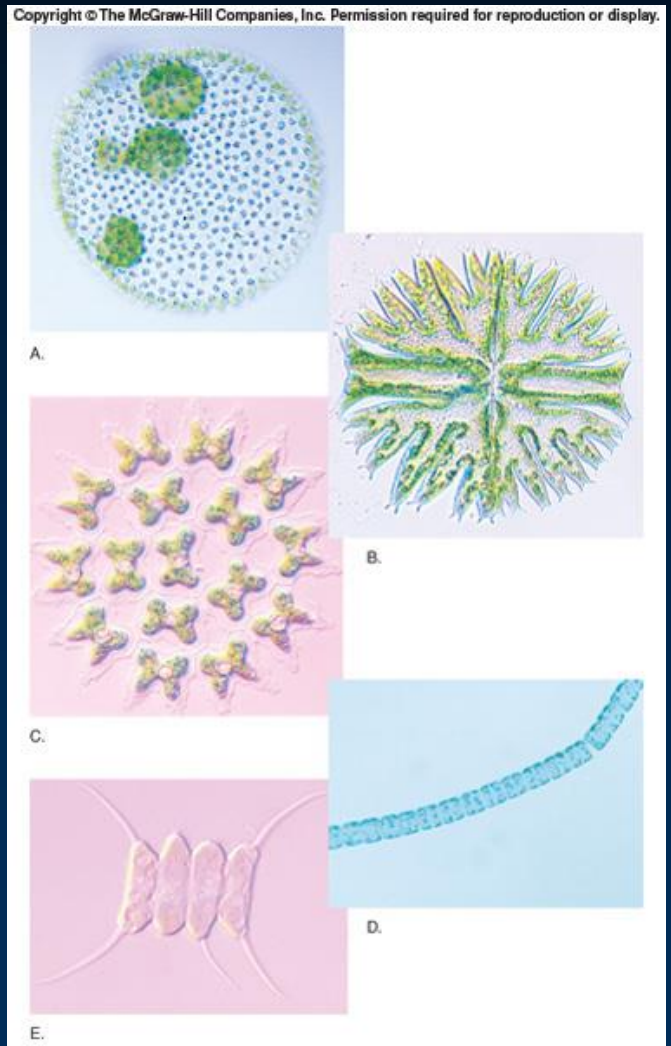
- **Less than 1 billion years ago, organisms confined to oceans**
  - Protected from drying out, ultraviolet radiation, and large fluctuations in temperature
  - Absorbed nutrients directly from water
- **About 400 million years ago, green algae began making transition from water to land.**
  - Gave rise to green plants

Features of Kingdom Protista

- **Organisms in Protista vary from unicellular to multicellular.**
  - Nutrition varied: photosynthetic, ingestion of food, absorption of food
  - Individual life cycles vary considerably.
  - Reproduction generally by cell division and sexual processes.
- **Algae are in Kingdom Protista (???)**
  - Grouped into several phyla based on form of reproductive cells, and combinations of pigments and food reserves.

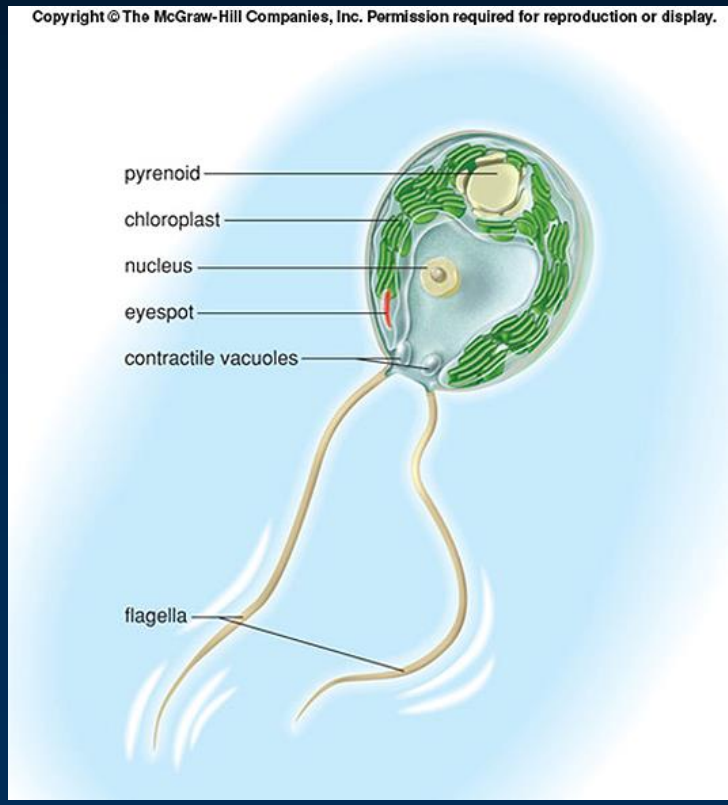
Phylum Chlorophyta

- **Green algae**
  - Unicellular, filamentous, platelike colonies, netlike tubes, hollow spheres, lettuce-like leaves
  - Greatest variety in freshwater lakes, ponds, and streams
    - Some on tree bark, in animal fur, in snowbanks, in flatworms or sponges, on rocks, in lichen “partnerships.”
  - **<u>Have chlorophylls a and b</u>**
  - Store food as starch
  - Most have a single nucleus per cell.
  - Most reproduce both sexually and asexually.



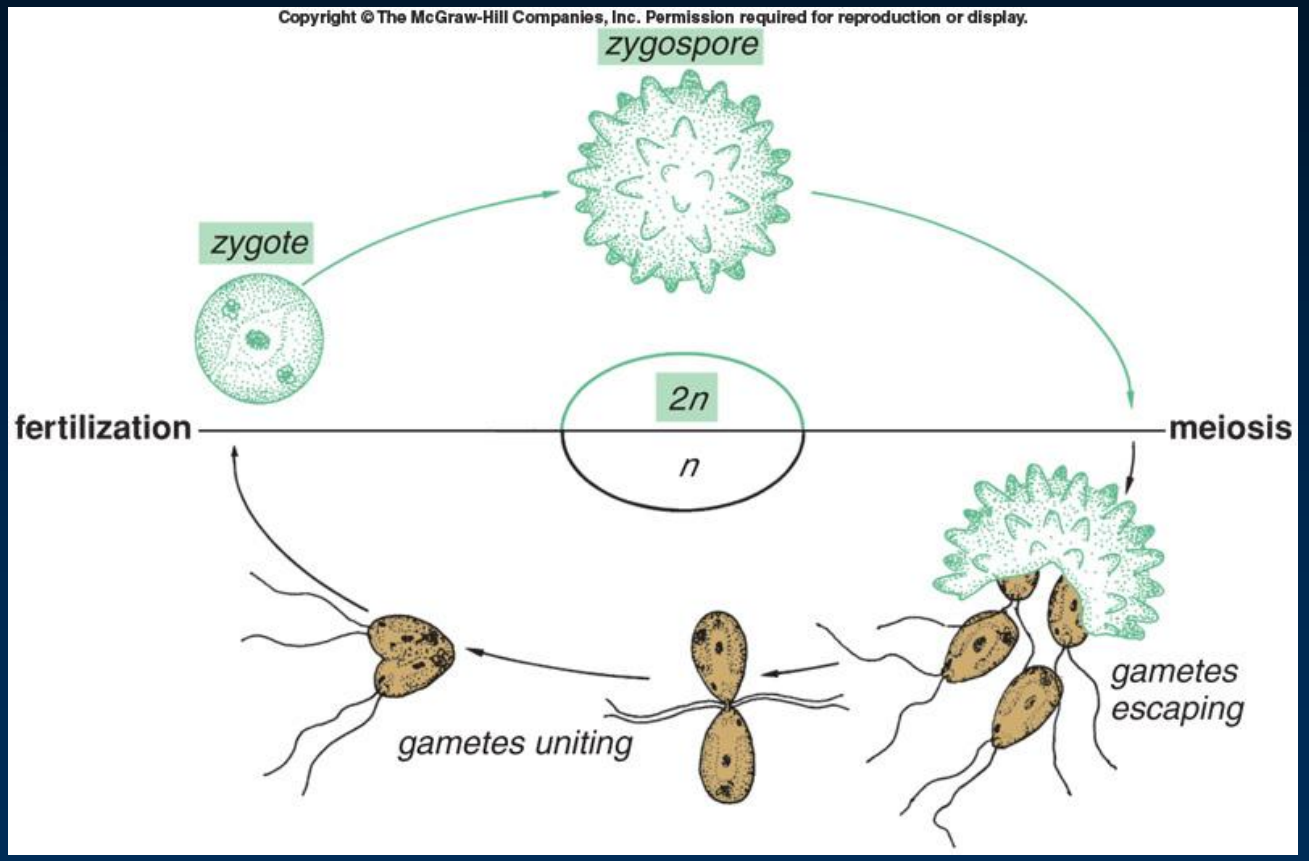
Phylum Chlorophyta

- ***Chlamydomonas***
  - Common inhabitant of freshwater pools
  - Unicellular
  - Pair of whip-like flagella on one end pull cell through water.
  - Two or more vacuoles at base of flagella
    - Regulate water content of cell and remove waste
  - Single, cup-shaped chloroplast with one or two pyrenoids inside
    - Pyrenoids - Structures associated with synthesis of starch
  - Red eyespot near base of flagella
    - Allows alga to swim toward light



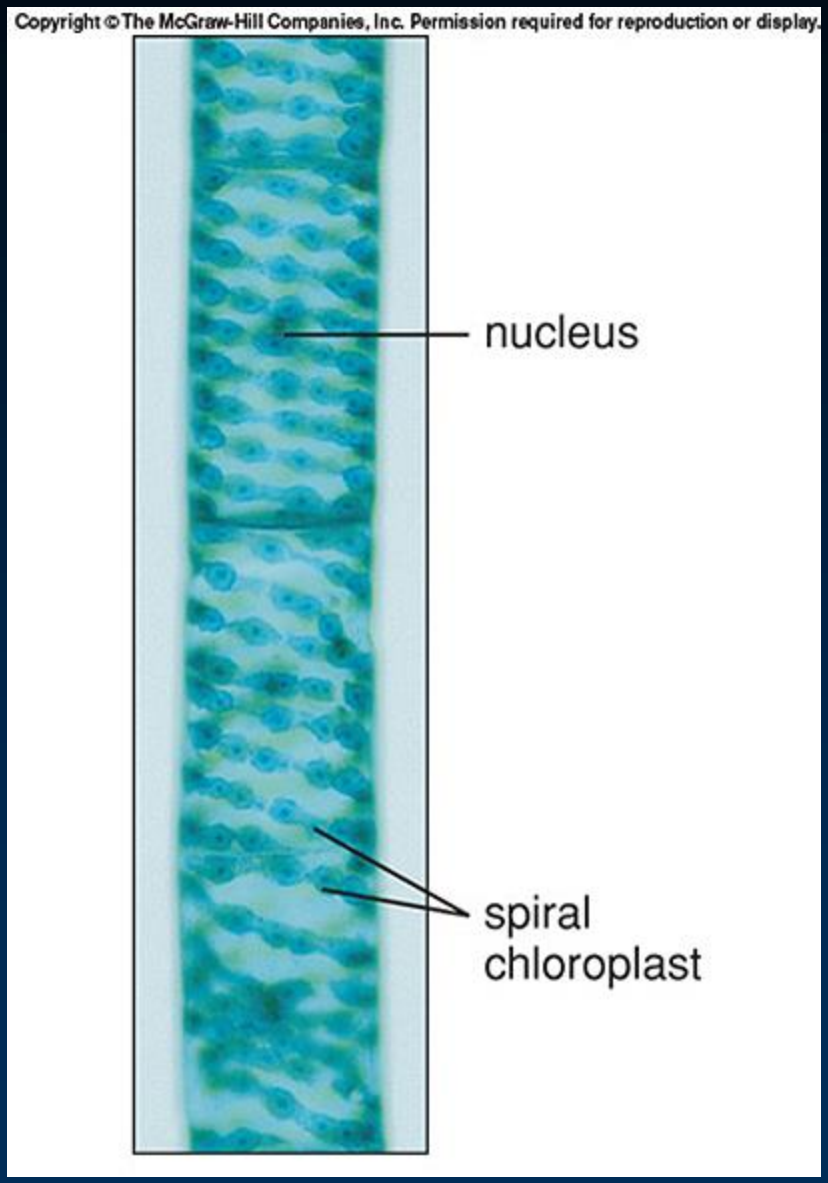
Phylum Chlorophyta

- ***Chlamydomonas* sexual reproduction:**
  - Meiosis occurs in zygospore, producing 4 haploid zoospores that grow into full-sized algae.
  - Under certain conditions, cells congregate together.
  - Two cells fuse together to form zygote, that will become zygospore and may remain dormant.



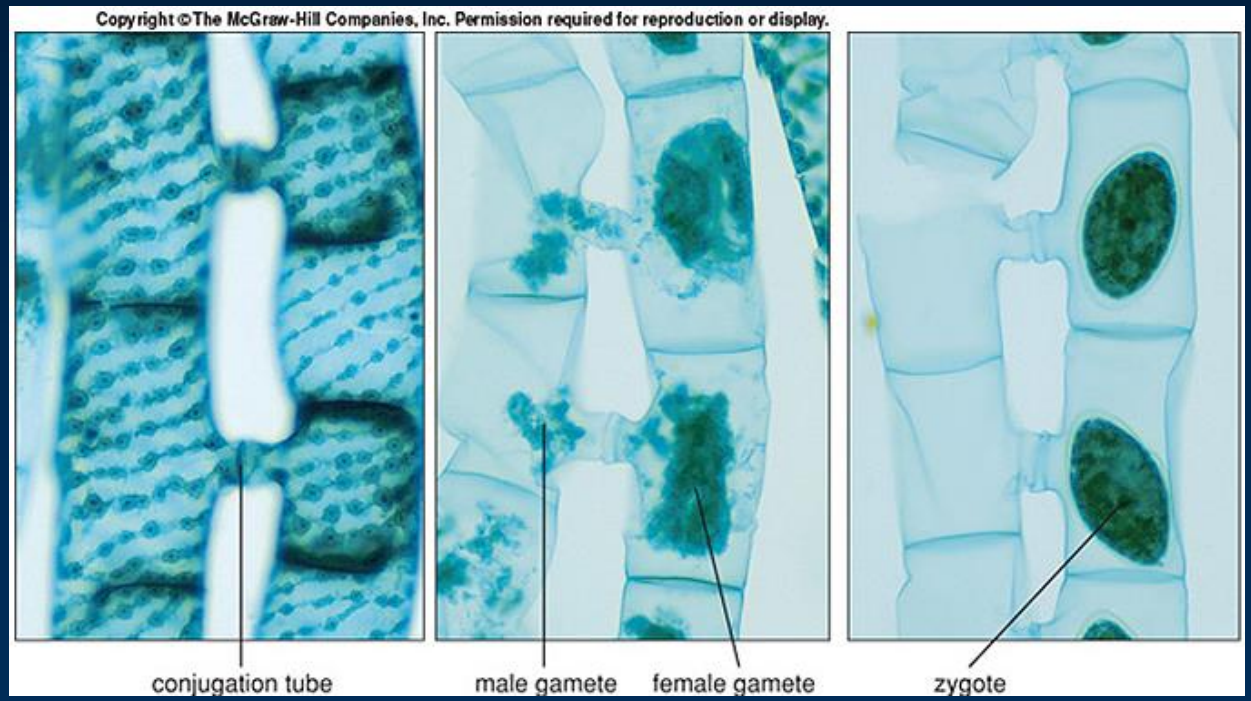
Phylum Chlorophyta

- ***Spirogyra*** **(watersilk)**
  - Filaments of cylindrical cells
  - Frequently floats in masses on surface of quiet freshwater
  - Chloroplast ribbon-shaped and spirally wrapped around vacuole, with pyrenoids at regular intervals.
  - Asexual reproduction:
    - Only by fragmentation of filament



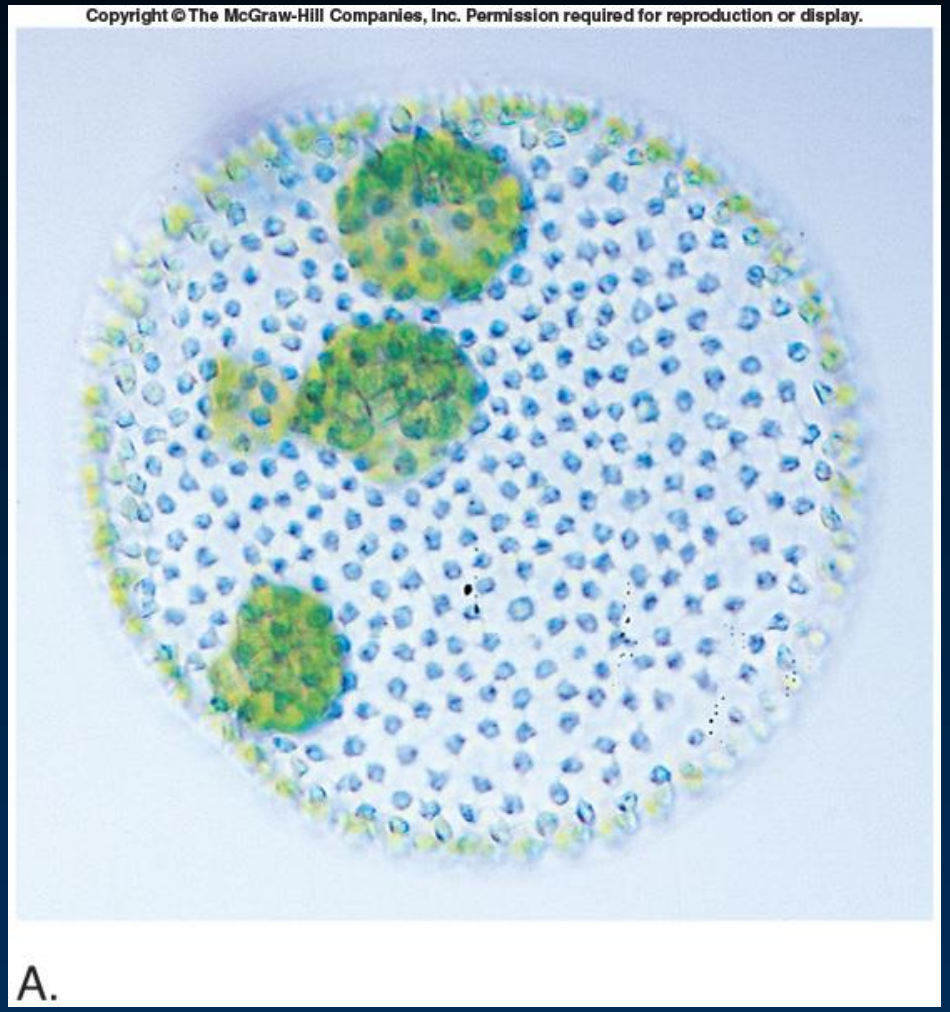
Phylum Chlorophyta

- ***Spirogyra* (watersilk)**
  - **Sexual reproduction by conjugation (form conjugation tubes)**
    - Condensed protoplast of one filament flows or crawls through tube to adjacent cell.
    - Protoplasts fuse, forming zygote that develops thick wall.
    - Eventually zygote undergoes meiosis.



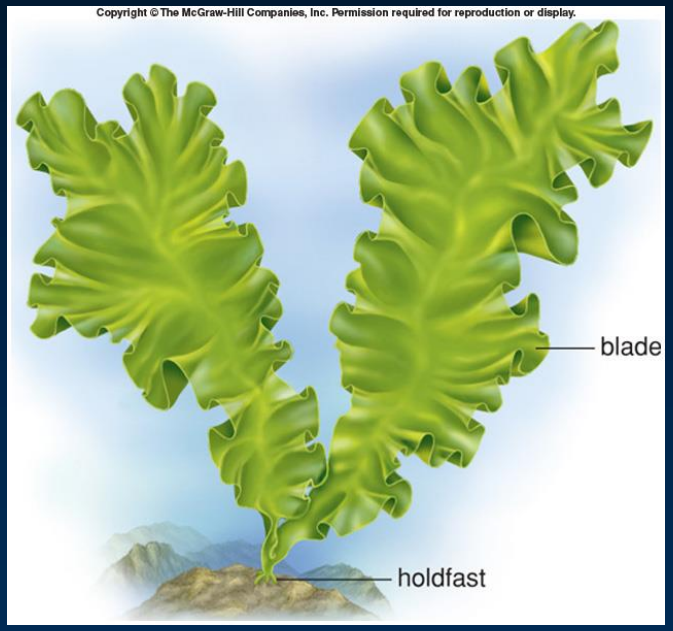
Phylum Chlorophyta

- **Other green algae**
  - *Volvox* - Colonial green algae held together in a secretion of gelatinous material, resembling hollow ball
    - Reproduction asexual or sexual
      - Smaller daughter colonies formed inside parent colony



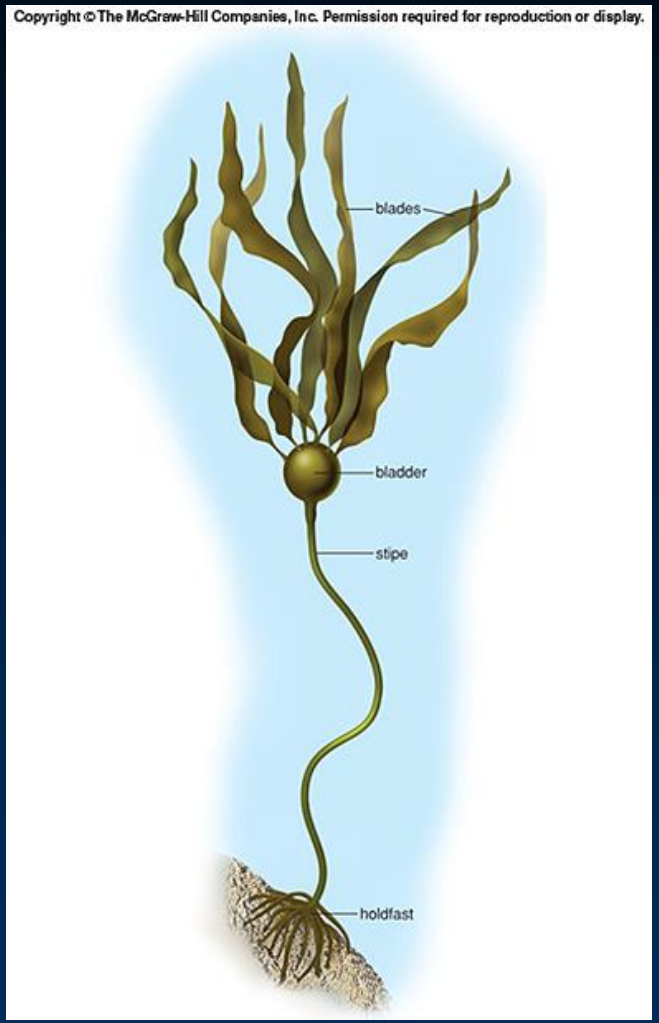
Phylum Chlorophyta

- **Other green algae**
  - *Ulva* (sea lettuce) - Multicellular seaweed with flattened green blades and basal holdfast to anchor blades to rocks
    - Haploid and diploid blades
      - Diploid blades produce spores that develop into haploid blades.
      - Haploid blades bear gametangia that form gametes.
      - Gametes fuse to form zygotes that grow into diploid blades.
    - Exhibit isomorphism - Haploid and diploid blades indistinguishable.



Phylum Chromophyta

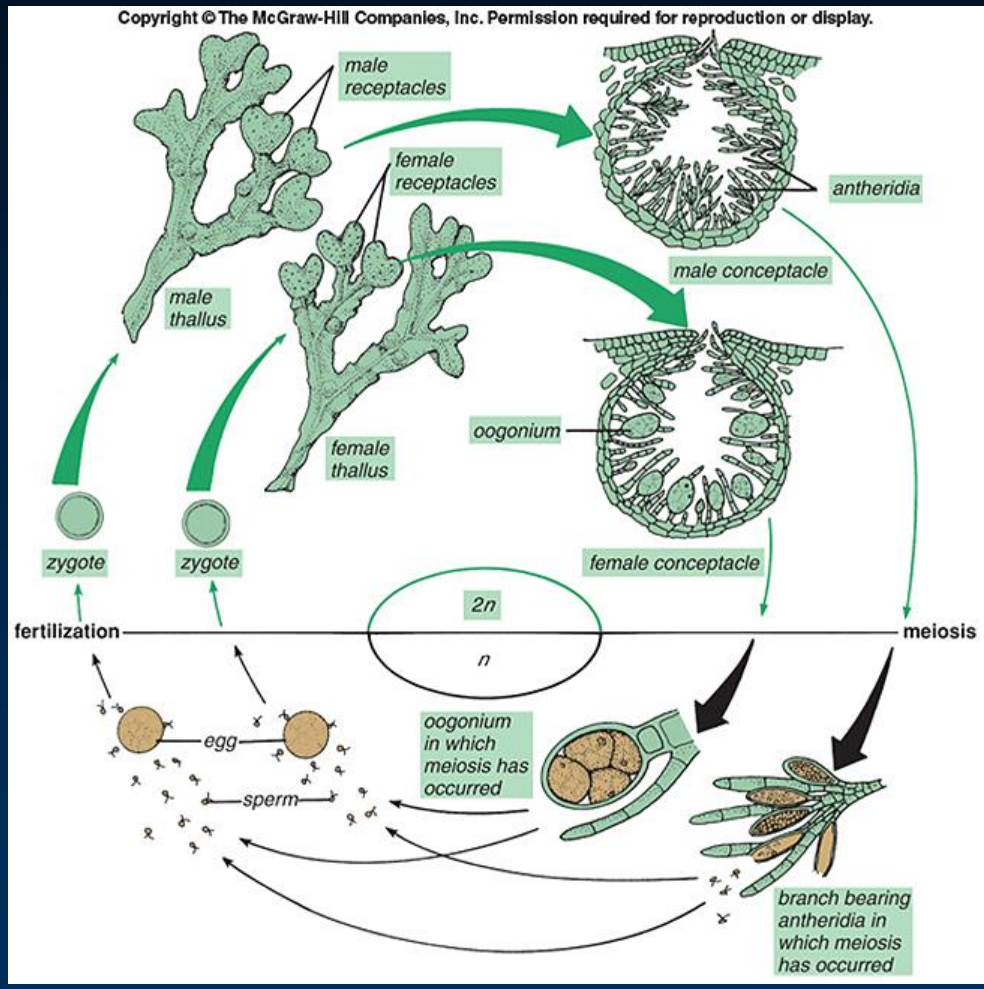
- **Brown algae (Phaeophyceae)**
  - Relatively large; none unicellular or colonial
  - Most marine; majority in cold, shallow water, except giant kelp
  - Many have a thallus differentiated into a holdfast, a stipe, and blades.
    - Blades may have gas-filled bladders.
  - Chlorophylls a and c, fucoxanthin
  - Food reserve = laminarin
  - Algin in cell walls.



Nereocystis, a kelp

Phylum Chromophyta

- **Brown algae (Phaeophyceae)**
  - *Fucus* - Common rockweed
    - Sexual reproduction:
      - Receptacles at tips of branches contain spherical chambers called conceptacles with gametangia inside.
        - « Oogonium produces 8 eggs.
        - « Antheridium produces 64 sperm.
      - Eggs and sperm released into water.



Phylum Rhodophyta

- **The red algae**
  - In warmer and deeper waters than brown algae
  - Most are filamentous with filaments so tightly packed they appear to have flattened blades or branched segments.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Phylum Rhodophyta

- **The red algae**
  - Colors mostly due to phycobilins.
    - Similar to those of cyanobacteria
      - Red algae may have been derived from cyanobacteria.
  - Chlorophylls a, and sometimes d
  - Food reserve - Floridean starch
  - Numbers of species produce agar.

Phylum Charophyta

- **The Stoneworts**
  - Shallow, freshwater lakes and ponds
  - Often precipitate calcium salts on their surfaces
  - Axis with short lateral branches in whorls.
  - Sexual reproduction is oogamous.
  - Multicellular antheridia


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Human and Ecological Relevance of Algae

- **Algin**
  - Produced by giant kelps and other brown algae
    - Ice cream, salad dressing
    - Latex paint, textiles, ceramics
    - Regulates water behavior
      - Controls development of ice crystals
      - Regulates penetration of water
      - Stabilizes suspensions

Vessel harvesting kelp

Human and Ecological Relevance of Algae

- **Agar**
  - Produced by red alga *Gelidium*
    - Solidifier of nutrient culture media
    - Retains moistness in bakery products
    - Base for cosmetics

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