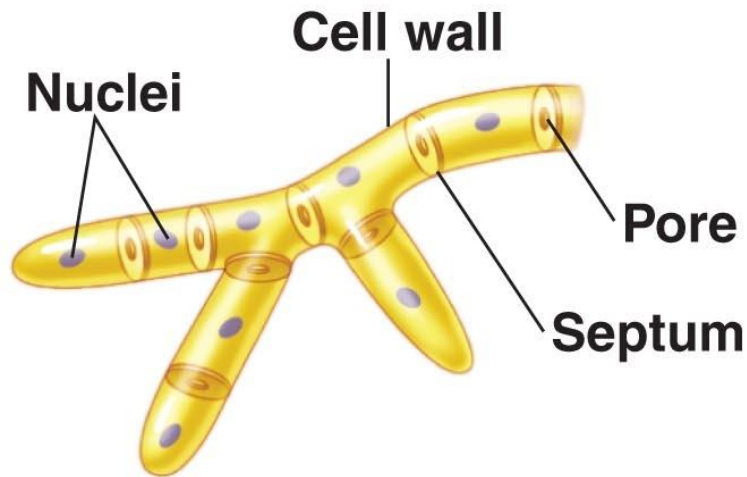


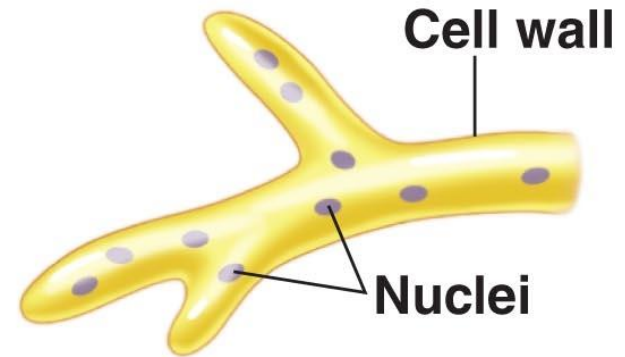
Fungi

Hyphal Types



(a) Septate hypha

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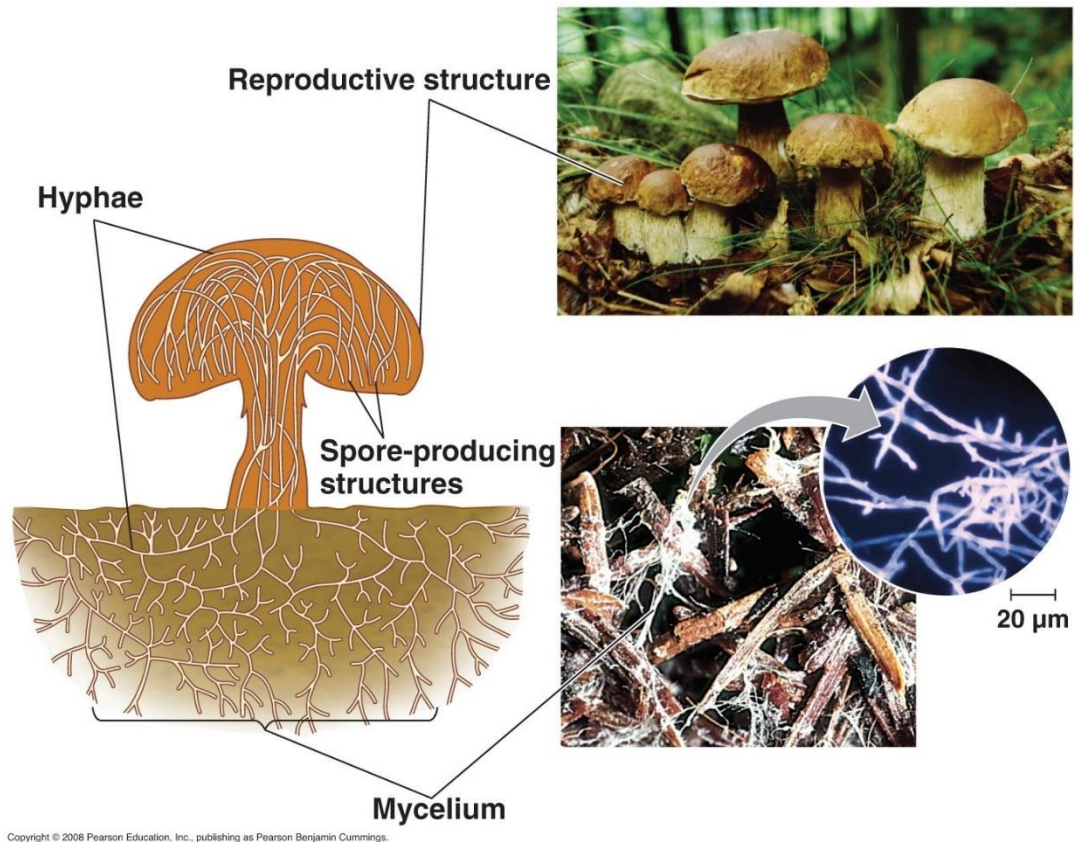


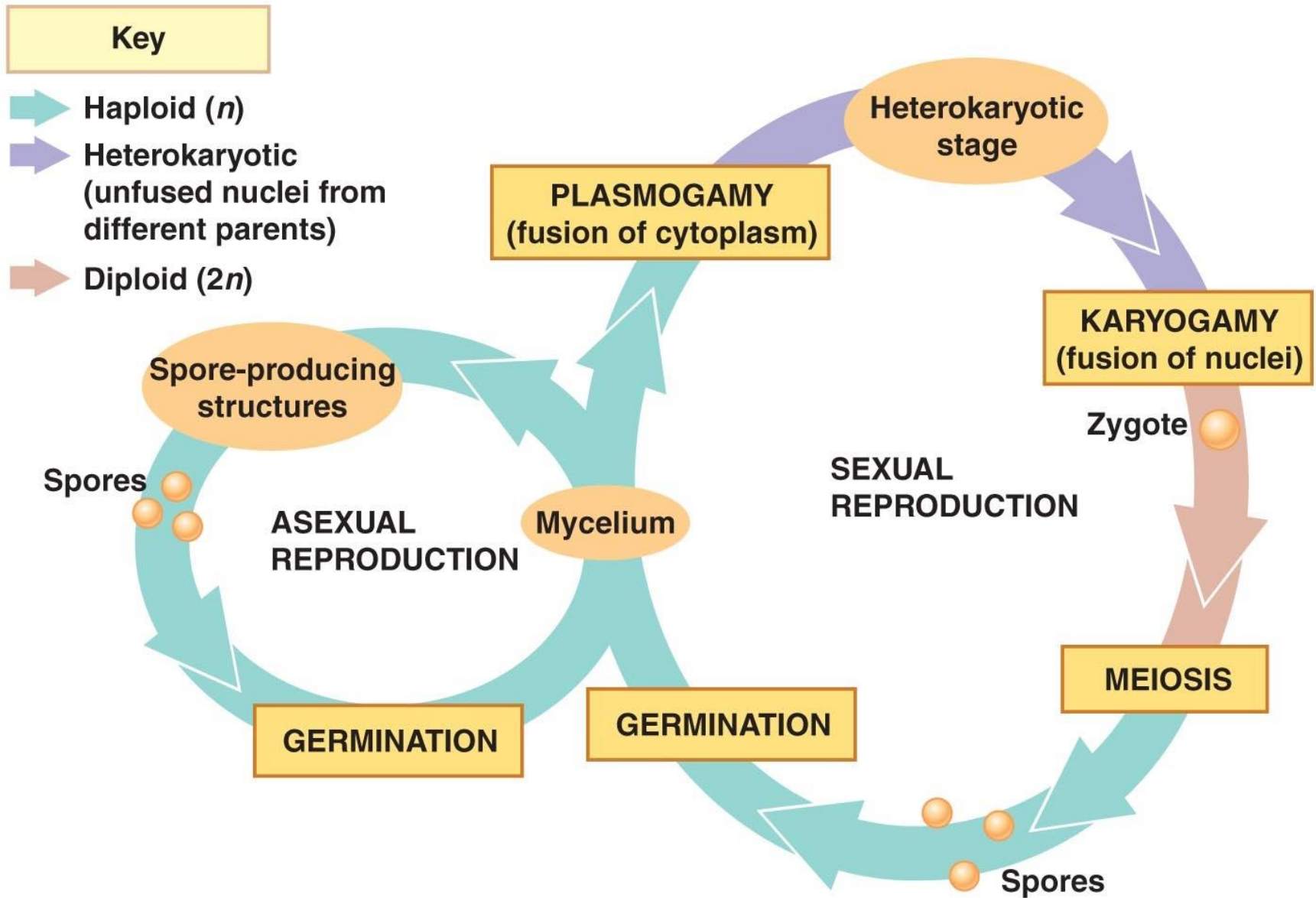
(b) Coenocytic hypha

- Septate
- Coenocytic

Fungal Body

- Mycelium
- Loosely woven mat of hyphae
- Feeding structure





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Introduction

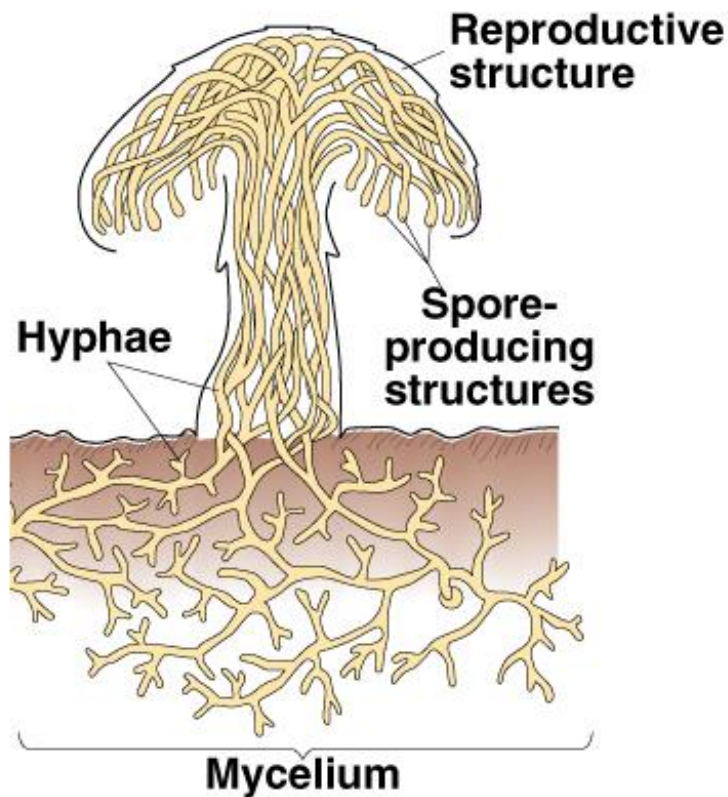


- Fungi are eukaryotes
- Nearly all multicellular (yeasts are unicellular)
- Distinguished from other kingdoms by:
 - ✦ Nutrition
 - ✦ Structural organisation
 - ✦ Growth
 - ✦ Reproduction

Absorptive nutrition enables fungi to live as decomposers and symbionts

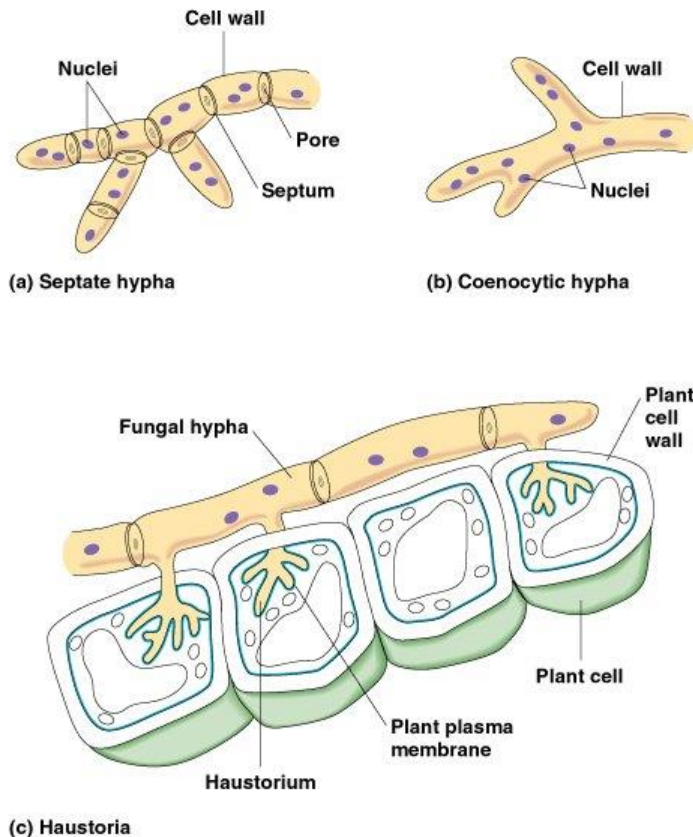
- Fungi are heterotrophs that acquire nutrients by absorption
- Secrete hydrolytic enzymes and acids to decompose complex molecules into simpler ones that can be absorbed
- Specialised into three main types:
 - Saprobies - absorb nutrients from dead organic material
 - Parasitic fungi - absorb nutrients 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: 10cm² of soil may contain 1km of hyphae with 314cm² surface area

Fungal hyphae may be septate or aseptate

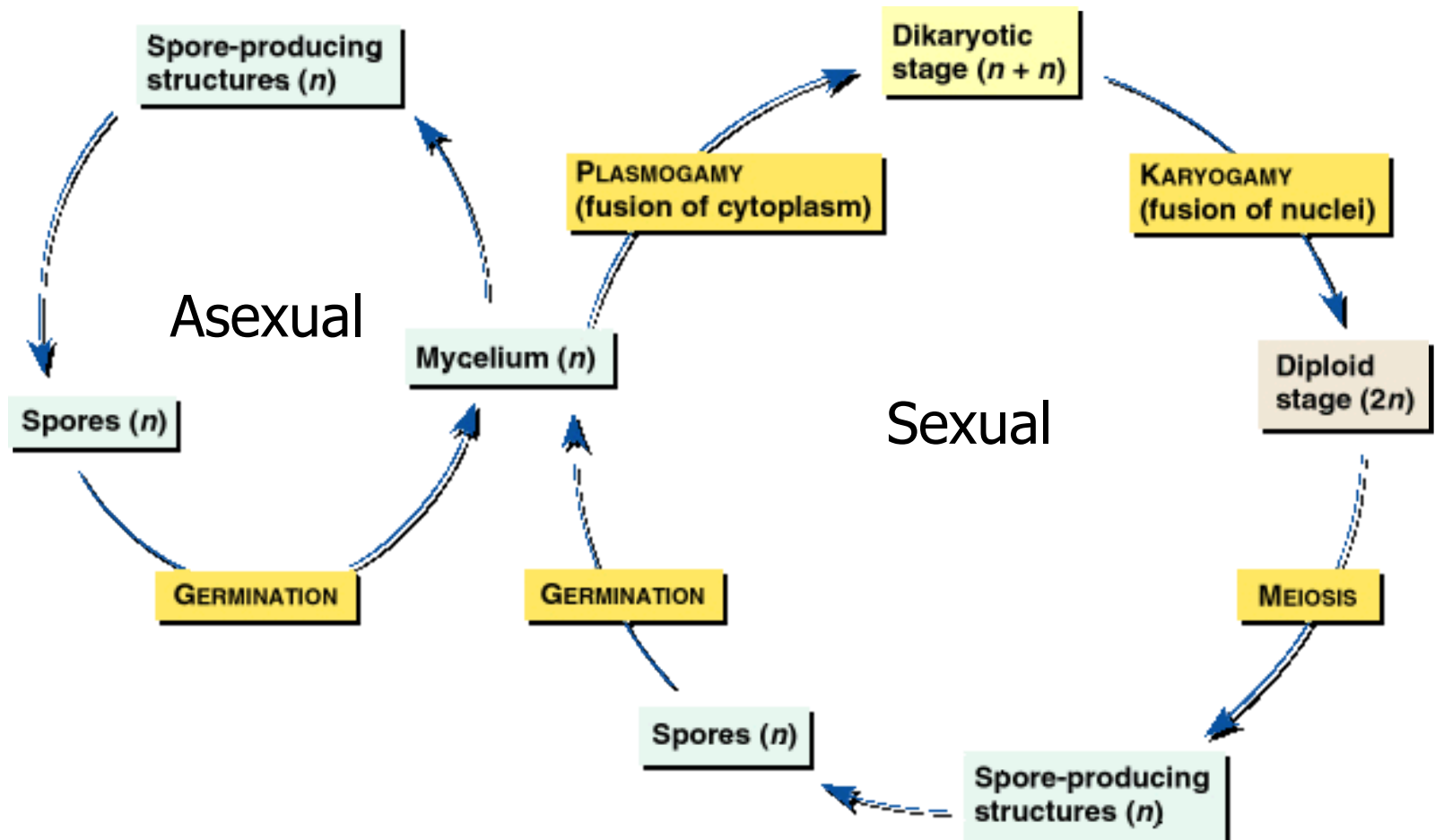


- Hyphae of septate fungi are divided into cells by crosswalls called **septa**
- Hyphae of aseptate fungi lack cross walls (coenocytic)
- Parasitic fungi have modified hyphae called haustoria, which penetrate the host tissue but remain outside cell membrane

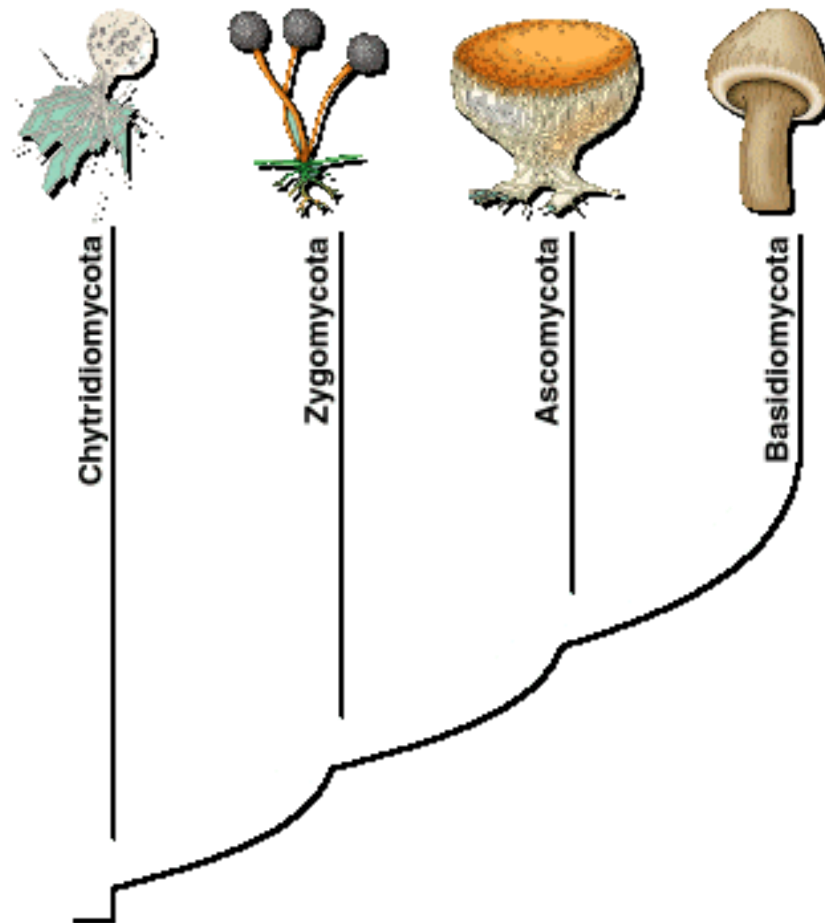
Fungi reproduce by releasing spores that are produced either sexually or asexually

- **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

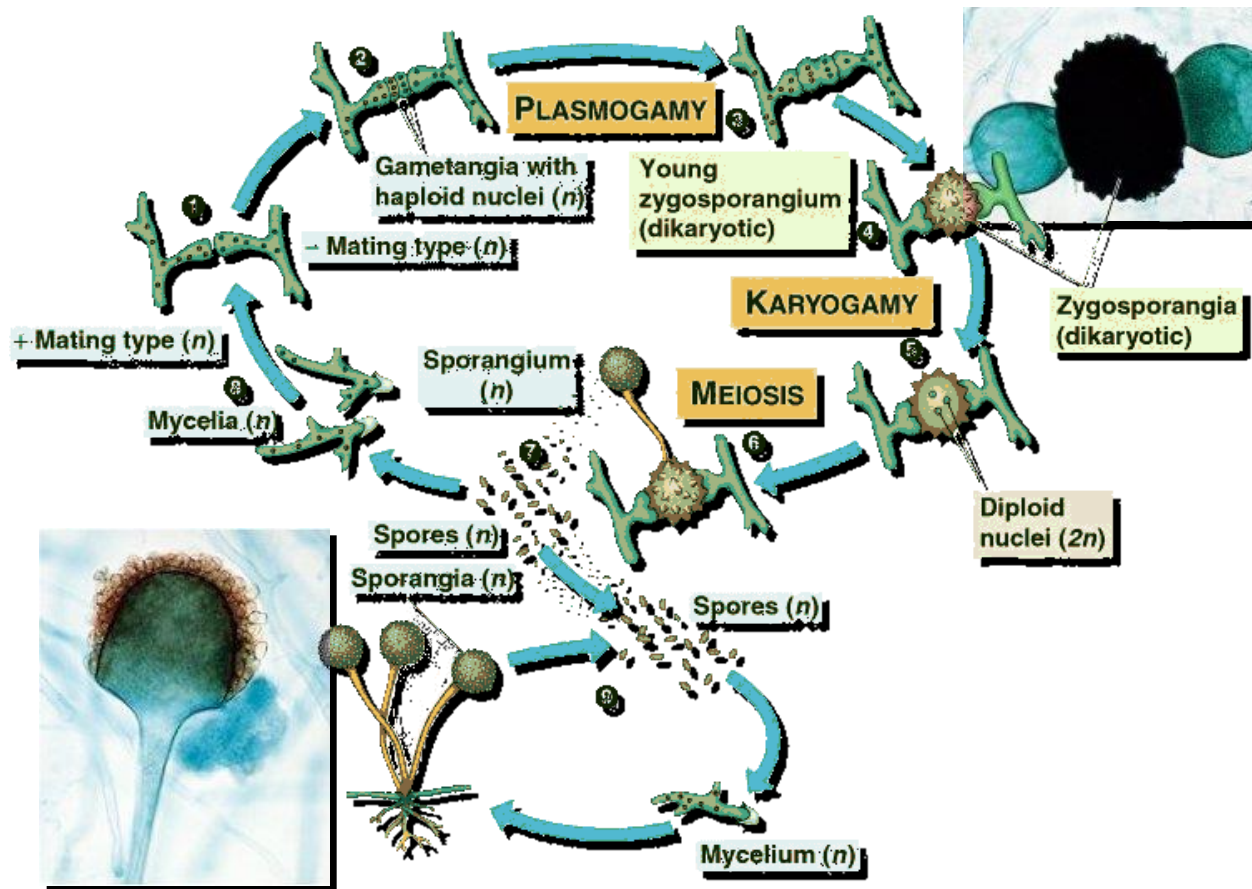


Division Zygomycota



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

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

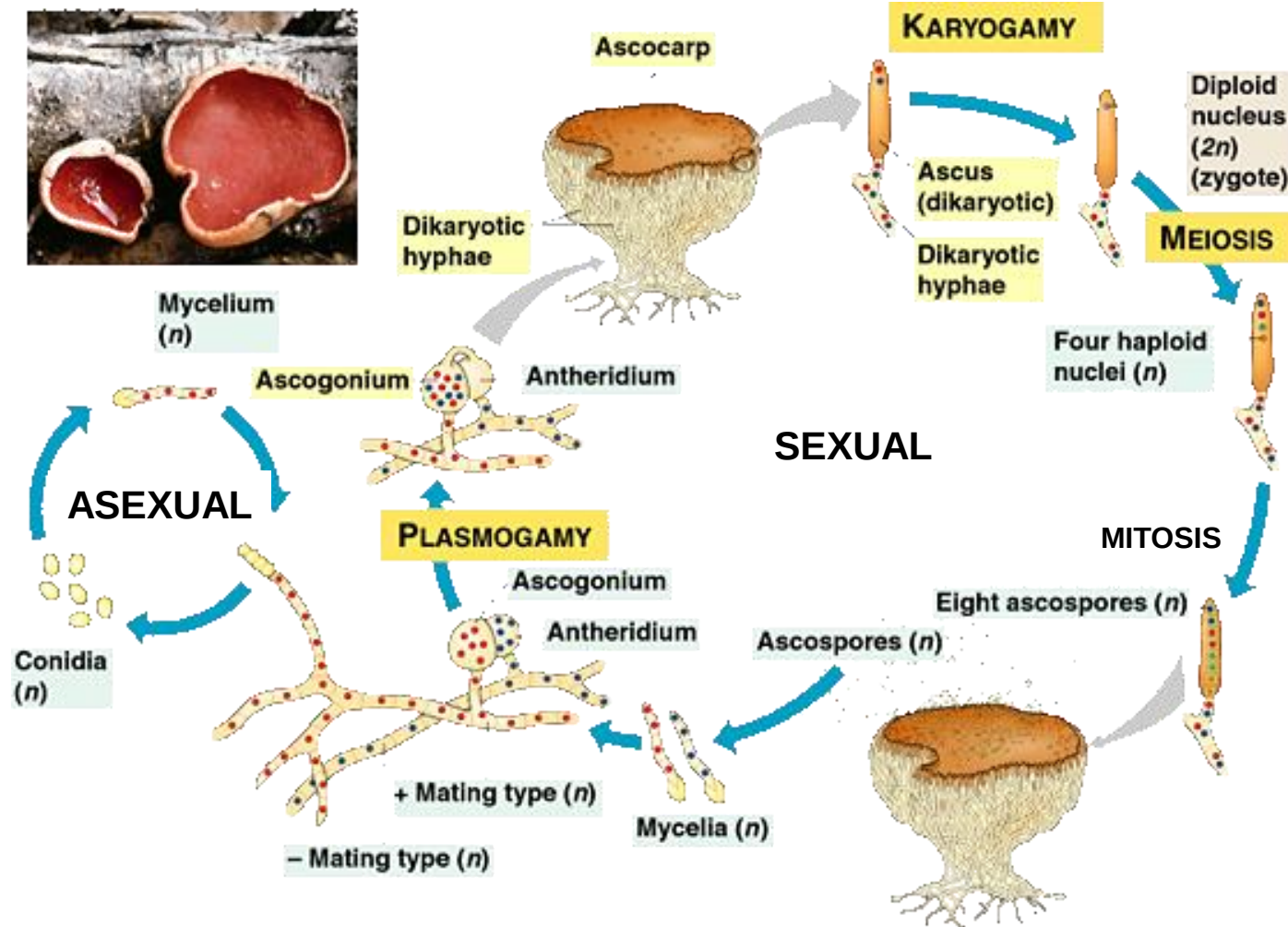


Division Ascomycota: sac fungi produce sexual spores in saclike asci



- 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

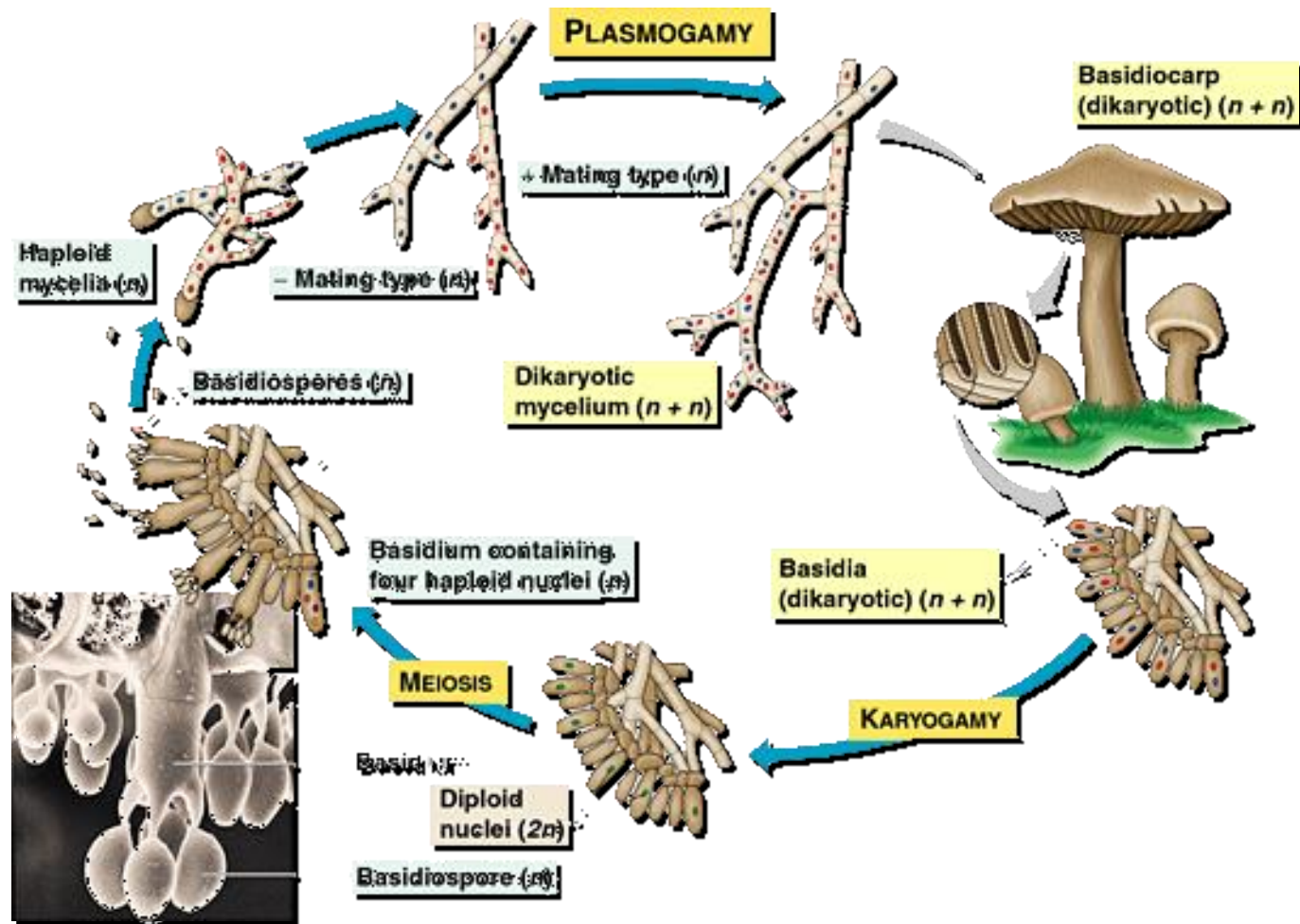


Division Basidiomycota: club fungi



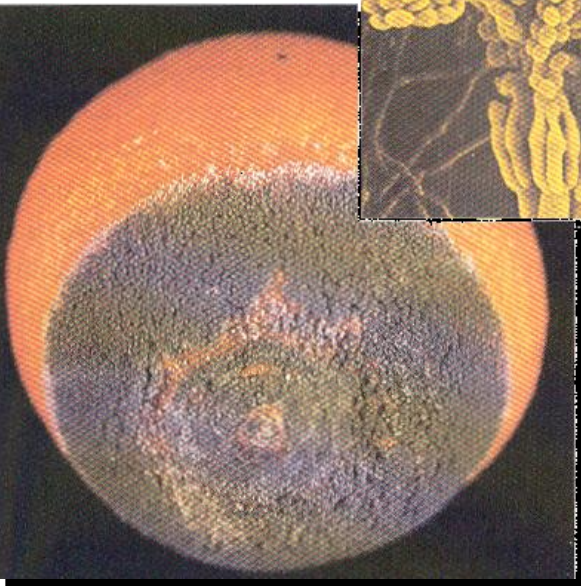
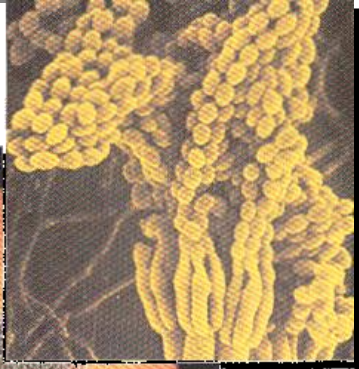
- **Named after transient diploid stage: basidium**
- **Important decomposers of wood / plant material**
- **Include:**
 - **Mycorrhiza-forming mutualists**
 - **Mushroom-forming fungi**
 - **Plant parasites e.g. rusts and smuts**
- **Characterised by dikaryotic mycelium that reproduces sexually via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

Life cycle of a mushroom-forming basidiomycete



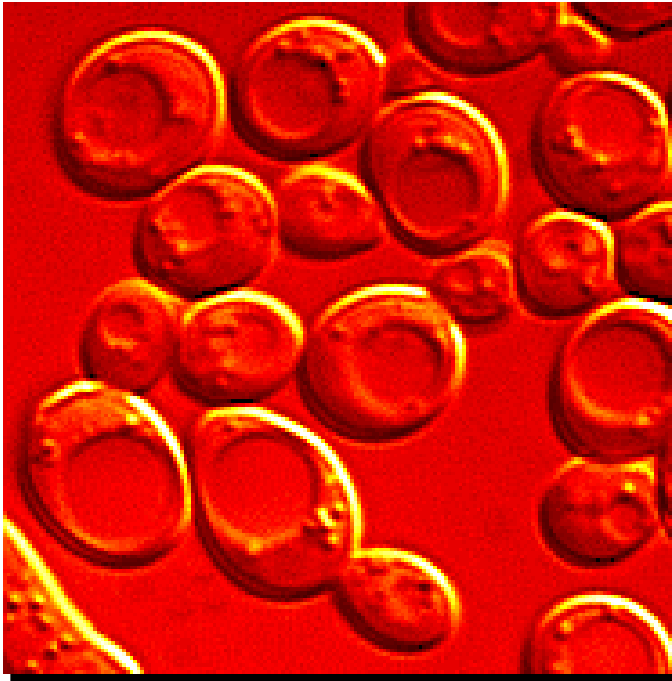
Moulds

- 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"



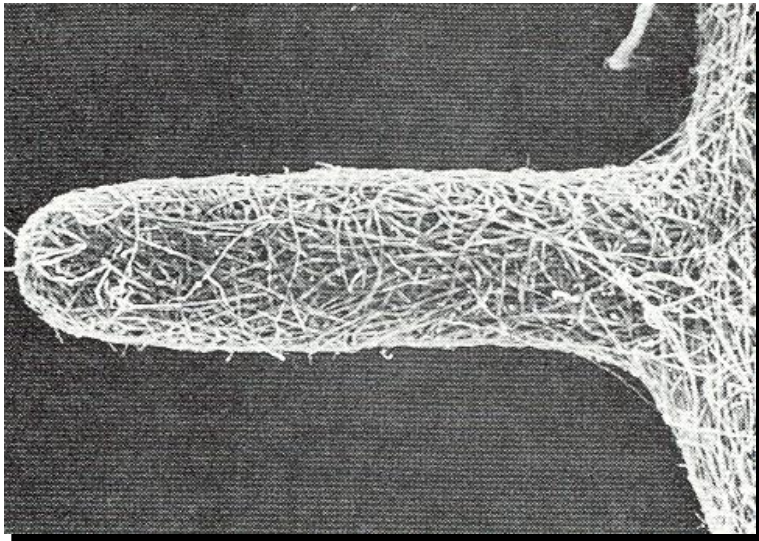
Lichens

- 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

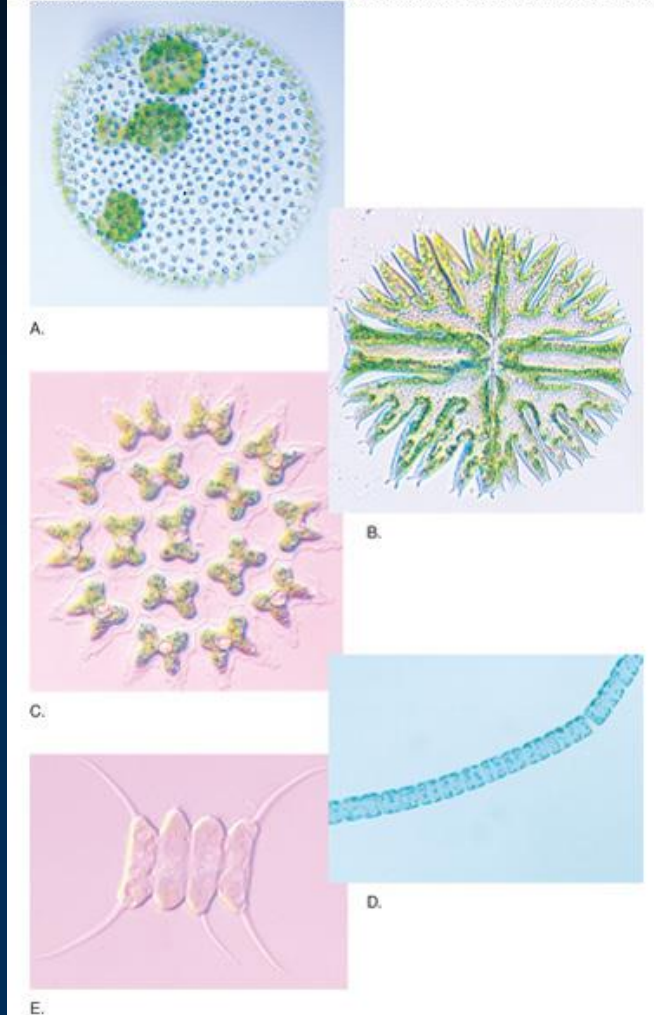
- ❖ **Organisms in Protista vary from unicellular to multicellular.**
 - Nutrition varied: photosynthetic, ingestion of food, absorption of food
 - Individual life cycles vary considerably.
 - Reproduction generally by cell division and sexual processes.
- ❖ **Algae are in Kingdom Protista (???)**
 - 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.”
- Have chlorophylls a and b
- Store food as starch
- Most have a single nucleus per cell.
- Most reproduce both sexually and asexually.

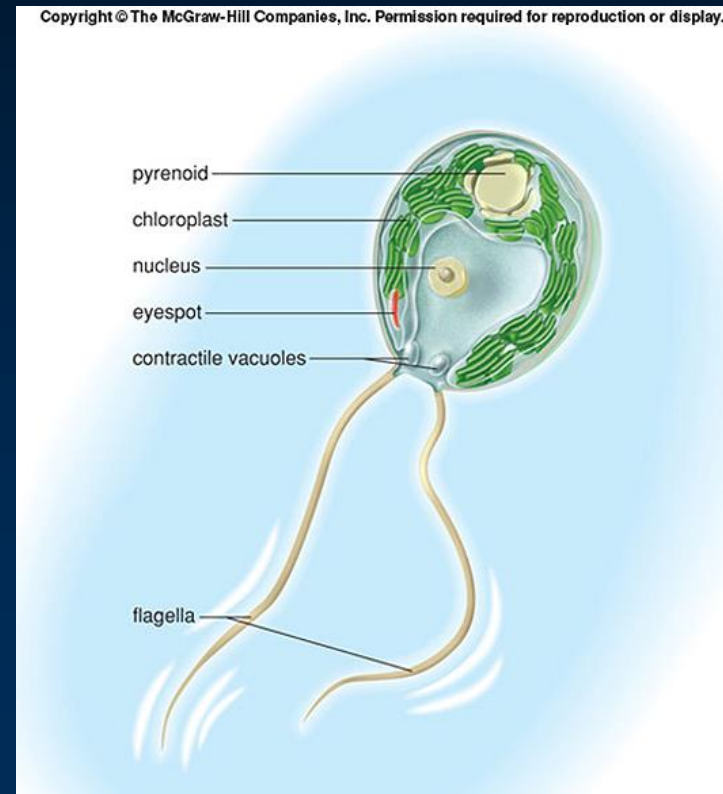
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Phylum Chlorophyta

❖ *Chlamydomonas*

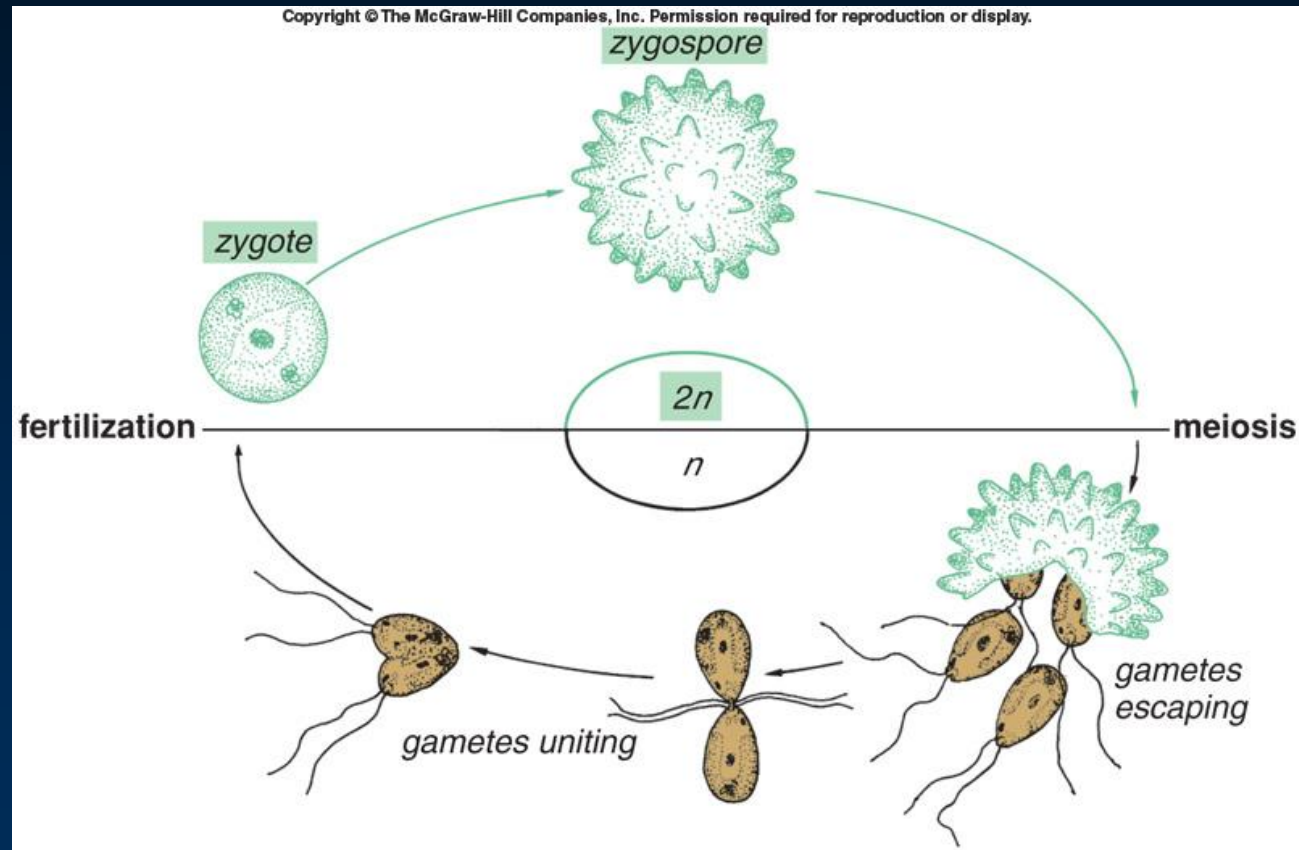
- Common inhabitant of freshwater pools
- Unicellular
- Pair of whip-like flagella on one end pull cell through water.
- Two or more vacuoles at base of flagella
 - Regulate water content of cell and remove waste
- Single, cup-shaped chloroplast with one or two pyrenoids inside
 - **Pyrenoids** - Structures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



Phylum Chlorophyta

❖ *Chlamydomonas* sexual reproduction:

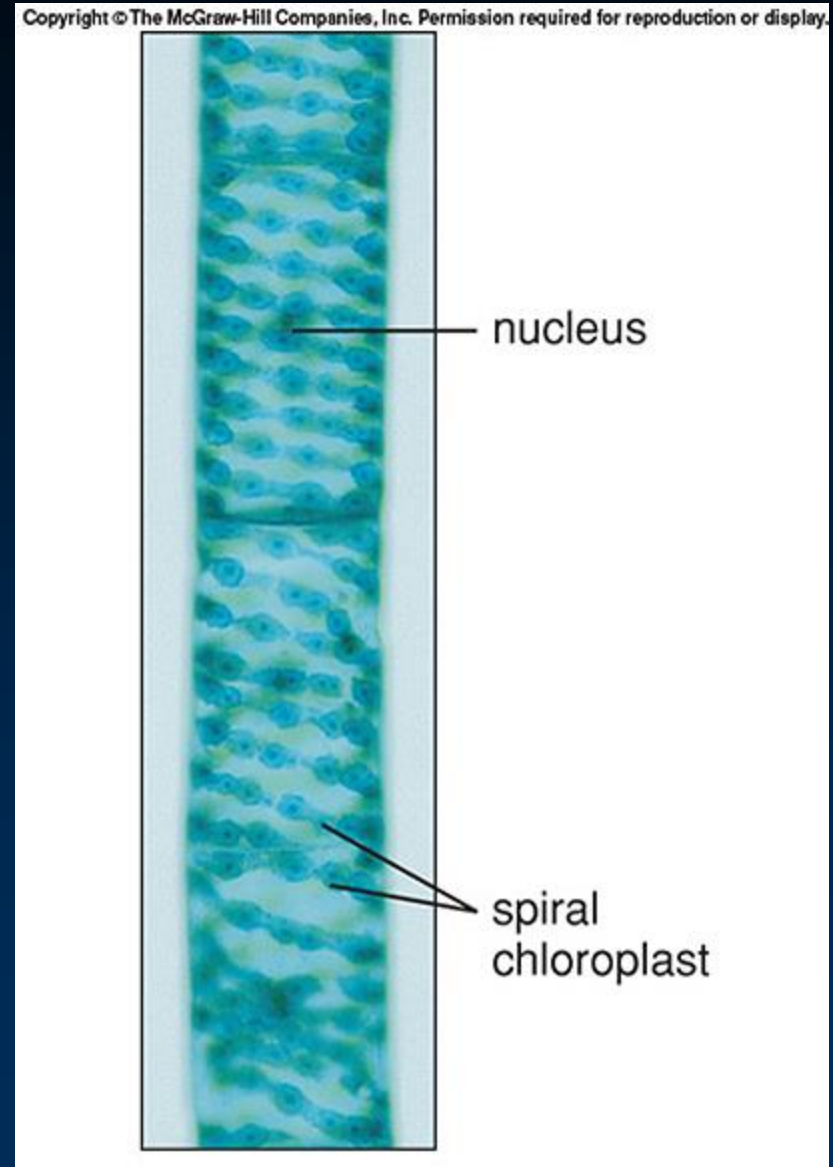
- Meiosis occurs in zygospore, producing 4 haploid zoospores that grow into full-sized algae.
- Under certain conditions, cells congregate together.
- Two cells fuse together to form zygote, that will become zygospore and may remain dormant.



Phylum Chlorophyta

❖ *Spirogyra* (watersilk)

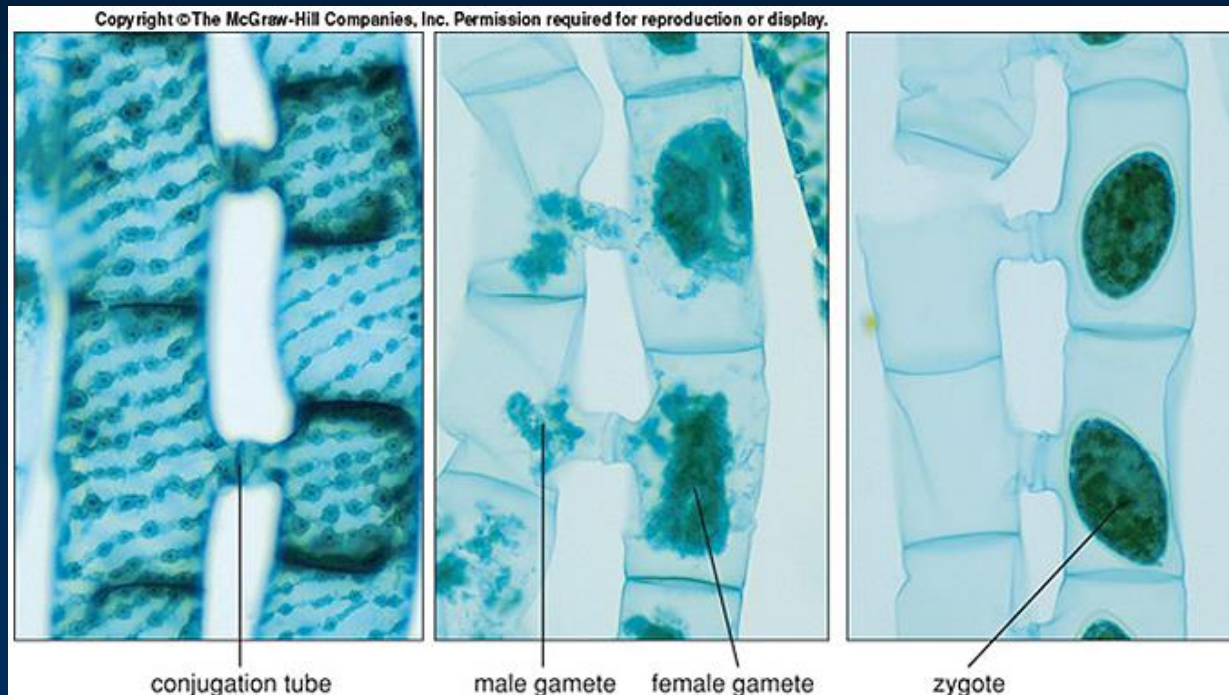
- Filaments of cylindrical cells
- Frequently floats in masses on surface of quiet freshwater
- Chloroplast ribbon-shaped and spirally wrapped around vacuole, with pyrenoids at regular intervals.
- Asexual reproduction:
 - Only by fragmentation of filament



Phylum Chlorophyta

❖ *Spirogyra* (watersilk)

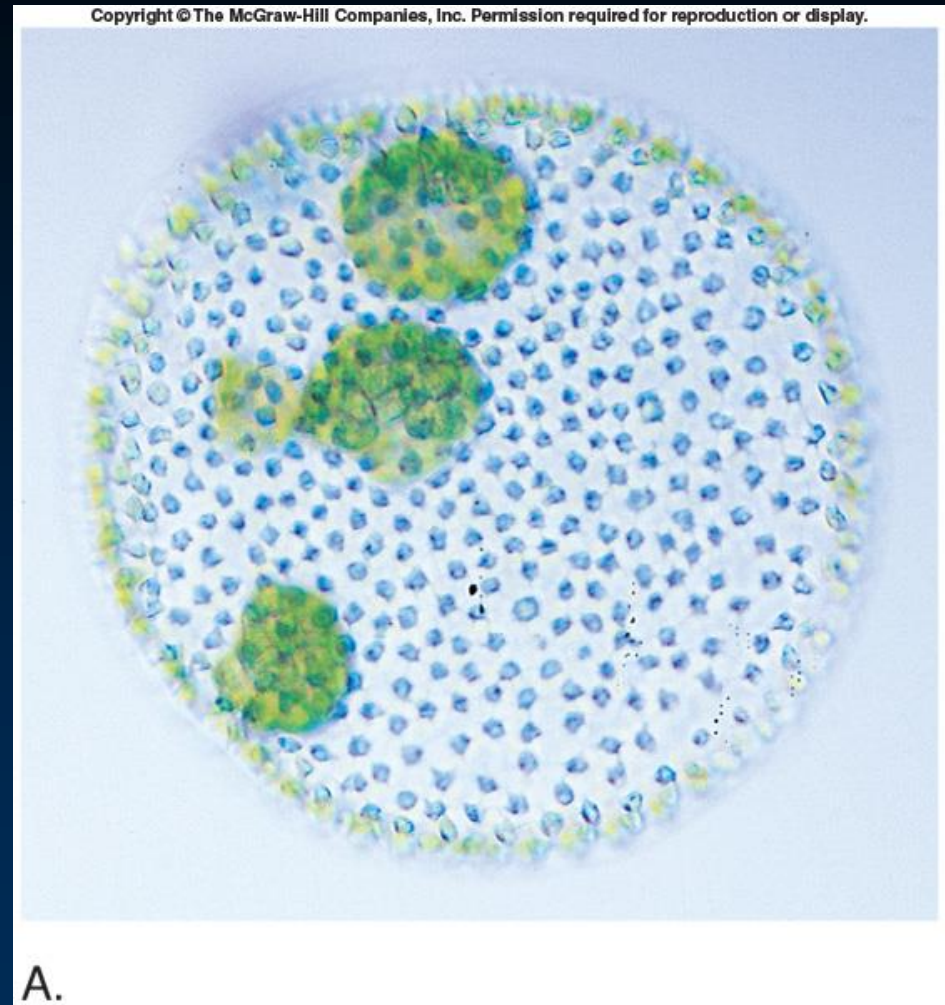
- Sexual reproduction by **conjugation** (form conjugation tubes)
 - Condensed protoplast of one filament flows or crawls through tube to adjacent cell.
 - Protoplasts fuse, forming zygote that develops thick wall.
 - Eventually zygote undergoes meiosis.



Phylum Chlorophyta

❖ Other green algae

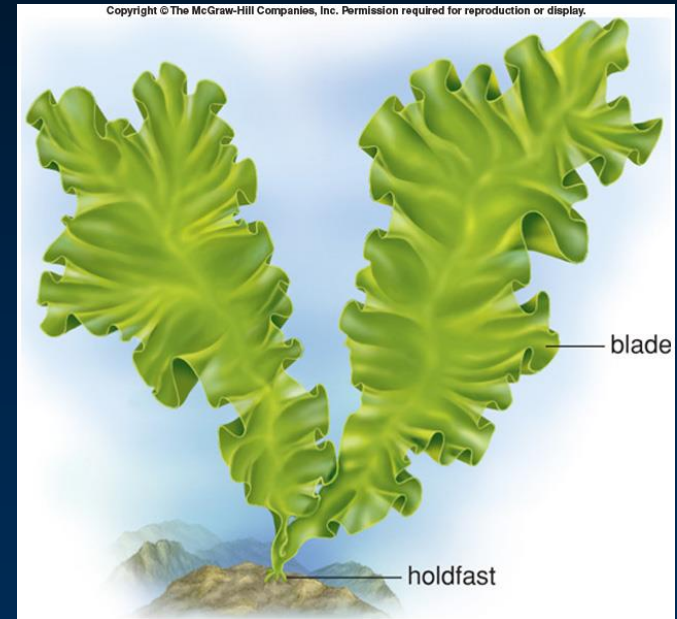
- *Volvox* - Colonial green algae held together in a secretion of gelatinous material, resembling hollow ball
 - Reproduction asexual or sexual
 - Smaller daughter colonies formed inside parent colony



Phylum Chlorophyta

❖ Other green algae

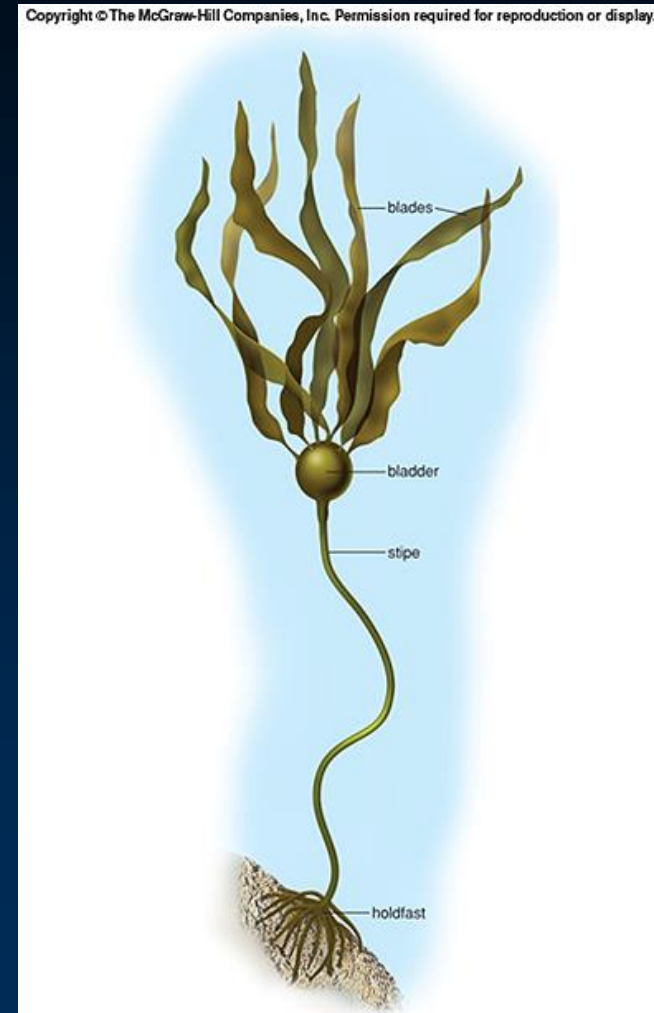
- *Ulva* (sea lettuce) - Multicellular seaweed with flattened green blades and basal holdfast to anchor blades to rocks
 - Haploid and diploid blades
 - Diploid blades produce spores that develop into haploid blades.
 - Haploid blades bear gametangia that form gametes.
 - Gametes fuse to form zygotes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

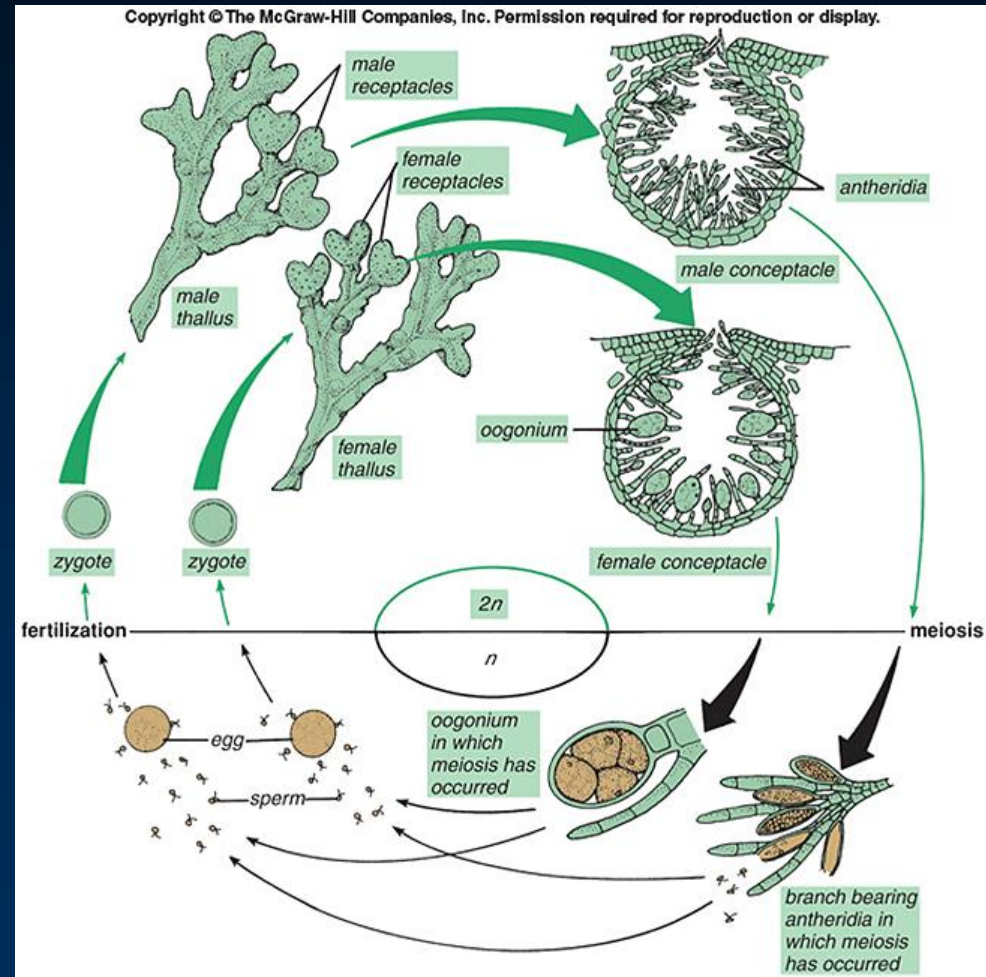
Phylum Chromophyta

❖ 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.



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



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

