

# Diversity of Life

Bacteria

Archae

Protista

Fungi

## Bacteria on the point of a pin



# Archaeobacteria & Eubacteria

- prokaryotic cells
- Abundant
  - Ex: in the human body- for every one human cell there are 10 prokaryotic cells
- important decomposers and symbionts

# Prokaryotes are fundamentally different than Eukaryotes

- Unicellular
  - Can form colonies (masses of single species) or biofilms (complex community of different species)
- Usually very small
  - ten times smaller than typical eukaryotic cells
  - Typically 1-10 microns long

# Prokaryotes are fundamentally different than Eukaryotes

- Nucleoid region
  - Have a single circular chromosome made up of DNA and histone-like proteins in a nucleoid region of the cell
  - May have small circular DNA's called plasmids outside of nucleoid region
- Cell division
  - Binary fission (no spindle, no phases of mitosis)

# Prokaryotes are fundamentally different than Eukaryotes

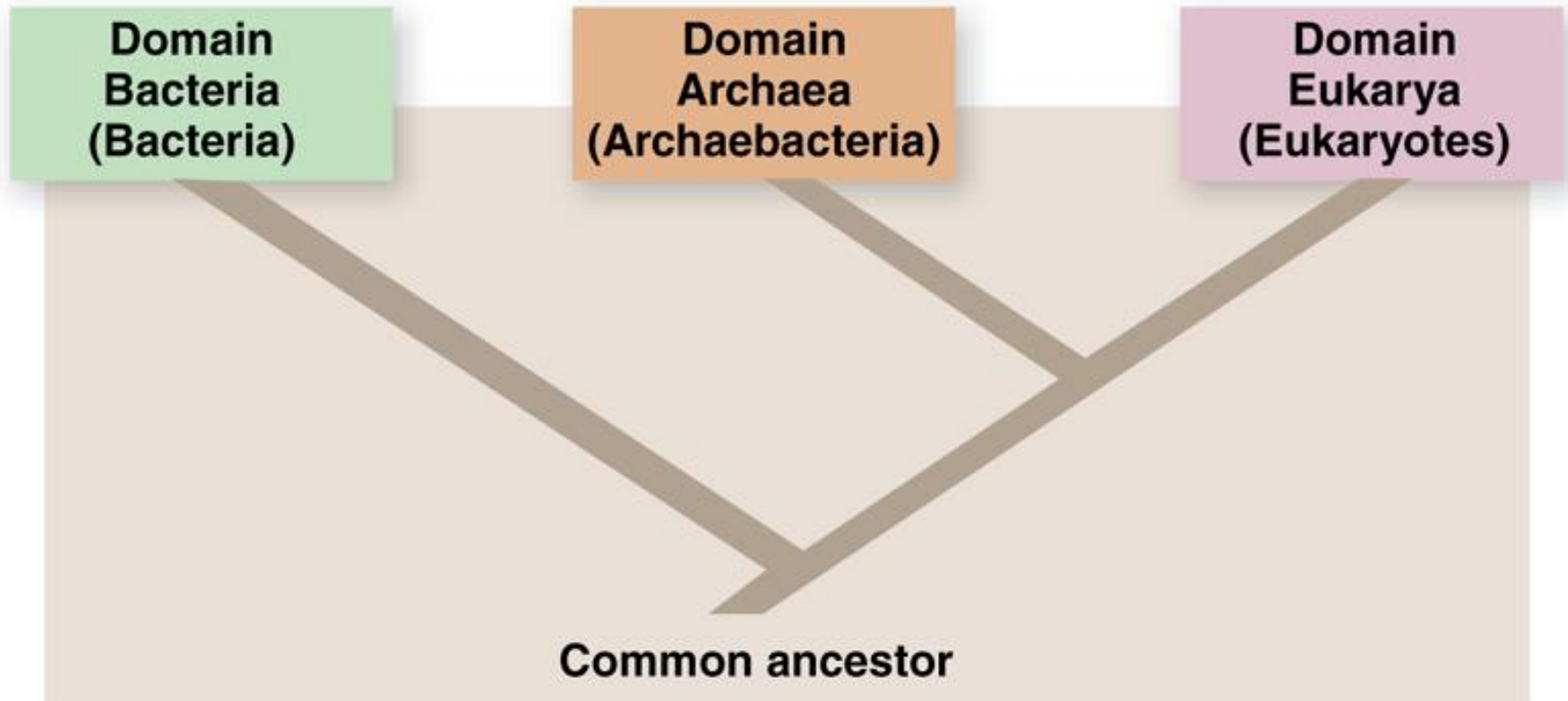
- Genetic recombination:
  - Horizontal gene transfer
    - Conjugation – cell to cell transfer of plasmids
    - Transduction – viral transfer of DNA
    - Transformation – uptake of pieces of DNA not associated with cells or virus
  - No sexual cycle (no meiosis)
- Internal compartmentalization
  - Cytoplasm does not have extensive internal compartments and no membrane-bounded organelles

# Prokaryotic Evolution

- Kingdom Monera is NOT monophyletic
- Two main branches
  - Archaeobacteria = extreme environments
  - Eubacteria or Bacteria

# Molecular Classification

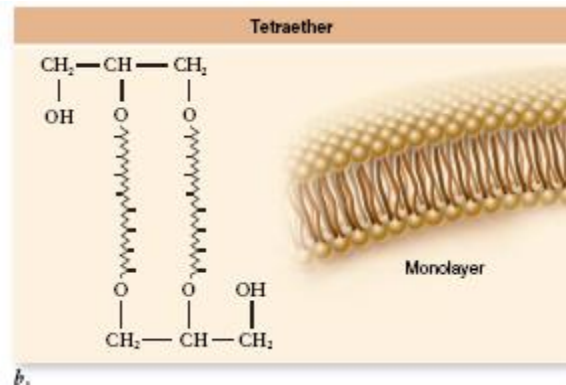
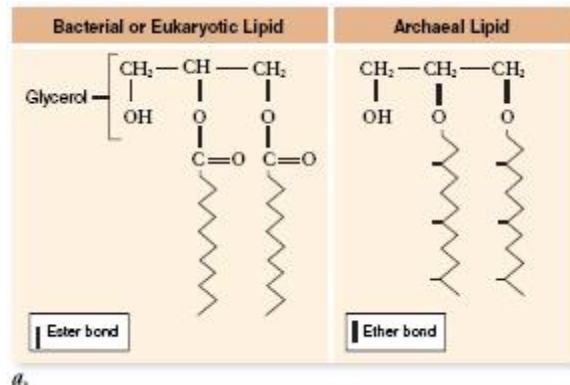
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# Bacteria and Archaeae differ fundamentally

- Plasma Membranes
  - Archaeal membrane lipids are composed of glycerol linked to hydrocarbon chains by ether linkages, not the ester linkages seen in bacteria and eukaryotes



# Bacteria and Archae differ fundamentally

- Cell Wall
  - Bacterial cell walls are made of peptidoglycan, Archae are not
- DNA replication
  - Both have single origin but Archaeal initiation of DNA replication is more similar to that of eukaryotes
- Gene expression
  - Archaea may have more than one RNA polymerase (Transcription: reads DNA to make RNA), and these enzymes more closely resemble the eukaryotic RNA polymerases than they do the single bacterial RNA polymerase

**Table 25.1** Features of the Domains of Life

Feature	Domain		
	Archaea	Bacteria	Eukarya
Amino acid that initiates protein synthesis	Methionine	Formyl-methionine	Methionine
Introns	Present in some genes	Absent	Present
Membrane-bounded organelles	Absent	Absent	Present
Membrane lipid structure	Branched	Unbranched	Unbranched
Nuclear envelope	Absent	Absent	Present
Number of different RNA polymerases	Several	One	Several
Peptidoglycan in cell wall	Absent	Present	Absent
Response to the antibiotics streptomycin and chloramphenicol	Growth not inhibited	Growth inhibited	Growth not inhibited

## “Heat-loving” prokaryotes

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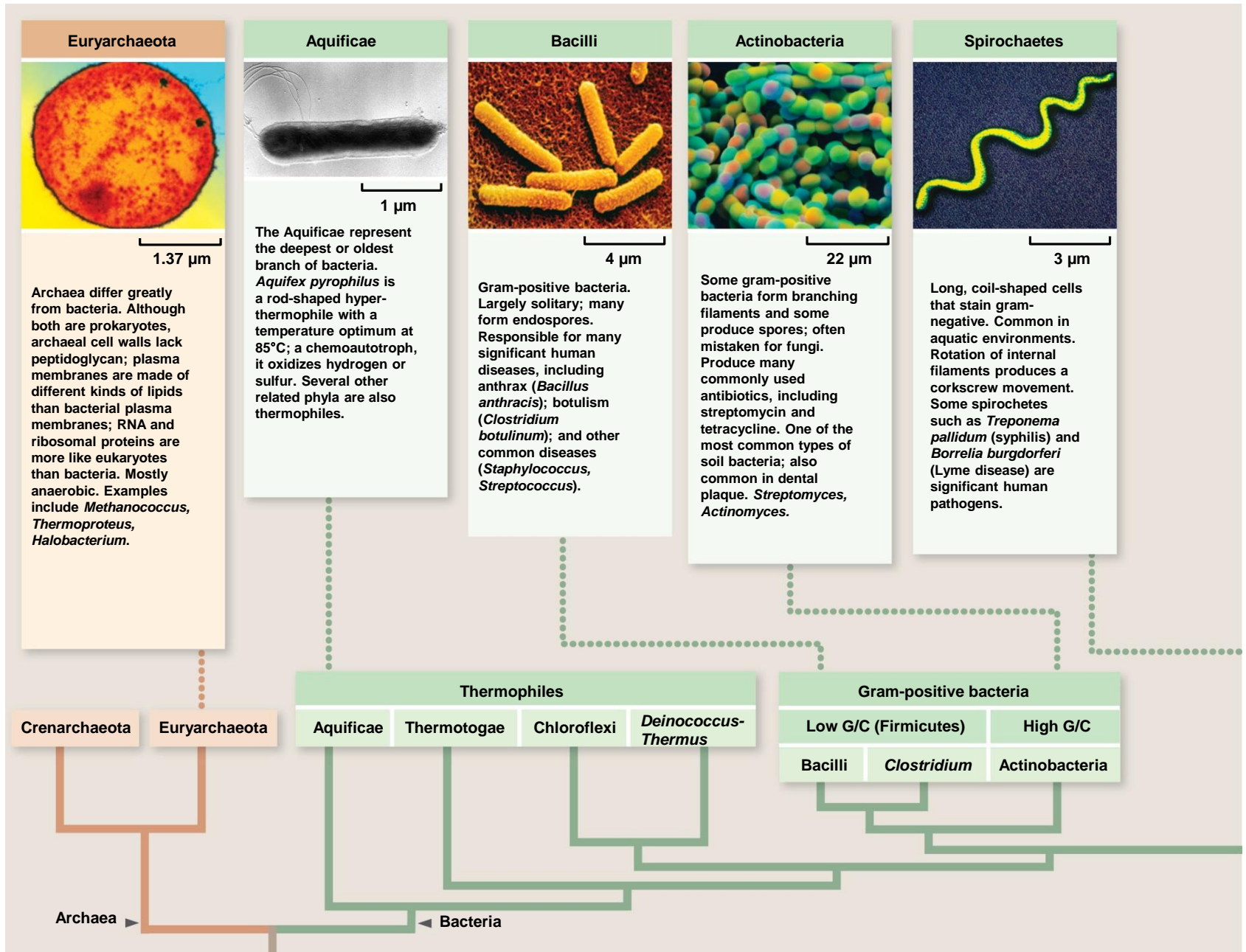


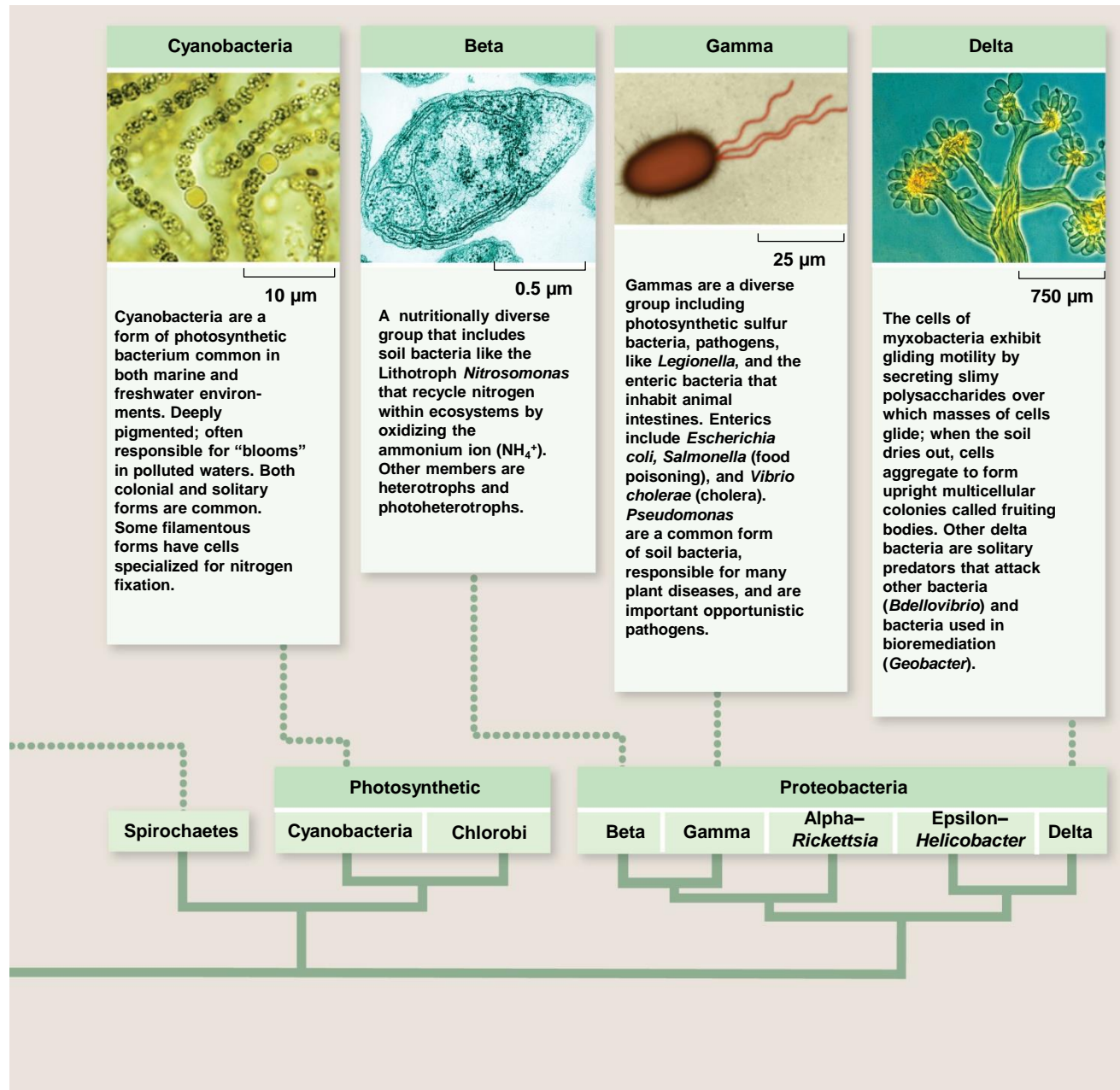


# Extreme halophiles



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Cummins





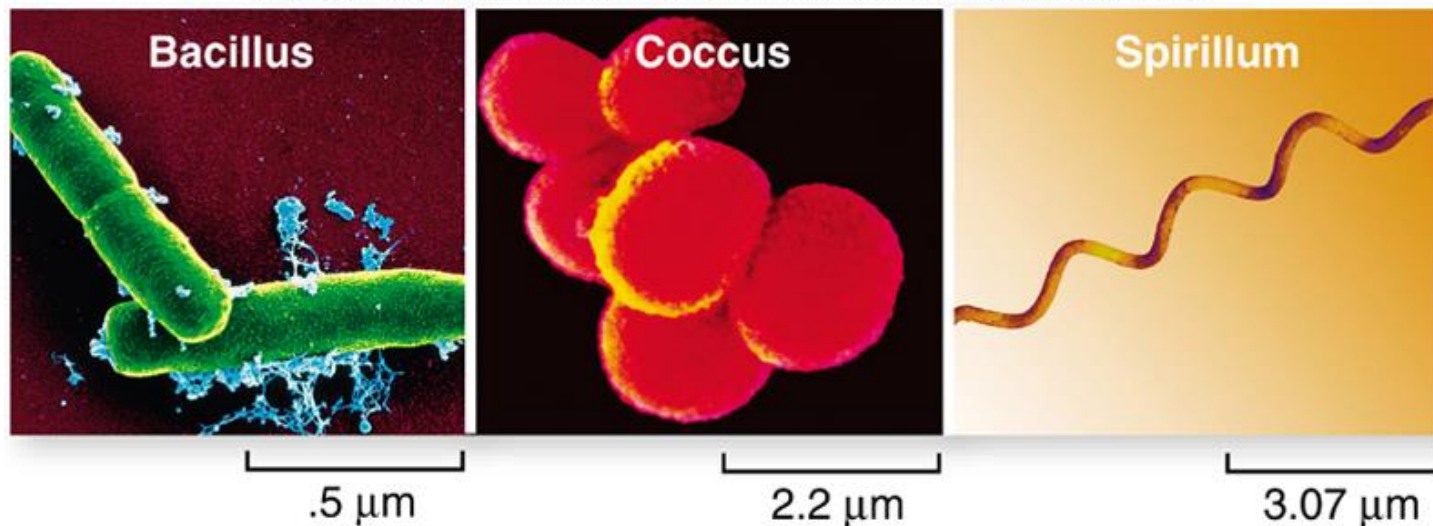


# Prokaryotic Shapes

Most prokaryotes have one of 3 basic shapes

- Bacillus** = Rod-shaped
- Coccus** = Spherical
- Spirillum** = Helical-shaped

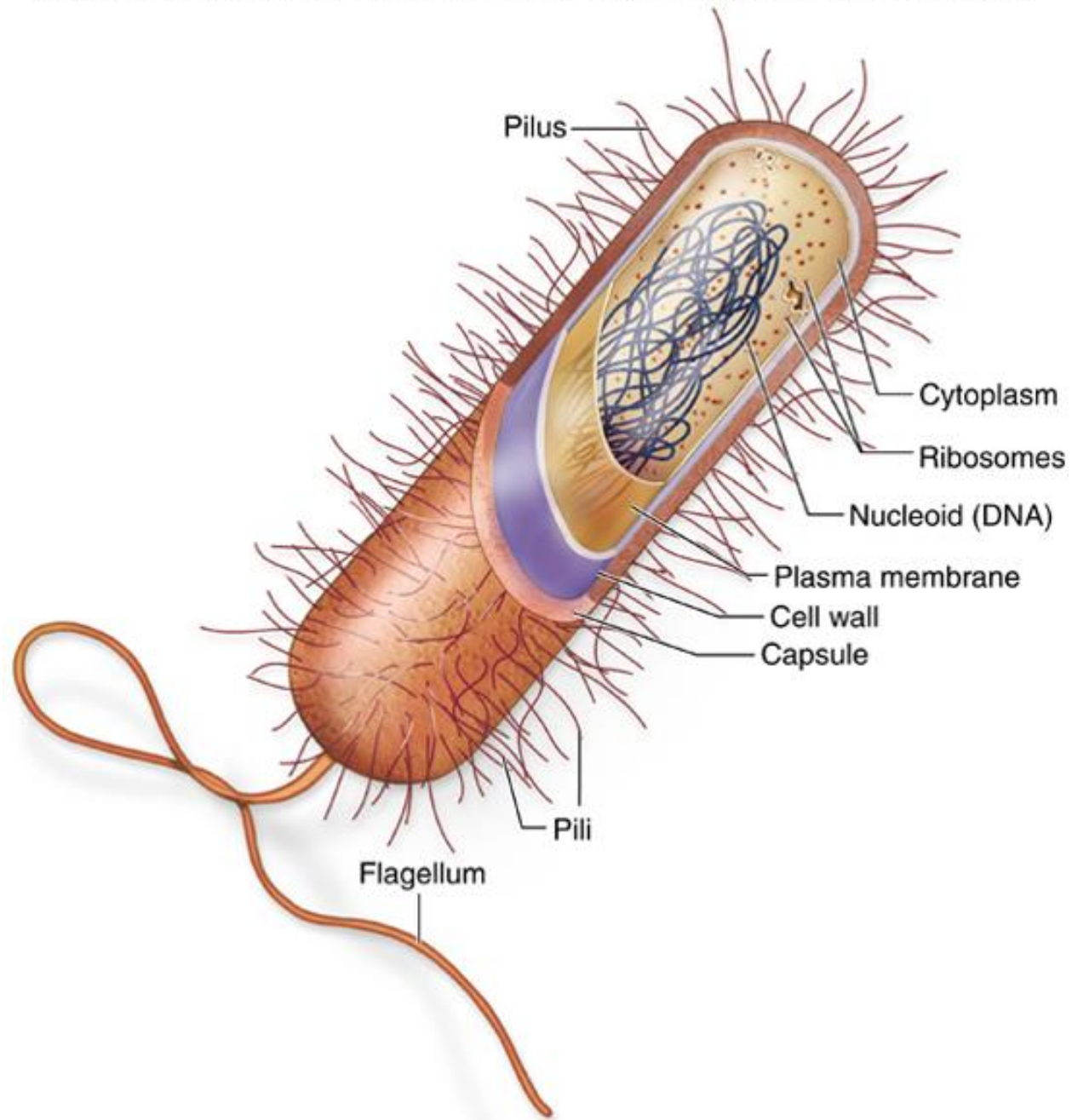
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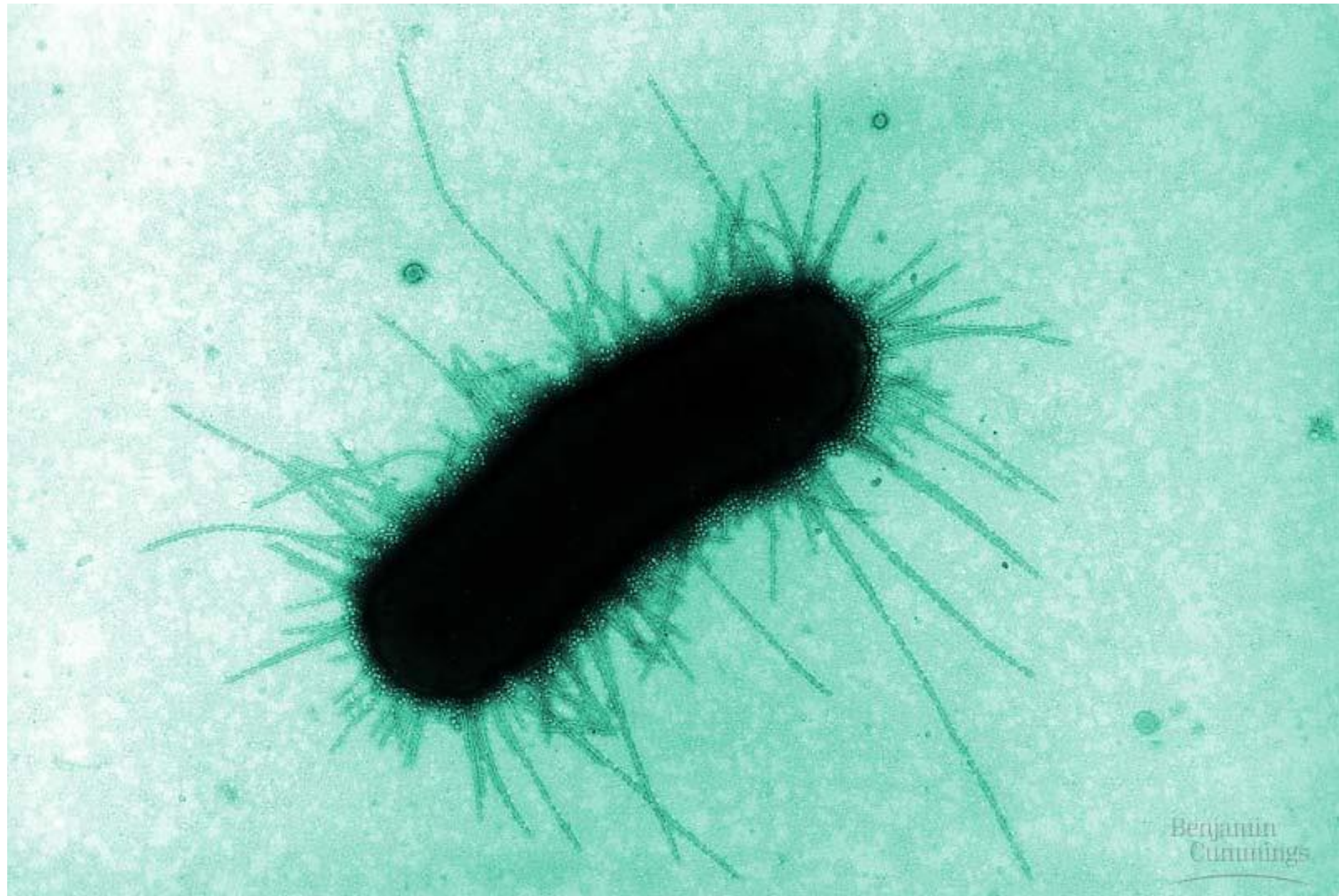




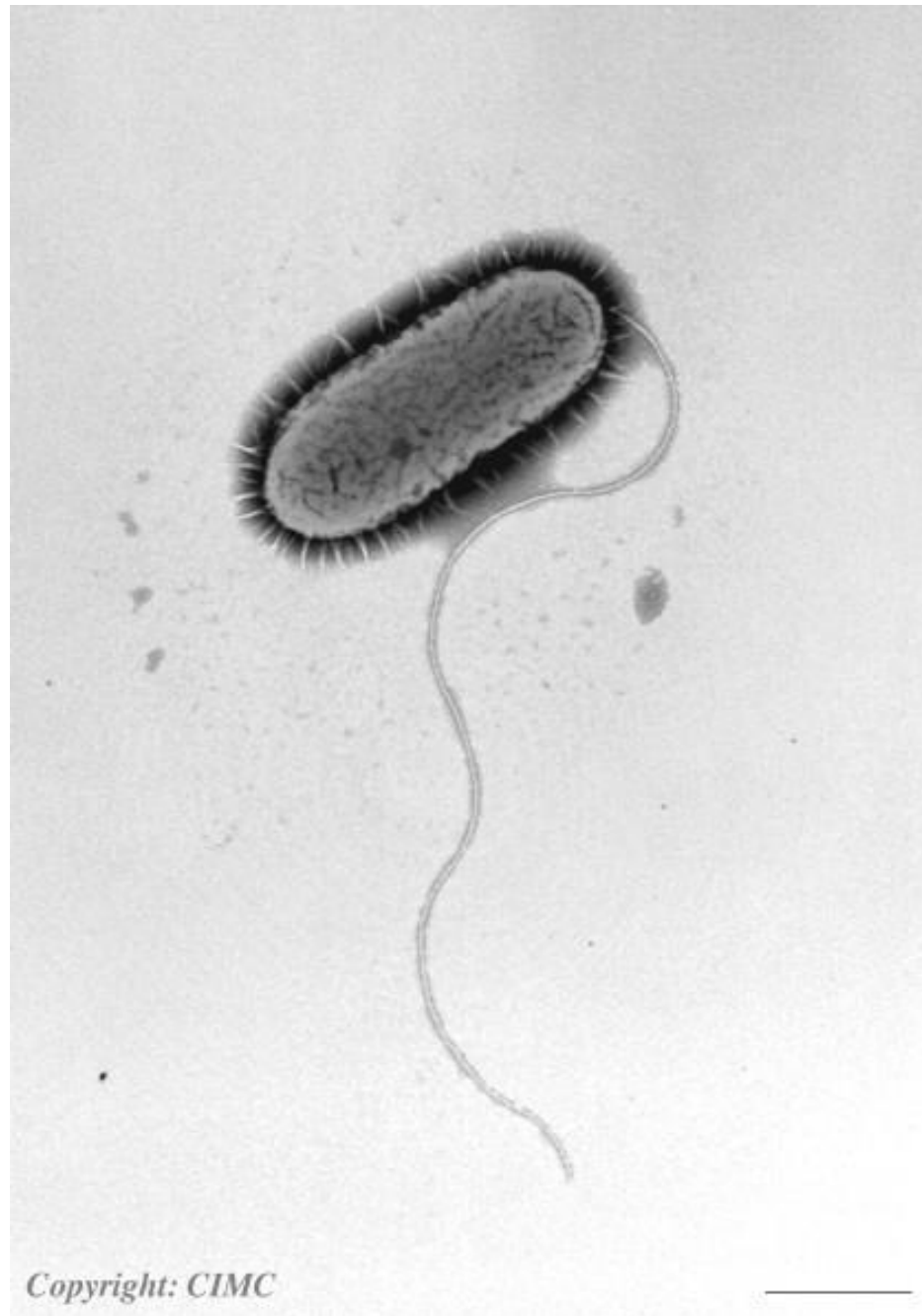
# Prokaryotic Cell Surfaces

- Cell surfaces
  - Plasma membrane
  - Cell walls of peptidoglycan in Eubacteria
    - Polysaccharides cross-linked with peptides
    - Archaea do not possess peptidoglycan
  - may have S-layer (Archae always do)
    - Function is diverse and variable but often involve adhesion to surfaces or protection
  - may have capsule
    - An additional gelatinous layer- interfering with recognition by phagocytic cells- ability to cause disease
  - may have Pili for adhesion and/or flagella for movement

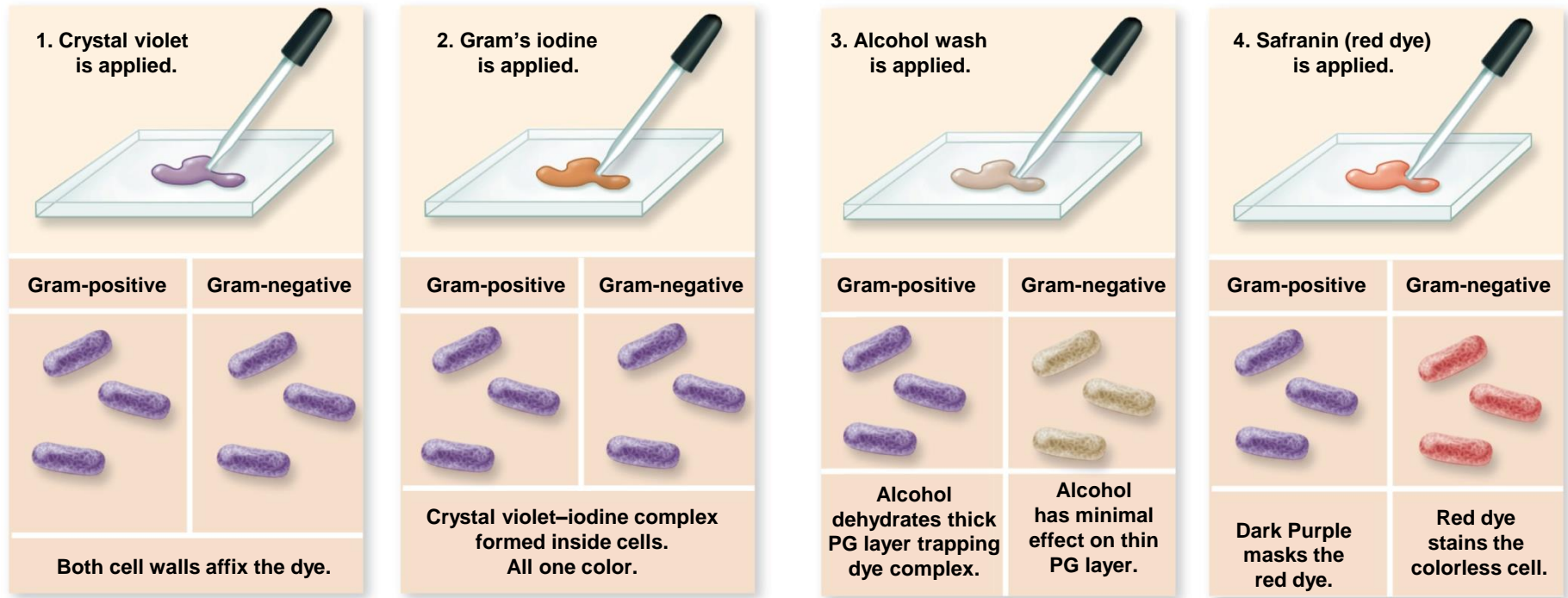




## Prokaryotic flagella (*Bacillus*)







**Gram-positive** bacteria have a thicker peptidoglycan wall and stain a purple color, whereas the more common **gram-negative** bacteria contain less peptidoglycan and do not retain the purple-colored dye.

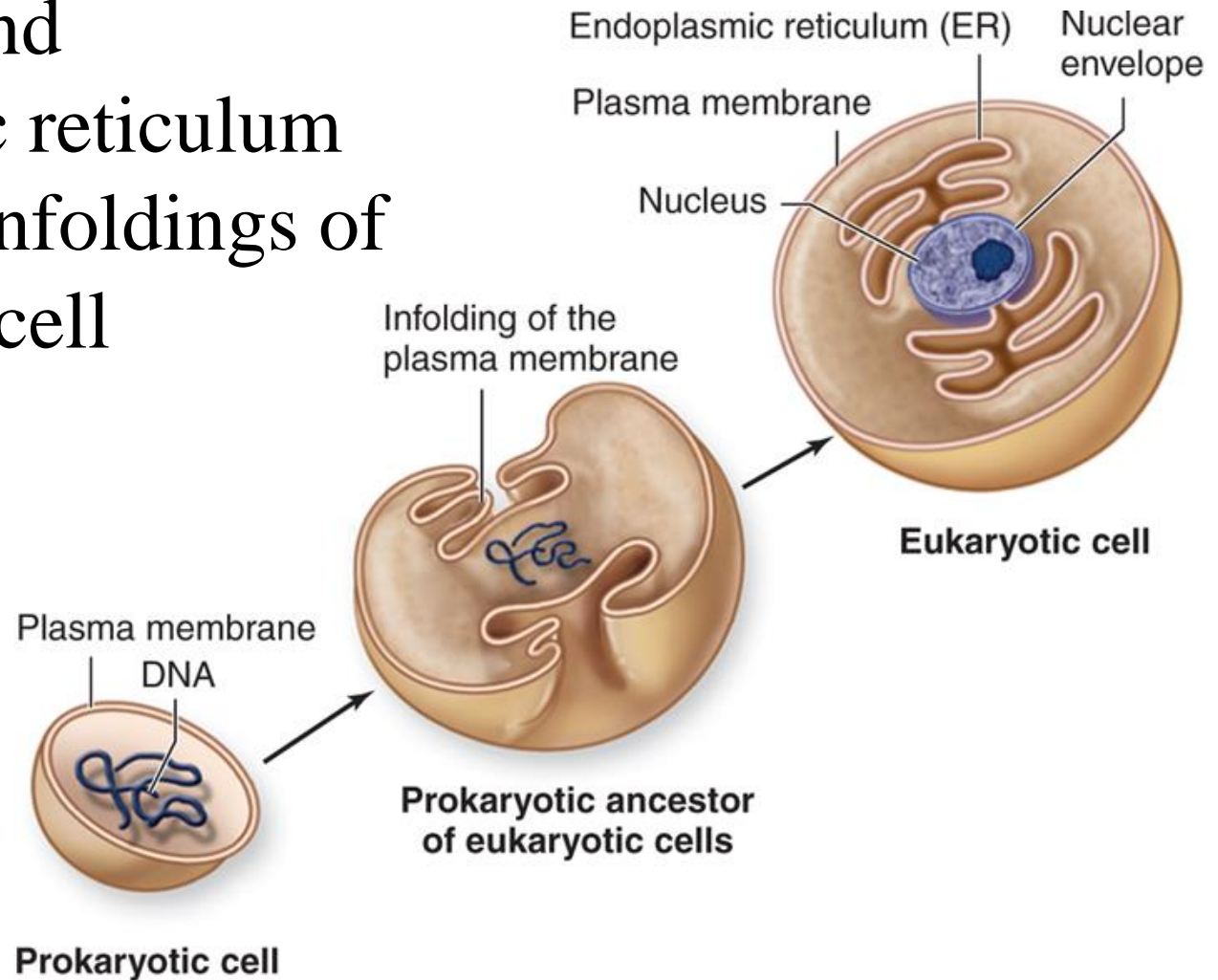


# Prokaryotic Genome

- in the nucleoid region
- major chromosome
  - one doubled stranded DNA molecule forms a ring
- Plasmids
  - Small circular pieces of DNA
  - Not required for normal cell function
  - Exchanged in conjugation

# Eukaryotic Origins

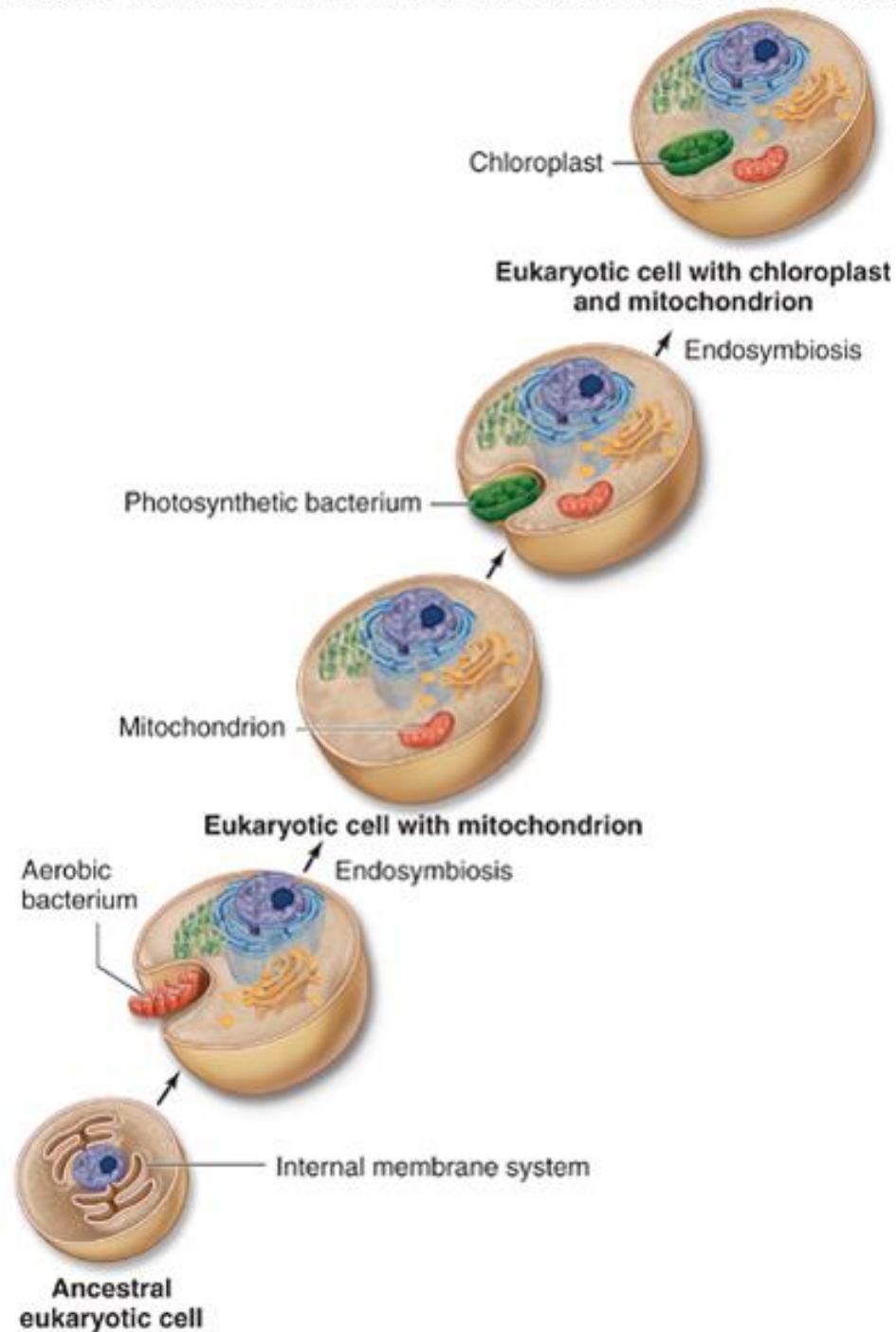
The nucleus and endoplasmic reticulum arose from infoldings of prokaryotic cell membrane



# Endosymbiotic theory

- Eukaryotic organelles evolved from a consortium of symbiotic prokaryotes
  - mitochondria were aerobic heterotrophic prokaryotes
  - chloroplasts were photosynthetic prokaryotes





# Kingdom Protista

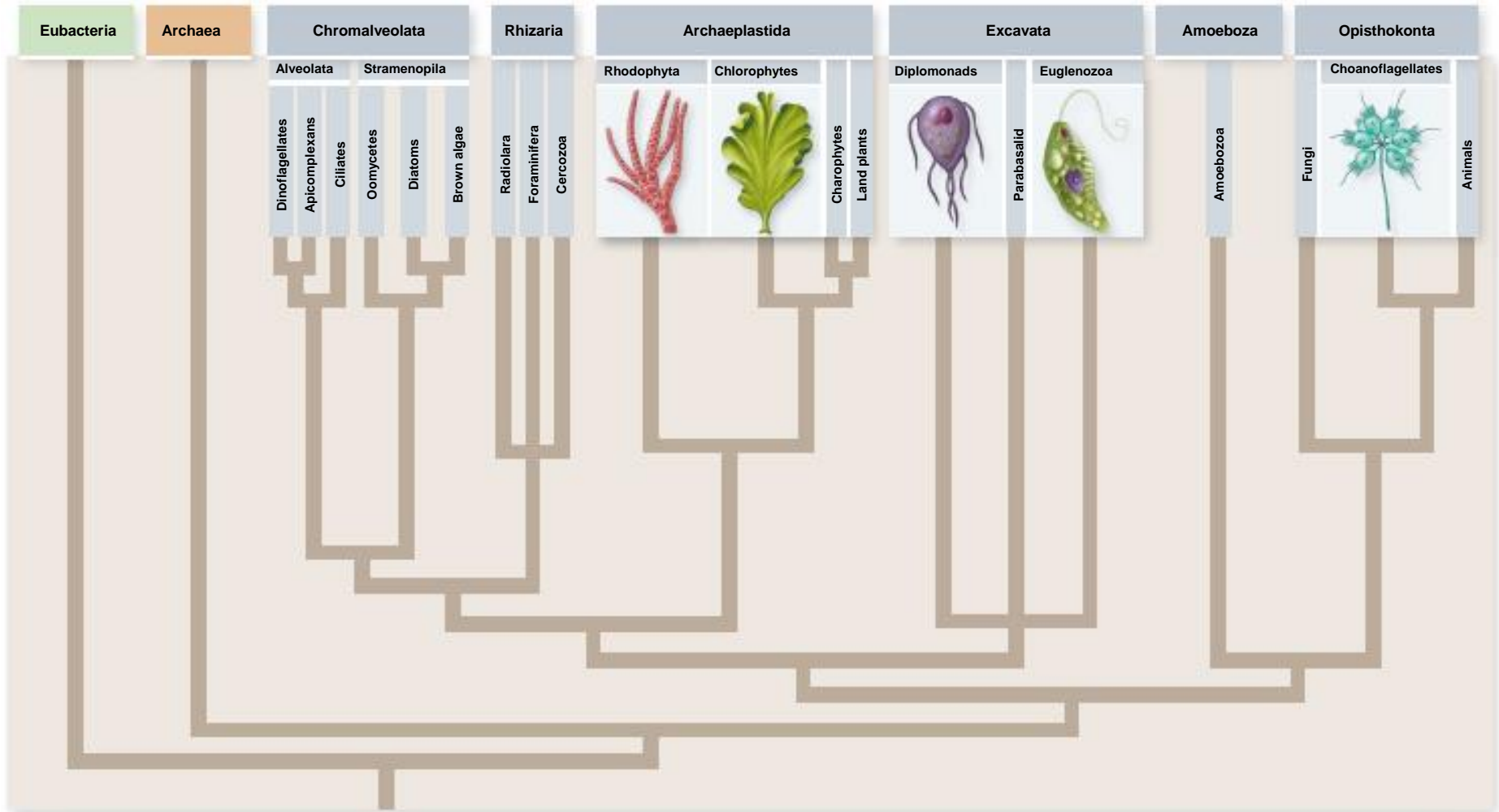
- **Eukaryotic**
- Most are unicellular (there are some simple multicellular ones)

# Protista Taxonomy

- Originally consisted of all unicellular eukaryotes
- was paraphyletic
- The 17 major protist phyla are grouped into six major monophyletic groups

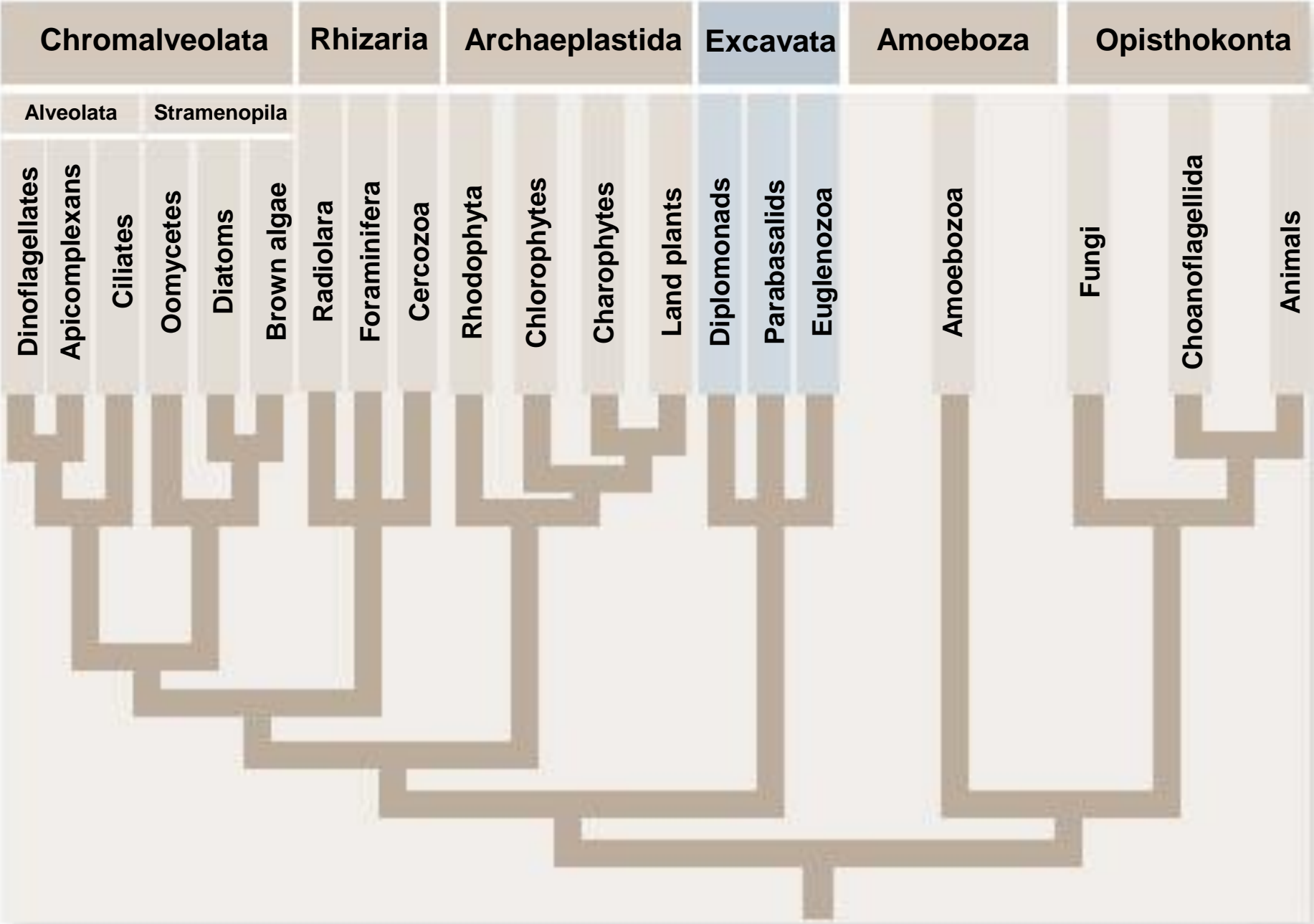
# Fig. 29.5

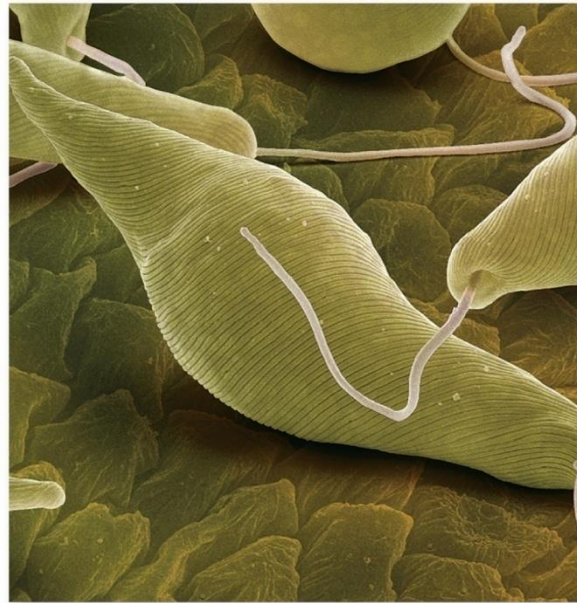
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# Characteristics Used to Classify Protists

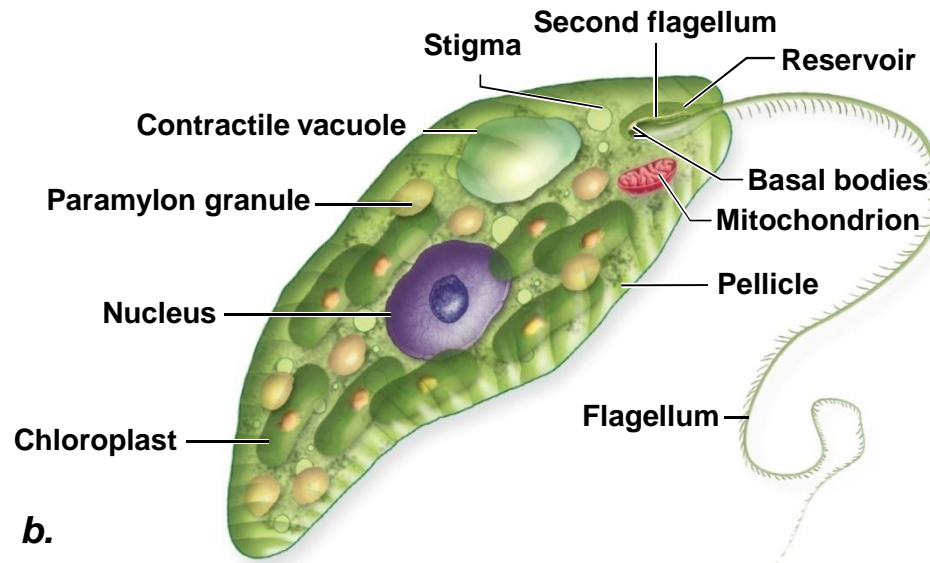
- Mode of locomotion
- mode of nutrition
- overall body form
- pigments
- & others...



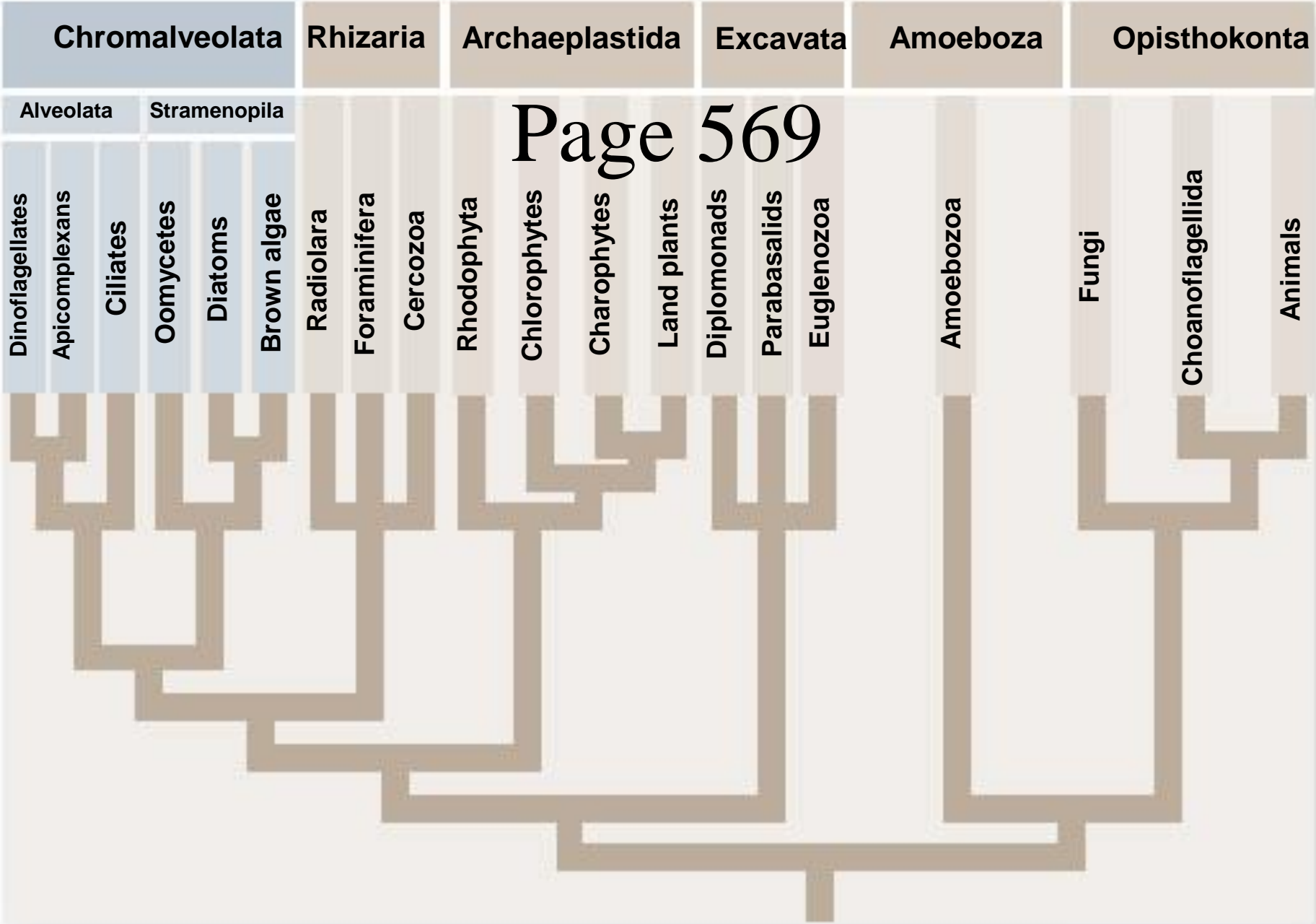


6  $\mu$ m

**a.**



**b.**

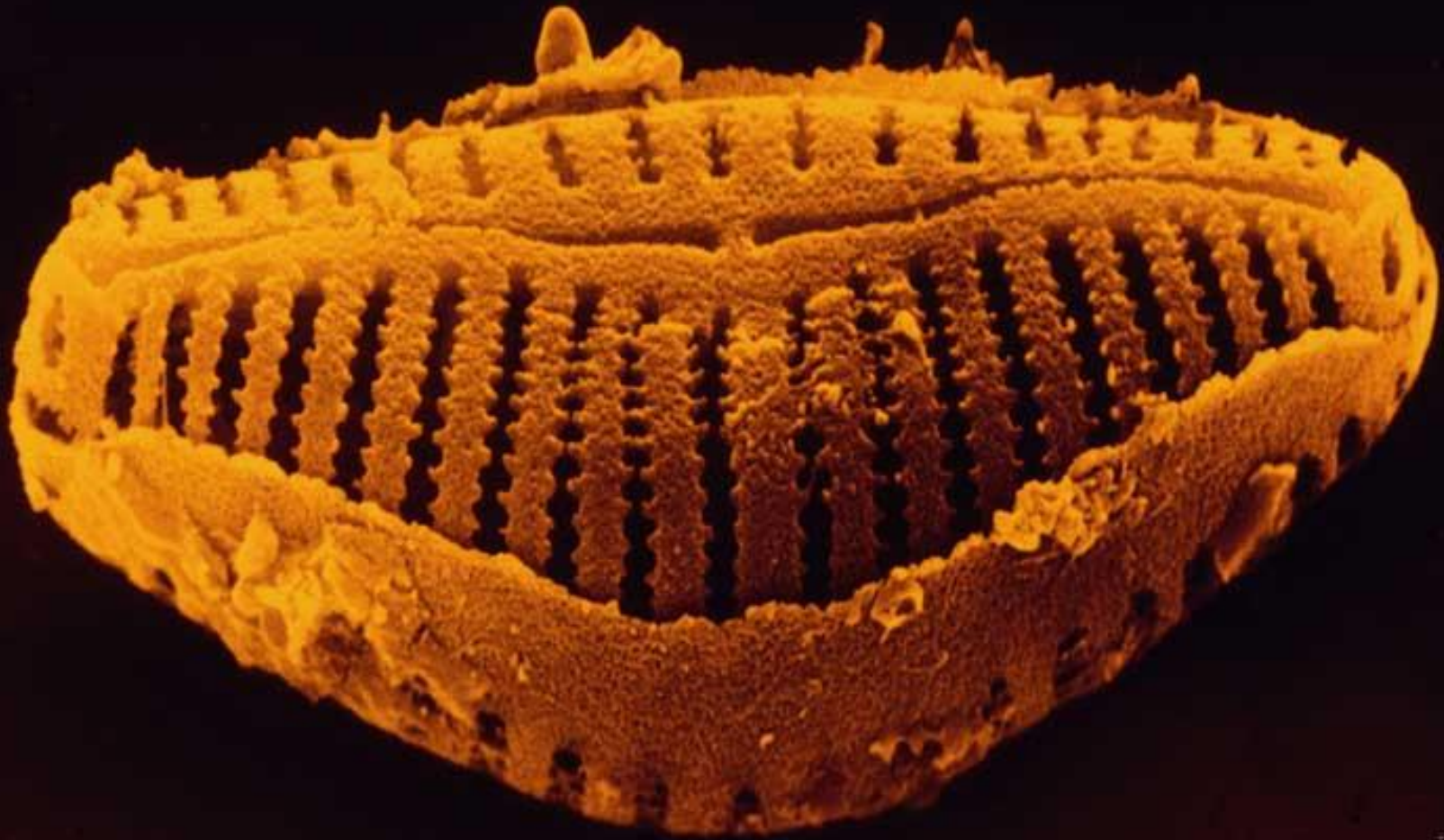




A ciliated protozoan



Too diverse for one kingdom: a diatom, a unicellular "alga"

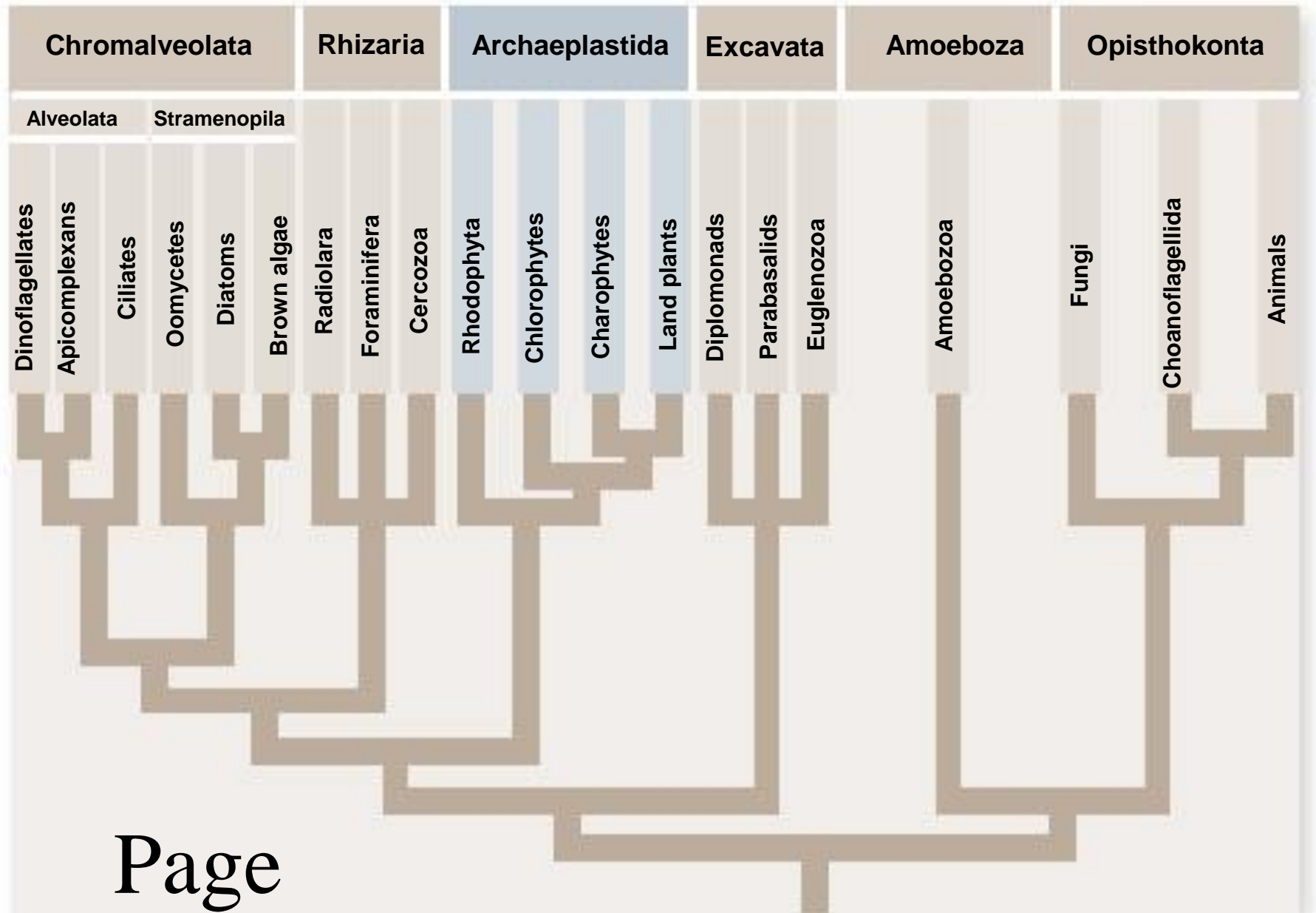


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Too diverse for one kingdom: Australian bull kelp (*Durvillea potatorum*)

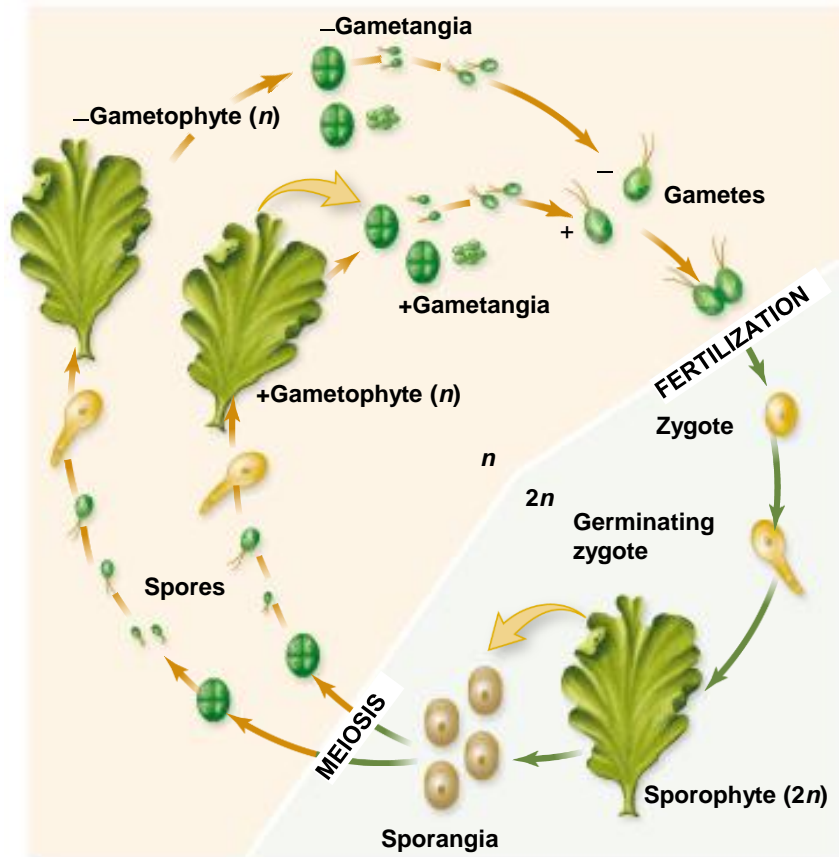


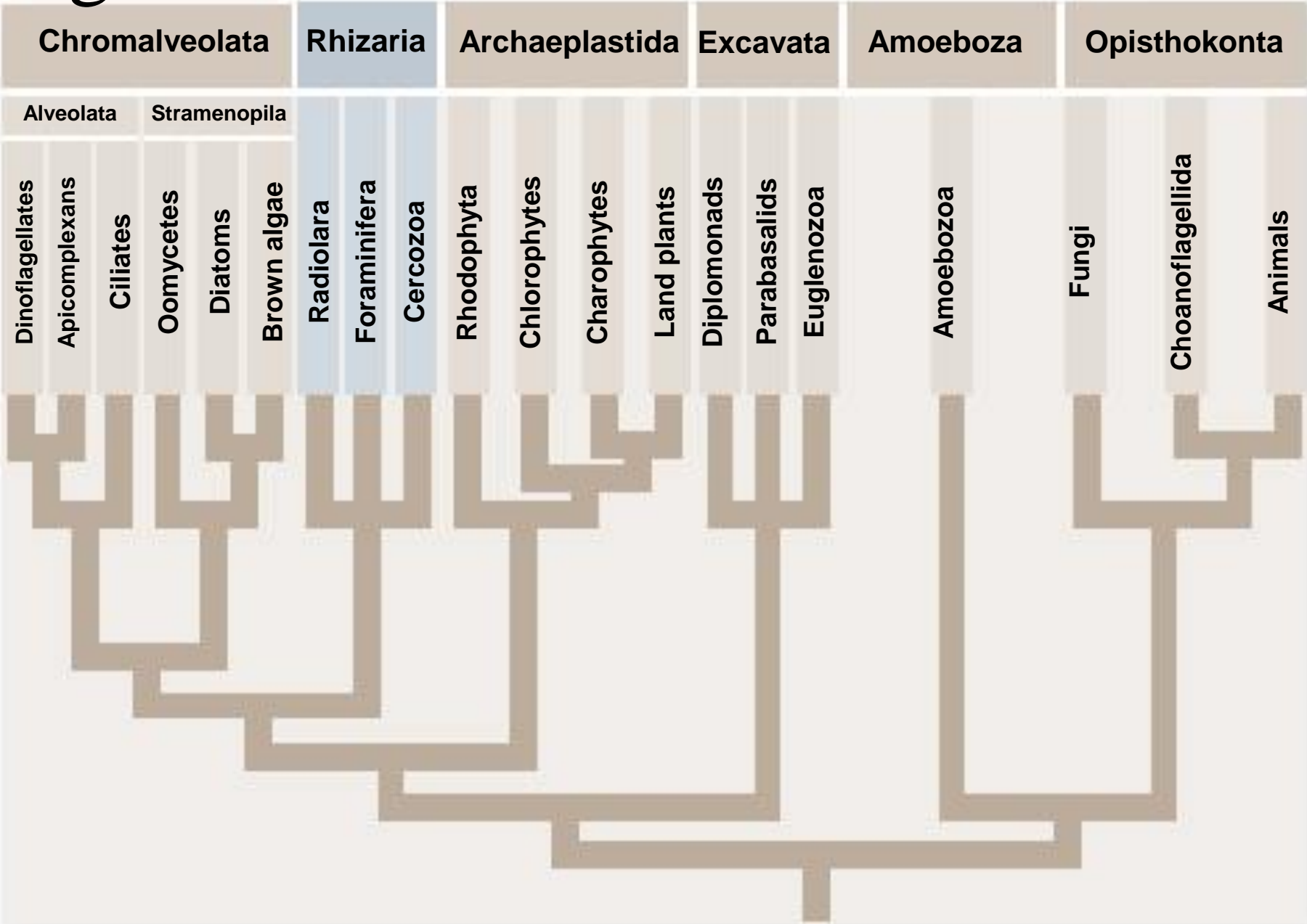


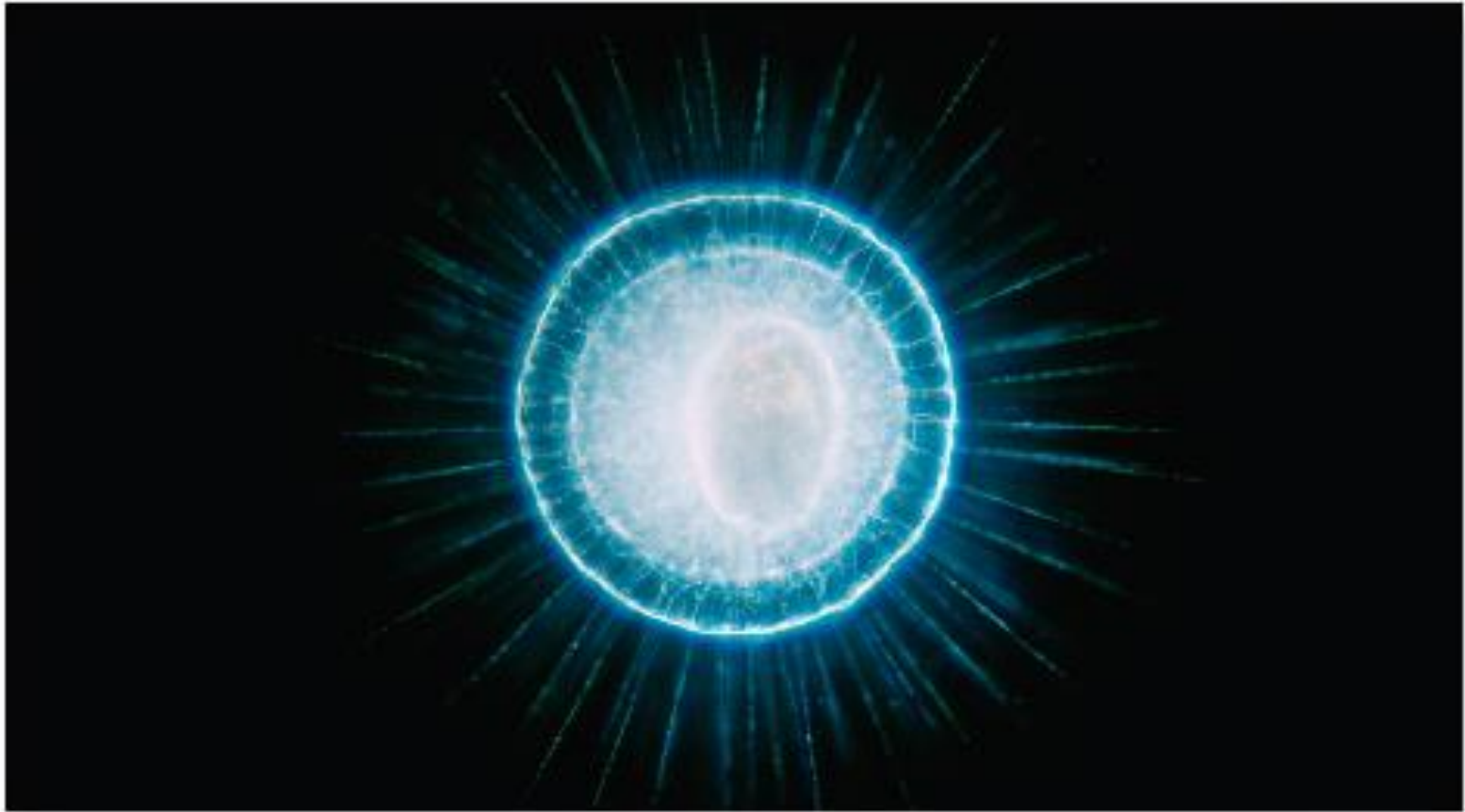




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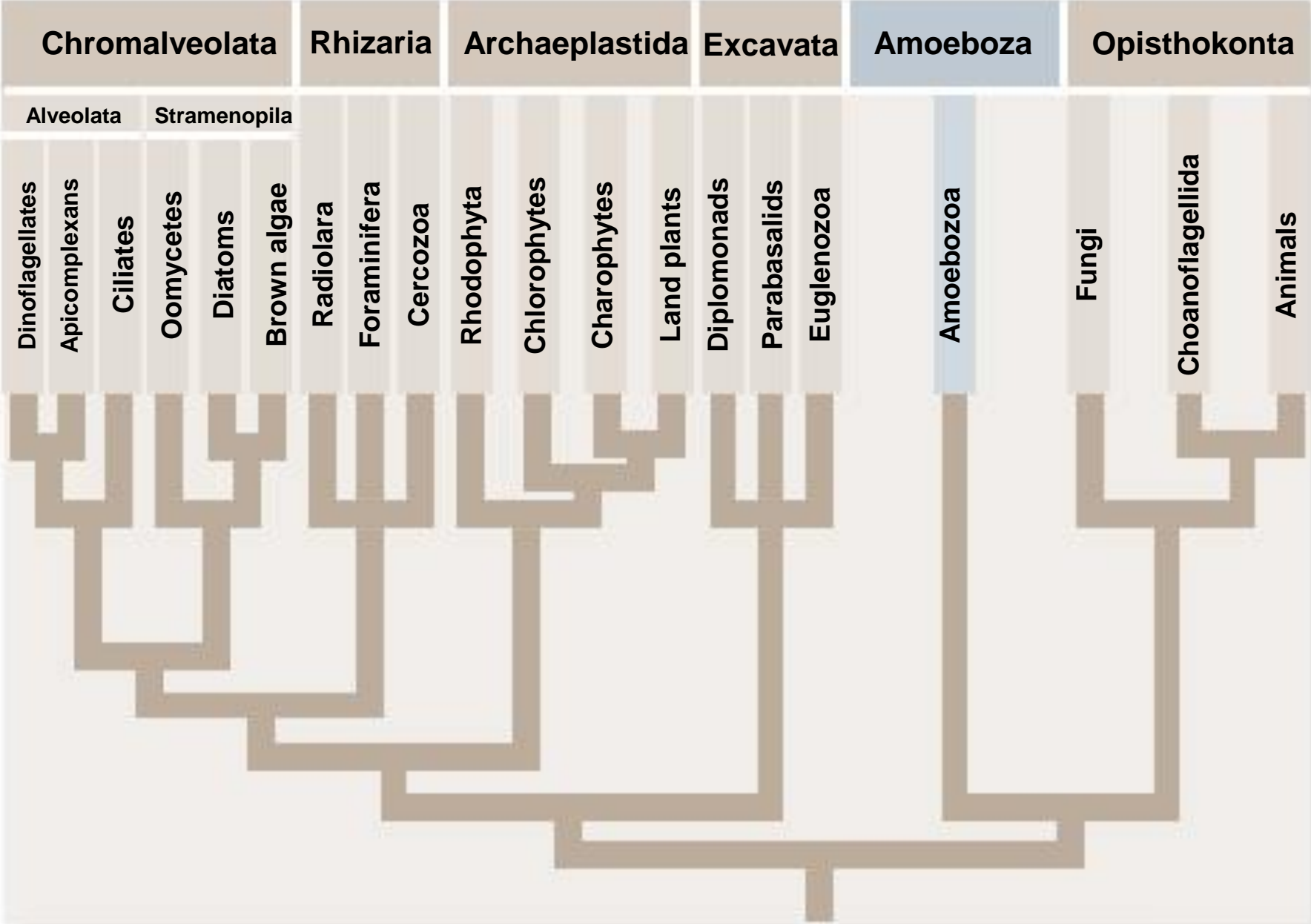


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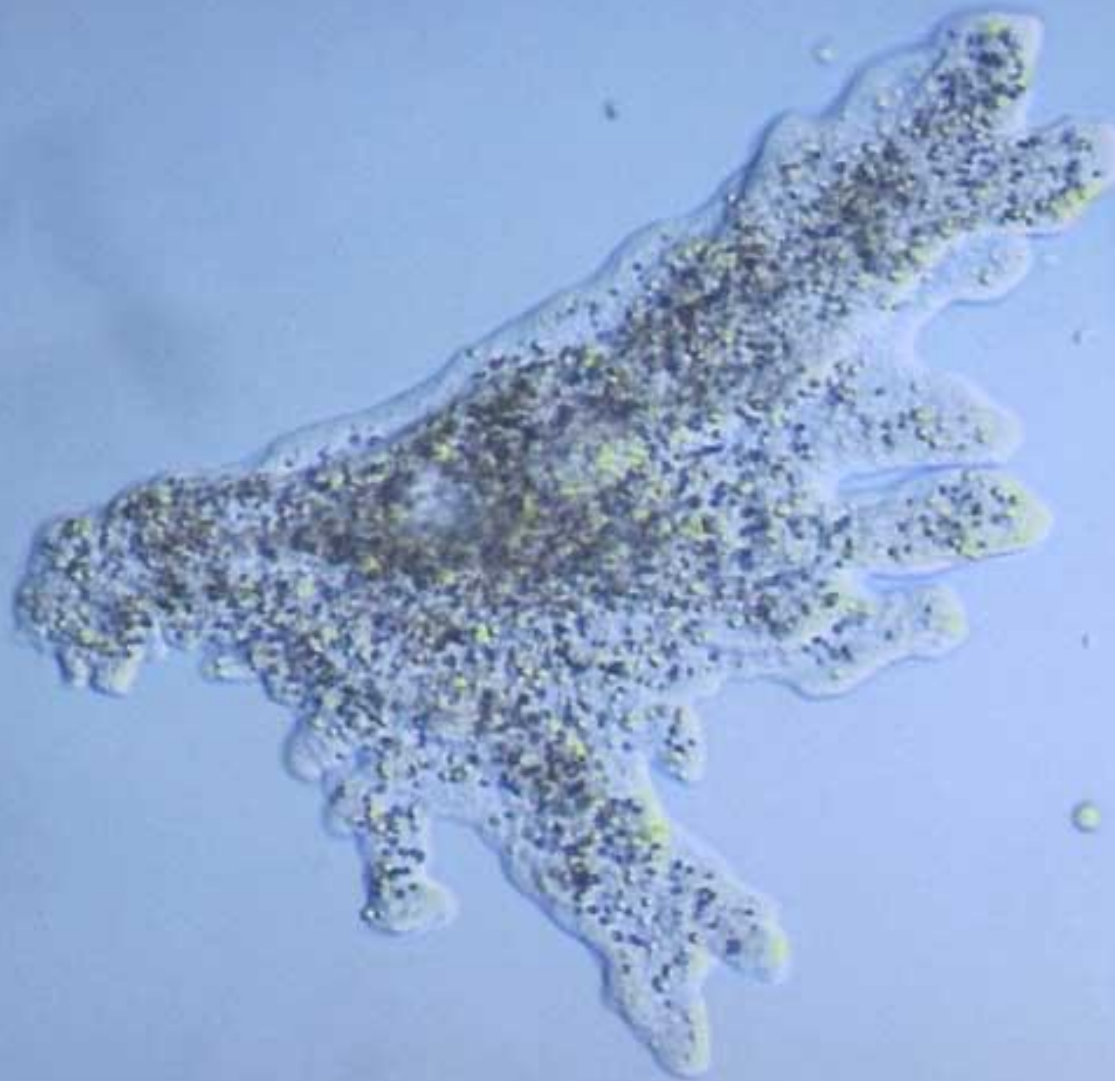


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8  $\mu\text{m}$



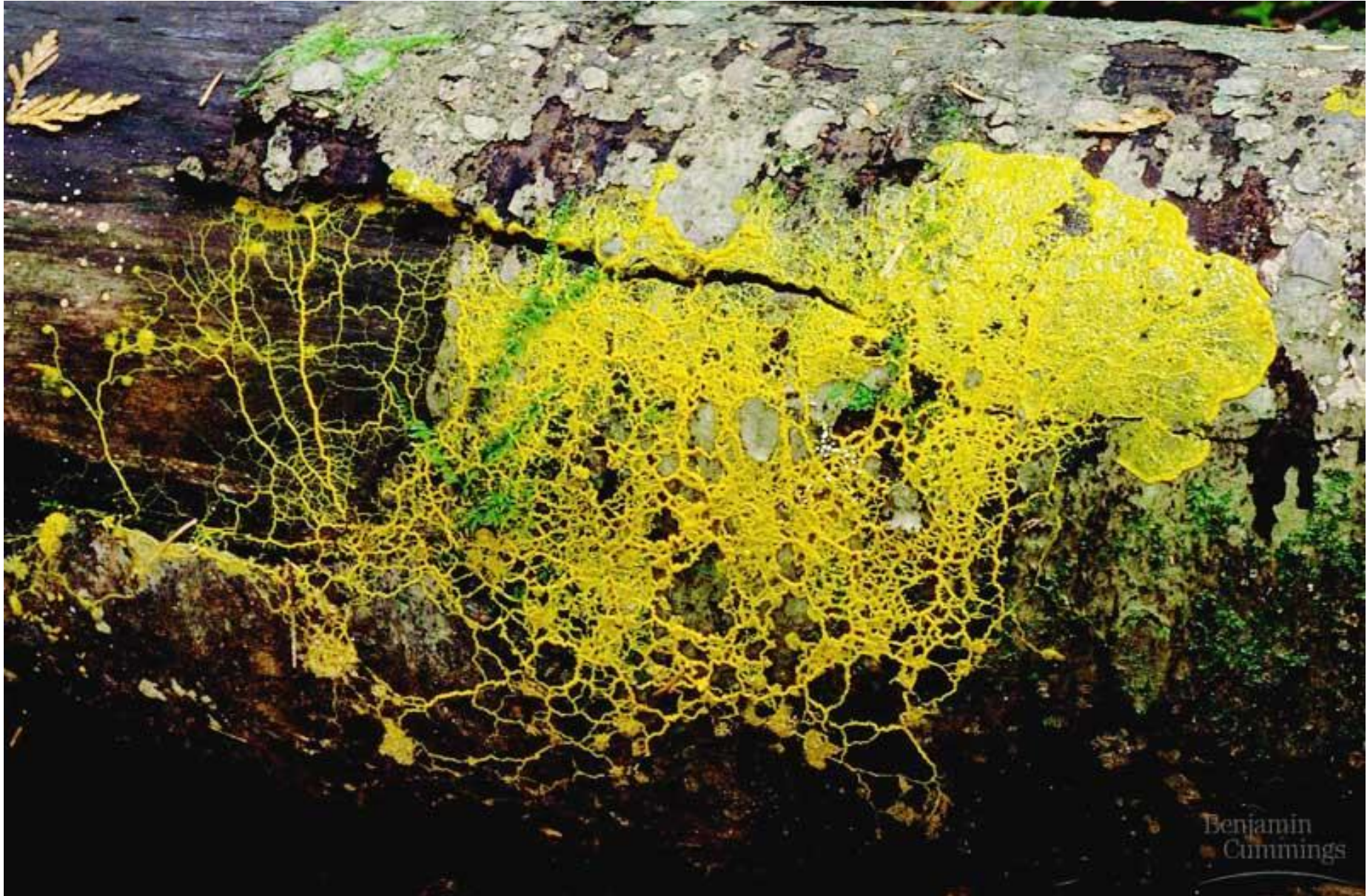
Too diverse for one kingdom: *Amoeba proteus*, a unicellular "protozoan"



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Too diverse for one kingdom: a slime mold (*Physarum polychalum*)



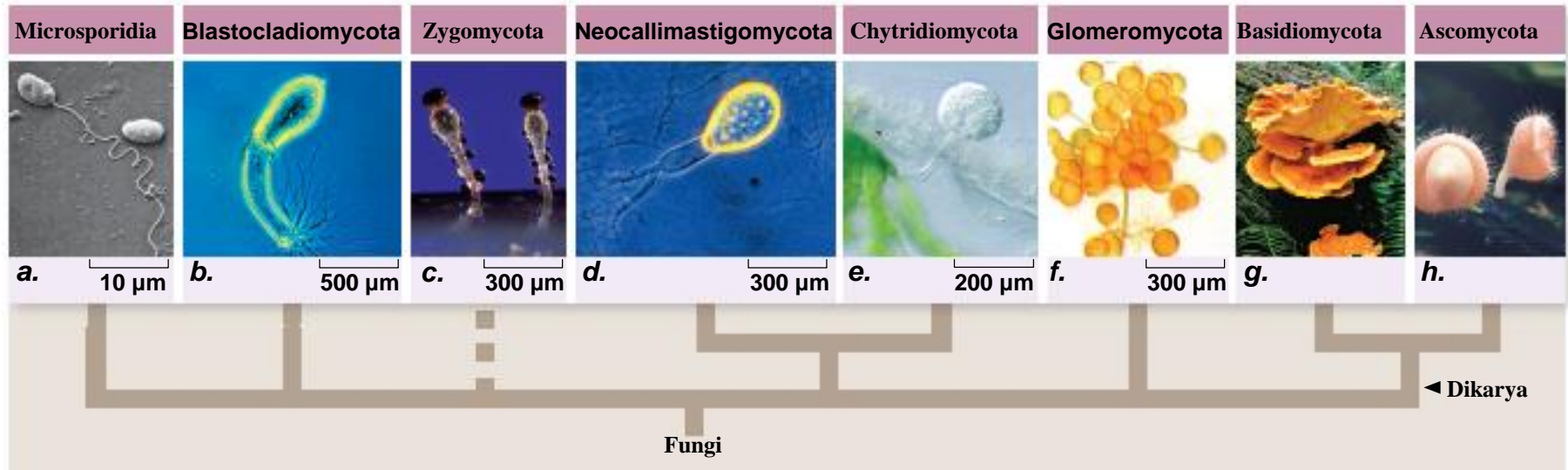
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# Kingdom Fungi

- Eukaryotes, mostly multicellular, heterotrophic, have cell walls (chitin)
- decomposers, food, some cause disease
- Acquire nutrients through **absorption**

# Fig. 32.1

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# Table 32.1

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TABLE 32.1 Fungi			
Group	Typical Examples	Key Characteristics	Approximate Number of Living Species
Chytridiomycota	<i>Allomyces</i>	Aquatic, flagellated fungi that produce haploid gametes in sexual reproduction or diploid zoospores in asexual reproduction.	1000
Zygomycota	<i>Rhizopus</i> , <i>Pilobolus</i>	Multinucleate hyphae lack septa, except for reproductive structures; fusion of hyphae leads directly to formation of a zygote in zygosporangium, in which meiosis occurs just before it germinates; asexual reproduction is most common.	1050
Glomeromycota	<i>Glomus</i>	Form arbuscular mycorrhizae. Multinucleate hyphae lack septa. Reproduce asexually.	150
Ascomycota	Truffles, morels	In sexual reproduction, ascospores are formed inside a sac called an ascus; asexual reproduction is also common.	45,000
Basidiomycota	Mushrooms, toadstools, rusts	In sexual reproduction, basidiospores are borne on club-shaped structures called basidia; asexual reproduction occurs occasionally.	22,000

# Defining Fungi

**Mycologists** believe there may be as many as 1.5 million fungal species

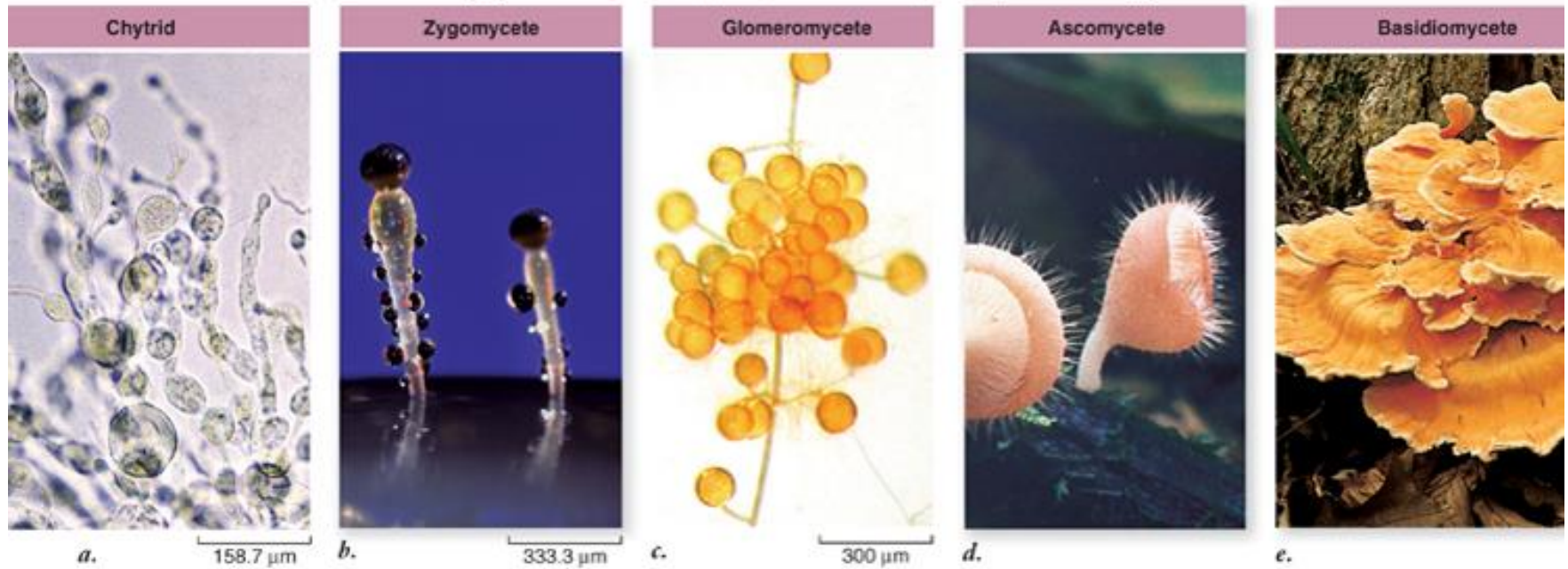
**Fungi** are classified into 5 major phyla based on mode of reproduction

- **Chytrids** (aquatic, flagellated, ancestral)
- **Zygomycetes** (bread molds)
- **Glomeromycetes** (mycorrhizae)
- **Ascomycetes** (bread yeast, truffles)
- **Basidiomycetes** (mushrooms)

-

# Defining Fungi

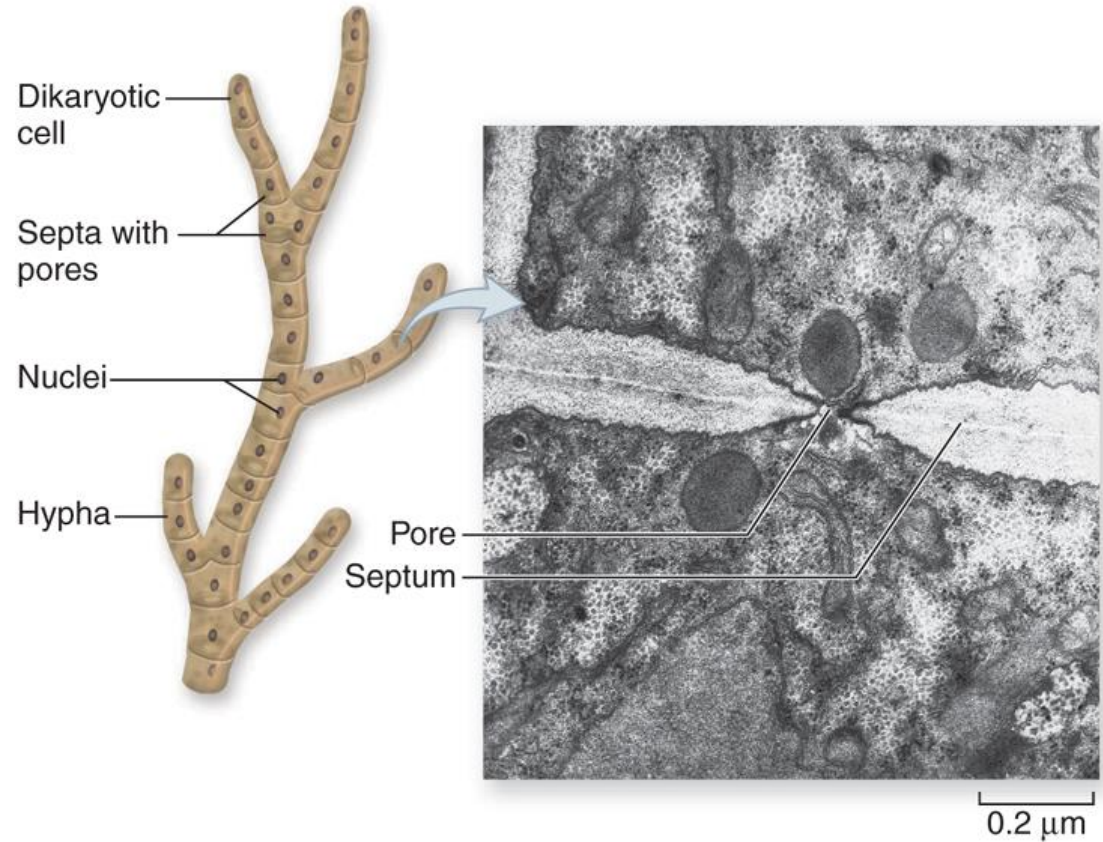
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# General Biology of the Fungi

Multicellular fungi consist of long, slender filaments called **hyphae**

- Some hyphae are continuous
- Others are divided by **septa**

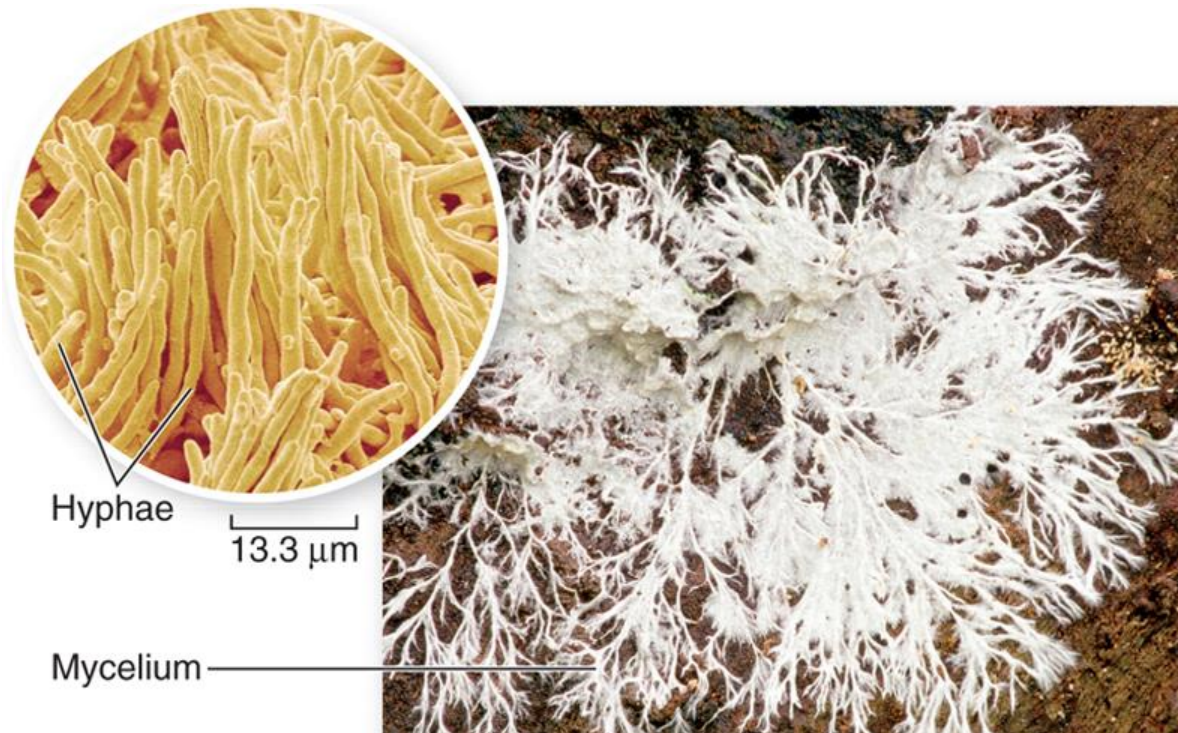




# General Biology of the Fungi

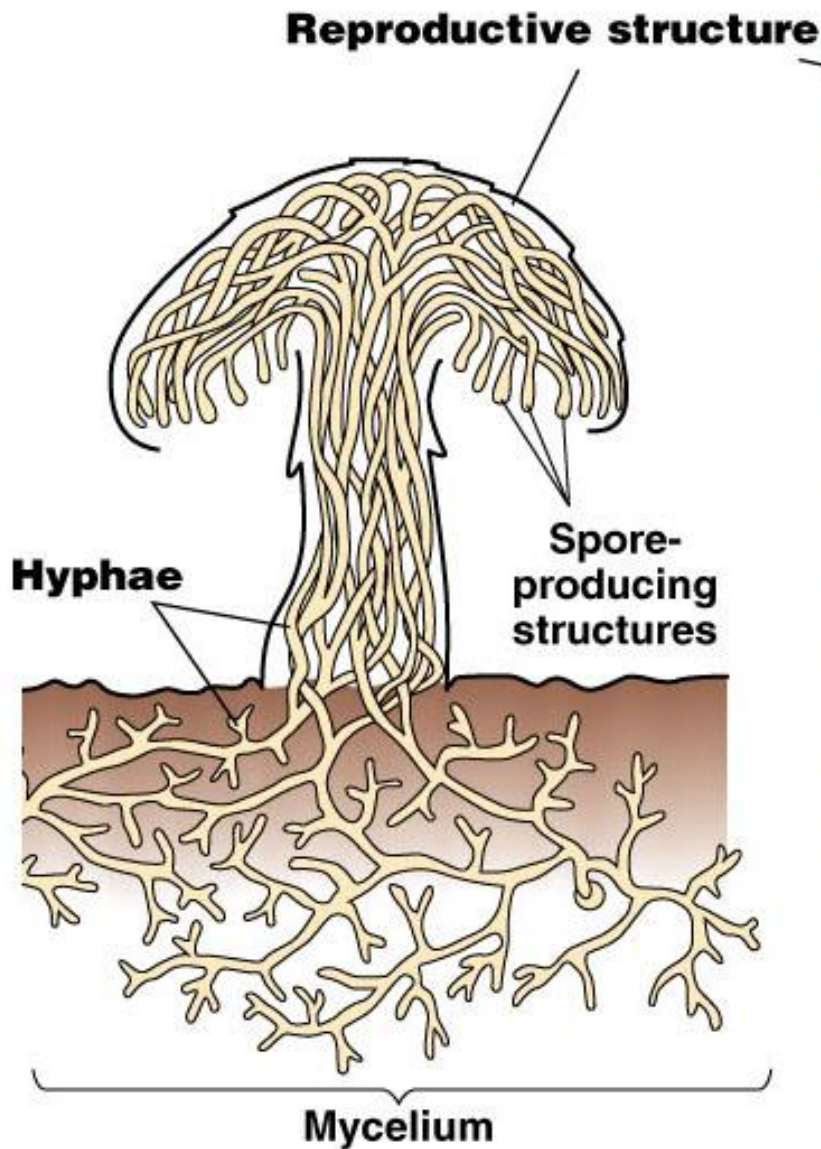
A mass of connected hyphae is called a **mycelium**

-It grows through and digests its substrate





# Fungal mycelia



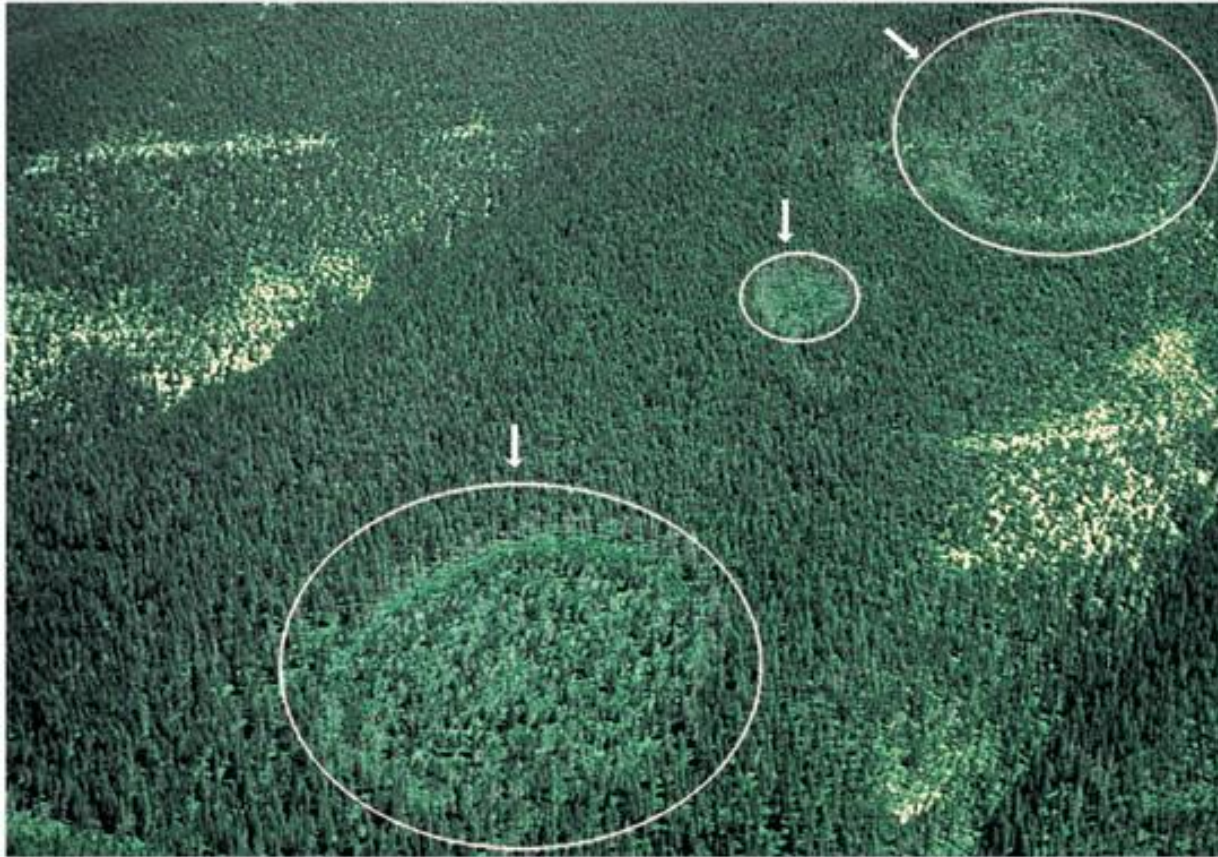






# Fungal Parasites and Pathogens

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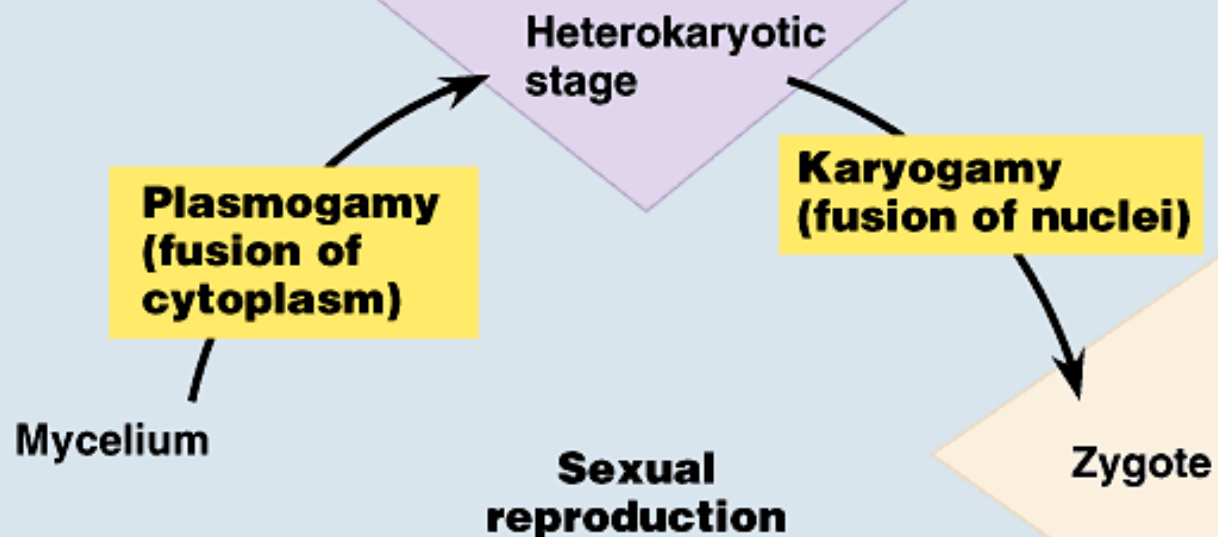
Largest Organism?

*Armillaria* –a pathogenic fungus – 8 hectares

# Fungi Reproduction

- spores are produced either sexually or asexually
- hyphae and spore nuclei are haploid
  - except for a brief diploid stage that occurs during sexual reproduction

Figure 31.3 Generalized life cycle of fungi (Layer 1)



- ☐ Haploid ( $n$ )
- ☒ Heterokaryotic  
(unfused nuclei from  
different parents)
- ☐ Diploid ( $2n$ )

Figure 31.3 Generalized life cycle of fungi (Layer 2)

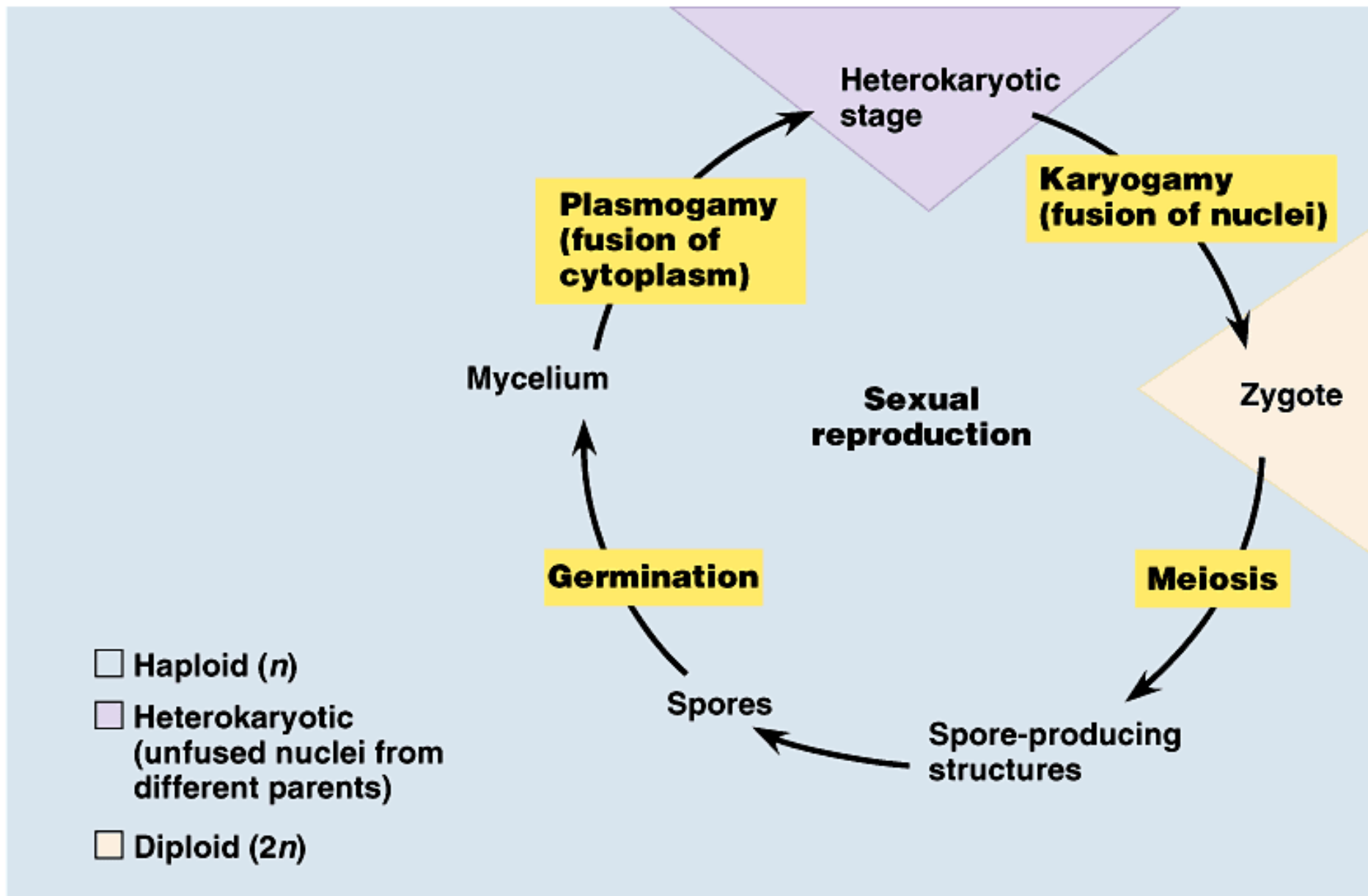


Figure 31.3 Generalized life cycle of fungi (Layer 3)

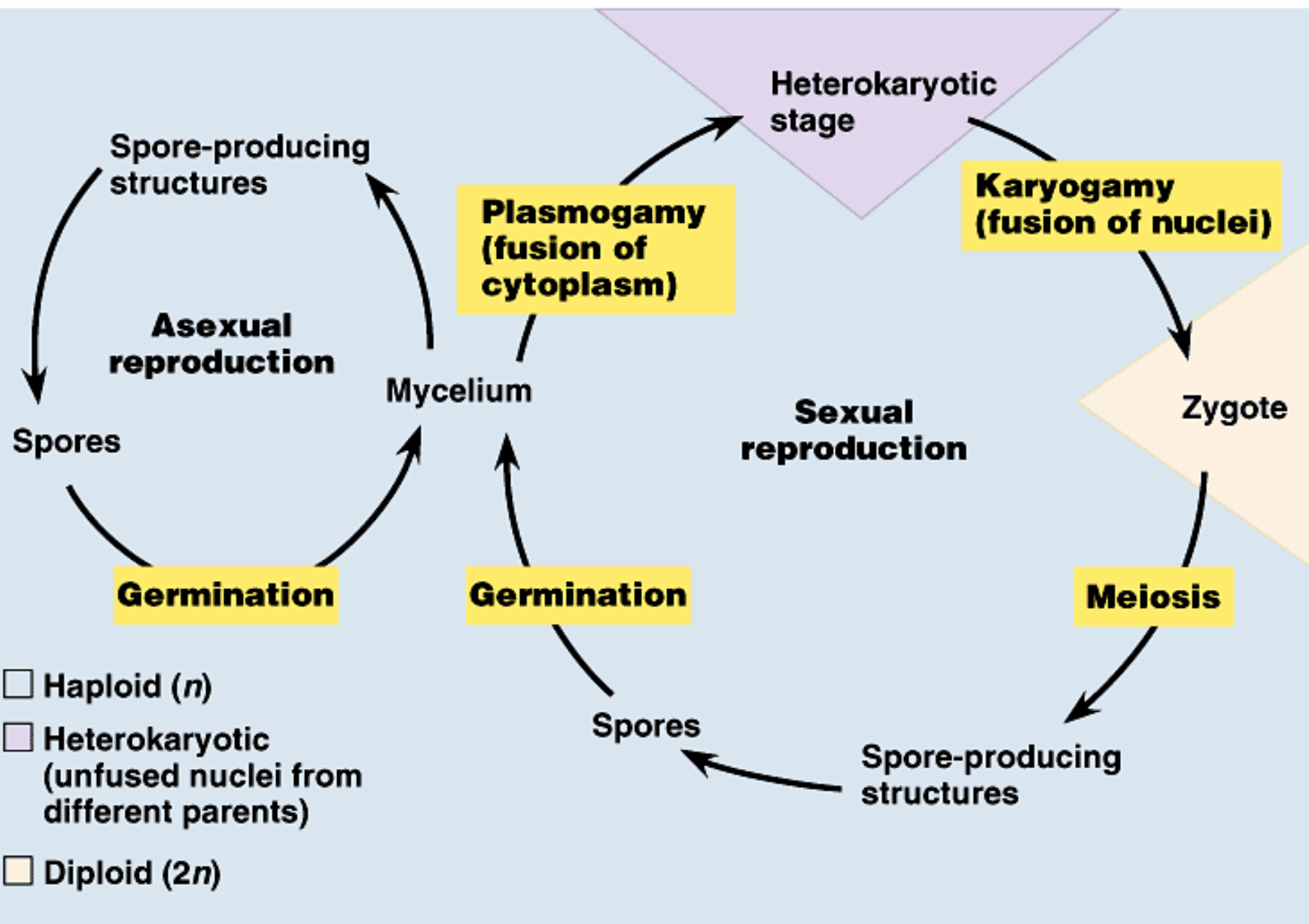
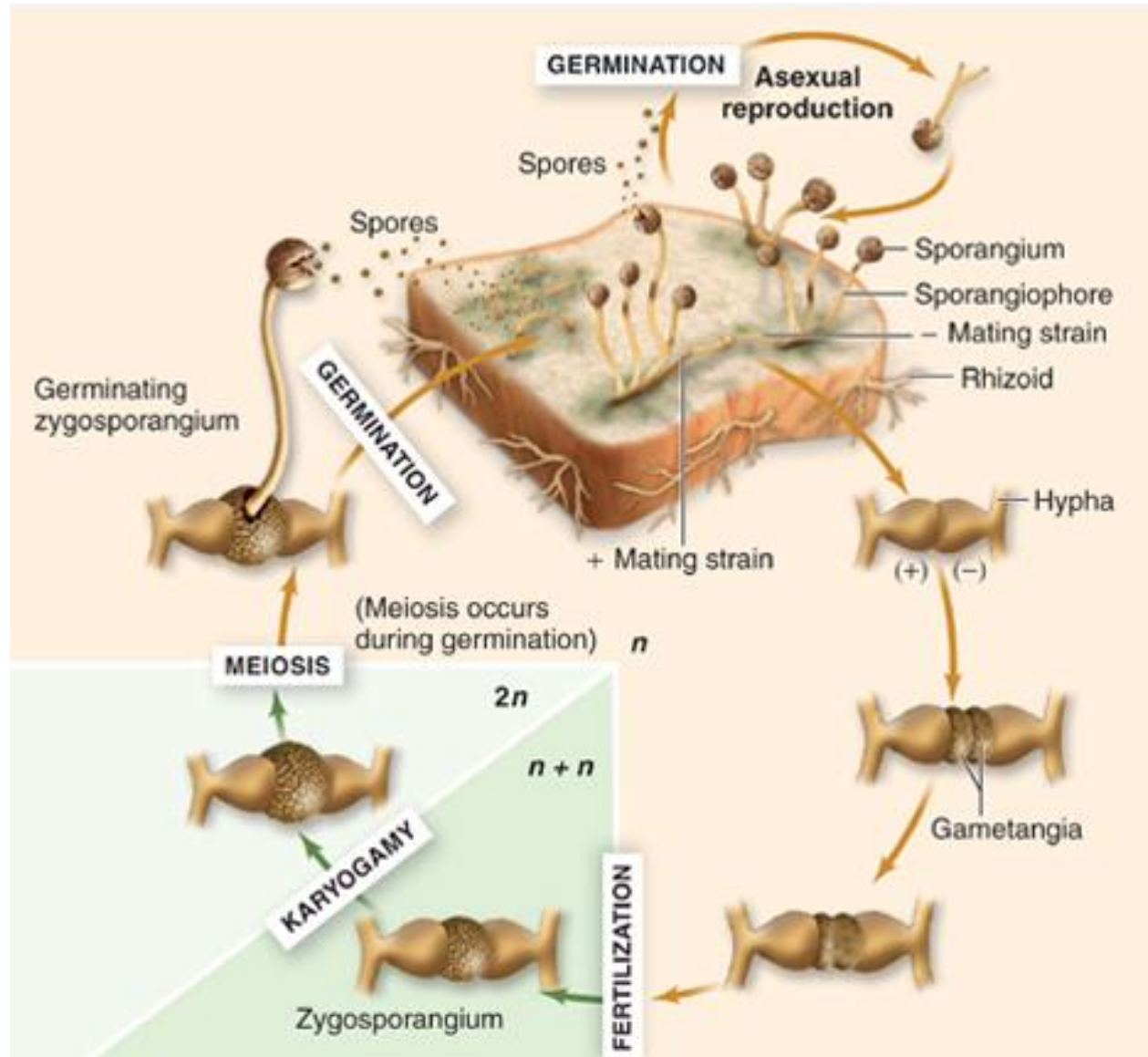




Figure 31.6 The common mold *Rhizopus* decomposing strawberries



# Zygomycetes





# Lichens



(a)



(b)

- Mutualism between fungi and algae or cyanobacteria
- Sensitive to pollution due to absorption capabilities

# Fig. 32.15

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**Fruticose Lichen**



**a.**

**Foliose Lichen**



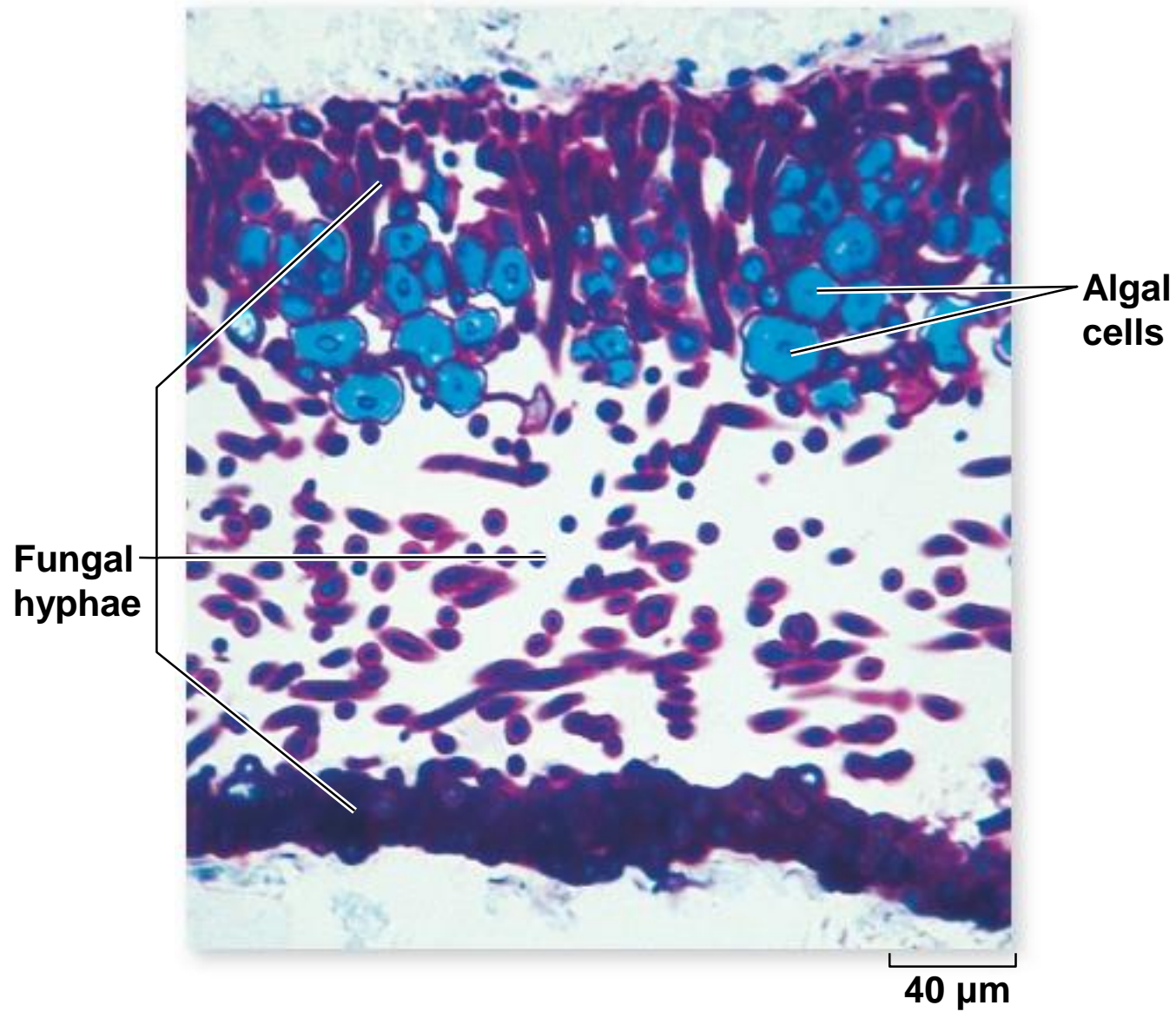
**b.**

**Crustose Lichen**



**c.**

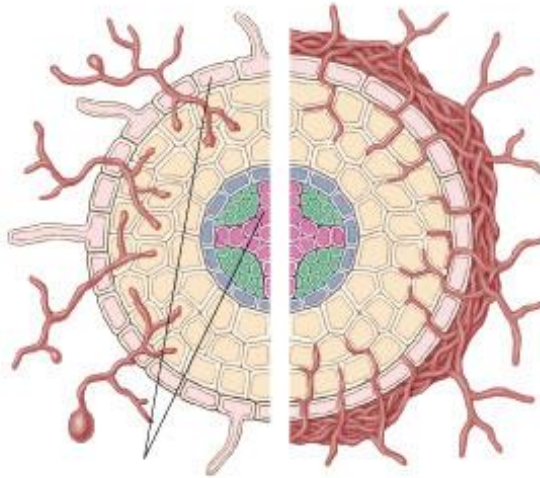
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# Mycorrhizae

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(a)



(b)

- Mutualism between fungi and the roots of 90% of all vascular plants
- Increases absorption of phosphorous, zinc & other nutrients