Kingdom: Fungi

Fungi are absorptive heterotrophs

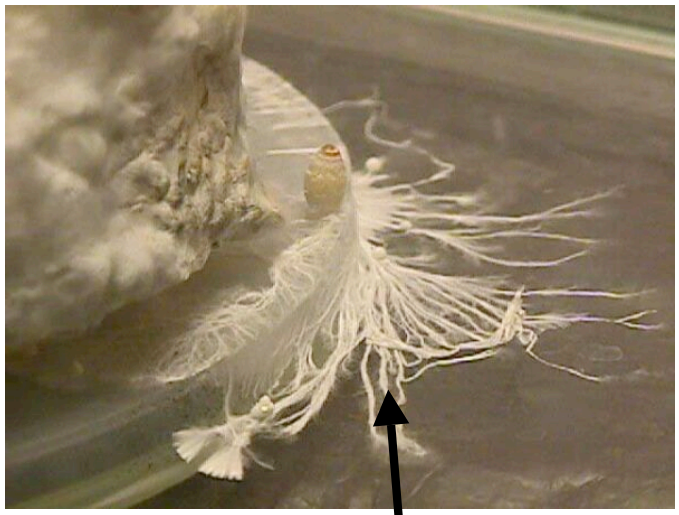
Most are multicellular

Ecological Importance

Fungi bind soil, absorb water & breakdown detritus to recycle nutrients (decomposers)

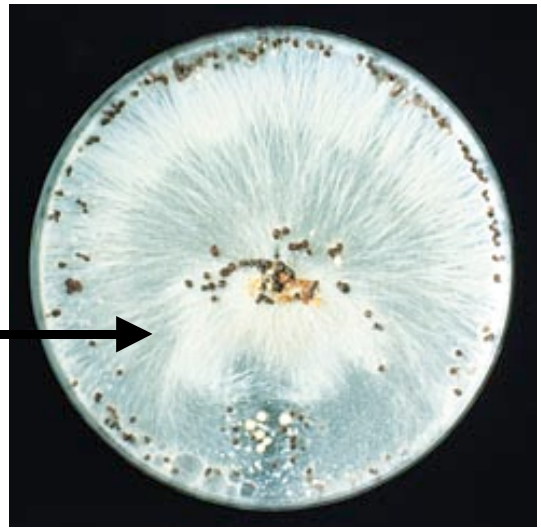
Fungi

- **Cell = Hypha**
- **Mass of hyphae = Mycelium**
- **Reproductive structure (fruiting body) that makes spores**



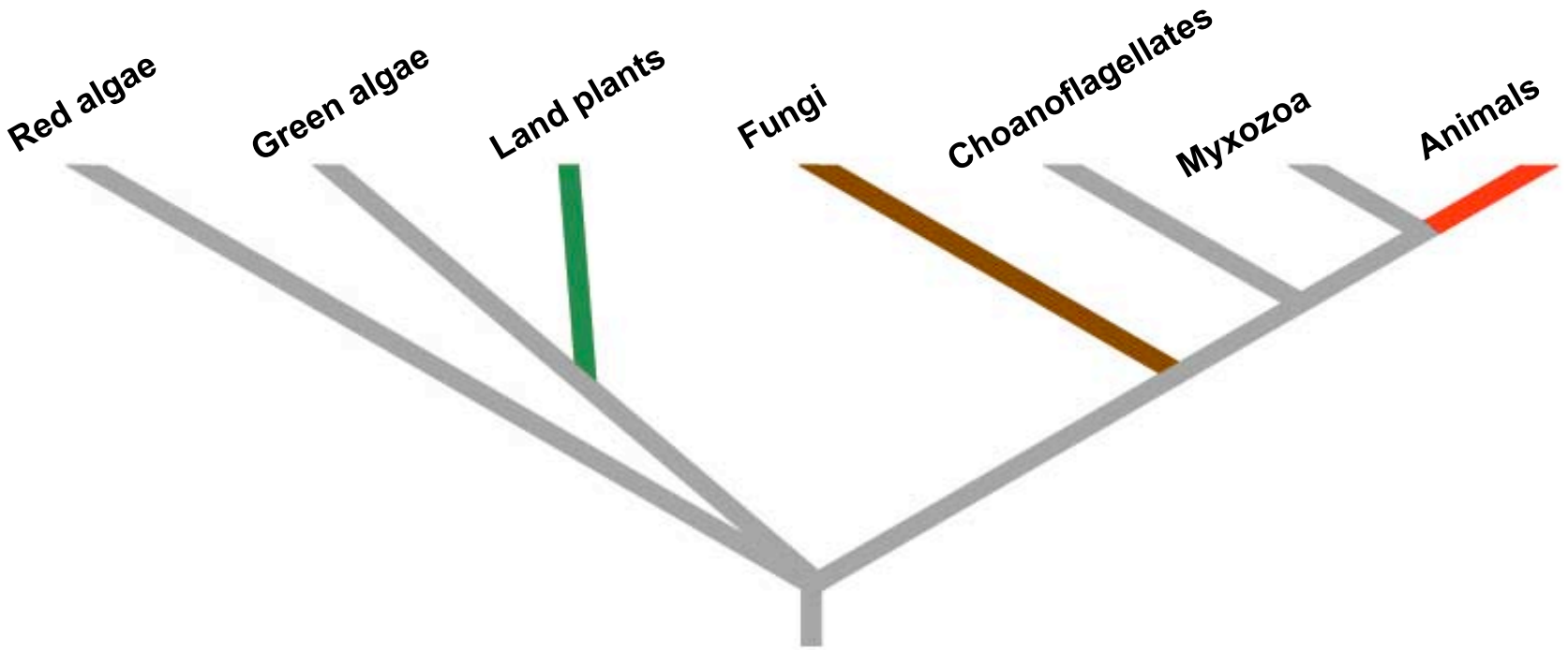
Fungal Hyphae

Mycelium



Mycelium grows outward in a ring

Fungi & animals share a common protistan ancestor



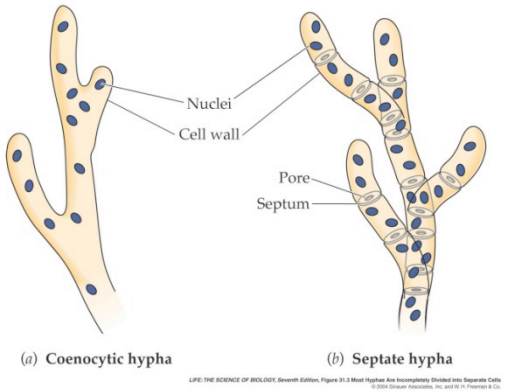
Fungi & animals are derived from a protistan lineage

Similarities between fungi & animals

- **Heterotrophs**
- **Presence of Chitin** (all fungi, some animals)
- **Glycogen as storage molecule**
- **rRNA sequence data similarities**

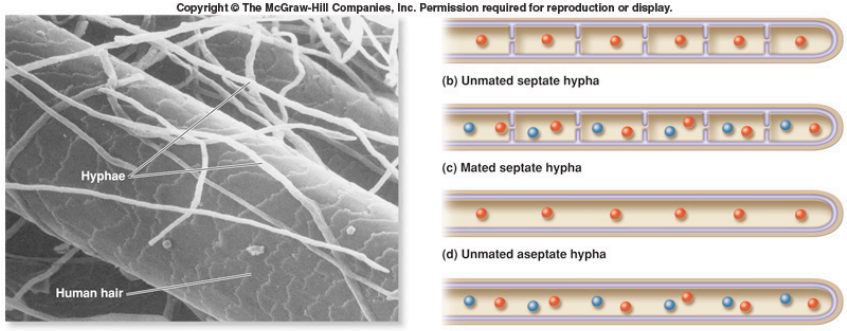
Features of Fungi

- Cell walls of chitin
- Hyphae
  - Septate - with crosswalls
  - Coenocytic - multinucleate

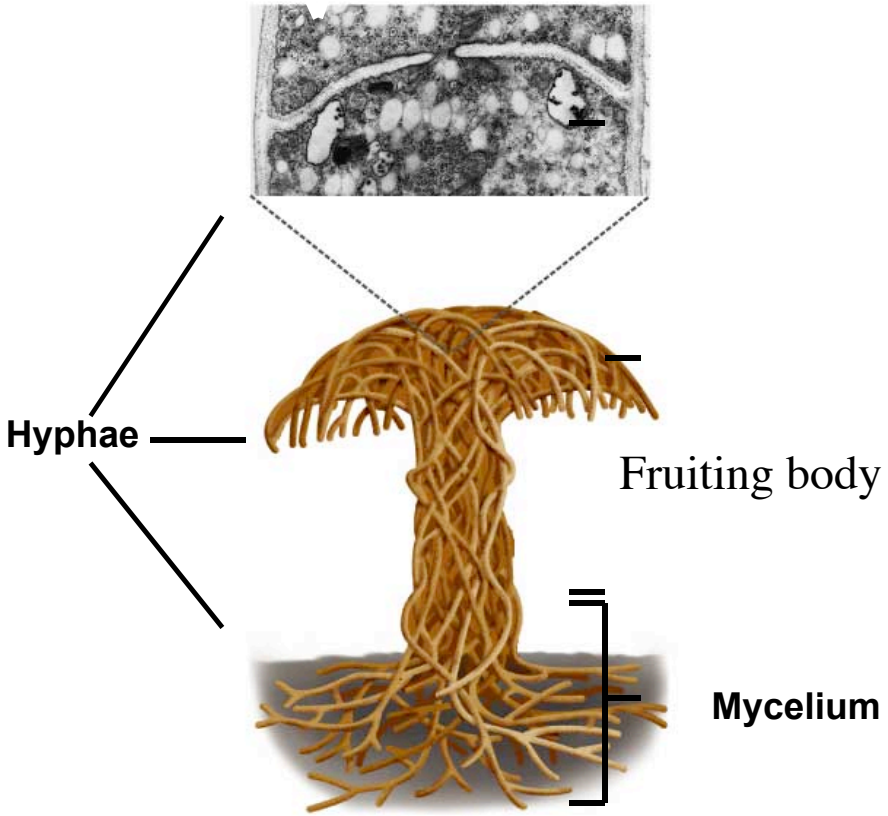


- Spores for dispersal & dormancy
- Fruiting body produces spores

- Most produce no gametes (derived trait)
  - Flagellated gametes (ancestral trait)
- Sex: Nuclear exchange & fusion

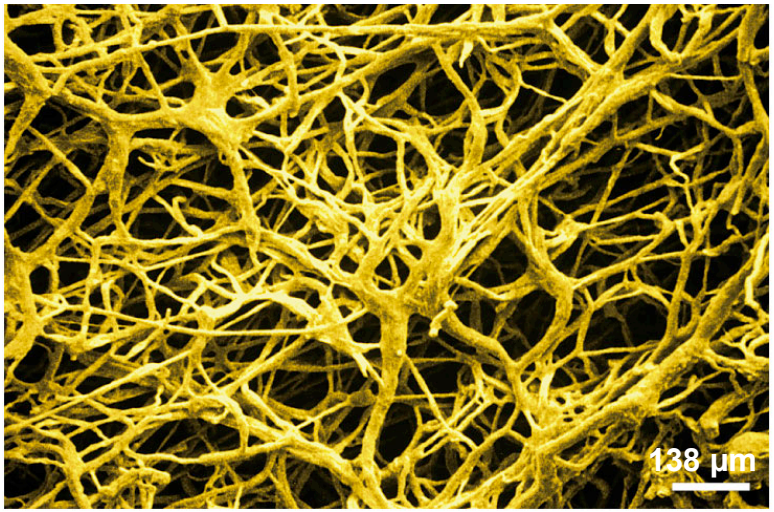


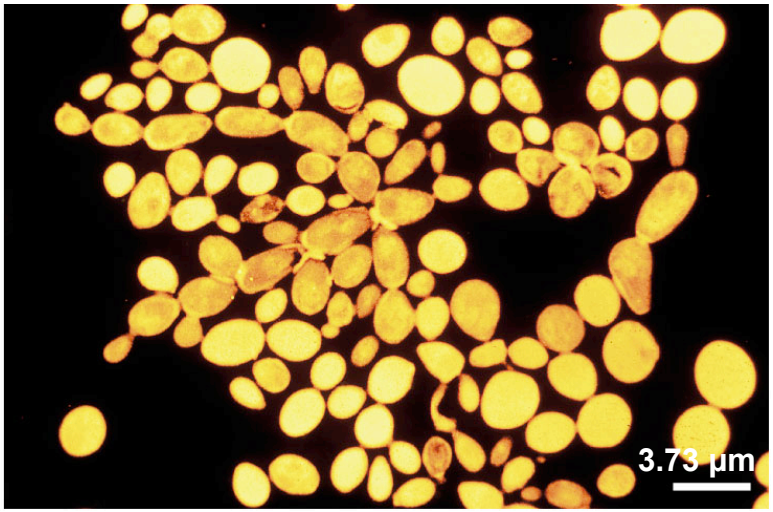
a: © Garry T. Cole/Biological Photo Service



Multicellular fungi are composed of hyphae

Unicellular fungi are called yeasts





<u>Hyphae: an adaptation for absorption</u>

Fungal hypha maximizes surface area to volume ratio.

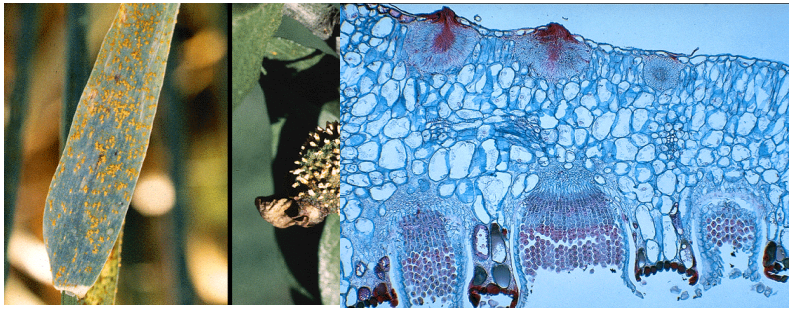
Lifestyles of Fungi

Saprobes - decomposers

breakdown organic molecules

in soil or water

Parasites - pathogens of plants & animals



Mutualists - with autotrophs

(*a*)

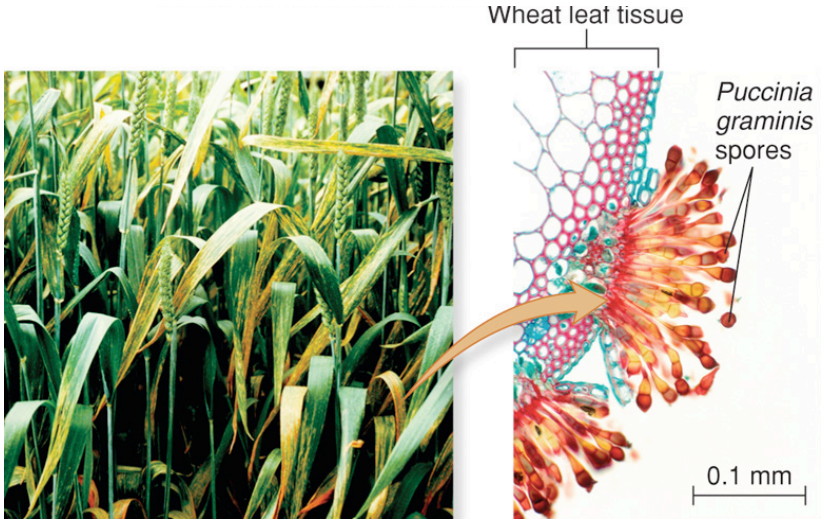
(*b*)

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 31.1 Parasitic Fungi Attack Other Living Orga**

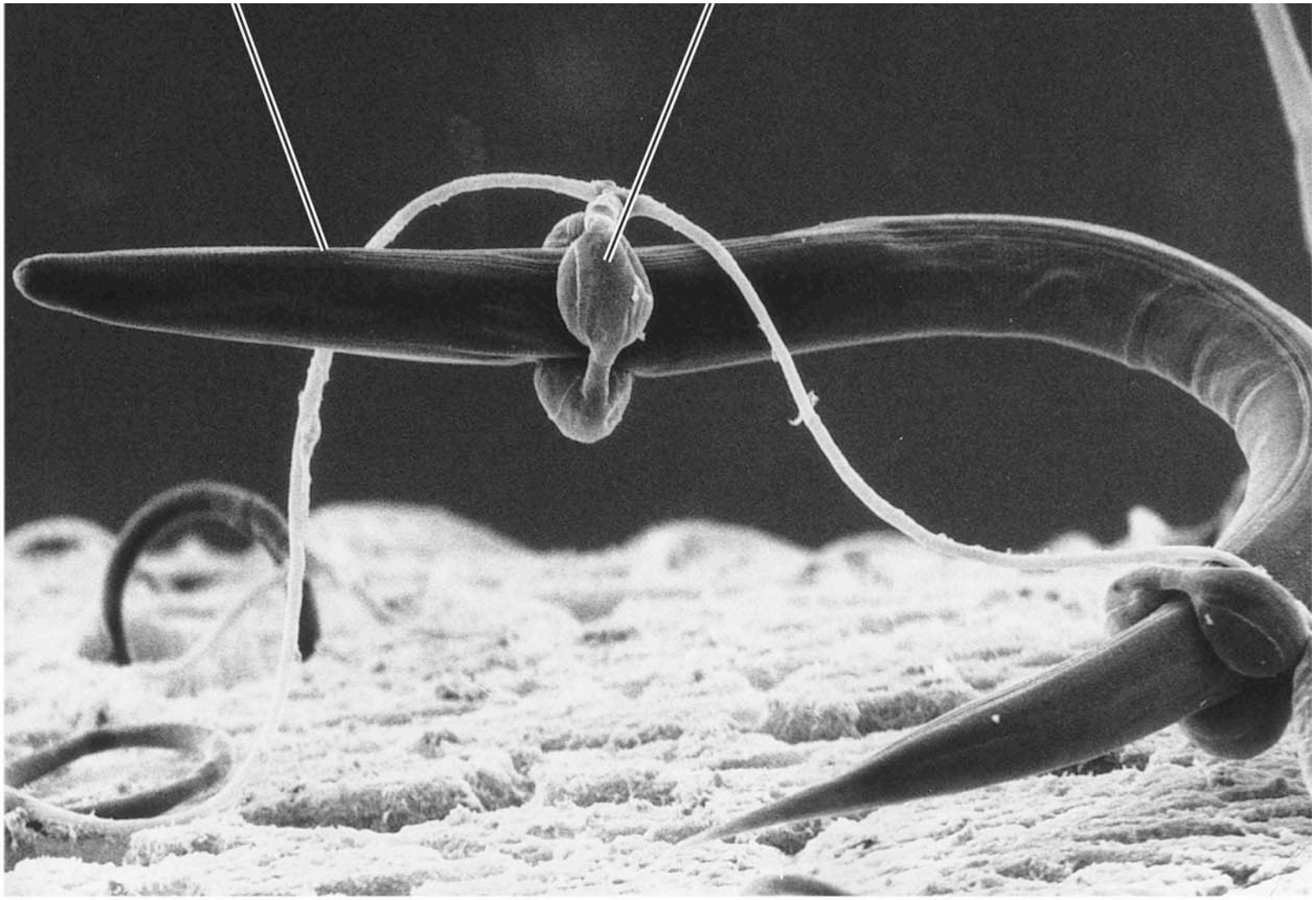
Fungal pathogens

- 5000 species cause serious crop diseases
  - Rusts

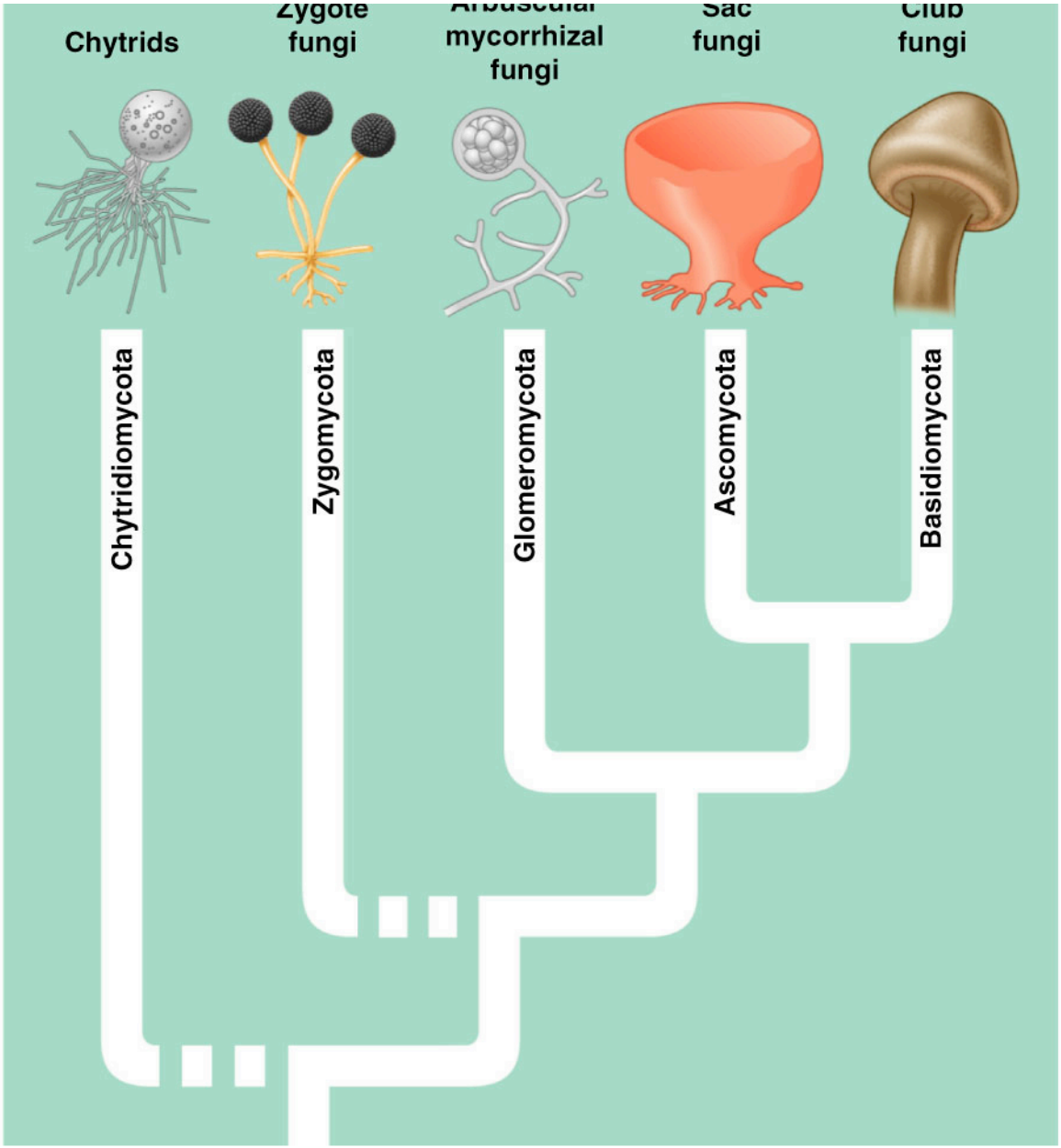
- Several human diseases
  - Dermatophytes - athlete's foot, ringworm
  - *Pneomocystis carinii* pneumonia in AIDS



A few fungi are predators on animals



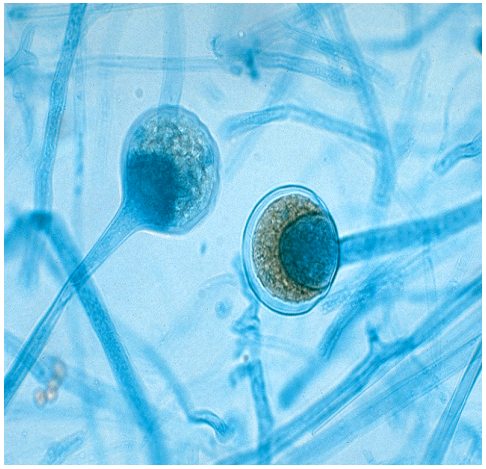
LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 31.5 Some Fungi**



Reproduction in Fungi

Asexual **(phyla have different methods)**

- **Fragmentation - pieces of mycelia**
- **Sporangia produce haploid spores**
- **Conidia ("naked spores) at tips of hyphae**
- **Budding or fission (by mitosis)**



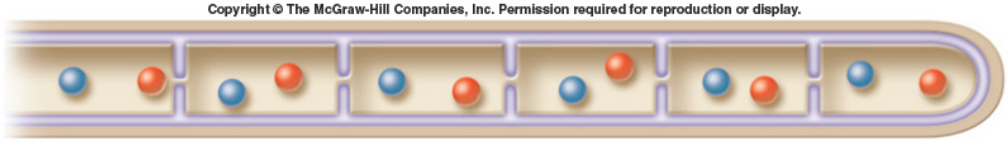
Sporangia

Conidia

Reproduction in Fungi

Sexual

- + & - Mating types: no males or females
- 2 different mating types can fuse gametes or hyphae
- Zygote nucleus may be only diploid stage
- Meiosis occurs in zygote to form haploid spores



(c) Mated septate hypha

Fruiting bodies disperse spores by wind

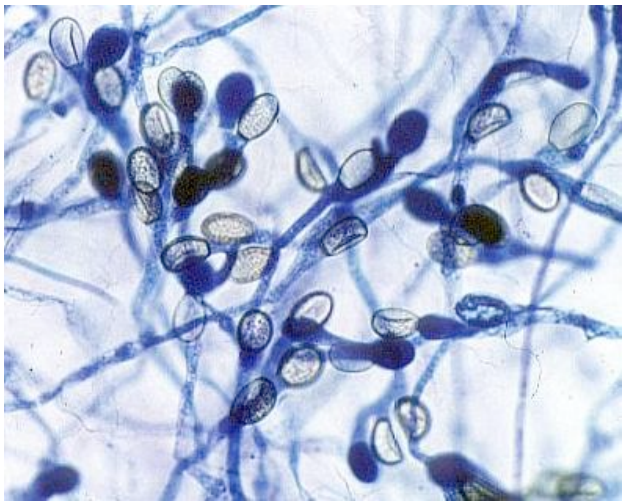
(a) (b)

a: © Felix Labhardt/Getty Images; b: Bob Gibbons/ardea.com

phylum: Chytridiomycota

"Chytrids"

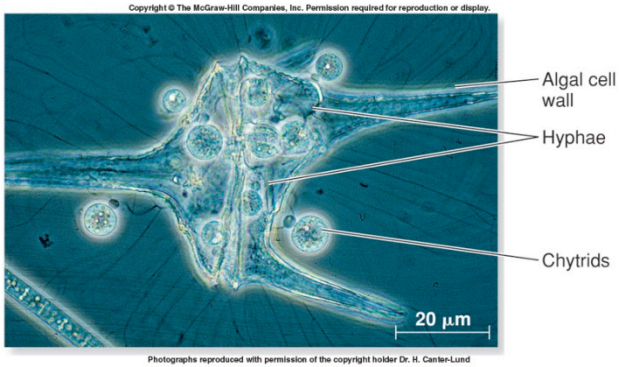
- **Ancestral clade**
- **Aquatic habitats:**
  - **freshwater (most)**
  - **marine**
  - **moist soil**

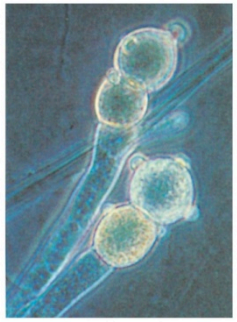


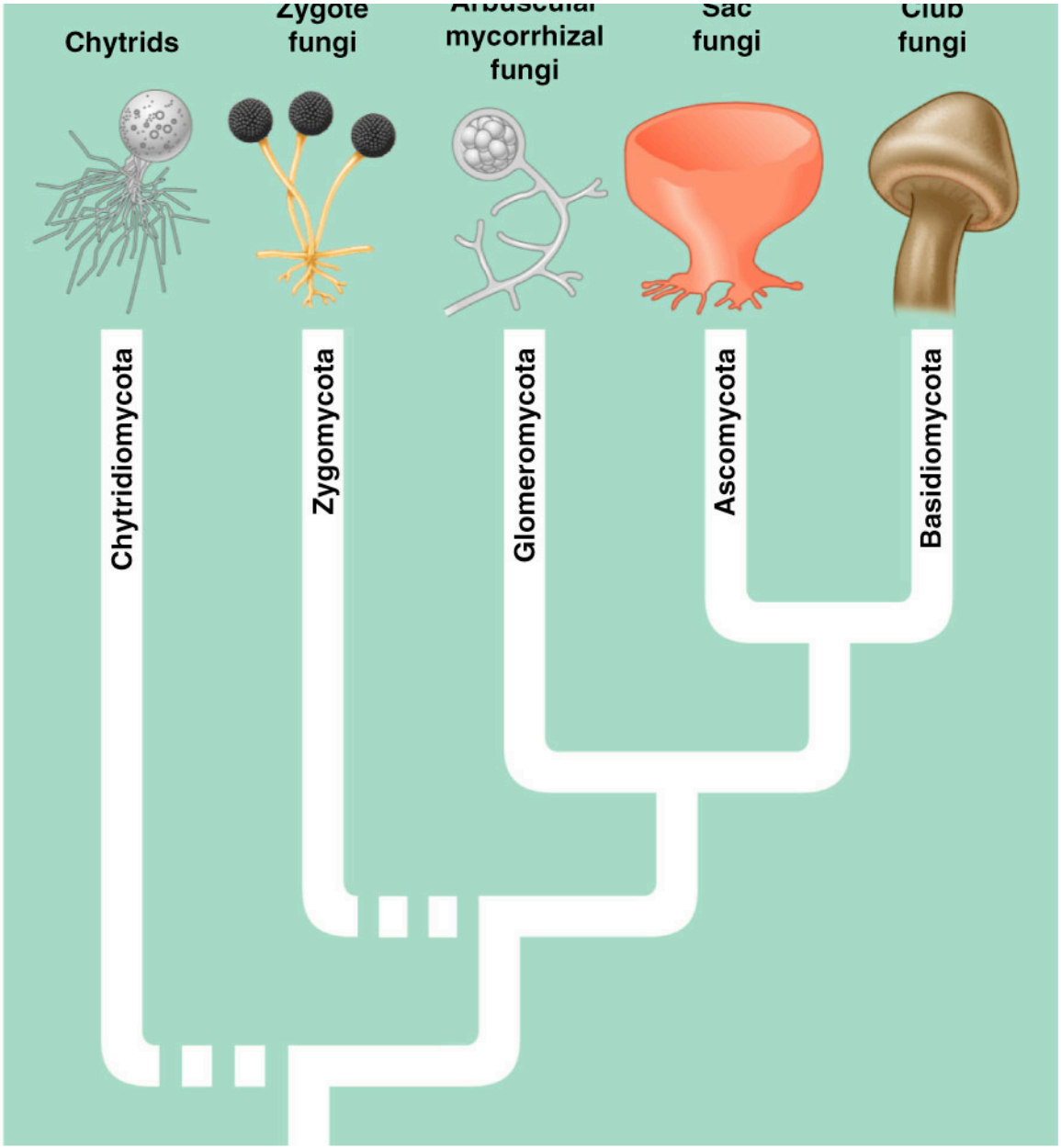
- **Saprobes (most)**
- **Parasites (some)**

phylum: Chytridomycota

- **Unicellular or multicellular mycelia**
- **Flagellated spores called zoospores (1N)**
  - **Produced in zoosporangia**
- **Flagellated gametes (1N)**
  - **Produced in gametangia**
- ***Both of these cell types can fuse with like ones***



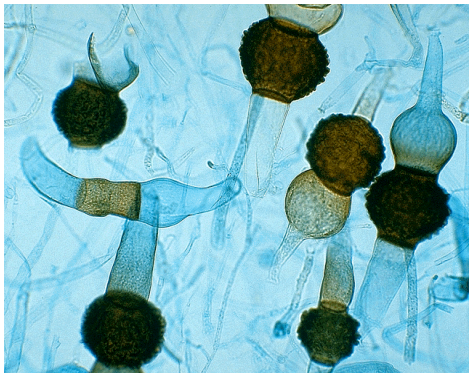




phylum: Zygomycota

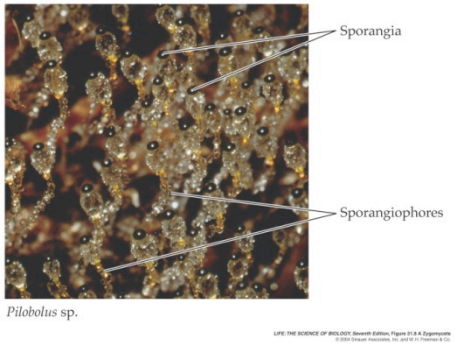
"Bread molds & Dung fungi"

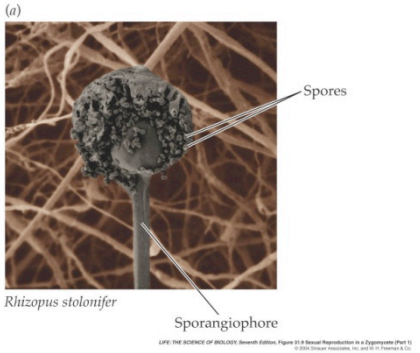
- Terrestrial fungi
  - Saprobes in soil
  - Bread & fruit mold
  - Animal feces (dung)



- Coenocytic hyphae

Dung fungus





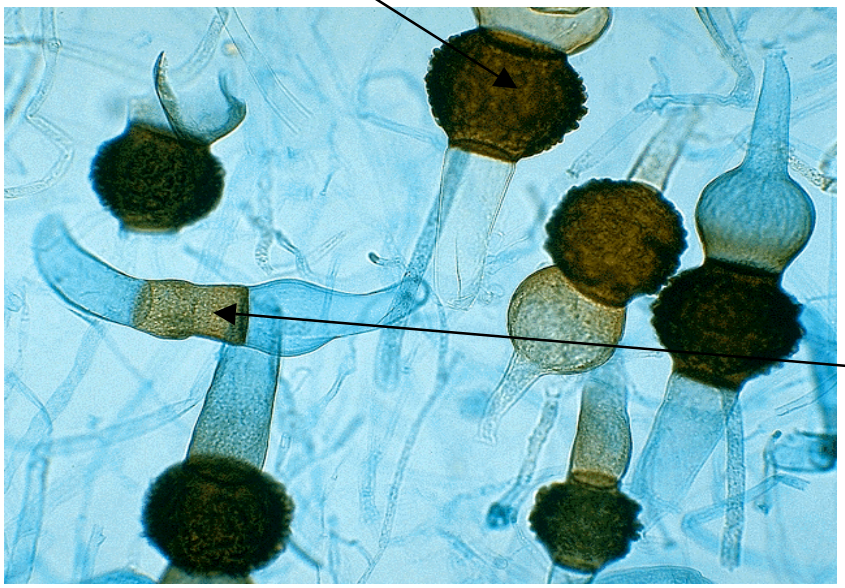
Black bread mold

phylum: Zygomycota

Sexual Reproduction

Zygospore in zygosporangium

- **Zygote is only 2N stage**
  - **in zygosporangium**
- **No fleshy fruiting body**

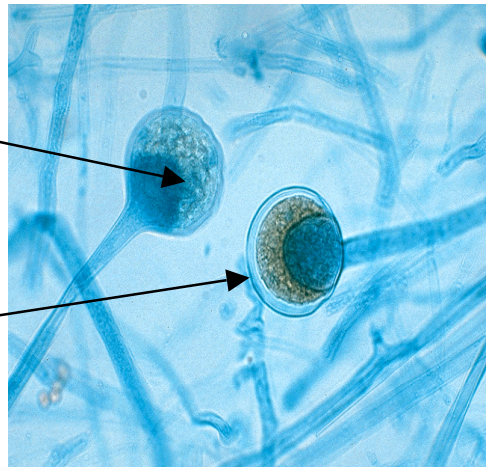


Gametangia at tips of hyphae fuse

Zygomycetes

Asexual reproduction by Spores

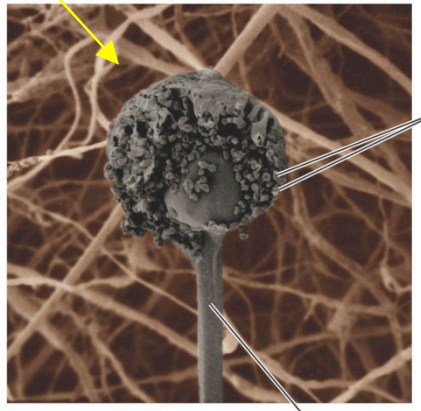
Spores produced in sporangia



Pilobolus sp.

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 31.8 A Zygomycete
© 2004 Sinauer Associates, Inc. and W. H. Freeman & Co.

(*a*)



Rhizopus stolonifer

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 31.9 Sexual Reproduction in a Zygomycete (Part 1)
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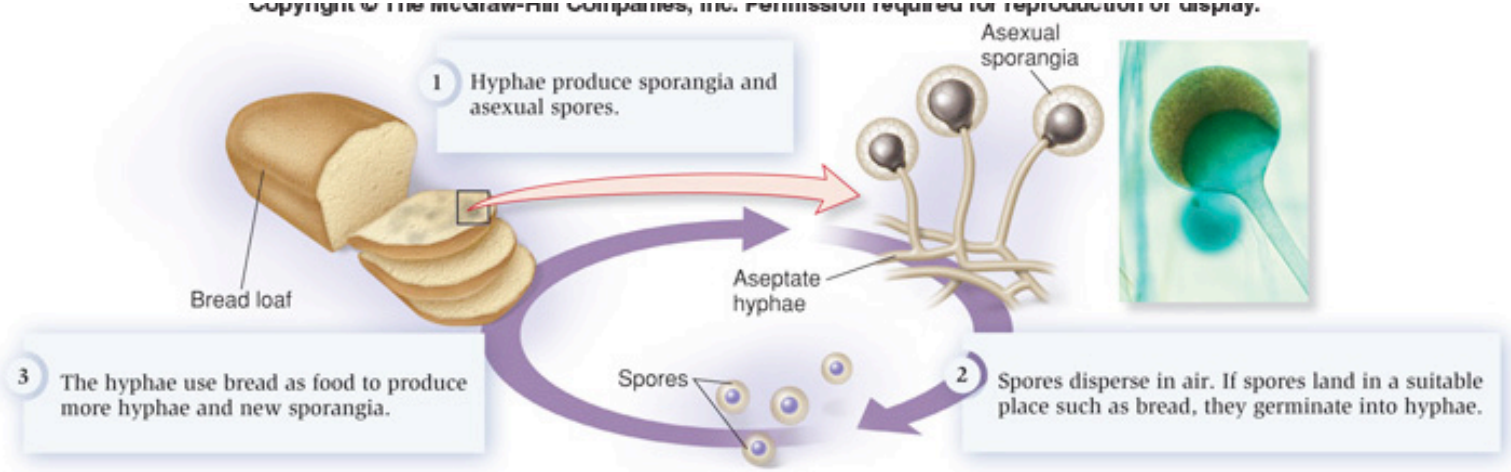
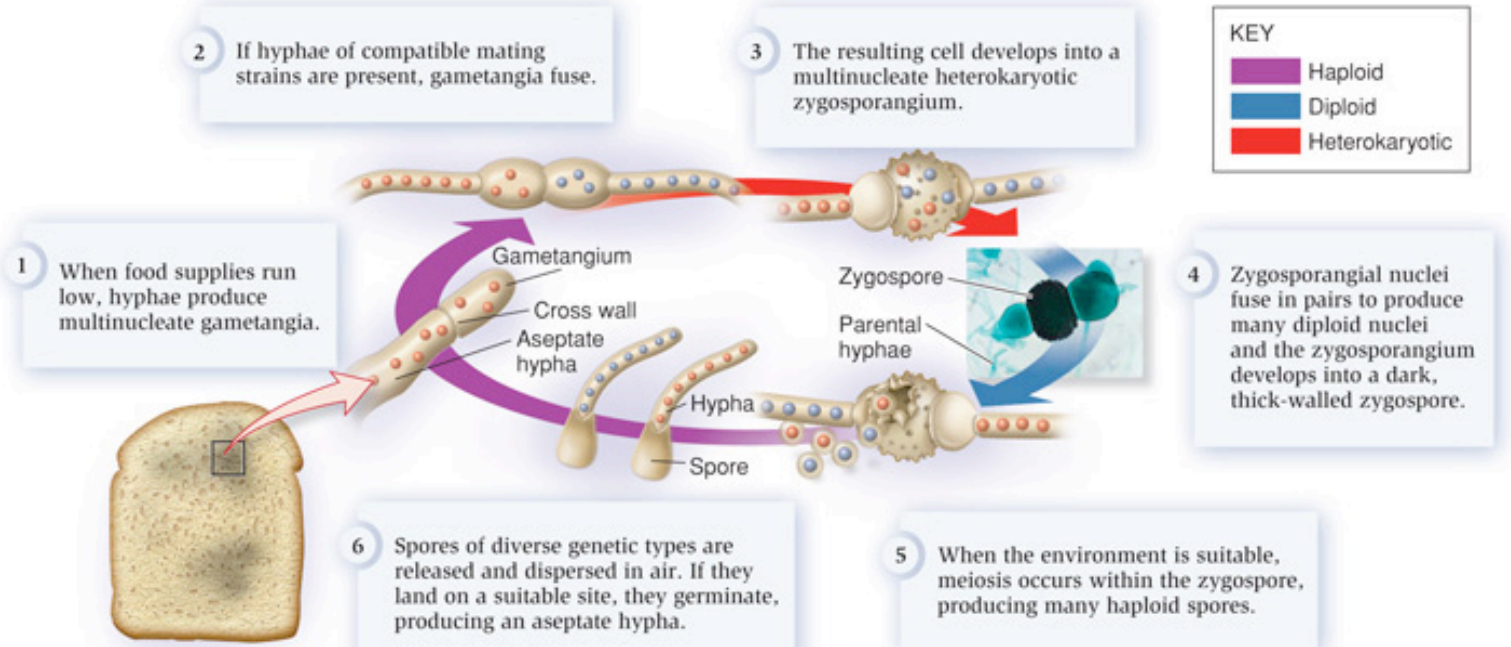
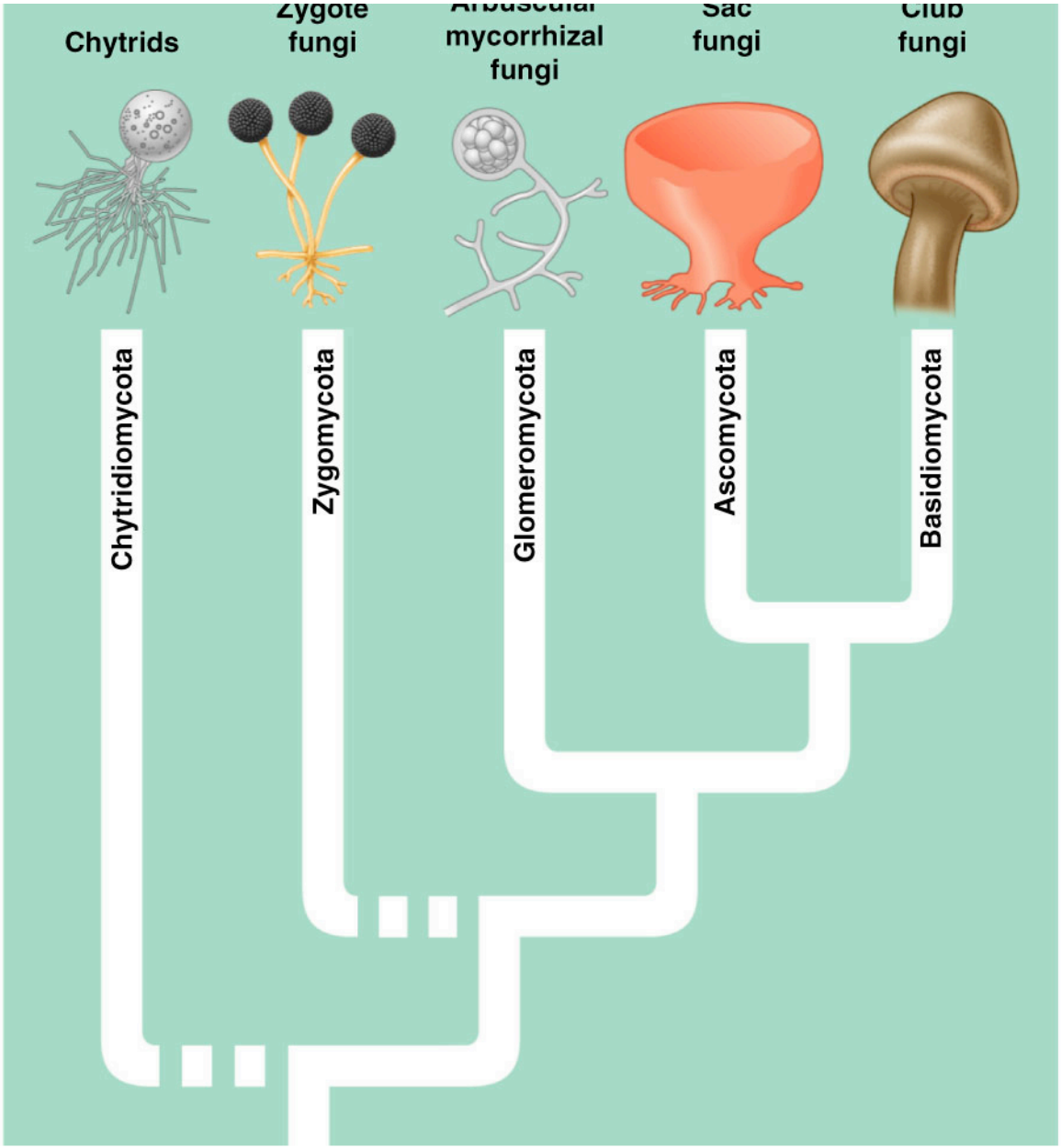


(a) Asexual reproduction



(b) Sexual reproduction

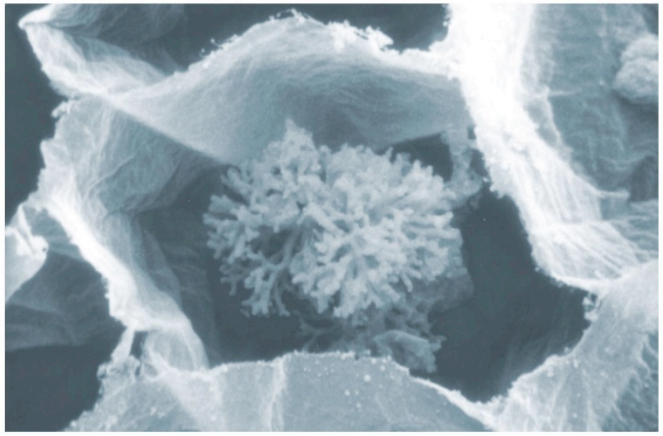
a(2): © Peres/Custom Medical Stock Photo; b(4): © William E. Schadel/Biological Photo Service

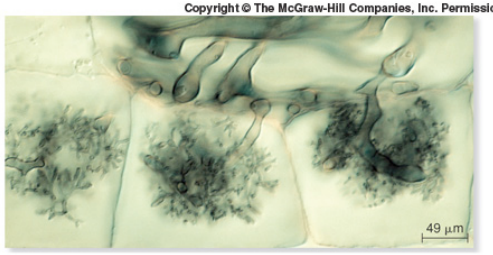


phylum: Glomeromycota

"AM fungi"

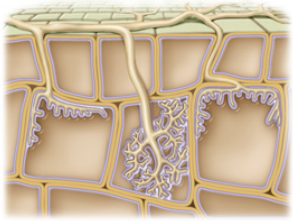
- Arbuscular mycorrhizae
- Formerly classified as Zygomycete
- Occur as endomycorrhizae in plant cells





(a)

a: Mark Brundrett



(b)

Plant cells with fungi inside

phylum: Glomeromycota

"AM fungi"

- Aseptate hyphae - Coenocytic
- Asexual reproduction by spores
- Live in soil

Yolande Dalpé, Agriculture and Agri-Food Canada

Large multinucleate spores

Mycorrhizae

myco = fungus / rhiza = root

Symbiotic mutualism

+ Plant gets water & minerals

+ Fungus gets sugar (food)

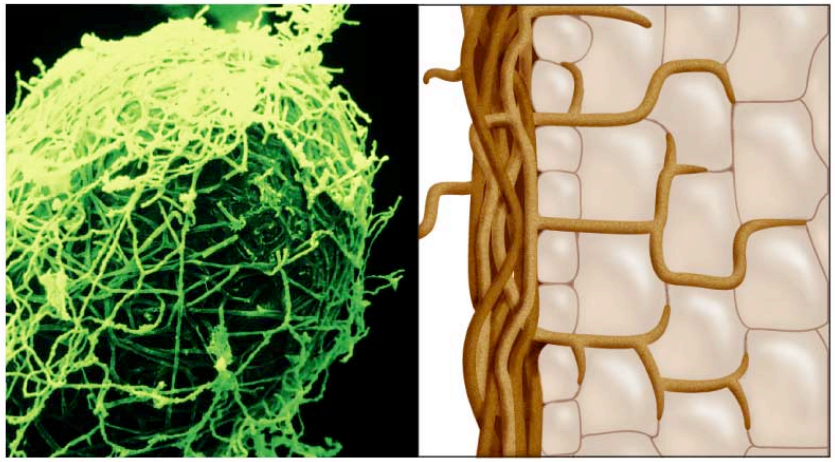
Fungus absent **Fungus present**

Western Red Cedar

Mycorrhizal fungi

Enhances plant nutrient uptake (phosphorous) by increasing absorptive surface area of roots

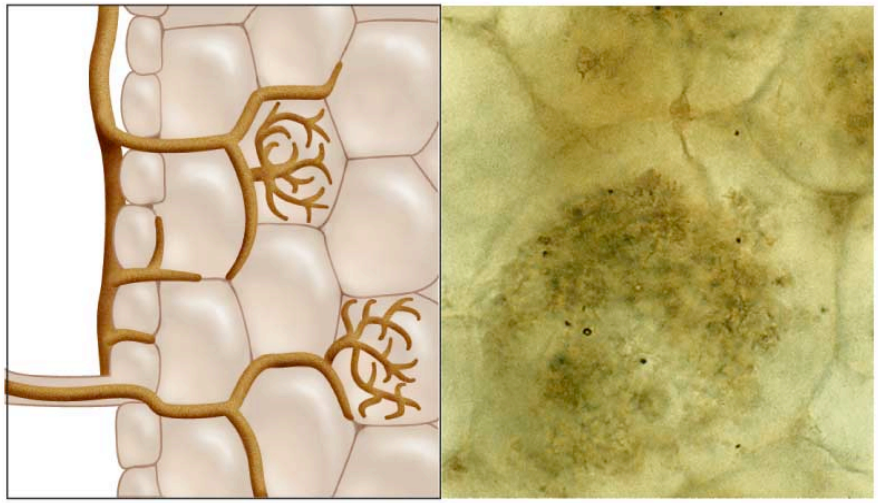
Ectomycorrhizae



Basidiomycota

Fungus wraps around plant roots & grows between or within root cells

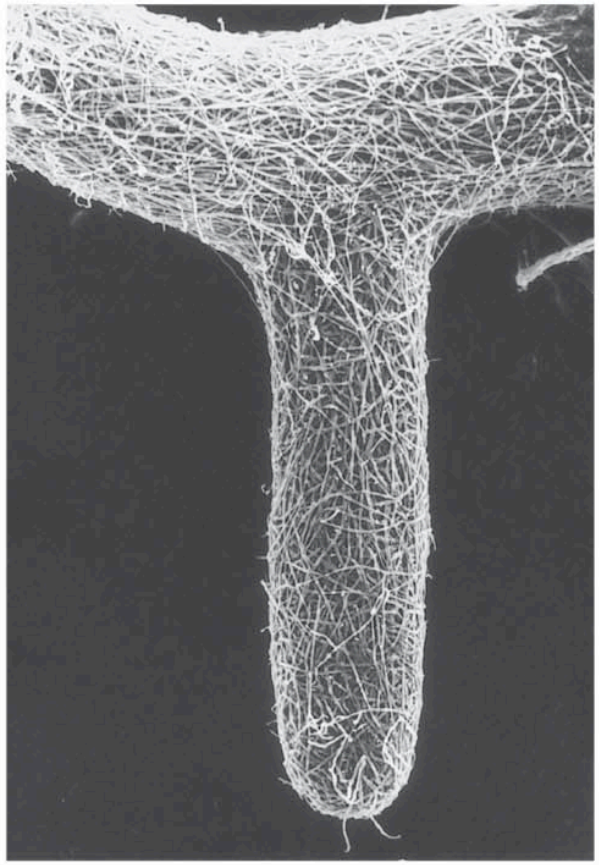
Endomycorrhizae (VA)



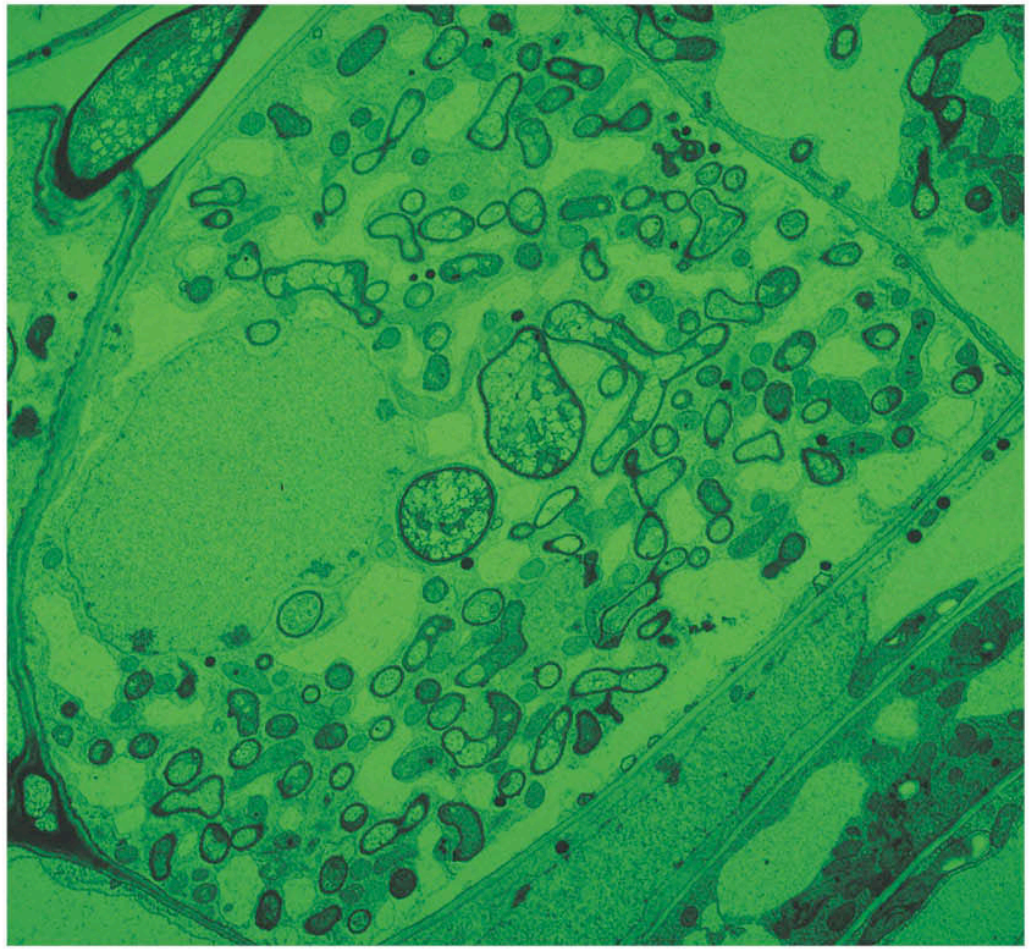
Glomeromycota

Mycorrhizal fungi on root & inside of root cell

(a)



(b)

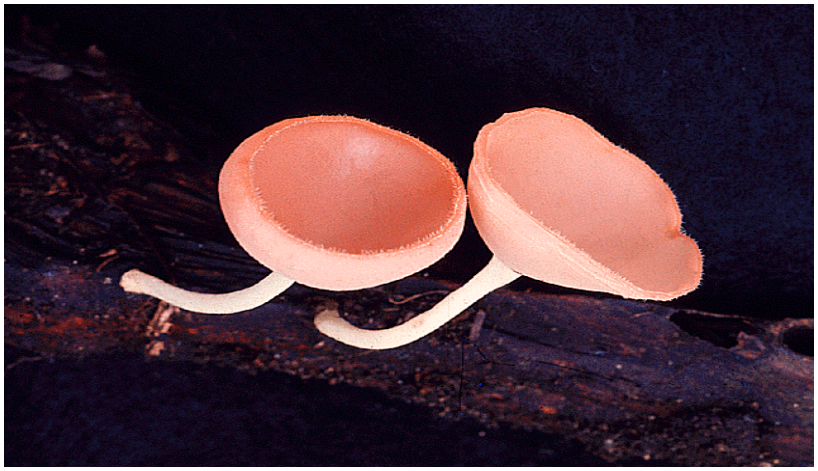


LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 31.16 Mycorrhizal Associations

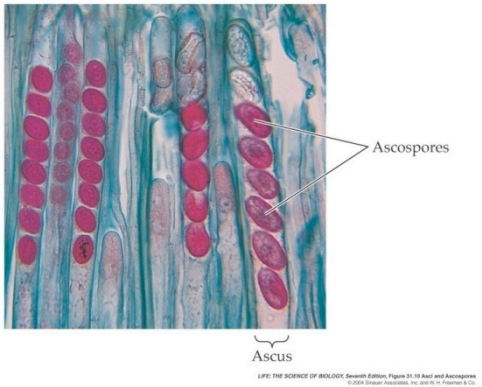
phylum: Ascomycota

"Sac Fungi"

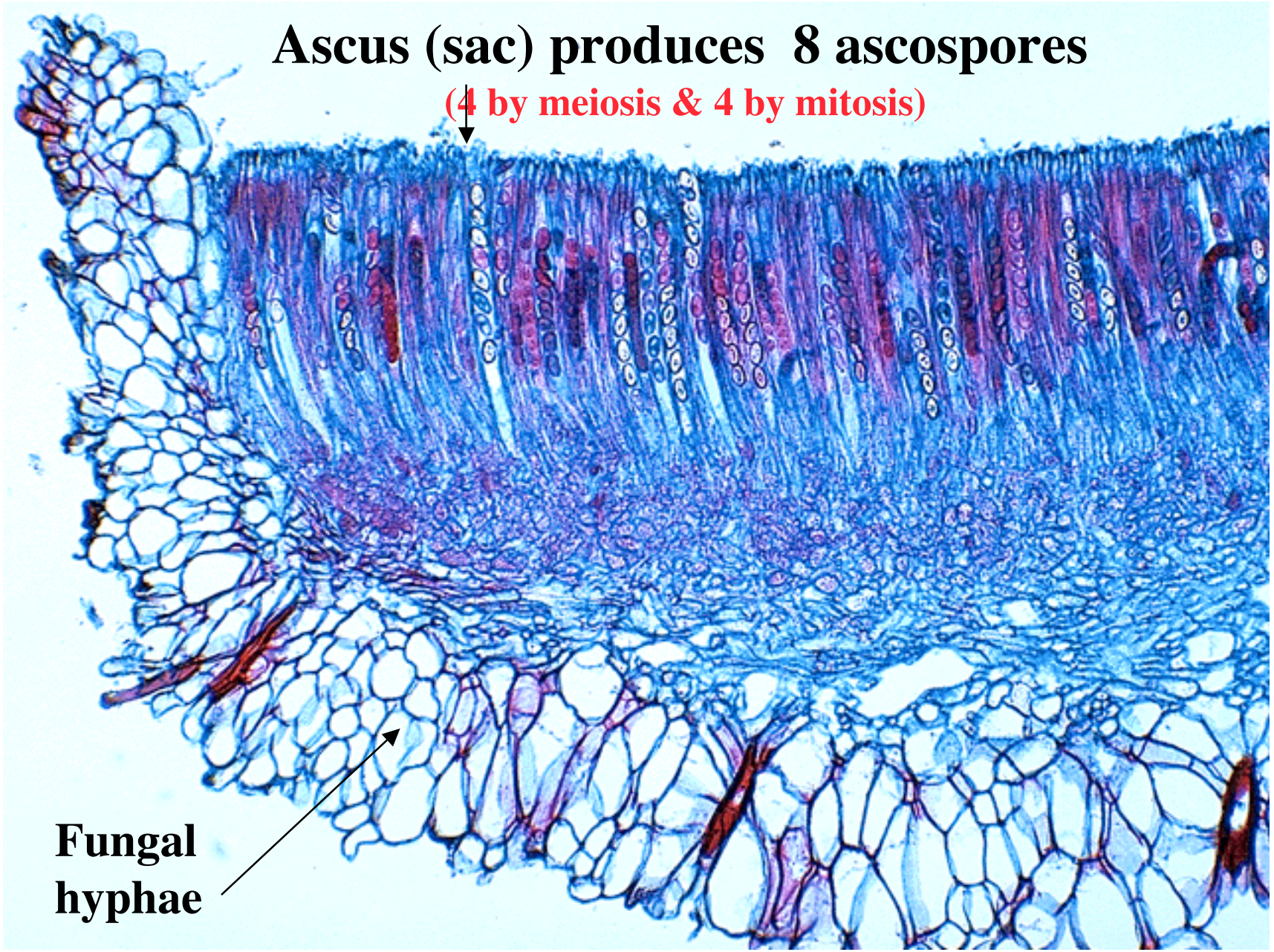
- Hyphae w/ septae
- Live in soil or as parasites or mutualists
- Ascospores produced in a sac called an ascus
- Asci located in fruiting bodies (ascocarps)



Ascocarps

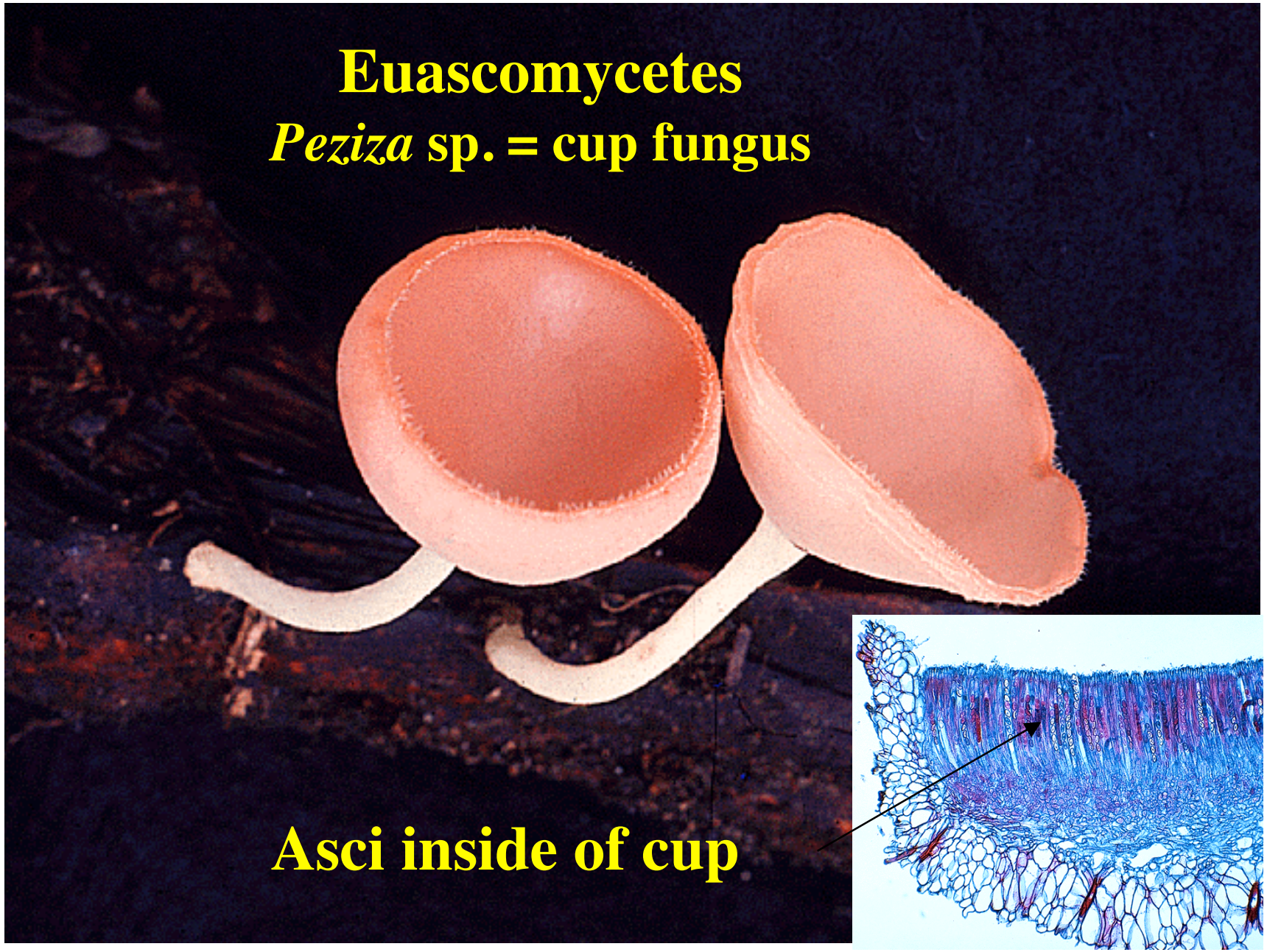


Asci with ascospores


Ascus (sac) produces 8 ascospores
(4 by meiosis & 4 by mitosis)
Fungal hyphae

Euascomycetes

Peziza sp. = cup fungus



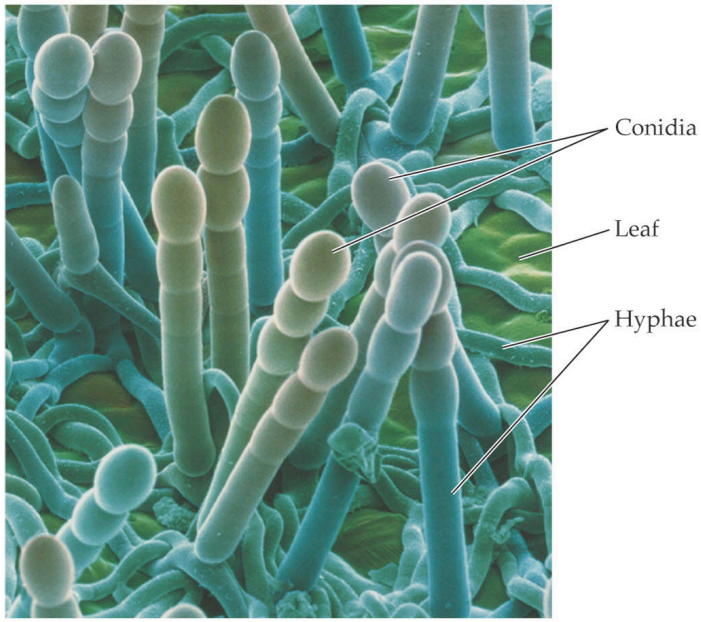
Asci inside of cup

(*a*) *Morchella esculenta*

(*b*) *Sarcoscypha coccinea*

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 31.11 Two Cup Fungi**

Ascomycete pathogen of plants reproducing asexually by conidia



Erysiphe sp.

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 31.12 Conidia

Nigel Cattlin

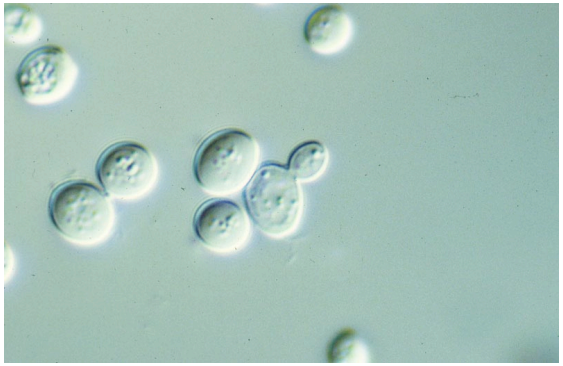
Hemiascomycetes

Yeasts are unicellular fungi that conduct fermentation

Glucose is broken down to produce ATP: CO_2 & ethanol are by-products

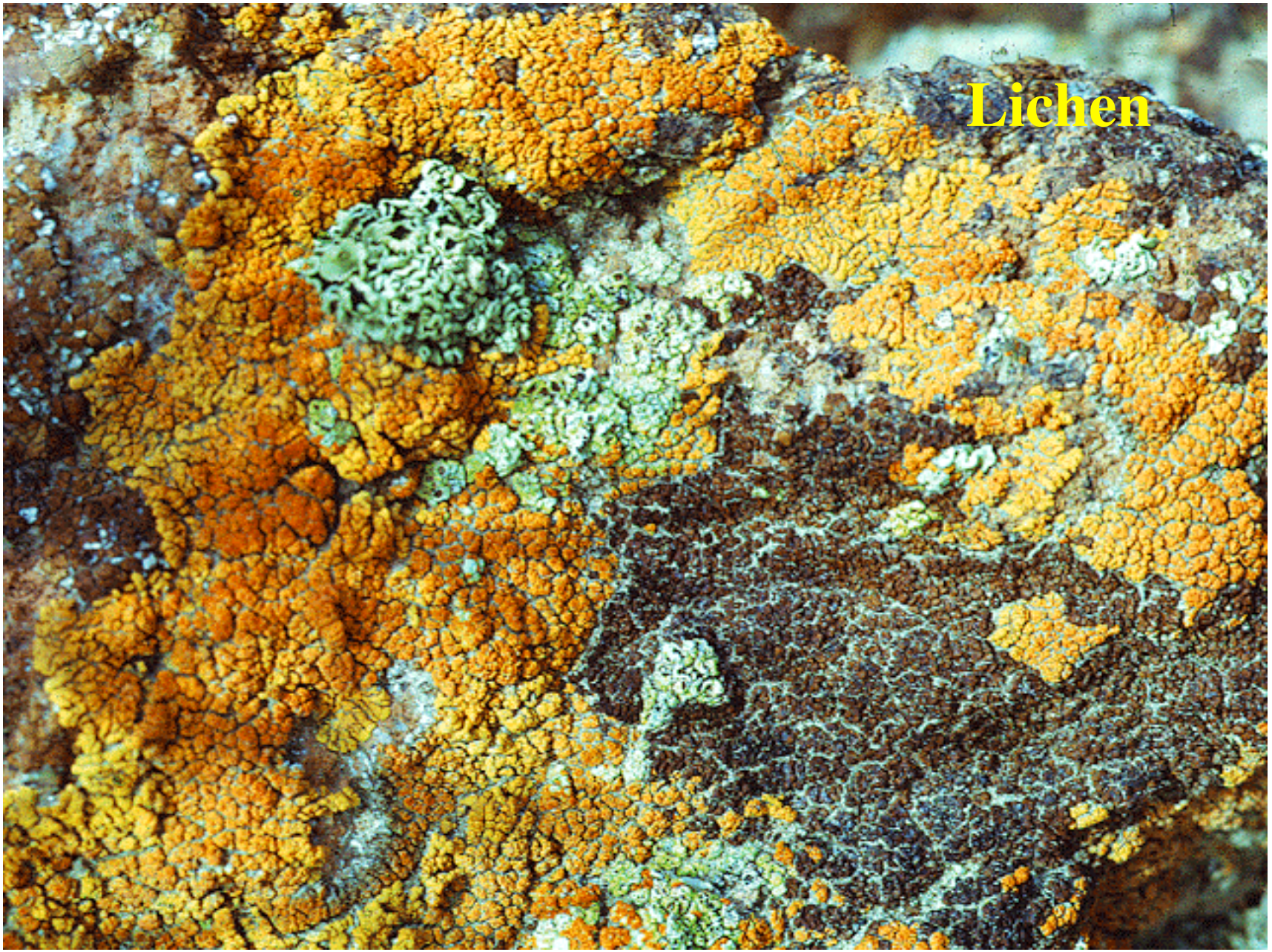
Asexual reproduction

Budding or fission



Sexual reproduction

- 2 haploid cells fuse
- zygote undergoes meiosis
  (entire cell becomes an ascus)
- 4 or 8 haploid cells are produced

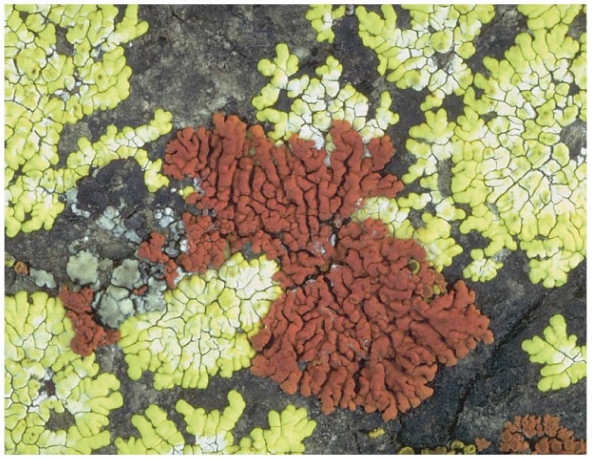

Lichen

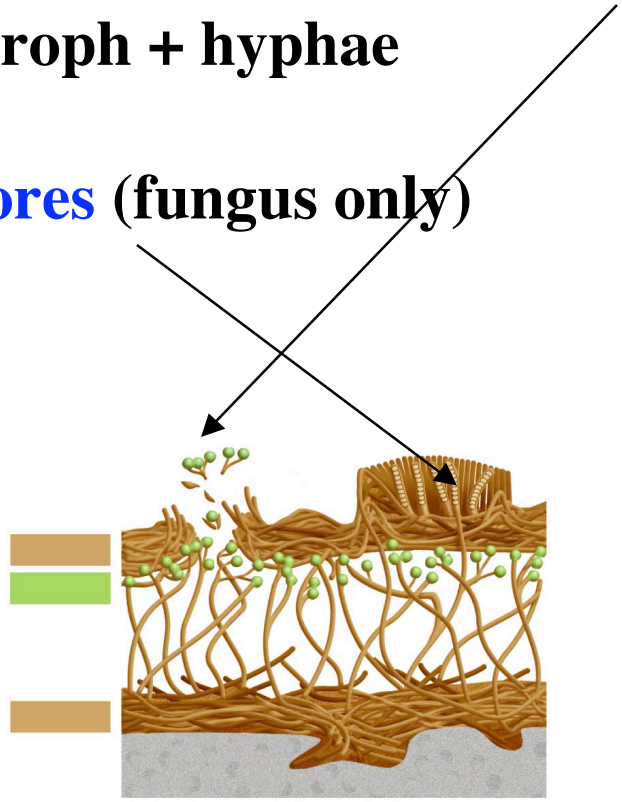
Lichens: symbiotic mutualisms

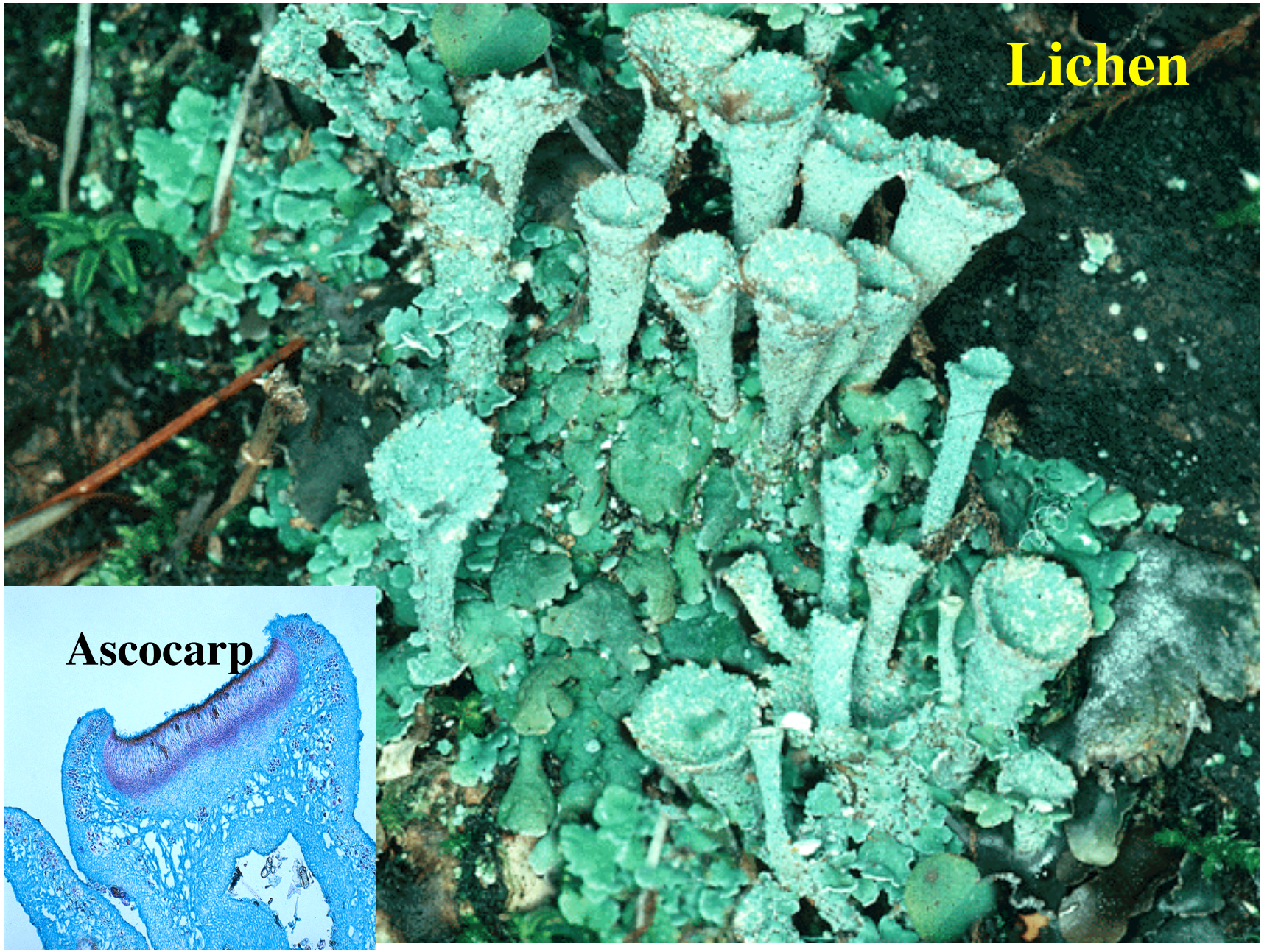
between fungi (ascomycetes) & cyanobacteria or green algae

- **Body is called a thallus**
- **Asexual reproduction by fragmentation or soridea**
  - **Soridium = groups of autotroph + hyphae**

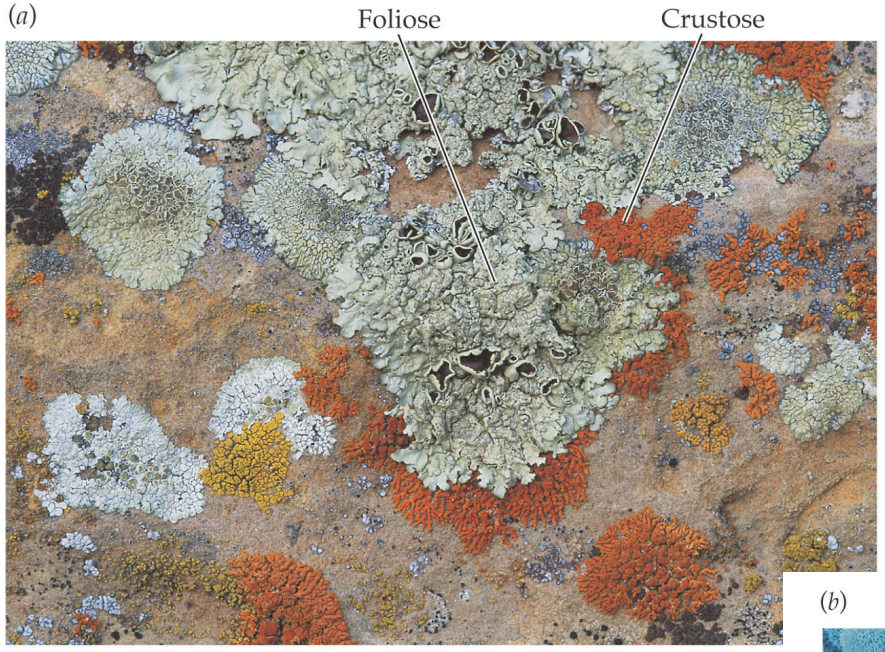
- **Sexual reproduction by ascospores (fungus only)**






Lichen
Ascocarp

(*a*)

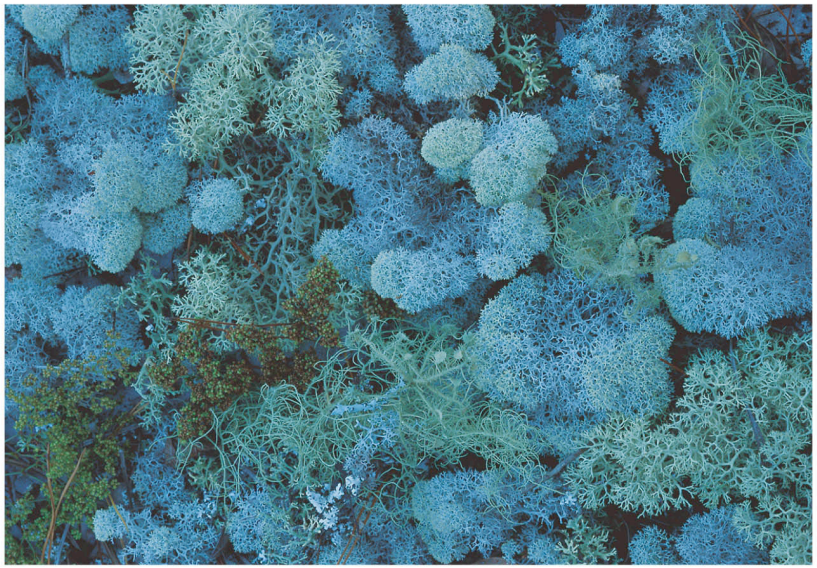


LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 31.17 Li

Types of Lichens

- Crustose
- Foliose
- Fruiticose

(*b*)

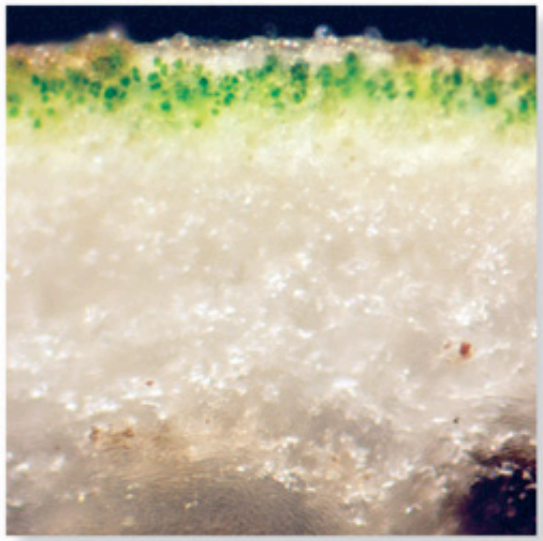


LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 31.17 Lichen Body Forms (Part 2)

(a)

(b)

(c)



(d)

a: © Joe McDonald/CORBIS; b: Lee W. Wilcox; c: Ed Reschke/Peter Arnold, Inc.; d: Lee W. Wilcox

Types of Lichens

- Crustose
- Foliose
- Fruiticose

phylum: Basidiomycota

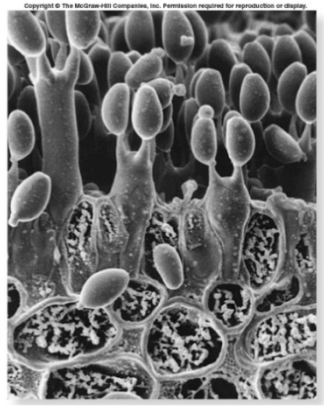
"Club Fungi"

- Live in soil
- Decomposers, mycorrhizae & plant pathogens
- Most recent fungal clade

Basidiomycota

- **Hyphae w/ septae**
- **Fruiting body = basidiocarp (mushroom)**
- **Basidiocarp makes basidia**
- **Basidium produces spores**

  Meiosis inside of basidium makes 4 basidiospores

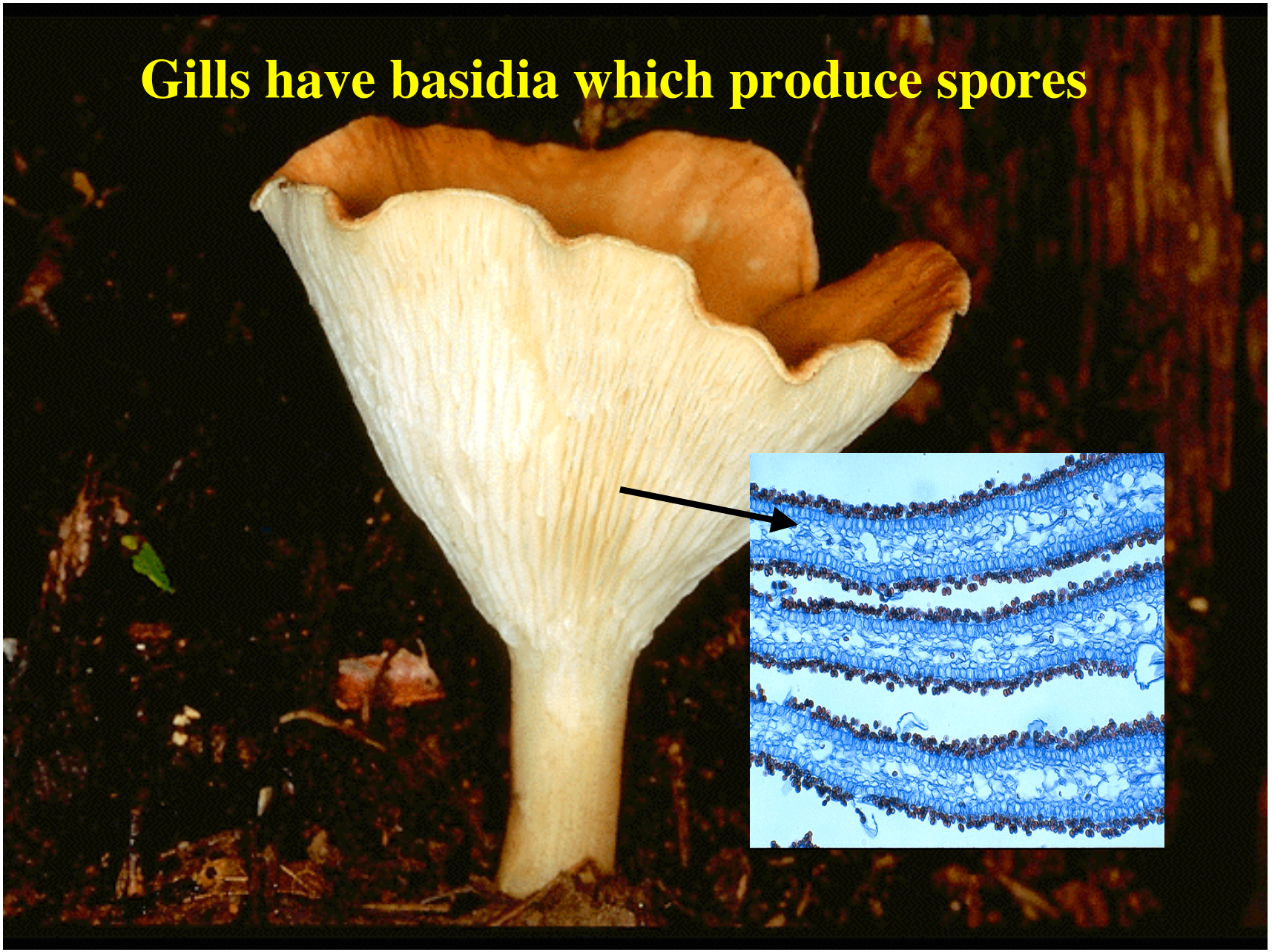


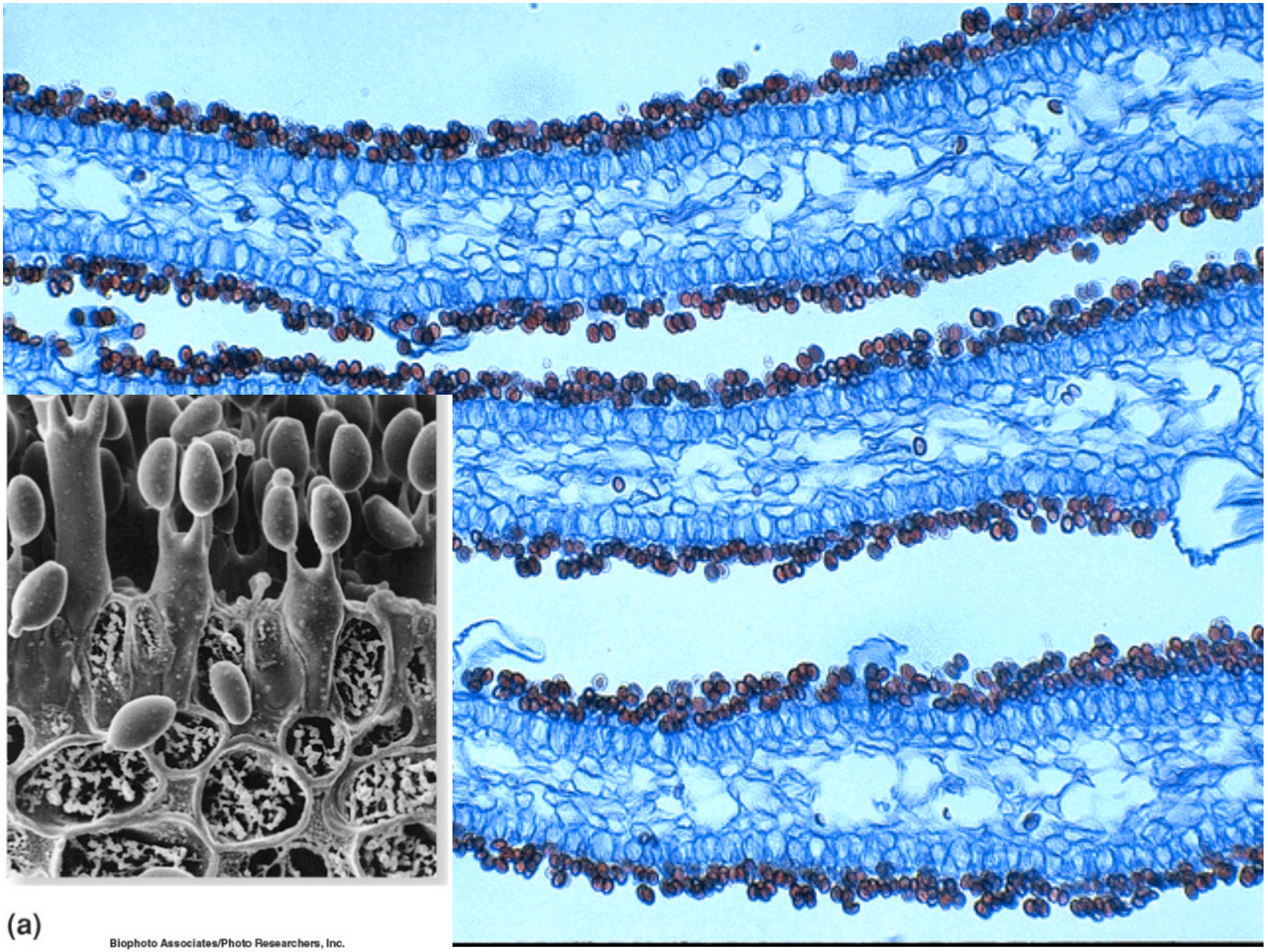
(a)

Biophoto Associates/Photo Researchers, Inc.


Basidiocarp = mushroom "cap"
Mycelia in the soil

Gills have basidia which produce spores



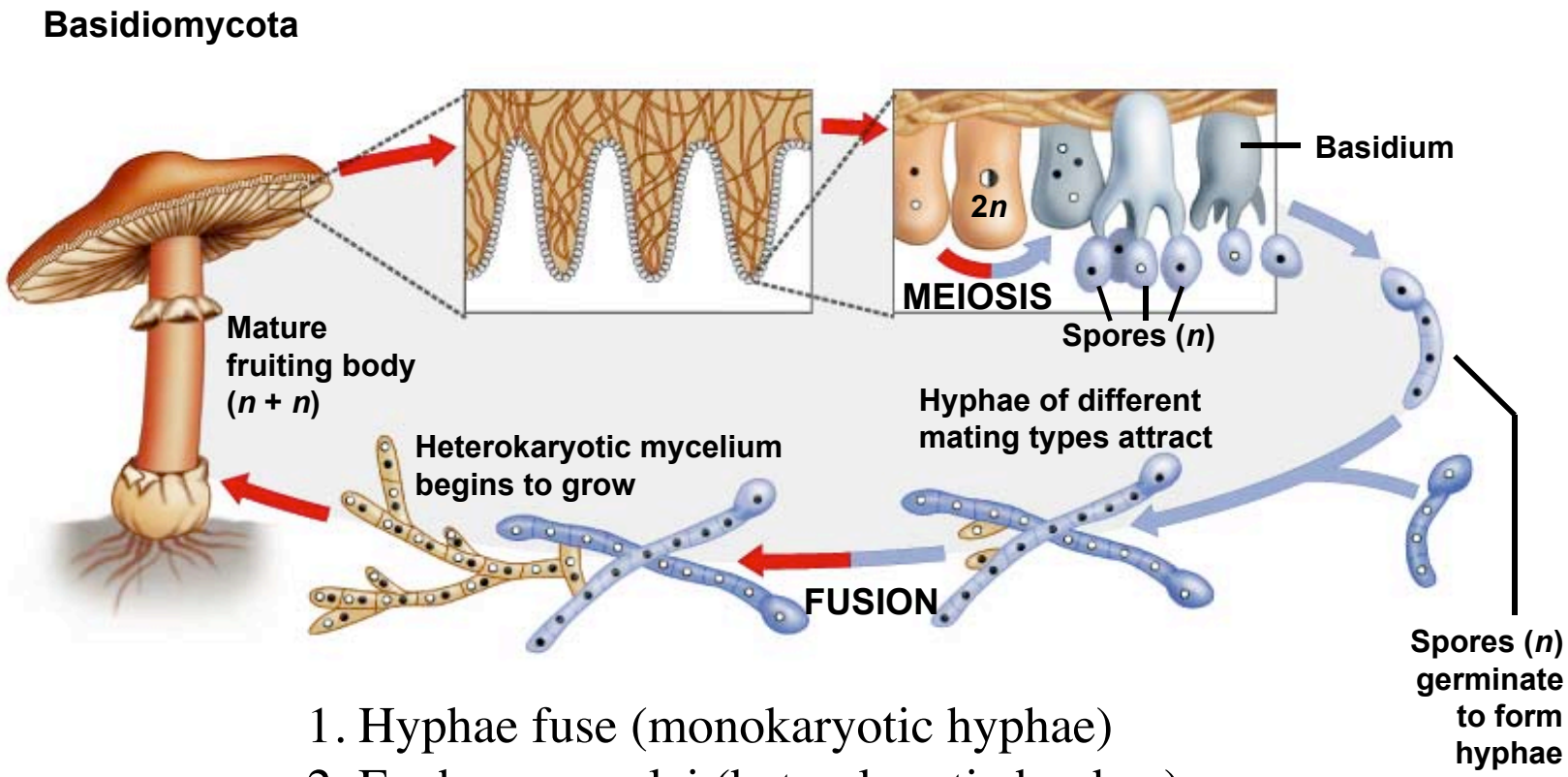


(a)

Biophoto Associates/Photo Researchers, Inc.

Figure 29.4c

Sexual reproduction



1. Hyphae fuse (monokaryotic hyphae)
2. Exchange nuclei (heterokarytic hyphae)
3. Fruiting body forms - Nuclei fuse (in basidium)
4. Meiosis makes spores

Dikaryon is present in all 3 phyla

In sexual reproduction:

- Plasmogamy: cytoplasm of 2 hyphae fuse (1N)

- 2 genetically different nuclei coexist in the cells
- Hypha is now a *Dikaryon (or heterokaryon: 1N + 1N)*

- Karyogamy: 2 nuclei fuse in dikaryon
- Zygote (2N) -> meiosis -> 4 spores (1N)

- Spores produce a hypha upon germination

Diploid tissue never produced in these life cycles

No gamete cells; only gamete nuclei

- Many fungi produce substances in the fruiting body to deter consumption
  - Toxins can cause liver failure requiring a transplant
  - Hallucinogenic or psychoactive substances

Fritz Polking/Peter Arnold, Inc.

rob casey/Alamy

Hans Pfletschinger/Peter Arnold, Inc.