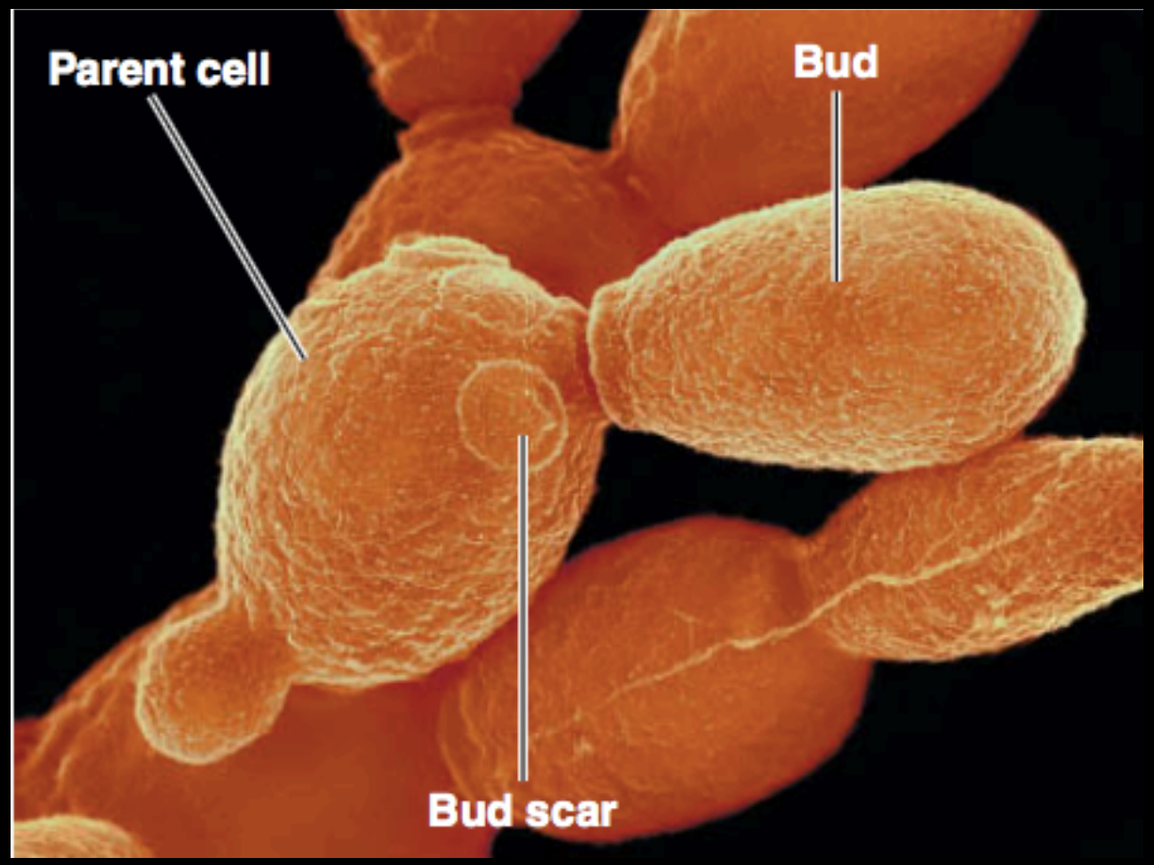
MIKROBIOLOGI

PERTEMUAN KE 5

IRMA MARDIAH M.SI

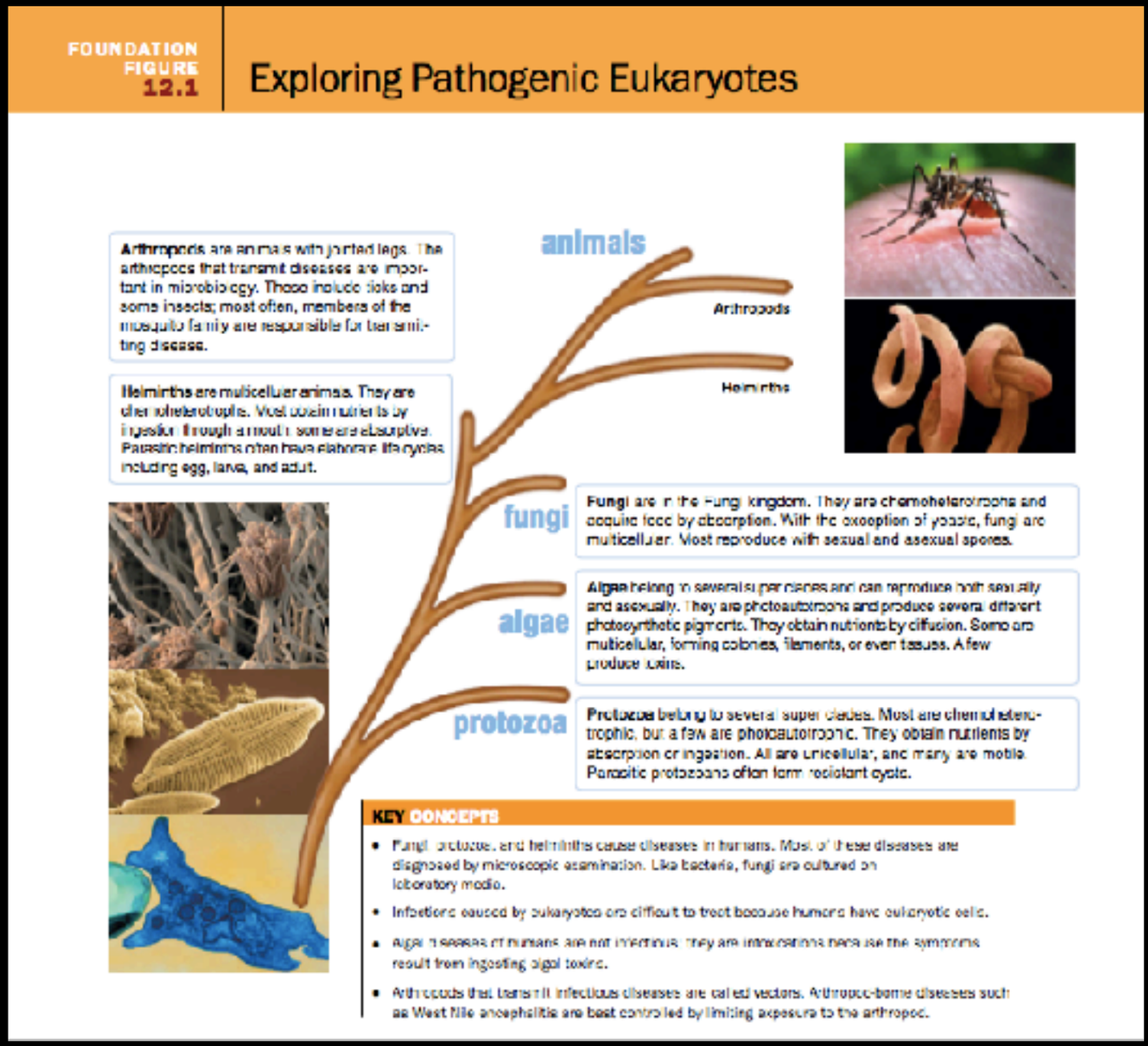


EUKARYOT

FUNGI, ALGA, PROTOZOA DAN HELMINTES

KONSEP KUNCI

- Fungi:
- Lichens:
- Alga:
- Protozoa:
- Jamur lendir:



Perbandingan Fungi & Bakteri

TABLE 12.1 Selected Features of Fungi and Bacteria Compared

	Fungi	Bacteria
Cell Type	Eukaryotic	Prokaryotic
Cell Membrane	Sterols present	Sterols absent, except in *Mycoplasma*
Cell Wall	Glucans; mannans; chitin (no peptidoglycan)	Peptidoglycan
Spores	Sexual and asexual reproductive spores	Endospores (not for reproduction); some asexual reproductive spores
Metabolism	Limited to heterotrophic; aerobic, facultatively anaerobic	Heterotrophic, autotrophic; aerobic, facultatively anaerobic, anaerobic

Karakteristik Fungi

- Struktur Vegetatif
  - jamur
  - ragi
  - fungi dimorfik
- Siklus hidup
  - spora aseksual
  - spora seksual
- adaptasi nutrisi

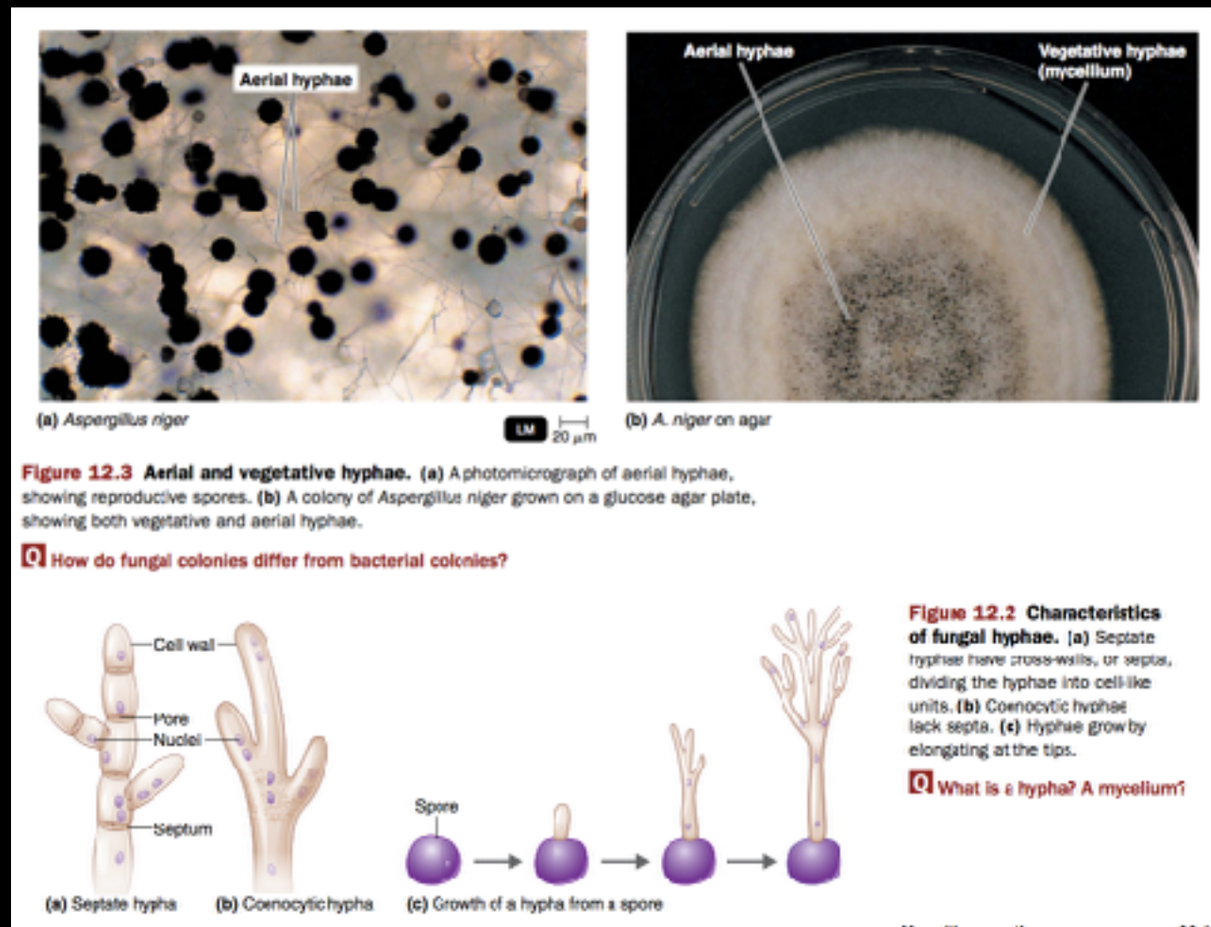


Figure 12.3 Aerial and vegetative hyphae. **(a)** A photomicrograph of aerial hyphae, showing reproductive spores. **(b)** A colony of *Aspergillus niger* grown on a glucose agar plate, showing both vegetative and aerial hyphae.

Q How do fungal colonies differ from bacterial colonies?

Figure 12.2 Characteristics of fungal hyphae. **(a)** Septate hyphae have cross-walls, or septa, dividing the hyphae into cell-like units. **(b)** Coenocytic hyphae lack septa. **(c)** Hyphae grow by elongating at the tips.

Q What is a hypha? A mycelium?

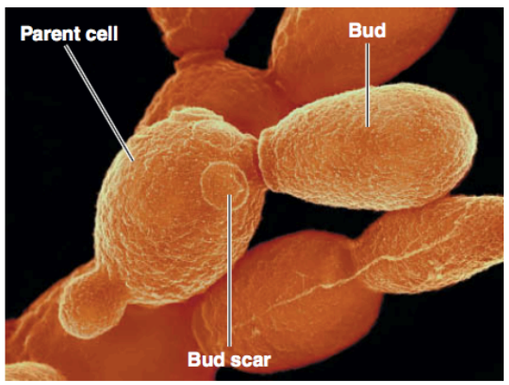


Figure 12.4 A budding yeast. A micrograph of *Saccharomyces cerevisiae* in various stages of budding.

Q How does a bud differ from a spore?

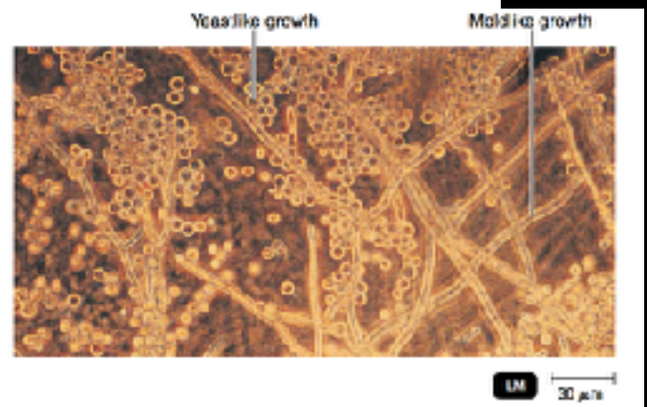
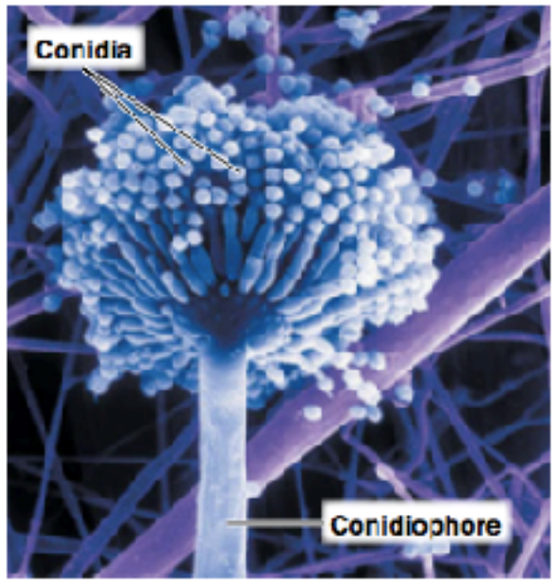


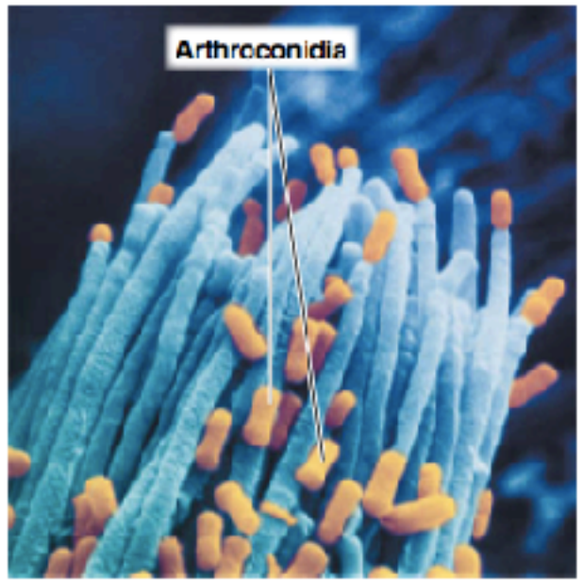
Figure 12.5 Fungal dimorphism. Dimorphism in the fungus *Mucor rouxii* depends on CO_2 concentration. On the agar surface, *Mucor* exhibits yeastlike growth, but in the agar where CO_2 from metabolism has accumulated, it is moldlike.

Q What is fungal dimorphism?

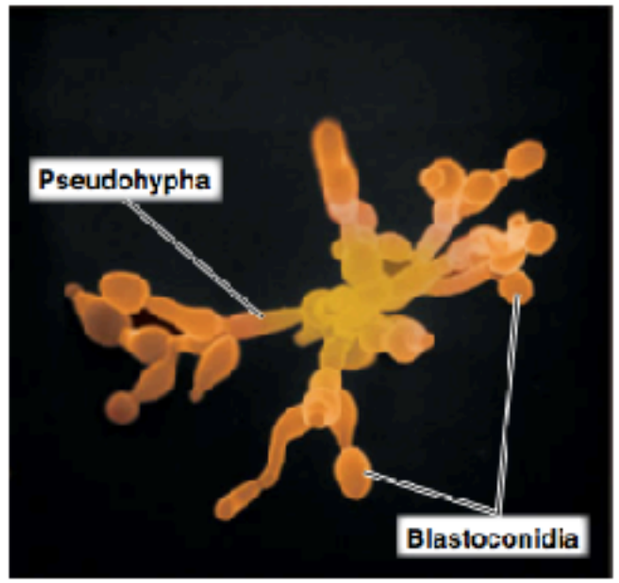
Karakteristik Fungi



(a) Conidia are arranged in chains at the end of an *Aspergillus niger* conidiophore. SEM 12 μm

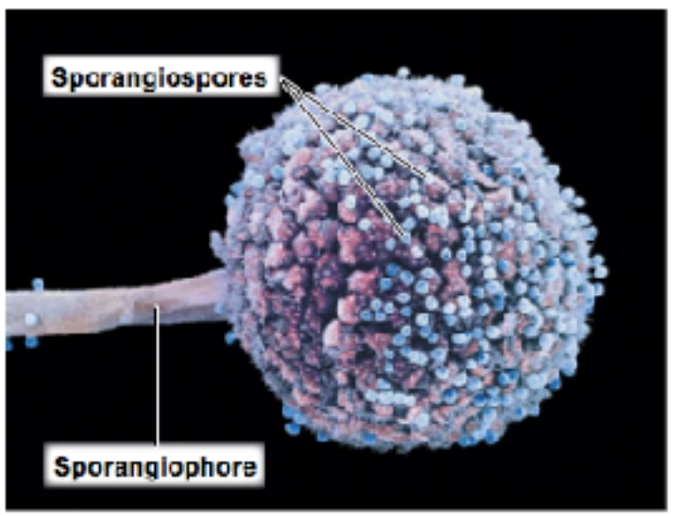


(b) Fragmentation of hyphae results in the formation of arthroconidia in *Ceratocystis ulmi*. SEM 2.5 μm



(c) Blastoconidia are formed from the buds of a parent cell of *Candida albicans*. SEM 13 μm

(d) Chlamydoconidia are thick-walled cells within hyphae of this *Candida albicans*. SEM 5 μm



(e) Sporangiospores are formed within a sporangium of *Rhizopus stolonifer*. SEM 5 μm

Figure 12.6 Representative asexual spores.

Q What are the green powdery structures on moldy food?

Fungi Penting Dunia Medis

- Zygomycota
- Mikrosporidia
- Askomikota
- Basidiomikota

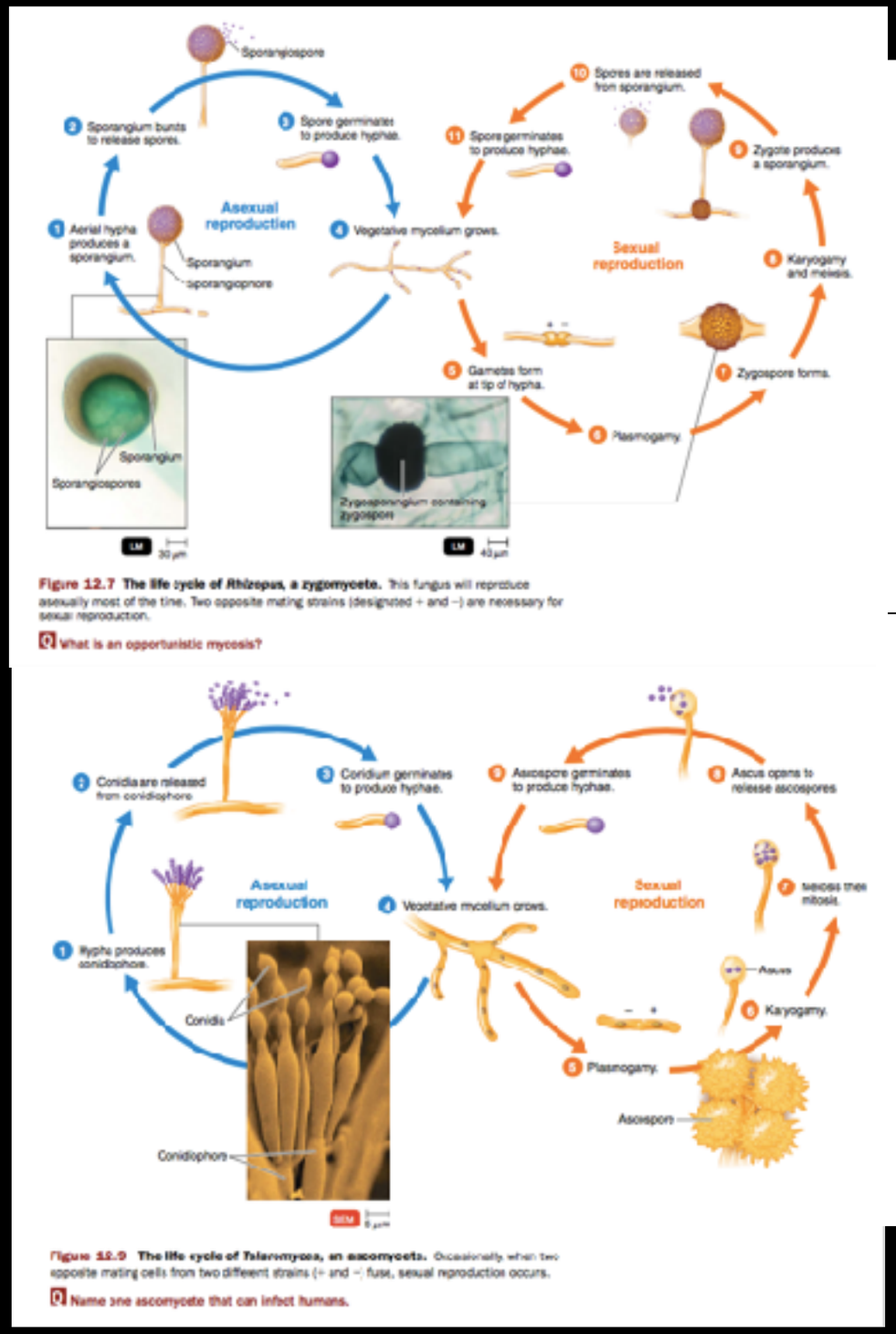


Figure 12.7 The life cycle of *Rhizopus*, a zygomycete. This fungus will reproduce asexually most of the time. Two opposite mating strains (designated + and −) are necessary for sexual reproduction.

Q What is an opportunistic mycosis?

Figure 12.9 The life cycle of *Talaromyces*, an ascomycete. Occasionally when two opposite mating cells from two different strains (+ and −) fuse, sexual reproduction occurs.

Q Name one ascomycete that can infect humans.

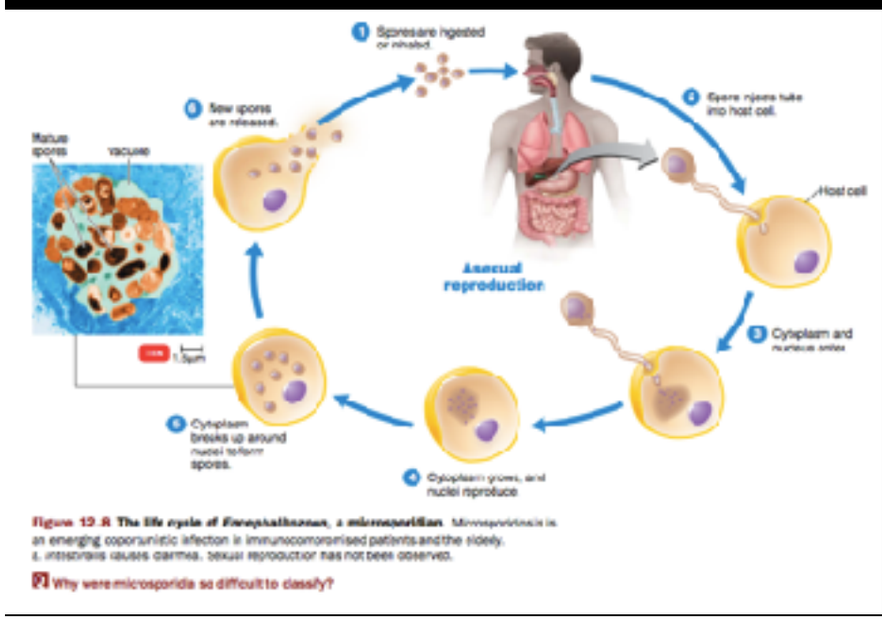


Figure 12.8 The life cycle of *Encephalitozoon*, a microsporidian. Microsporidiosis is an emerging opportunistic infection in immunocompromised patients and the elderly. *E. intestinalis* causes diarrhea. Sexual reproduction has not been observed.

Q Why were microsporidia so difficult to classify?

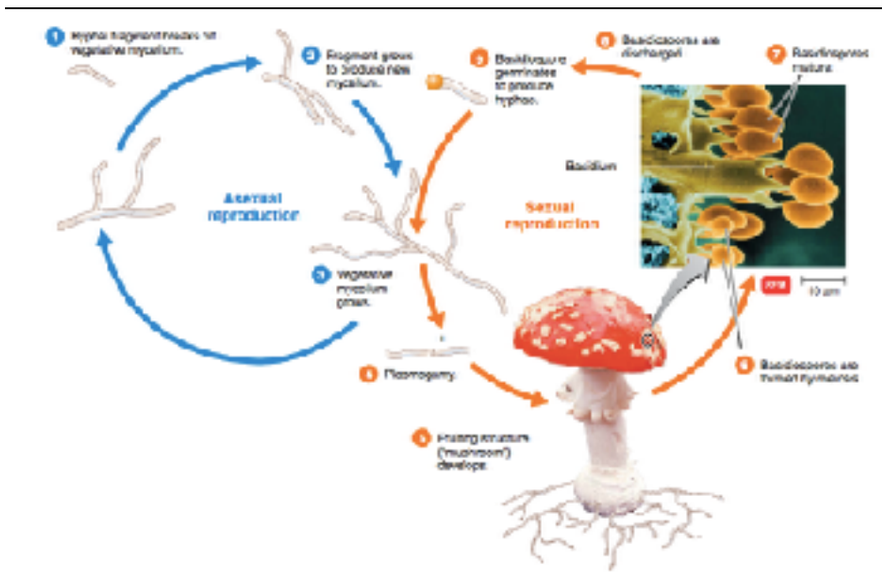


Figure 12.10 A generalized life cycle of a basidiomycete. Mushrooms appear after cells from two mating strains (+ and −) have fused.

Q On what basis are fungi classified into phyla?

Fungi Penyakit

TABLE 12.2 Characteristics of Some Pathogenic Fungi

Phylum	Growth Characteristics	Asexual Spore Types	Human Pathogens	Habitat	Type of Mycosis	Page
Zygomycota	Nonseptate hyphae	Sporangiospores	*Rhizopus*	Ubiquitous	Systemic	715
			Mucor	Ubiquitous	Systemic	715
Microsporidia	No hyphae	Nonmotile spores	*Encephalitozoon, Nosema*	Humans, other animals	Diarrhea, keratoconjunctivitis	—
Ascomycota		Conidia	*Aspergillus*	Ubiquitous	Systemic	715
			Claviceps purpurea	Grasses	Toxin ingestion	438
	Dimorphic		*Blastomyces** (or *Ajellomyces*†) *dermatitidis*	Unknown	Systemic	714
			*Histoplasma** (or *Ajellomyces*†) *capsulatum*	Soil	Systemic	711
	Septate hyphae, strong affinity for keratin	Conidia	*Microsporum*	Soil, animals	Cutaneous	607
		Arthroconidia Chlamydoconidia	*Trichophyton** (or *Arthroderma*†)	Soil, animals	Cutaneous	607
Anamorphs	Septate hyphae Dimorphic	Conidia	*Epidermophyton*	Soil, humans	Cutaneous	607
			Sporothrix schenckii,	Soil	Subcutaneous	608
			Stachybotrys	Soil		
		Arthroconidia	*Coccidioides immitis*	Soil	Systemic	712
	Yeastlike, pseudohyphae	Chlamydoconidia	*Candida albicans*	Human normal microbiota	Cutaneous, systemic, mucocutaneous	608, 779–780
	Unicellular	None	*Pneumocystis*	Human lungs	Systemic	713
Basidiomycota	Septate hyphae; includes rusts and smuts, and plant pathogens; yeastlike encapsulated cells	Conidia	*Cryptococcus** (or *Filobasidiella*†)	Soil, bird feces	Systemic	639
			Malassezia	Human skin	Cutaneous	592
			Amanita spp.	Soil	Toxin ingestion	439

*Anamorph name.
†Teleomorph name.

Efek Ekonomi Fungi

- Bioteknologi
- kontrol biologi
- agrikultural
- ekologi

EXPLORING THE MICROBIOME

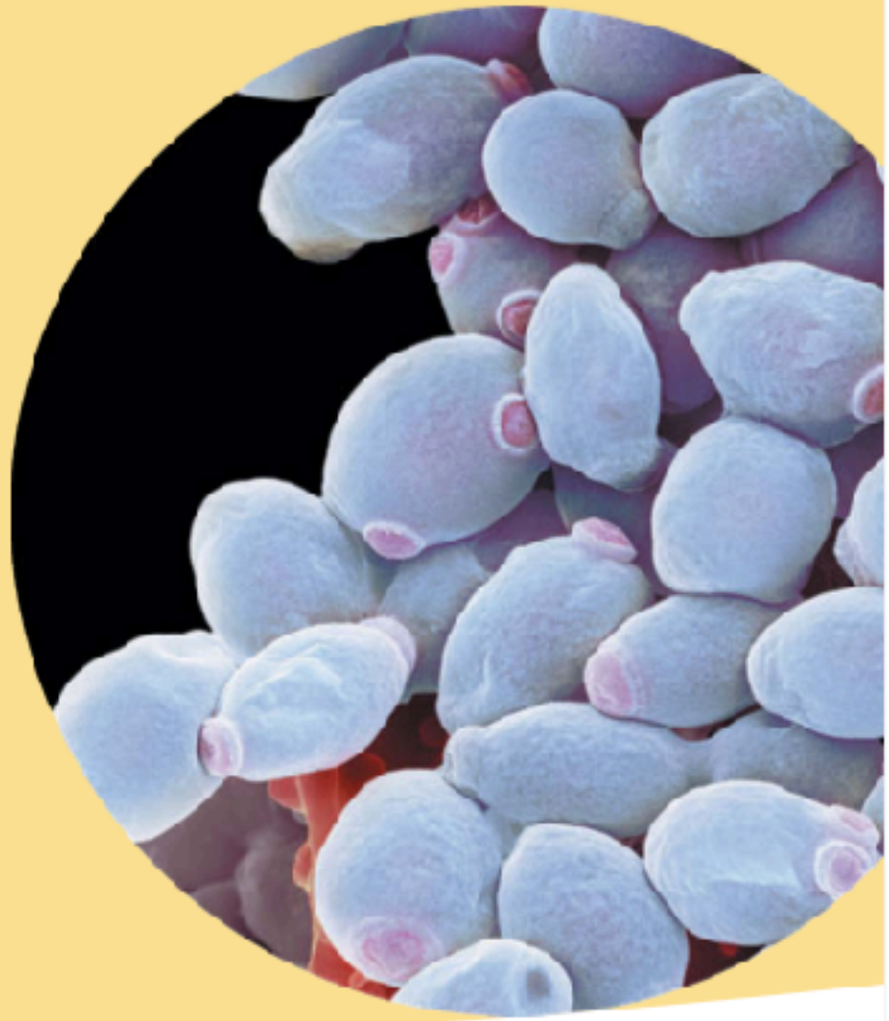
The Mycobiome

Just as viruses and bacteria are members of a healthy human microbiome, so are fungi. But unlike the bacterial portion of the microbiome, the so-called mycobiome is just beginning to be studied.

Members of the yeast genus *Candida* are the most common fungi that live as normal microbiota in the mouth, intestine, and vagina. The most diverse population of fungi is found in the mouth, where 101 species have been identified. In addition to *Candida*, the oral mycobiome includes *Saccharomyces*, *Cladosporium*, and *Pichia*. *Saccharomyces* and *Cladosporium* are common in the intestines, and *Malassezia* is the most abundant genus living on the skin.

Certain members of the mycobiome are well-known opportunistic pathogens. Yeast can proliferate and cause vaginal infections after other members of the microbiome die off from a course of antimicrobial drugs. *Candida albicans* in particular causes invasive infections in organ transplant recipients and other immune-compromised individuals, such as people with AIDS, or cancer patients undergoing chemotherapy.

Understanding how fungi among the mycobiome interact with each other is important. For instance, a decrease in oral *Pichia* abundance coincides with an increase in *Candida* growth in AIDS patients—this observation led to the discovery that *Pichia* secretes several proteins that inhibit *Candida*. Likewise, noting how fungi and bacteria within the microbiome compete with each other is also a key area of research. The yeast *Saccharomyces boulardii*, for example, makes a protease (enzyme) that digests *Clostridium difficile* toxin. *Clostridium difficile* is a tough-to-treat bacterium that causes diarrhea after antibiotics kill off other members of the intestinal microbiome.



Micrograph of *Candida albicans* yeast

Lichenes

- karakteristik & kebutuhan nutrisi
- peran fungi & alga pada lichen

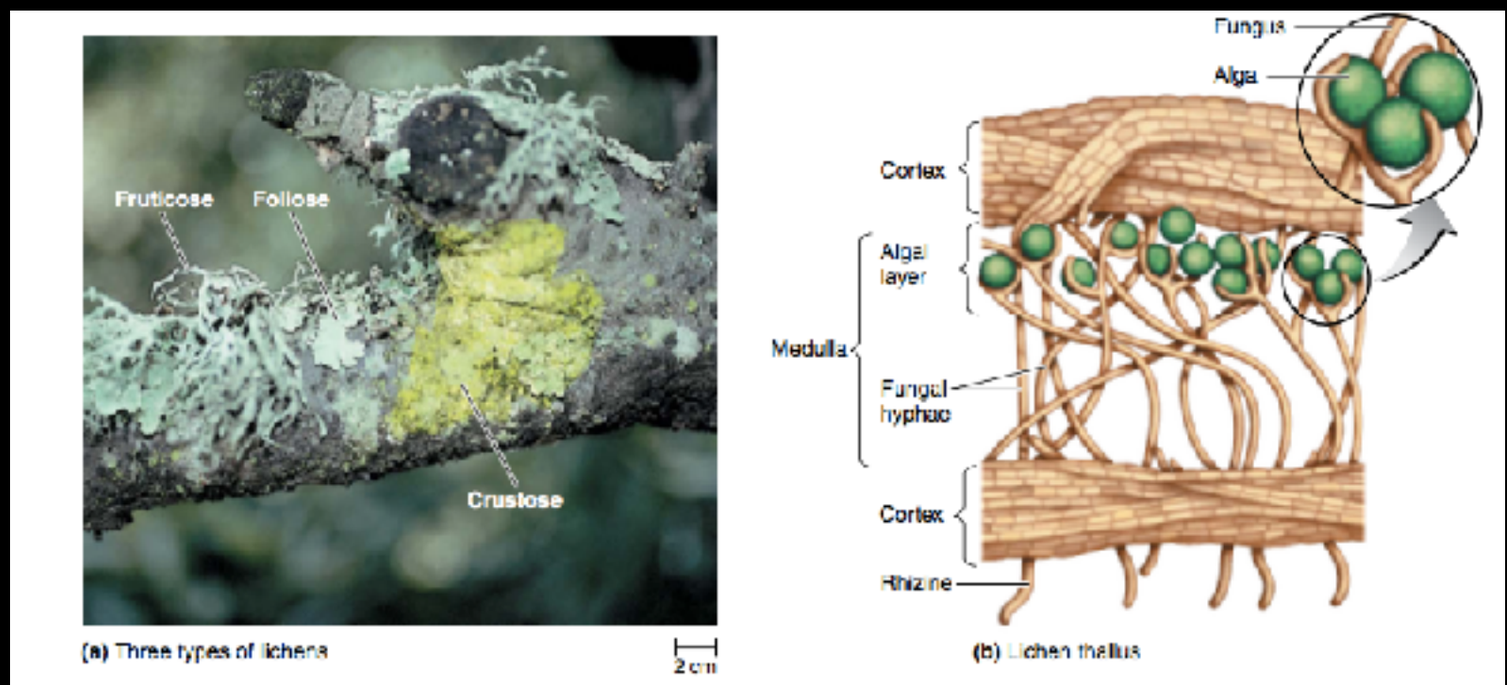


Figure 12.11 Lichens. The lichen medulla is composed of fungal hyphae surrounding the algal layer. The protective cortex is a layer of fungal hyphae that covers the surface and sometimes the bottom of the lichen.

Q In what ways are lichens unique?

Alga

- karakteristik Alga
- karakteristik 5 filum alga
- identifikasi 2 keuntungan & 2 kerugian alga

Karakteristik Alga

- Struktur Vegetatif
- Siklus hidup
- Nutrisi

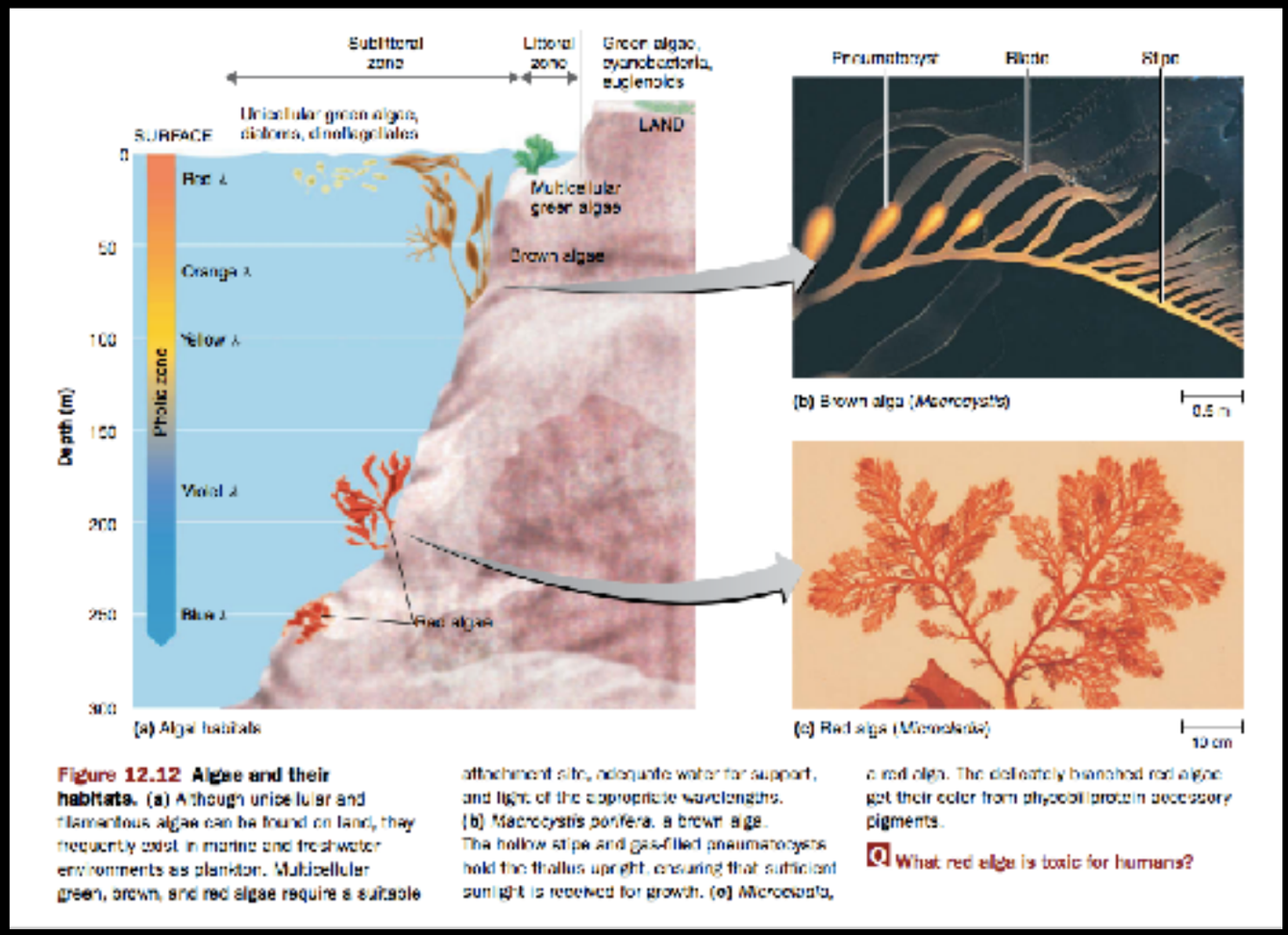


Figure 12.12 Algae and their habitats. (a) Although unicellular and filamentous algae can be found on land, they frequently exist in marine and freshwater environments as plankton. Multicellular green, brown, and red algae require a suitable attachment site, adequate water for support, and light of the appropriate wavelengths. (b) Macrocystis pinifera, a brown alga. The hollow stipe and gas-filled pneumatocysts hold the thallus upright, ensuring that sufficient sunlight is received for growth. (c) Microcladia, a red alga. The delicately branched red algae get their color from phycobiliprotein accessory pigments.

Q What red algae is toxic for humans?

Filum Terpilih pada Alga

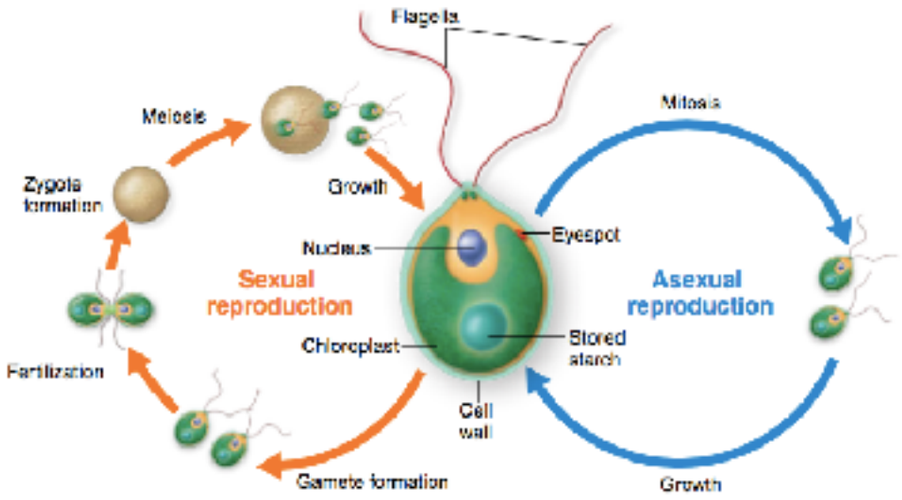
TABLE 12.3 Characteristics of Selected Algae

	Brown Algae	Diatoms	Dinoflagellates	Water Molds	Red Algae	Green Algae
Super Clade	SAR*	SAR	SAR	SAR	Archaeplastida	Archaeplastida
Phylum	Phaeophyta	Bacillariophyta	Dinoflagellata	Oomycota	Rhodophyta	Chlorophyta
Color	Brownish	Brownish	Brownish	Colorless, white	Reddish	Green
Cell Wall	Cellulose and alginic acid	Pectin and silica	Cellulose in membrane	Cellulose	Cellulose	Cellulose
Cell Arrangement	Multicellular	Unicellular	Unicellular	Multicellular	Multicellular (most)	Unicellular and multicellular
Photosynthetic Pigments	Chlorophyll *a* and *c*, xanthophylls	Chlorophyll *a* and *c*, carotene, xanthophylls	Chlorophyll *a* and *c*, carotene, xanthins	None	Chlorophyll *a* and *d*, phycobiliproteins	Chlorophyll *a* and *b*
Sexual Reproduction	Yes	Yes	In a few	Yes (similar to Zygomycota)	Yes	Yes
Storage Material	Carbohydrate	Oil	Starch	None	Glucose polymer	Starch
Pathogenicity	None	Toxins	Toxins	Parasitic	A few produce toxins	None

*SAR stands for Stramenopiles, Alveolates, Rhizaria.

Filum Terpilih pada Alga

(a) Multicellular green alga (*Ulva*) — 20 cm



(b) Life cycle of a unicellular green alga (*Chlamydomonas*)

Figure 12.13 Green algae. (a) The multicellular green alga *Ulva*. (b) The life cycle of the unicellular green alga *Chlamydomonas*. Two whiplike flagella propel this cell.

Q What is the primary role of algae in the ecosystem?

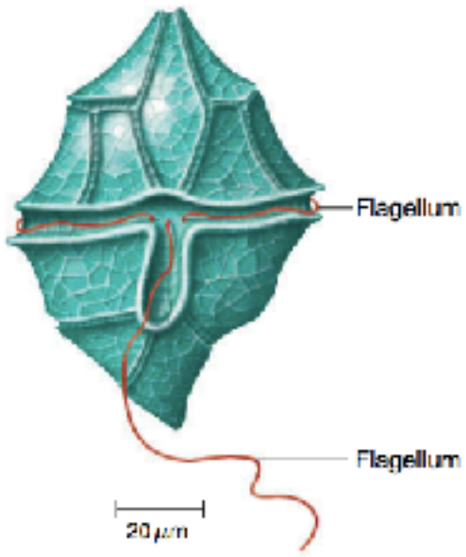
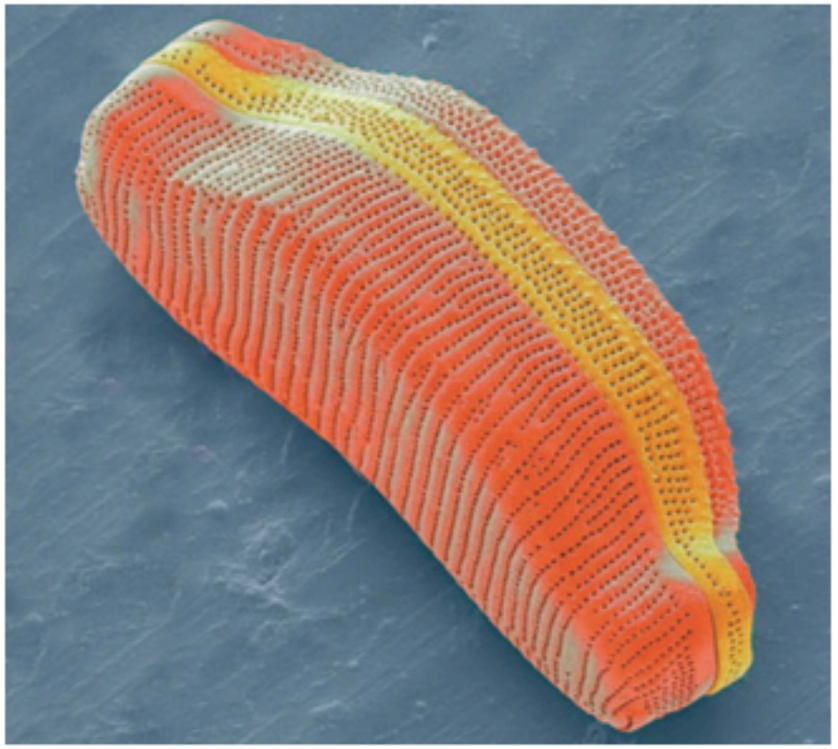


Figure 12.15 *Peridinium*, a dinoflagellate. Like all dinoflagellates, *Peridinium* has two flagella in perpendicular, opposing grooves. When the two flagella beat simultaneously, they cause the cell to spin.

Q What human diseases are caused by dinoflagellates?



(a) *Eunotia*, a freshwater diatom that grows in acidic water — SEM — 10 μm

(b) Asexual reproduction of a diatom

Figure 12.14 Diatoms. **(a)** In this micrograph of *Eunotia serra*, notice how the two parts of the cell wall fit together. **(b)** Asexual reproduction in a diatom. During mitosis, each daughter cell retains one-half of the cell wall from the parent (yellow) and must synthesize the remaining half (pink).

Q What human disease is caused by diatoms?

Peran Alga di Alam

- Rantai makanan perairan
- sumber bahan bakar
- simbiosis dengan hewan

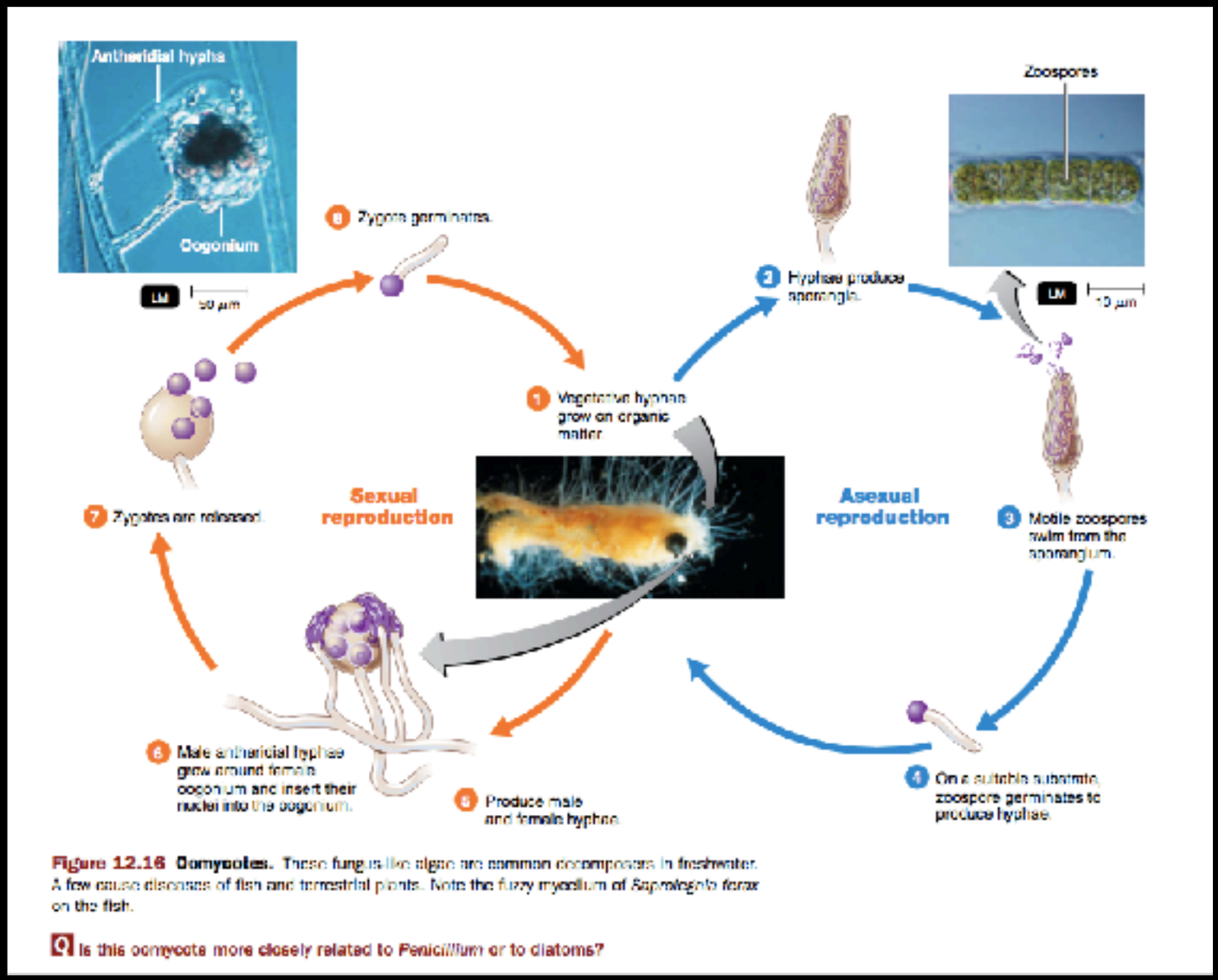


Figure 12.16 Oomycetes. These fungus-like algae are common decomposers in freshwater. A few cause diseases of fish and terrestrial plants. Note the fuzzy mycelium of *Saprolegnia ferax* on the fish.

Is this oomycete more closely related to *Penicillium* or to diatoms?

Protozoa

- Karakteristik protozoa
- karakter 7 filum protozoa
- perbedaan inang intermediate & inang definitif

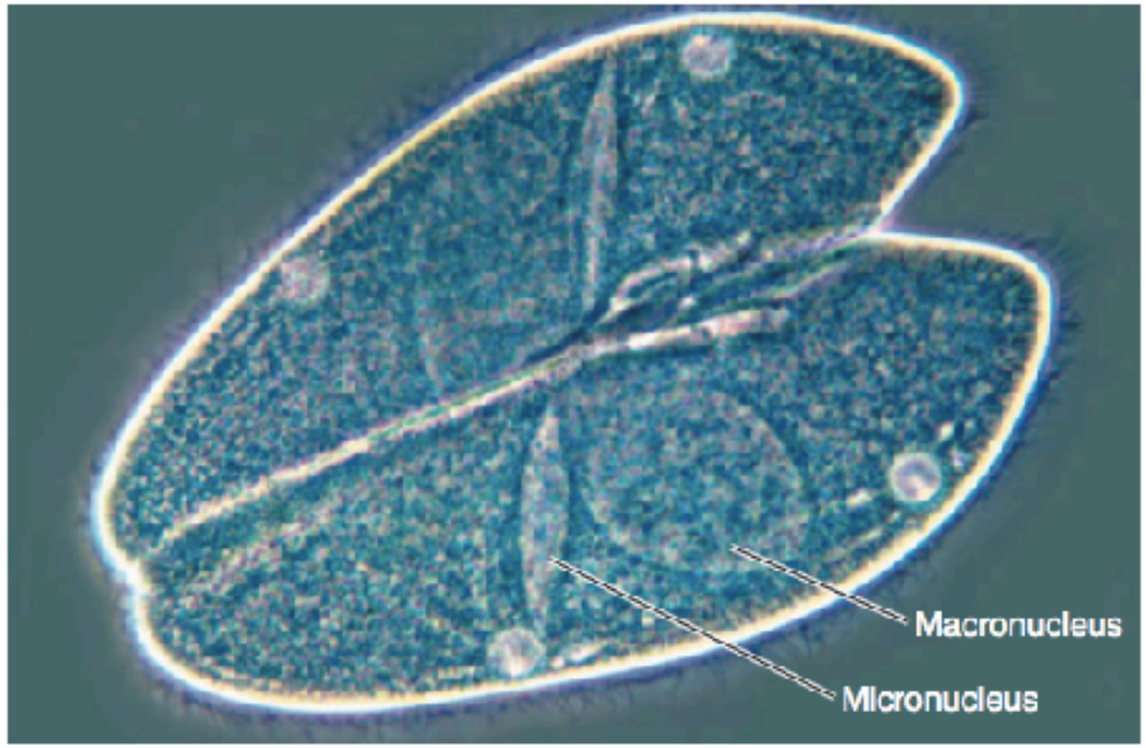


Figure 12.17 Conjugation in the ciliate protozoan *Paramecium*. Sexual reproduction in ciliates is by conjugation. Each cell has two nuclei: a micronucleus and a macronucleus. The micronucleus is haploid and is specialized for conjugation. One micronucleus from each cell will migrate to the other cell during conjugation. Both cells will then go on to produce two daughter cells.

Q Does conjugation result in more cells?

Karakteristik Protozoa

- Siklus hidup
- Tempat penyimpanan
- Nutrisi

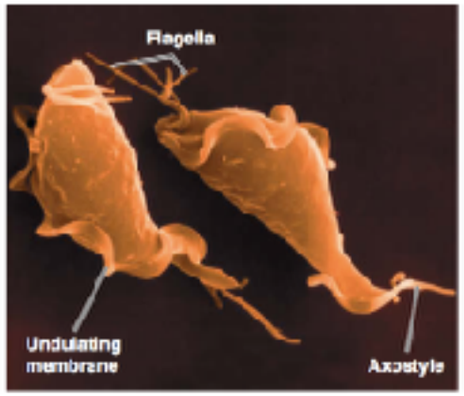
Figure 12.17 Conjugation in the ciliate protozoan *Paramecium*. Sexual reproduction in ciliates is by conjugation. Each cell has two nuclei: a micronucleus and a macronucleus. The micronucleus is haploid and is specialized for conjugation. One micronucleus from each cell will migrate to the other cell during conjugation. Both cells will then go on to produce two daughter cells.

Q Does conjugation result in more cells?

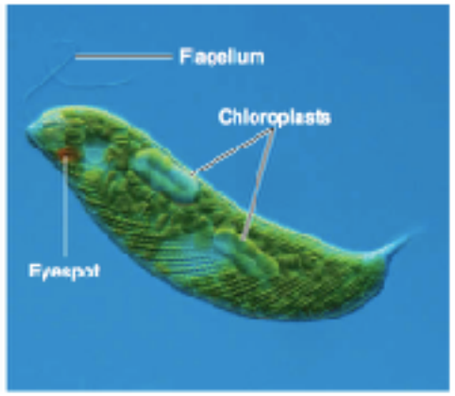
Protozoa yg penting scr Medis

- alur makan
- Euglenozoa
- Amebae
- Apikomplexa
- Siliata

(a) *Giardia intestinalis*. This parasite has eight flagella and a ventral sucker disk that the parasite uses to attach itself to the intestine. SEM 3 μm



(b) *Trichomonas vaginalis*. This flagellate causes urinary and genital tract infections. Notice the small undulating membrane. This flagellate does not have a cyst stage. SEM 7.5 μm



(c) *Euglena*. Euglenoids are autotrophs. Semirigid rings supporting the pellicle allow *Euglena* to change shape. SEM 10 μm

Figure 12.18 Members of the superkingdom Excavata are spindle-shaped and have flagella.

How does *Giardia* obtain energy without mitochondria?

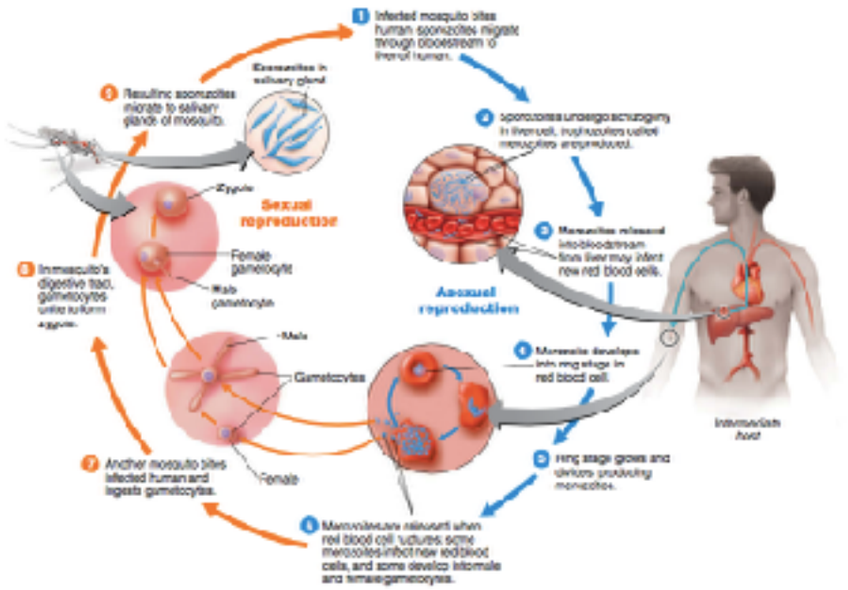
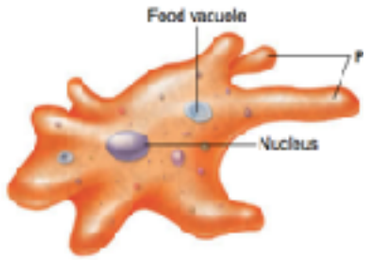
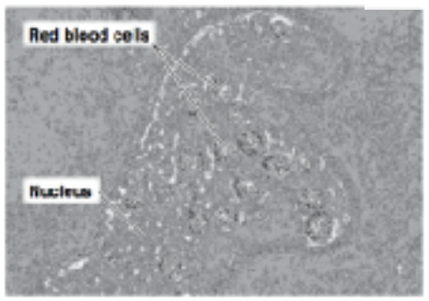


Figure 12.20 The life cycle of *Plasmodium vivax*, the apicomplexan that causes malaria. Asexual reproduction (schizogony) of the parasite takes place in the liver and in the red blood cells of a human host. Sexual reproduction occurs in the intestine of an *Anopheles* mosquito after the mosquito has ingested gametocytes.

What is the definitive host for *Plasmodium*?



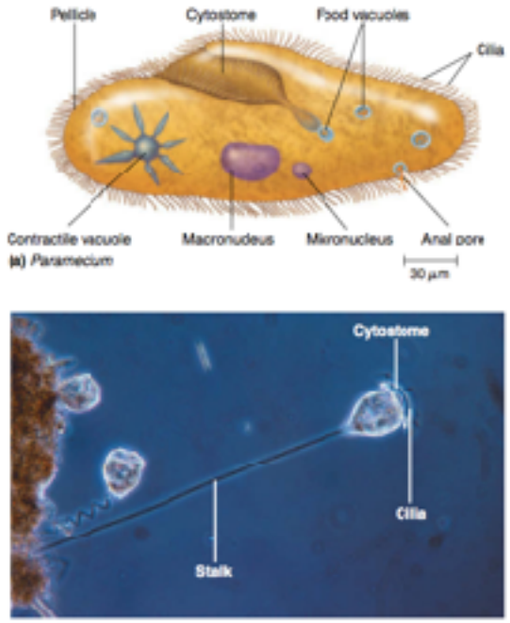
(a) *Amoeba proteus*



(b) *Entamoeba histolytica* LM 5 μm

Figure 12.19 Amebae. (a) To move and to engulf food, amebae such as this *Amoeba proteus* extend cytoplasmic structures called pseudopods. Food vacuoles are created when pseudopods surround food and bring it into the cell. (b) *Entamoeba histolytica*. The presence of ingested red blood cells is diagnostic for *Entamoeba*.

How do amebic dysentery and bacillary dysentery differ?



(b) Vorticella LM 30 μm

Figure 12.21 Ciliates. (a) Paramecium is covered with rows of cilia. It has specialized structures for ingestion (cytostome), elimination of wastes (anal pore), and the regulation of osmotic pressure (contractile vacuoles). The macronucleus is involved with protein synthesis and other ongoing cellular activities. The micronucleus functions in sexual reproduction. (b) Vorticella attaches to objects in water by the base of its stalk. The springlike stalk can expand, allowing Vorticella to feed in different areas. Cilia surround its cytostome.

What ciliate can cause disease in humans?

Protozoa Patogen

TABLE 12.4 Some Representative Pathogenic Protozoa

Super Clade	Phylum	Human Pathogens	Distinguishing Features	Disease	Source of Human Infections	Page
Excavata	Diplomonads	*Giardia intestinalis*	Two nuclei, eight flagella	Giardial enteritis	Fecal contamination of drinking water	747–749
	Parabasalids	*Trichomonas vaginalis*	No encysting stage	Urethritis, vaginitis	Contact with vaginal-urethral discharge	780
	Euglenozoa	*Leishmania*	Flagellated form in sand fly; ovoid form in vertebrate host	Leishmaniasis	Sand fly bite (*Phlebotomus*)	675
		Naegleria fowleri	Flagellated and ameboid forms	Meningoencephalitis	Water (during swimming)	640
		Trypanosoma cruzi	Undulating membrane	Chagas disease	*Triatoma* bite (kissing bug)	675
		T. brucei gambiense, T. b. rhodesiense		African trypanosomiasis	Tsetse fly bite	639
Amorphea	Amoebozoa	*Acanthamoeba*	Pseudopods	Keratitis	Water	613, 642
		Entamoeba histolytica, E. dispar		Amebic dysentery	Fecal contamination of drinking water	750
		Balamuthia		Encephalitis	Water	—
SAR*	Apicomplexa	*Babesia microti*	Complex life cycles may require multiple hosts	Babesiosis	Domestic animals, ticks	680
		Cryptosporidium		Diarrhea	Water, humans, other animals	749
		Cyclospora		Diarrhea	Water	750
		Plasmodium		Malaria	*Anopheles* mosquito bite	677
		Toxoplasma gondii		Toxoplasmosis	Cats; beef; congenital	676
	Dinoflagellates	*Alexandrium, Pfiesteria*	Photosynthetic (most)	Paralytic shellfish poisoning; ciguatera	Ingestion of dinoflagellates in mollusks or fish	439
	Ciliates	*Balantidium coli*	Only parasitic ciliate of humans	Balantidial dysentery	Fecal contamination of drinking water	—

*SAR stands for Stramenopiles, Alveolates, Rhizaria.

Jamur Lendir

- Selular
- plasmodial

DAFTAR PUSTAKA

1. Tortora GJ, Funke BR, Case CL, 2007, Microbiology an Introduction, 13th edition, Benjamin Cummings, Animprint of Addison Wesley, Longman Inc., USA