

Endosymbiosis & Protists

FIGURE 31.6
Pelomyxa palustris.
This unique, amoeba-like protist lacks mitochondria and does not undergo mitosis. *Pelomyxa* may represent a very early stage in the evolution of eukaryotic cells. This species is the only member of the phylum Caryoblastea.

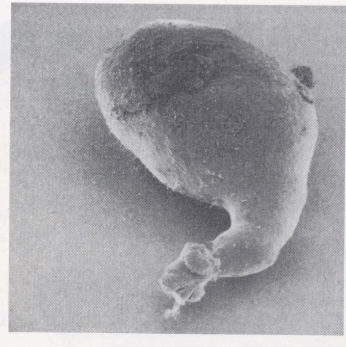
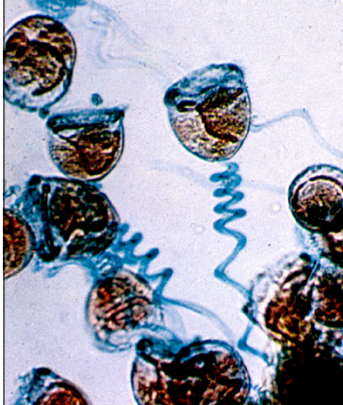
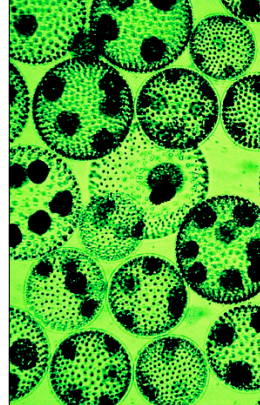


Fig. 35.5 Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



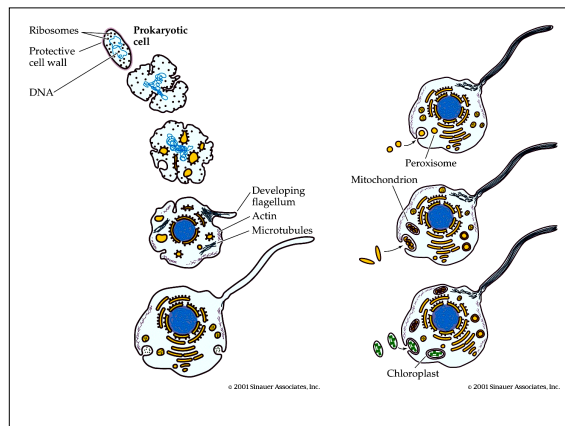
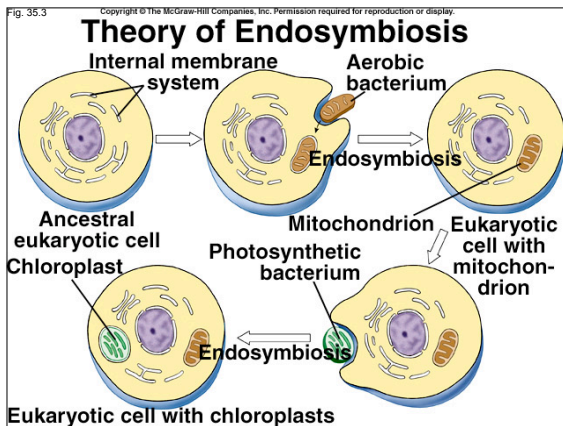
Unicellular Protist – Vorticella

Fig. 35.1 Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



A Colonial Protist – Volvox

Fig. 35.3 Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Endosymbiotic Hypothesis

- ✓ 1. Nuclear envelope and E.R. presumed to have evolved from invagination of cell or plasma membrane

- (Circular naked DNA to linear DNA packed on histones)

- ✓ 2. Purples non-sulfur or Rhizobial or Rickettsial bacteria gave rise to mitochondria

- ✓ Cyanobacteria (prochlorobacteria) gave rise to chloroplasts

- ✓ 3. Lynn Margulis suggested spirocheates gave rise to eukaryotic flagella

- ✓ Peroxisome maybe endosymbiotic

Testing the Hypothesis -

Chlorella inside a *Paramecium*

Cyanophera - 50,000 - 1 million years -

still have peptidoglycan

15% DNA compare to 5%



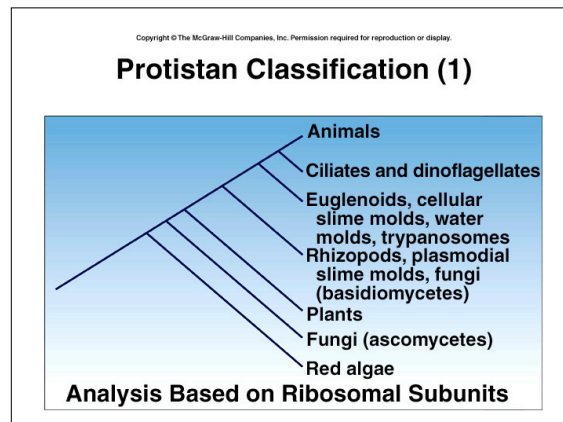
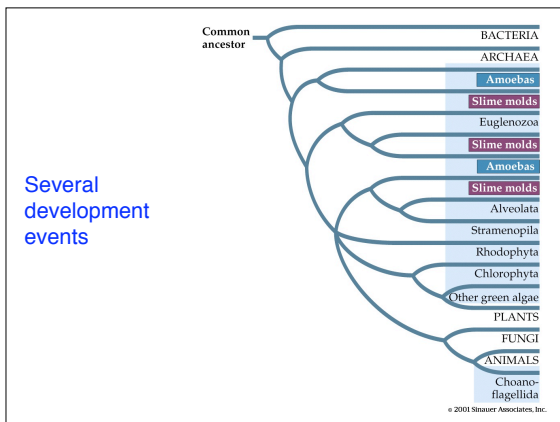
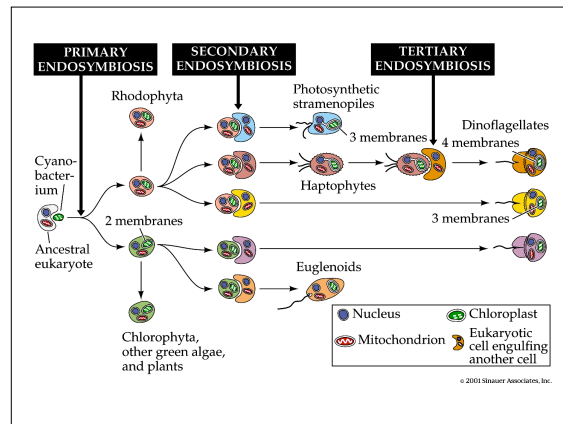
Testing the Hypothesis -

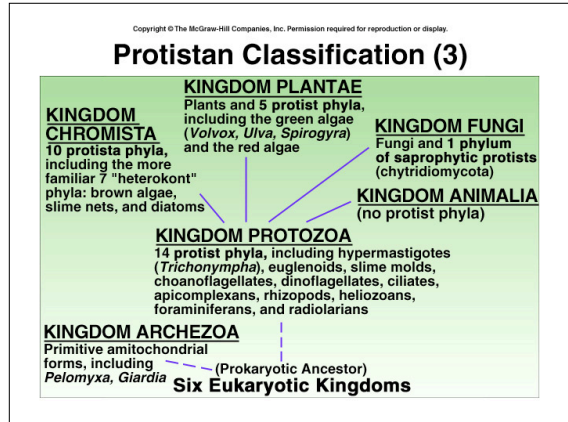
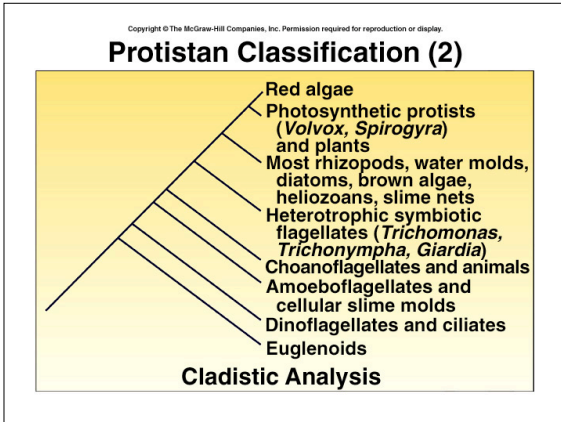
- ✓ Coral bleaching

- Symbiotic relationship with dinoflagellates

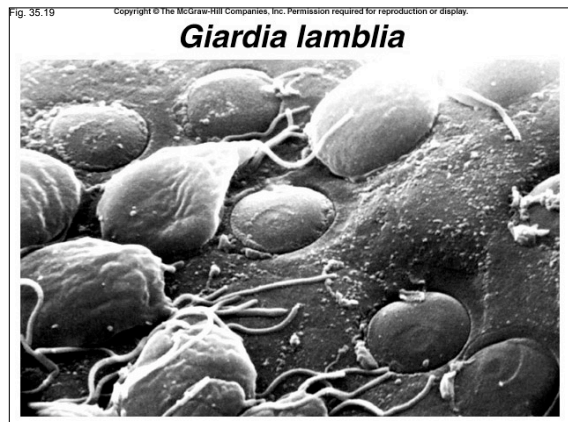
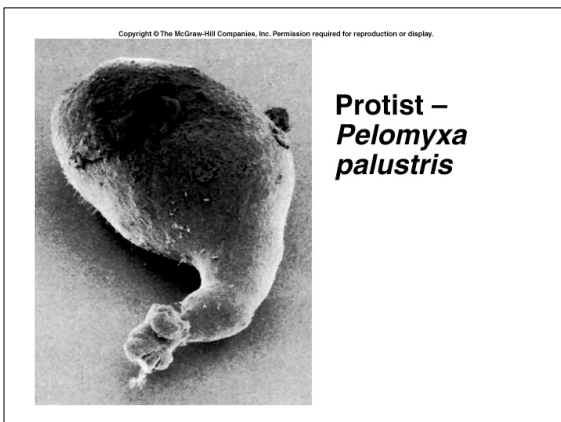
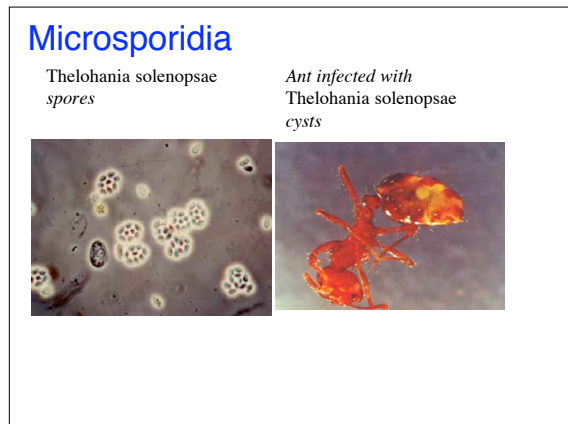
- ✓ Treatment with chloramphenicol

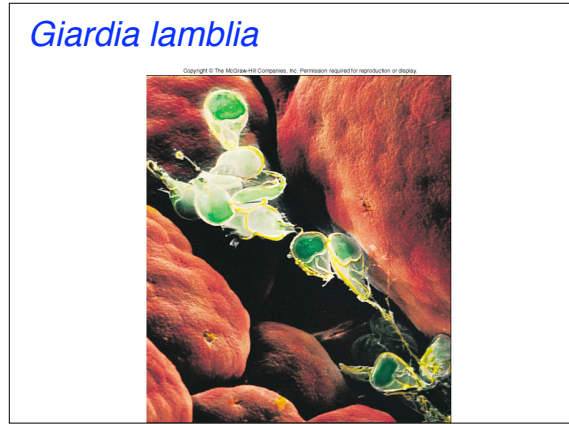
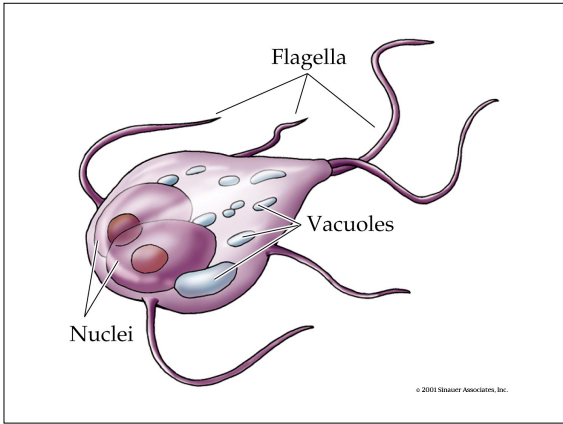
- Kills chloroplasts






- ### Protists
- ✓ Kingdom Archezoa
 - ☐ No Endoplasmic reticulum and Golgi
 - ☐ No mitochondria
 - ☐ 70s ribosomes
 - Phylum Microsporidia
 - ☐ Nonmotile, cyst forms; no cilia, no lysosomes, no centrioles
 - ☐ *Nosema*
 - Phylum Archaemoeba
 - ☐ Pseudopodia, Lysosomes, centrioles, no cysts, non-functional cilia
 - ☐ *Chaos*, *Pelomyxa*
 - Phylum Metamonada
 - ☐ Lysosomes, centrioles, flagella, two nuclei, and cyst forms
 - ☐ *Giardia*





Protists

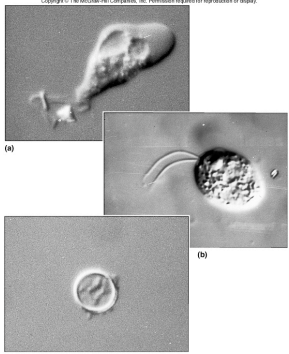
- ✓ Kingdom Protozoa
 - ER, Golgi, and usually mitochondria
- Phylum Percolozoa
 - 70s ribosomes, mitochondria, no Golgi, contaminated water (swimming)
 - Naegleria fowleri
- Phylum Parabasalia
 - 70s ribosomes, hydrogenosomes (makes ATP via hydrogen metabolism), and Golgi attached to ciliary root (parabasal body)
 - Trichonympha



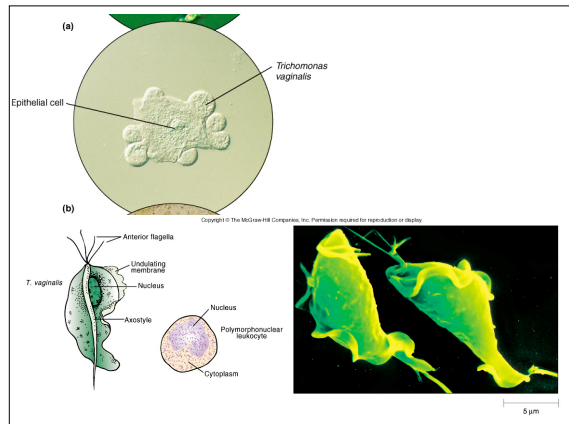
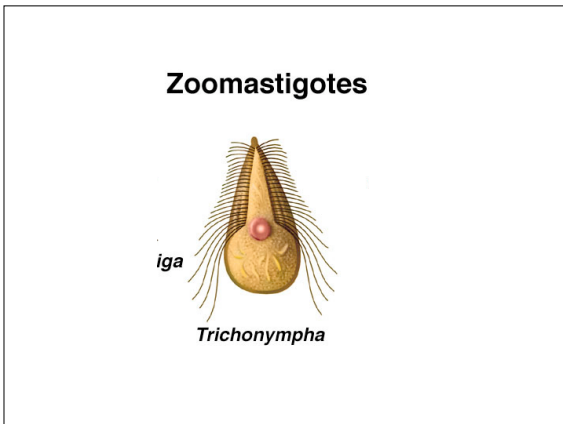
Plasticity (polymorphism)

Naegleria has many forms

- Human tissue - ameba
- Water - flagella
- Adverse conditions - cyst



Three micrographs labeled (a), (b), and (c) showing Naegleria in different forms: (a) ameba in human tissue, (b) flagella in water, and (c) cyst in adverse conditions. A copyright notice for © The McGraw-Hill Companies, Inc. is visible at the top center.



Protists

✓ Phylum Euglenozoa

- 80s ribosomes, hnRNA is tran-spliced instead of cis-spliced

- Sub-phylum Euglenoida

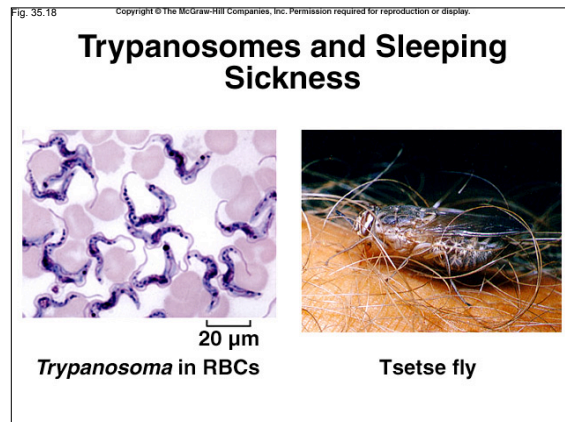
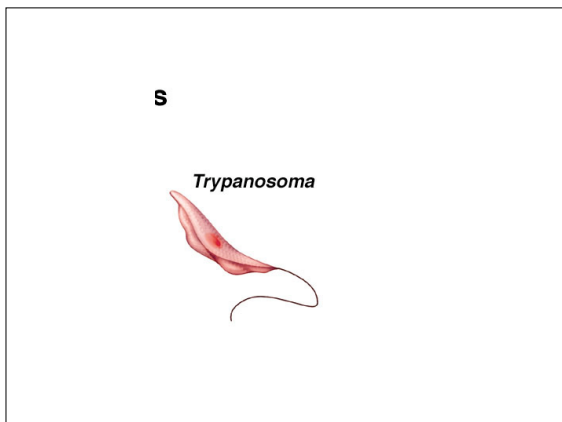
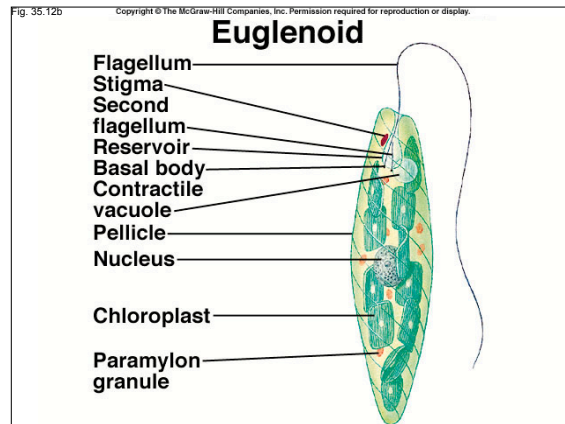
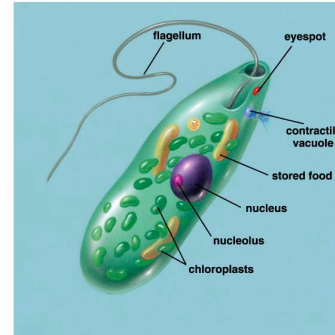
- Photosynthetic with 3 membrane chloroplasts, chlorophylls a and b, β-carotene, and xanthin pigments, paramylon (starch), pellicle, mitochondrial cristae discoid, two flagella (one short connected to the eyespot),

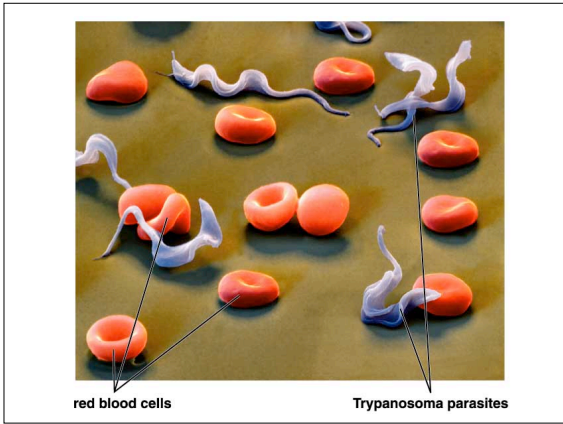
- Euglena*

- Sub-phylum Kinetoplasta

- No Chloroplasts, but chloroplast DNA in their genomes, 1 or 2 kinetoplasts (organelles within mt that contain plasmid-like DNA) in their mitochondria,

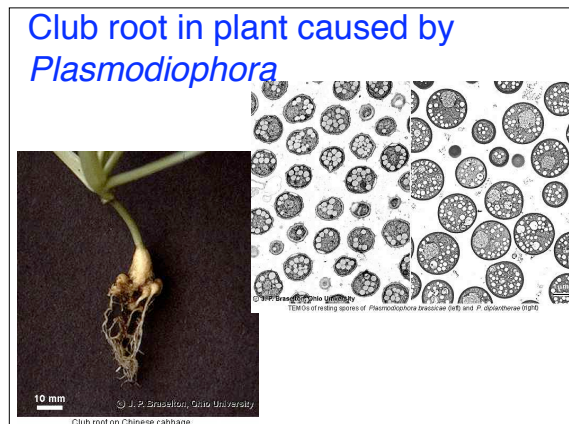
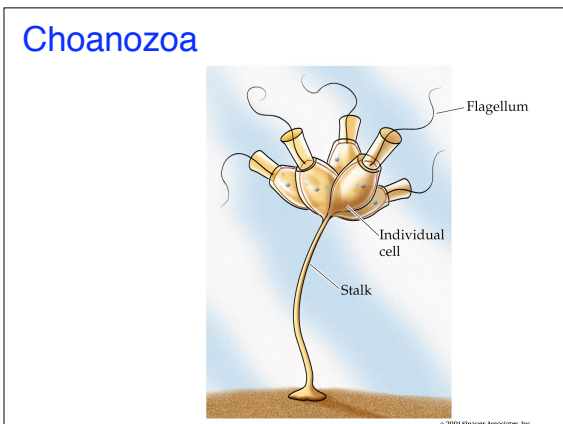
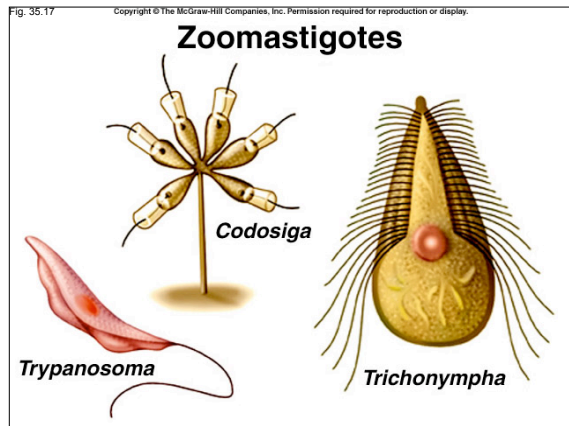
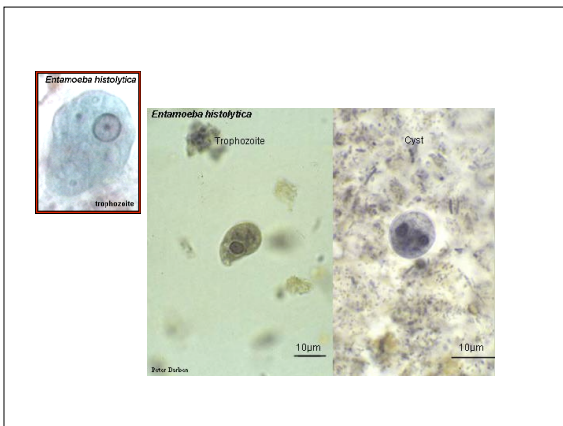
- Trypanosomes





Protists

- ✓ Phylum Entamoebia
 - 80s ribosomes, cis-spliced introns, lost of mt and peroxisomes, Golgi reduced or missing,
 - *Entamoeba histolytica*
- ✓ Phylum Choanozoa
 - Mt cristae flat, but not discoid, single flagellum surrounded by collar of microvilli, free living or colonial, ancestor to animals (sponges)
- ✓ Phylum Opalozoa
 - Small cilia-like flagella; parabasal body
 - *Opalina* and *Plasmodiophora brassicae* in cabbage



Protists

✓ Phylum Mycetozoa

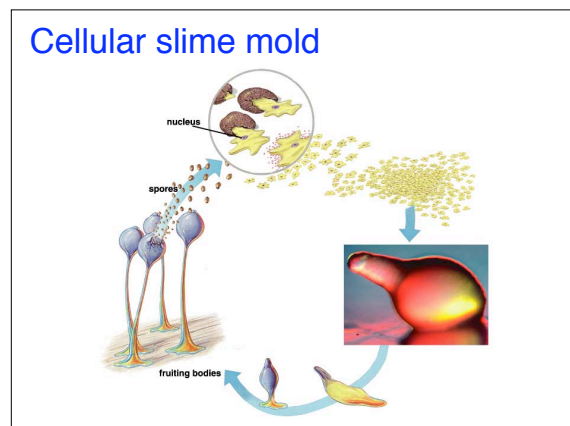
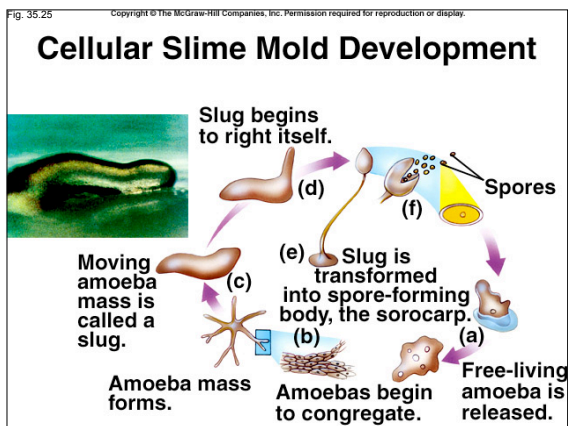
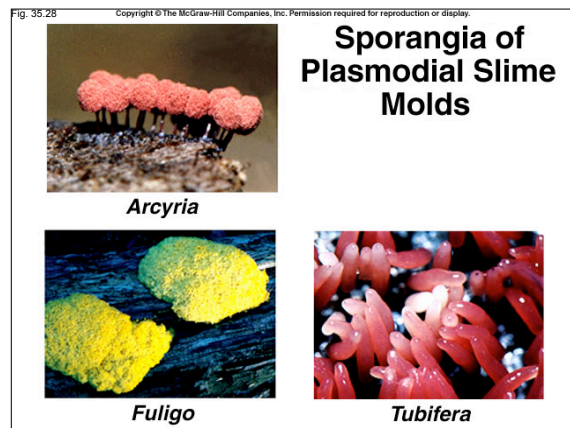
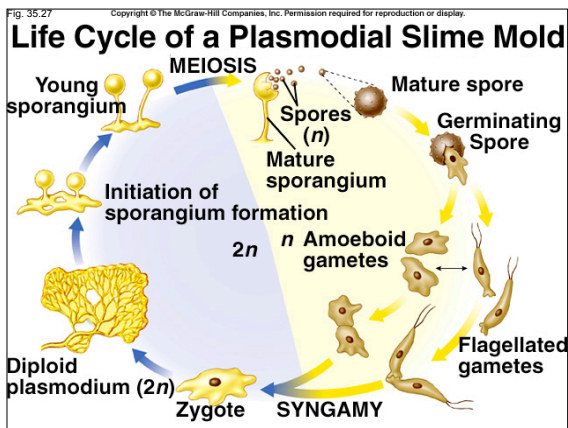
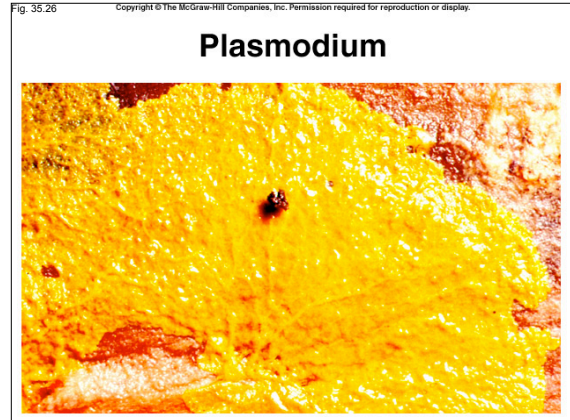
↳ Pseudopodia not fixed by microtubules into axopodia or reticulopodia, aerial fruiting bodies bearing spores

• Class Myxogastrea

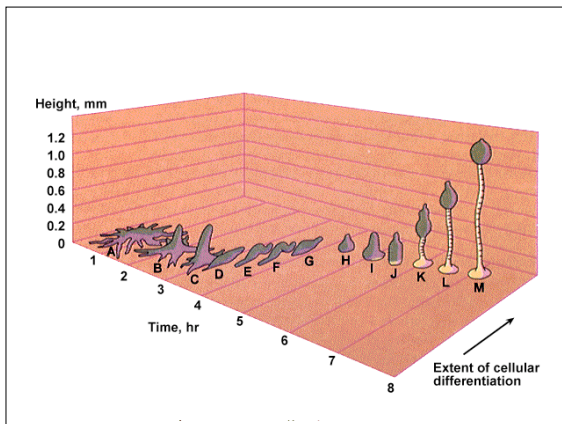
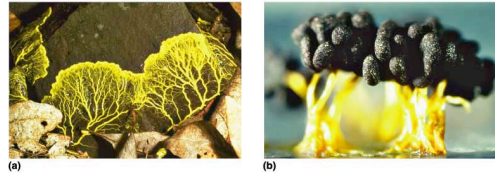
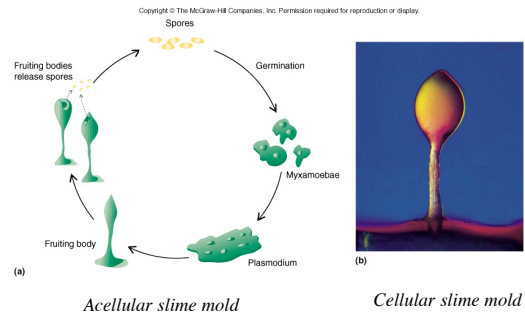
↳ Plasmodial (acellular) slime molds
↳ *Physarium*, *Arcyria*, *Stemonitis*

• Class Dictyostelium

↳ Cellular slime molds
↳ *Dictyostelium*



Slime molds

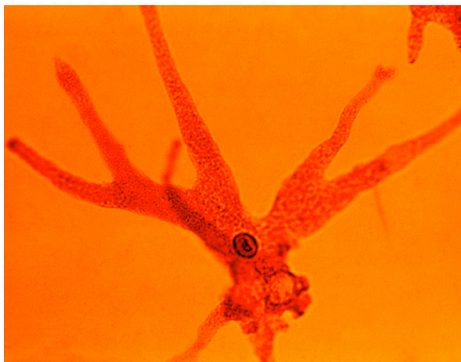


Protists

- ✓ Phylum Rhizopoda
 - Unicellular amoeba, no aggregation, no aerial fruiting bodies, pseudopodia not fixed into long arrays by microtubules,
 - *Amoeba proteus*
- ✓ Phylum Radiozoa
 - Fixed needle-like axopodia supported by microtubules and silica endoskeletons
 - Radiolarians, flint and chert are fossil beds
- ✓ Phylum Reticulosa
 - Net-like reticulopodia supported by microtubules, test of CaCO_3 , Cliffs of Dover,
 - Foraminiferans

Fig. 35.7 Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Amoeba Proteus



Amoeba

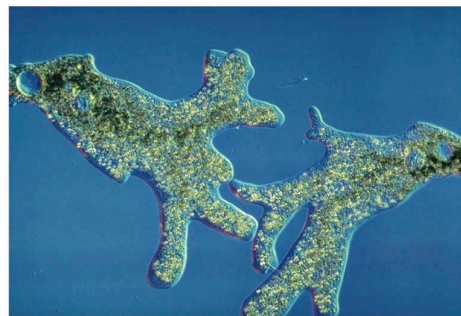
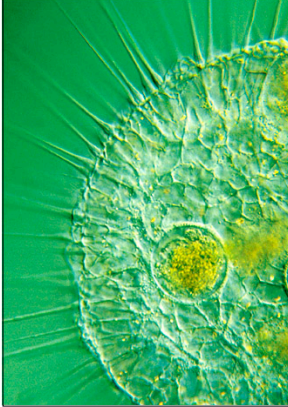
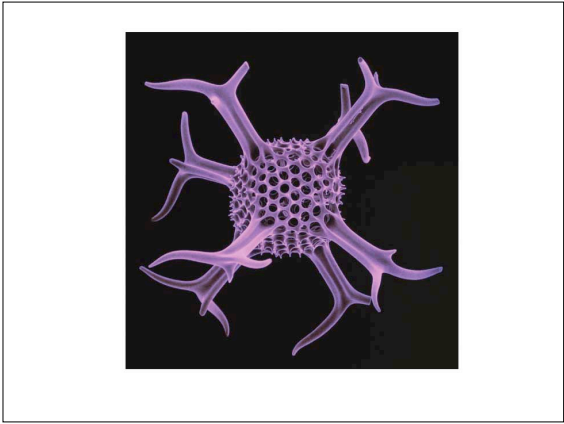
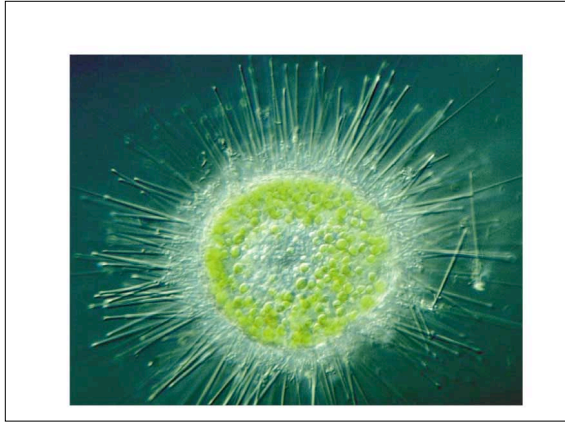


Fig. 35.8

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Protist—*Actinosphaerium*



Radialarians (hard silica)

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

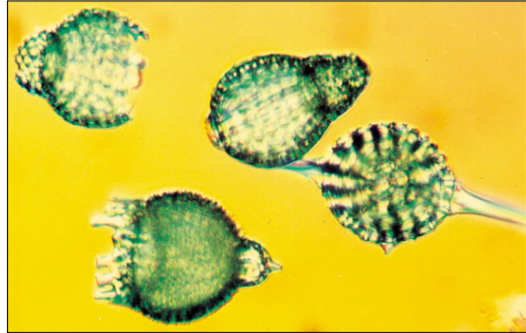
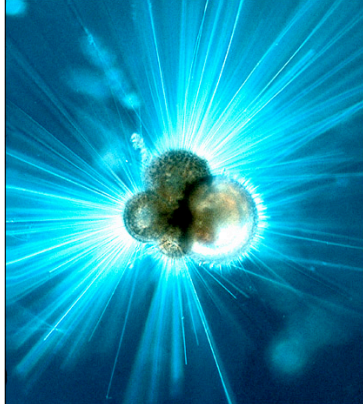


Fig. 35.9

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



**A
Foraminifera**

Fig. 35.10

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

White Cliffs of Dover



Protists

✓ Super phylum Alveolata

↳ Cortical alveoli below the plasma membrane

● Phylum Ciliophora

↳ Multinucleate (macro and micro nuclei), cilia motility and food capture, trichocysts common, contractile vacuoles, cytostome, and cytoproct

↳ *Paramecium*, *Didinium*, *Stentor*, *Vorticella*, *Euplates* (fused cilia in cirri that function like legs)

● Phylum Dinazoa (Pyrrophyta)

↳ Mononucleate, some photosynthetic, 3 membrane chloroplasts, chlorophylls a and c2, carotenoid pigments (brownish peridinin), many with cellulose plates, two flagella in perpendicular grooves, food stored as starch

↳ *Ceratium* & *Peridinium* are phytoplankton, *Progonyalax* & *Gymnodinium* produce saxitoxin (red tide), *Noctiluca* & *Gonyalax* produce luminescence

Fig. 35.20

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Ciliate – *Stentor*



Fig. 35.21

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Ciliate – *Paramecium*

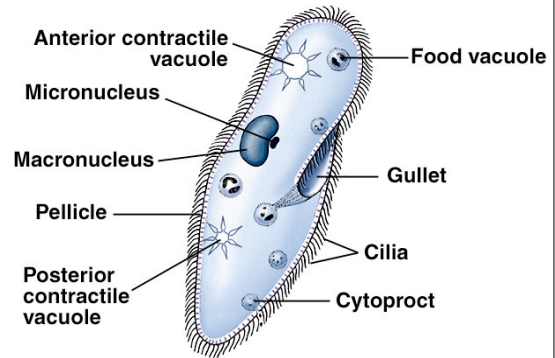


Fig. 35.22a

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Paramecium Reproduction



Asexual reproduction



Sexual reproduction

Fig. 35.22b

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Two *Paramecium* individuals of different mating types come into contact.

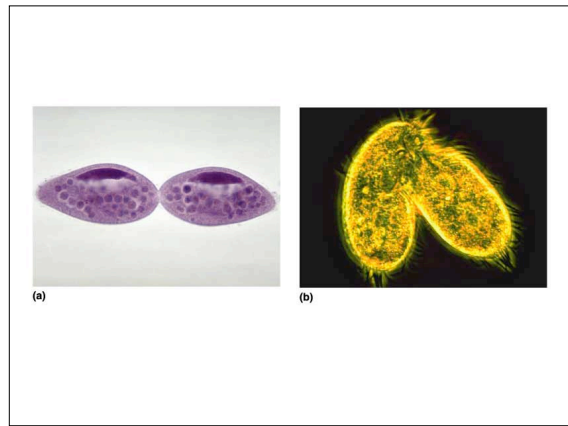
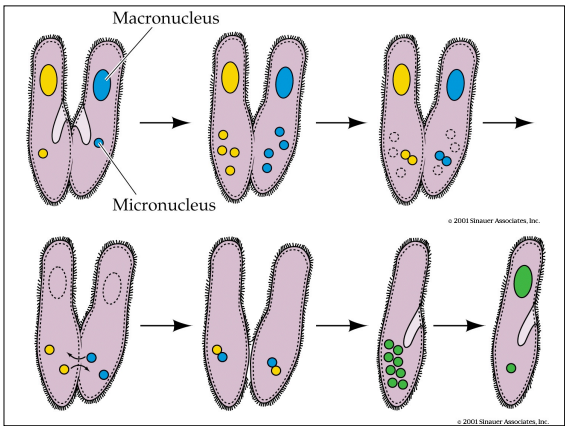
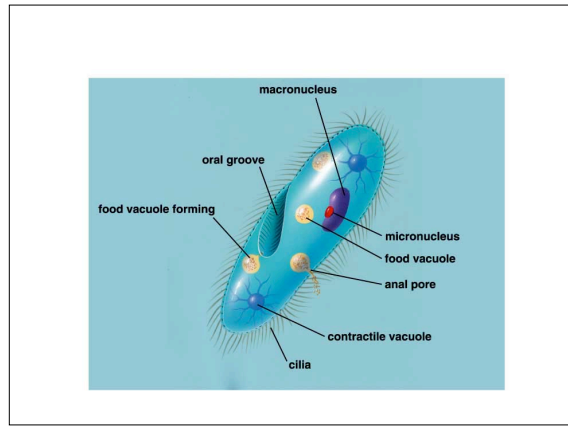
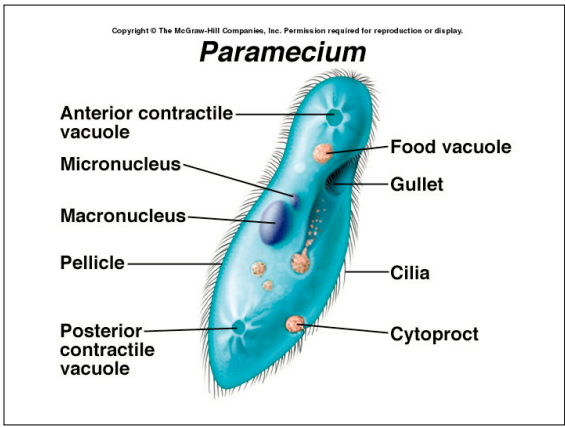
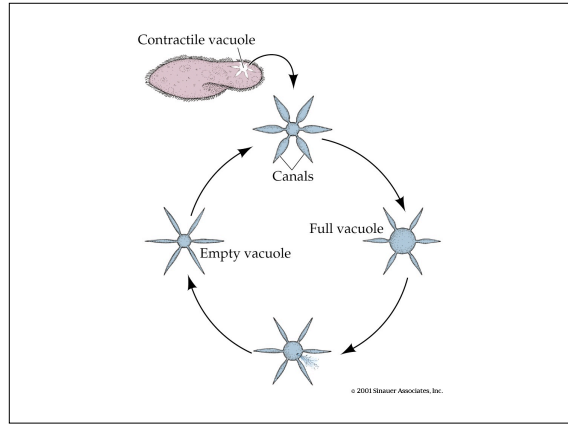
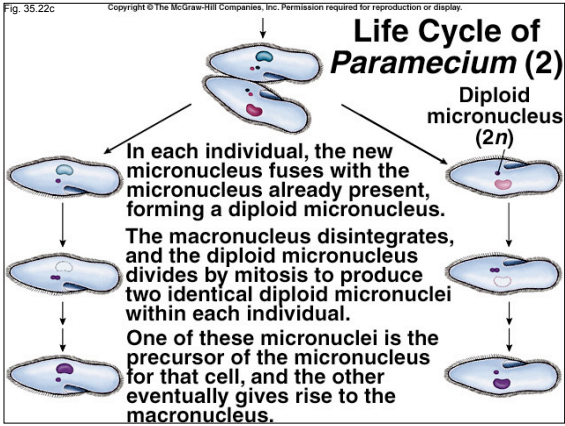
The diploid micronucleus in each divides by meiosis to produce four haploid micronuclei.

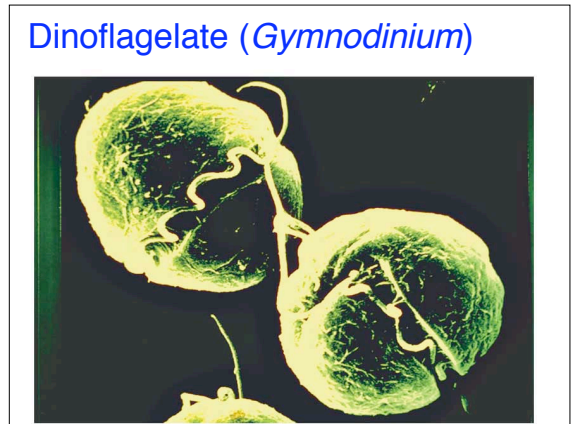
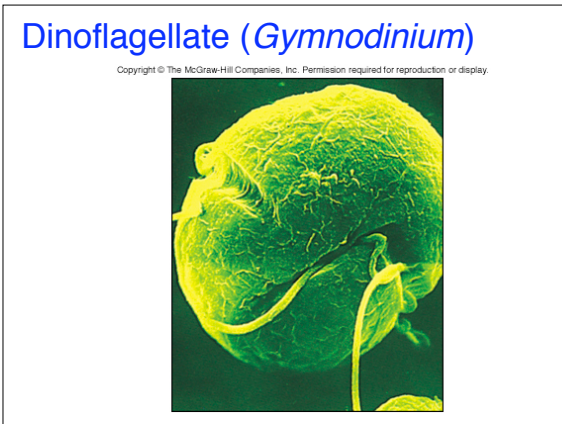
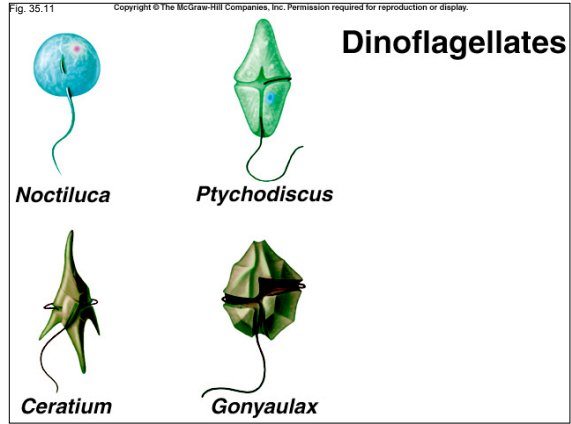
Three of the haploid micronuclei degenerate. The remaining micronucleus in each divides by mitosis.

Mates exchange micronuclei.



Life Cycle of *Paramecium* (1)

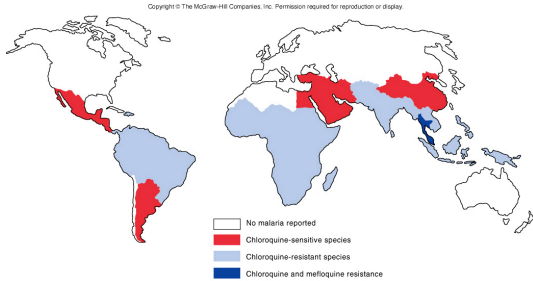




Protists

- ✓ Phylum Sporozoa (Apicomplexa)
 - Non-motile, vectored by arthropods, complex life cycles,
 - ↳ Subphylum Hematozoa
 - Centrioles with 9 triplets of microtubules
 - Malaria, *Plasmodium*;
 - ↳ Subphylum Sporozoa
 - Reduced centrioles with 9 singlet microtubules
 - Toxoplasmosis, *Toxoplasma gondii*; *Cryptosporidium*

Malaria distribution in 1996



Malaria

- ✓ 1955 - WHO began eradication
 - Insecticides such as DDT
 - Treating infected patients
 - 10/52 nations eradicated malaria
 - Bureaucracy and complacency and resistance
- The program failed in 1976
- ✓ Today - 3 million people die/year
- ✓ 300-500 million are infected/year

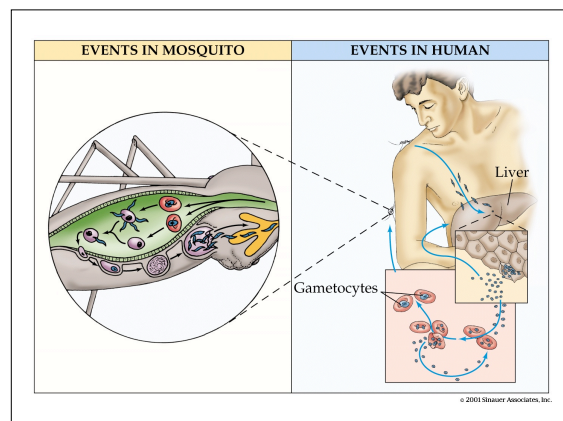
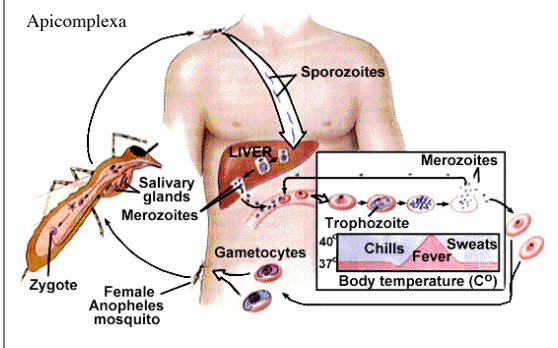
Malaria

- ✓ Organism
 - *Plasmodium vivax*
 - *Plasmodium falciparum*
 - *Plasmodium malariae*
 - *Plasmodium ovale*
- ✓ Non-motile

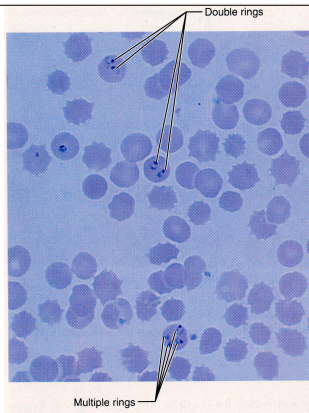
Malaria

- ✓ Transmission
 - Infected female *Anopheles* mosquito
 - Sharing needles
 - blood transfusions
- ✓ Resistance
 - Some lack the receptors on their RBC
 - Sickle cell anemia

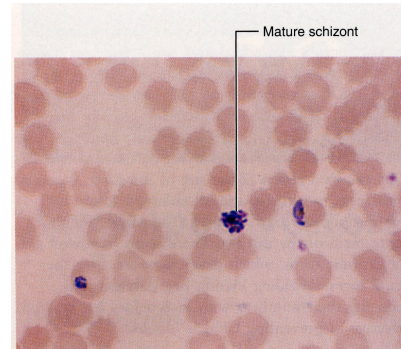
Life cycle of *Plasmodium* (malaria)



Trophozoite



Schizont



Malaria

✓ Sign/symptoms

- Incubation is about 1-2 weeks
 - Flu-like - fever, headache, pain in joints, and muscles - last for about 3 weeks
 - Cold phase - Cold chills for an hour
 - Hot phase - high fever (104°F)
 - Wet phase - temp fall and sweating occurs
 - Repeats every 48-72 hrs
- RBC become rigid, capillaries get plugged, tissue oxygen deprivation, anemia, enlarged spleen

Malaria

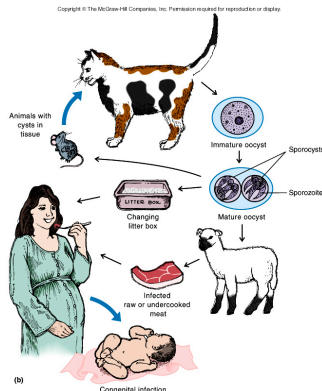
✓ Treatment

- Chloroquine - while living in endemic areas
- Primaquine - after leaving endemic areas
- Mefloquine + doxycycline
- Quinine

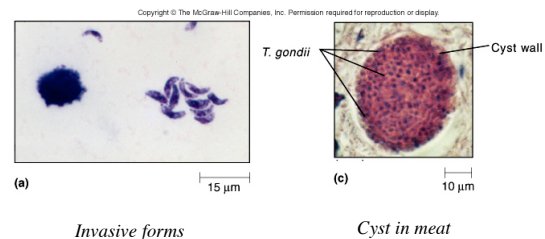
✓ Prevention

- DEET
- Insecticide covered netting

Toxoplasma gondii



Toxoplasma gondii



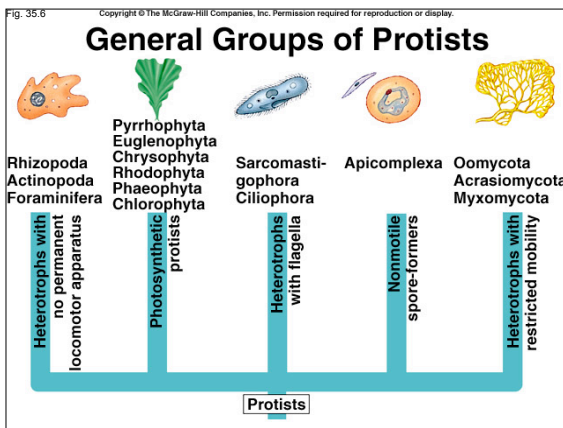
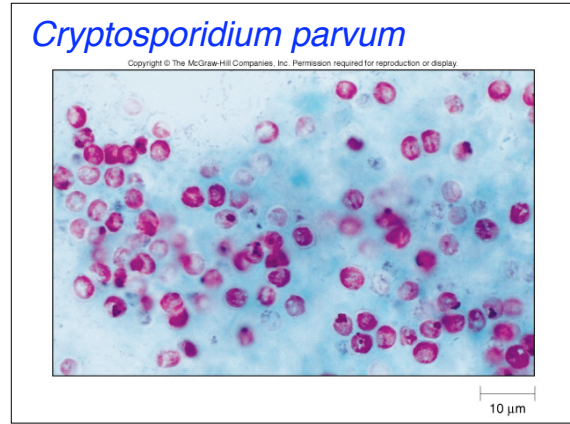
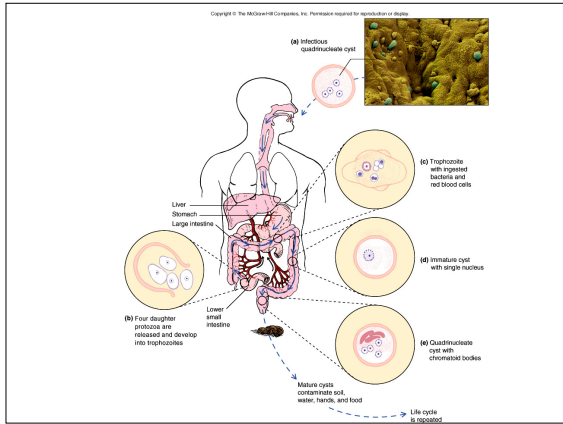
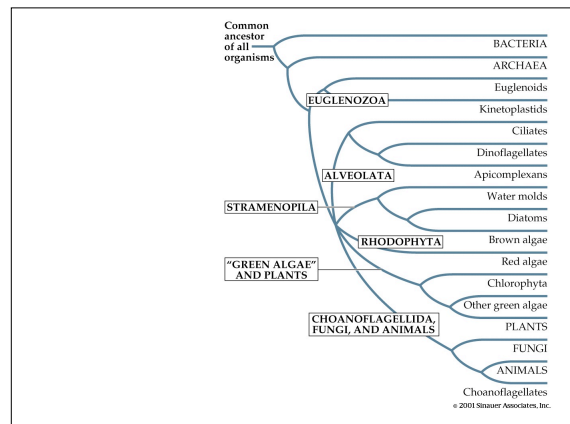


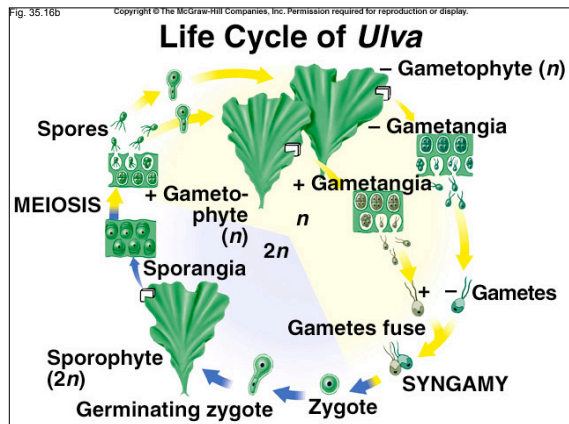
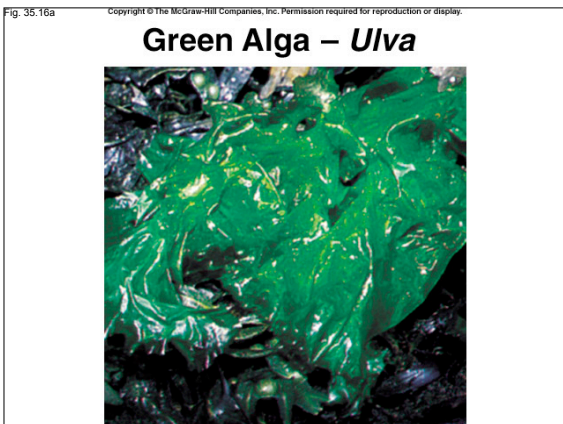
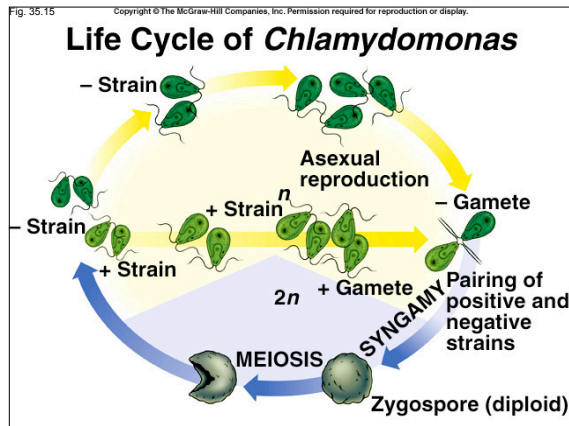
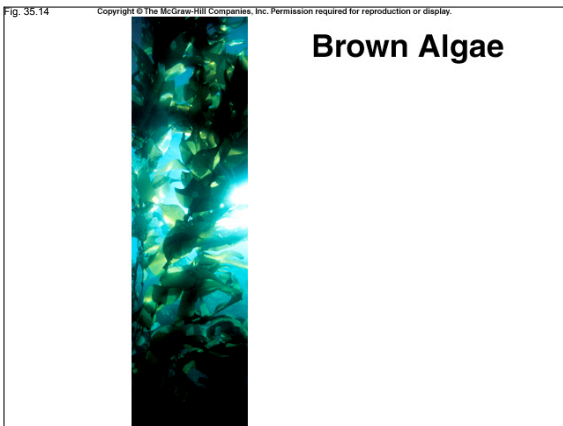
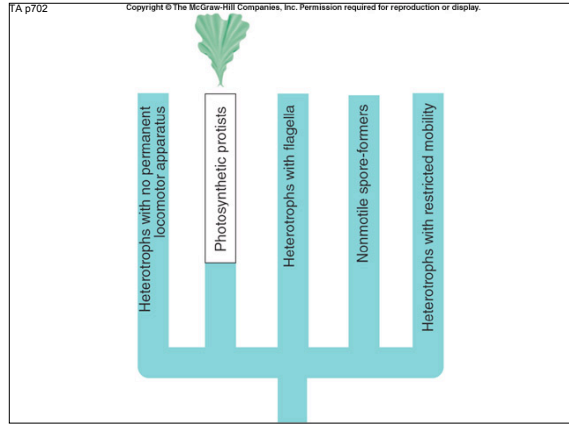
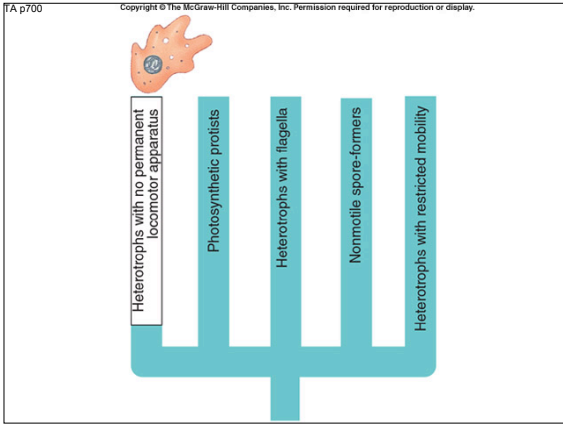
Table 35.1 Kinds of Protists

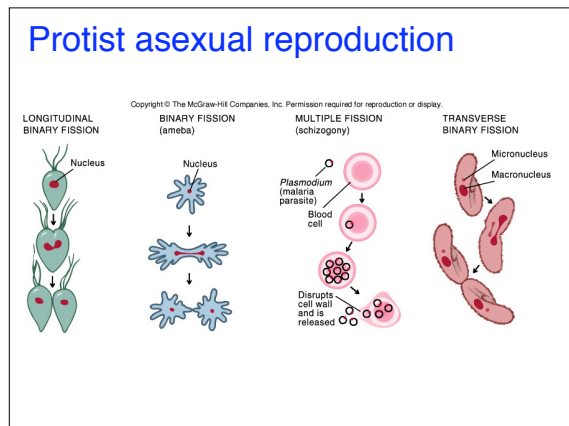
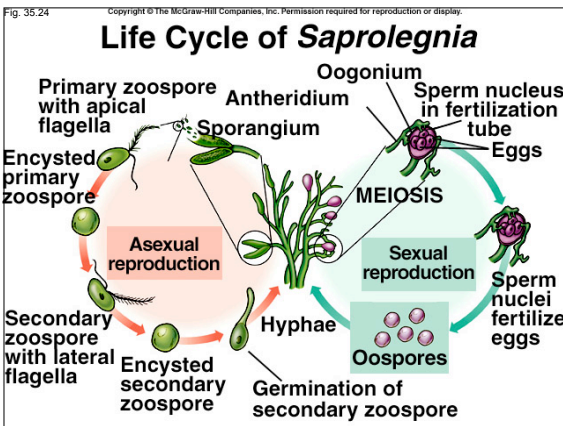
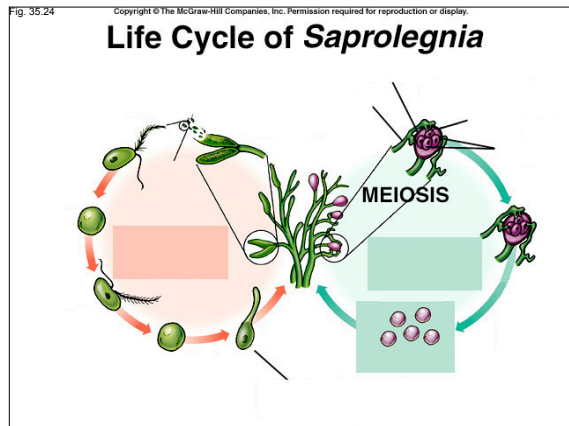
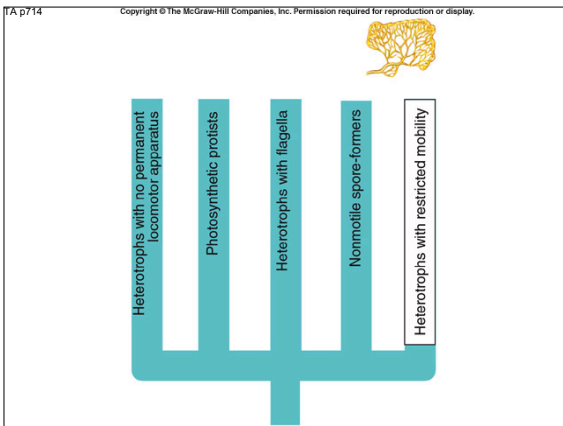
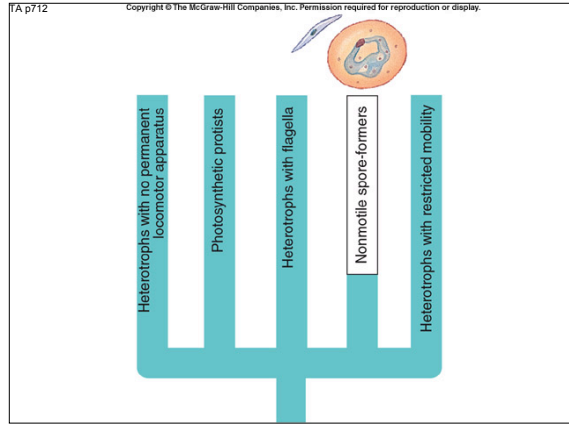
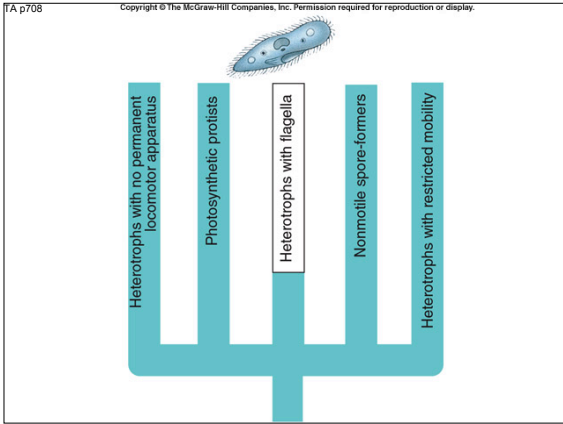
Group	Phylum	Typical Examples	Key Characteristics
HETEROTROPHS WITH NO PERMANENT LOCOMOTOR APPARATUS			
Amoebas	Rhizopoda	<i>Amoeba</i>	Move by pseudopodia
Radiolarians	Actinopoda	Radiolarians	Glassy skeletons; needlelike pseudopods
Forams	Foraminifera	Forams	Rigid shells; move by protoplasmic streaming
PHOTOSYNTHETIC PROTISTS			
Dinoflagellates	Pyrrophyta	Red tides	Photosynthetic; unicellular; two flagella; contain chlorophylls <i>a</i> and <i>b</i>
Euglenoids	Euglenophyta	<i>Euglena</i>	Some photosynthetic; others heterotrophic; unicellular; contain chlorophylls <i>a</i> and <i>b</i> or none
Diatoms	Chrysophyta	<i>Diatoma</i>	Unicellular; manufacture the carbohydrate chrysolaminarin; unique double shells of silica; contain chlorophylls <i>a</i> and <i>c</i>
Golden algae	Chrysophyta	Golden algae	Unicellular, but often colonial; manufacture the carbohydrate chrysolaminarin; contain chlorophylls <i>a</i> and <i>c</i>
Red algae	Rhodophyta	Coralline algae	Most multicellular; contain chlorophyll <i>a</i> and a red pigment
Brown algae	Phaeophyta	Kelp	Multicellular; contain chlorophylls <i>a</i> and <i>c</i>
Green algae	Chlorophyta	<i>Chlamydomonas</i>	Unicellular or multicellular; contain chlorophylls <i>a</i> and <i>b</i>

Table 35.1 Kinds of Protists (continued)

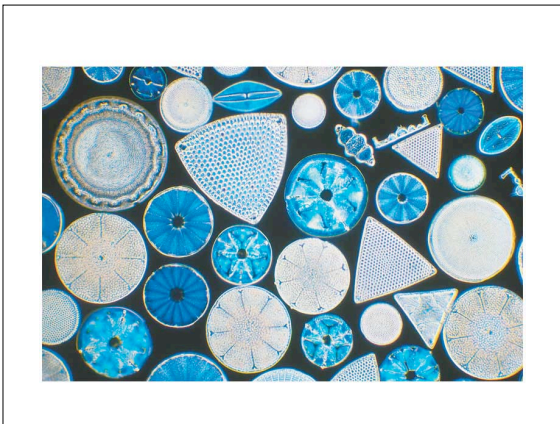
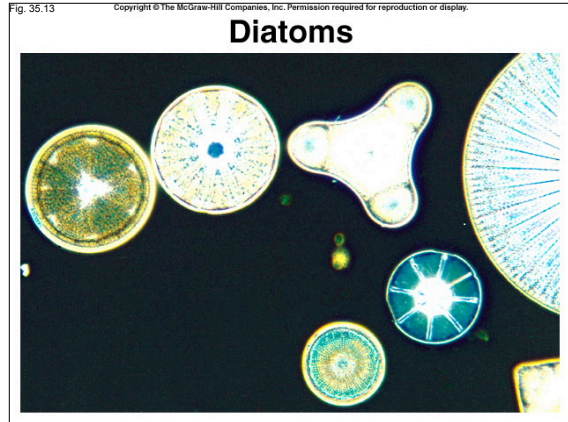
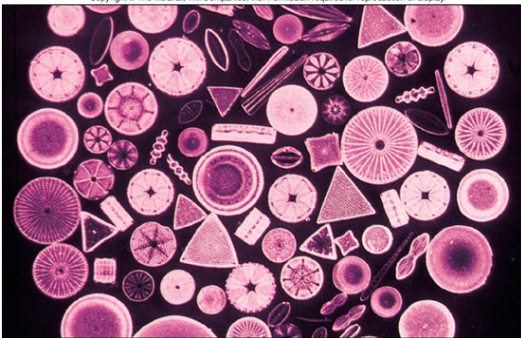
Group	Phylum	Typical Examples	Key Characteristics
HETEROTROPHS WITH FLAGELLA			
Zooastigotes	Sarcostigophora	Trypanosomes	Heterotrophic; unicellular
Ciliates	Ciliophora	<i>Paramecium</i>	Heterotrophic unicellular protists with cells of fixed shape possessing two nuclei and many cilia; many cells also contain highly complex and specialized organelles
NONMOTILE SPORE-FORMERS			
Sporozoans	Apicomplexa	<i>Plasmodium</i>	Nonmotile; unicellular; the apical end of the spores contains a complex mass of organelles
HETEROTROPHS WITH RESTRICTED MOBILITY			
Water molds	Oomycota	Water molds, rusts, and mildew	Terrestrial and freshwater
Cellular slime molds	Acrasiomycota	<i>Dictyostelium</i>	Colonial aggregations of individual cells; most closely related to amoebas
Plasmodial slime molds	Myxomycota	<i>Fuligo</i>	Stream along as a multinucleate mass of cytoplasm



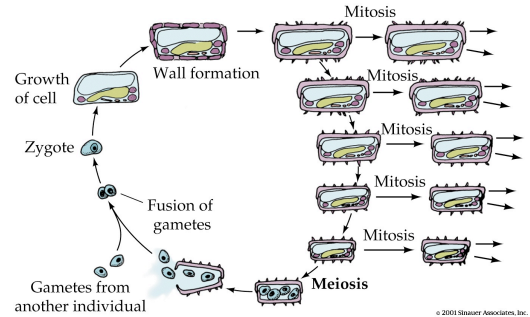




Diatoms



Diatom reproduction



The End.