Lecture (8) Protozoa

Definition .1
Properties .2
Structures .3
Shapes .4
Nutrition .5
Reproduction .6
Motility .7
Classification .8
Identification .9
Importance and impacts .10

Protozoa

- Eukaryotic
- cell is much larger and more complex than prokaryotic cell and contains a variety of organelles

(Golgi apparatus, mitochondria, ribosomes, etc).

- Unicellular
- They lack a cell wall
- Vegetative form is a trophozoite

Protozoa

- Asexual reproduction occurs by mitotic division.
- Some have true sexual reproduction with zygote formation
- Protozoa include both autotrophs and heterotrophs. They include free-living and parasitic forms.
- Protozoa move mainly using cilia or flagella and by using pseudopodia
- Cilia also used for feeding in many small metazoans.

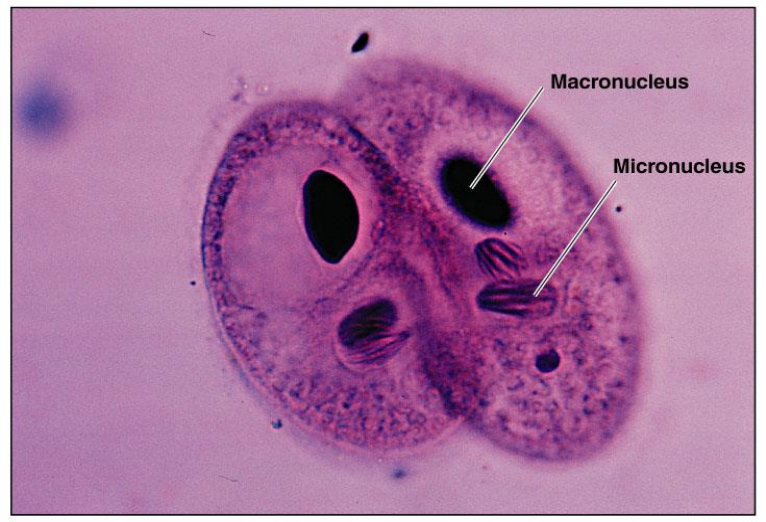
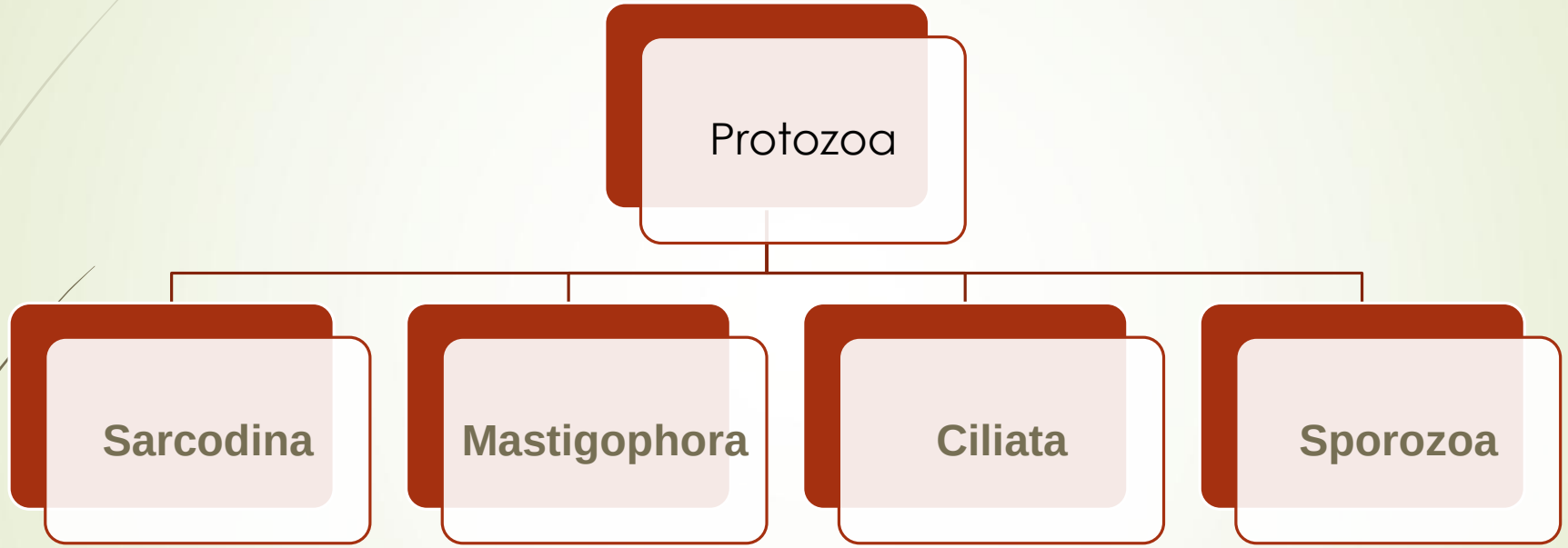


Figure 12.16

The Protozoa

- There are about 45,000 protozoan species; around 8000 are parasitic, and around 25 species are important to humans.
- Diagnosis - must learn to differentiate between the harmless and the medically important. This is most often based upon the morphology of respective organisms.
- Transmission - mostly person-to-person, via fecal-oral route; fecally contaminated food or water; other means include sexual transmission, insect bites or insect feces.


Protozoa
Sarcodina
Mastigophora
Ciliata
Sporozoa

Protozoa is classified into four subdivisions according to the methods of locomotion.

- (Sarcodina) The amoebae move by means of pseudopodia.
- (Mastigophora) The flagellates typically move by long, whiplike flagellae.
- (Ciliata) The ciliates are propelled by rows of cilia that beat with a synchronized wavelike motion.
- (Sporozoa) The sporozoans lack specialized organelles of motility.

Protozoa that enter the body via ingestion have two morphological forms

- Trophozoite
  - Feeding and reproducing stage that lives within the host
- Cyst
  - Infective form that survives in the environment

The Protozoa

- Trophozoite - the motile vegetative stage; multiplies via binary fission; colonizes host.
- Cyst - the inactive, non-motile, infective stage; survives the environment due to the presence of a cyst wall. Cysts do not multiply, however, some organisms divide within the cyst wall.

The Protozoa

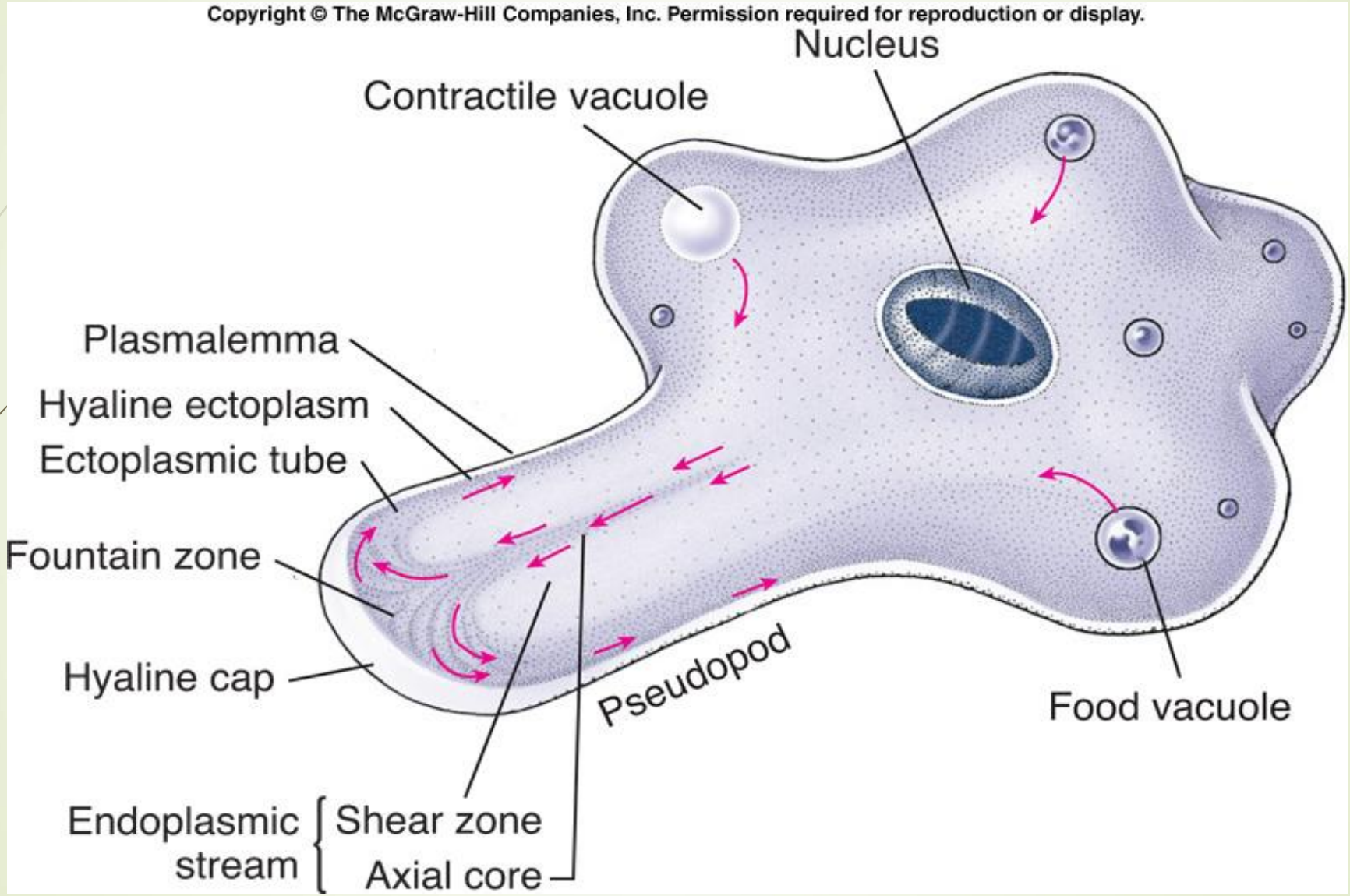
Diagnostic Features:

- Nuclear structure - important in species differentiation.
- Size - helpful in identifying organisms; must have calibrated objectives on the microscope in order to measure accurately.
- Cytoplasmic inclusions - chromatoid bars (coalesced RNA) food vacuoles containing bacteria, yeast, etc.
- Appearance of cytoplasm - smooth & clean or vacuolated.
- Type of motility - directional or non-directional; sluggish or fast.

Pseudopodia

- Amoeboid movement involves endoplasm and ectoplasm. Endoplasm is more fluid than ectoplasm which is gel-like.

- When a pseudopodium forms, an extension of ectoplasm appears and endoplasm flows into it and fountains to the periphery where it becomes ectoplasm. Thus, a tube of ectoplasm forms that the endoplasm flows through. The pseudopodium anchors to the substrate and the organism moves forward.

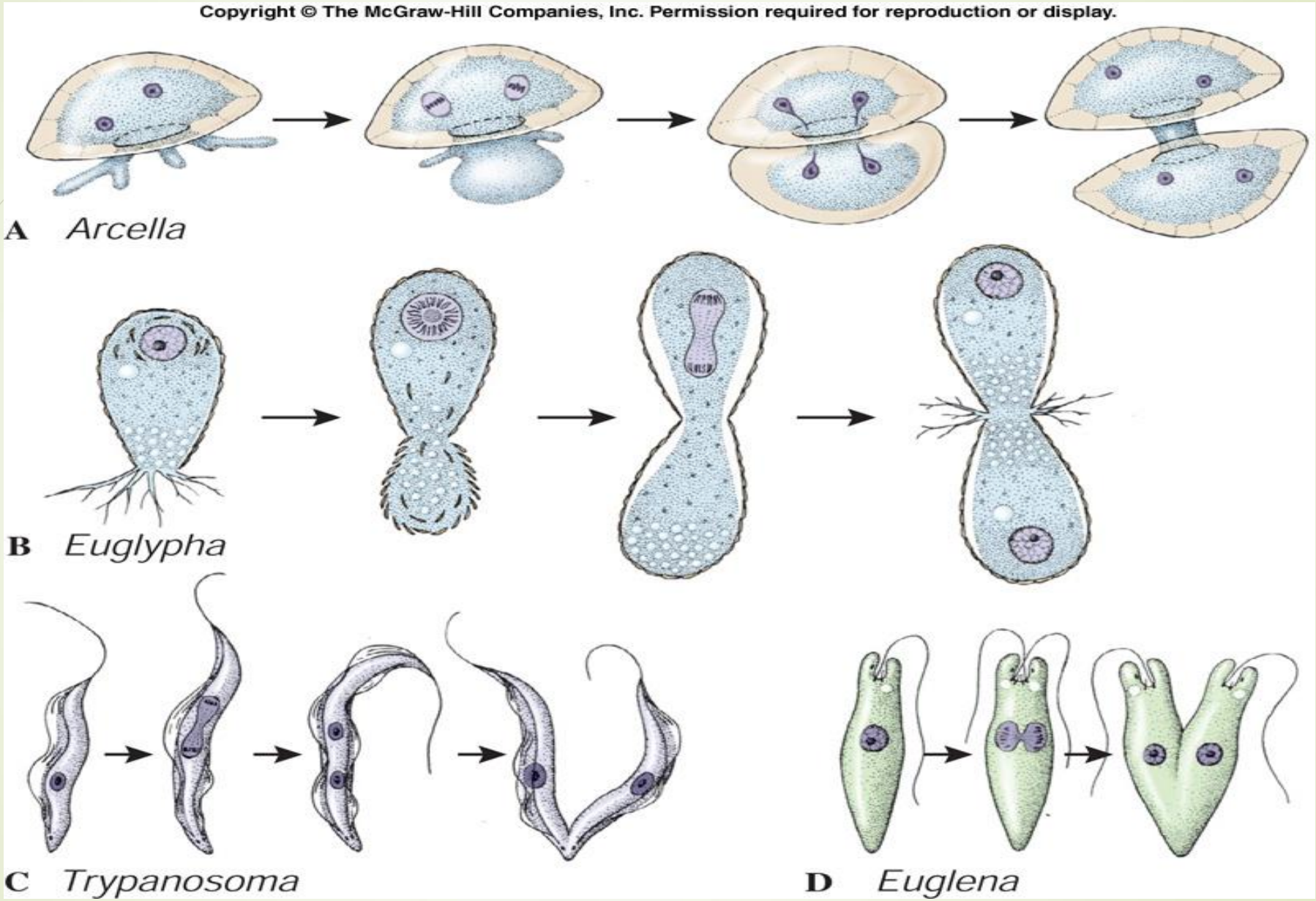


Reproduction in protozoa

- The commonest form of reproduction is ***binary fission*** in which two essentially identical individuals result.

- In some ciliates ***budding*** occurs in which a smaller progeny cell is budded off which later grows to adult size.

Binary fission in various taxa

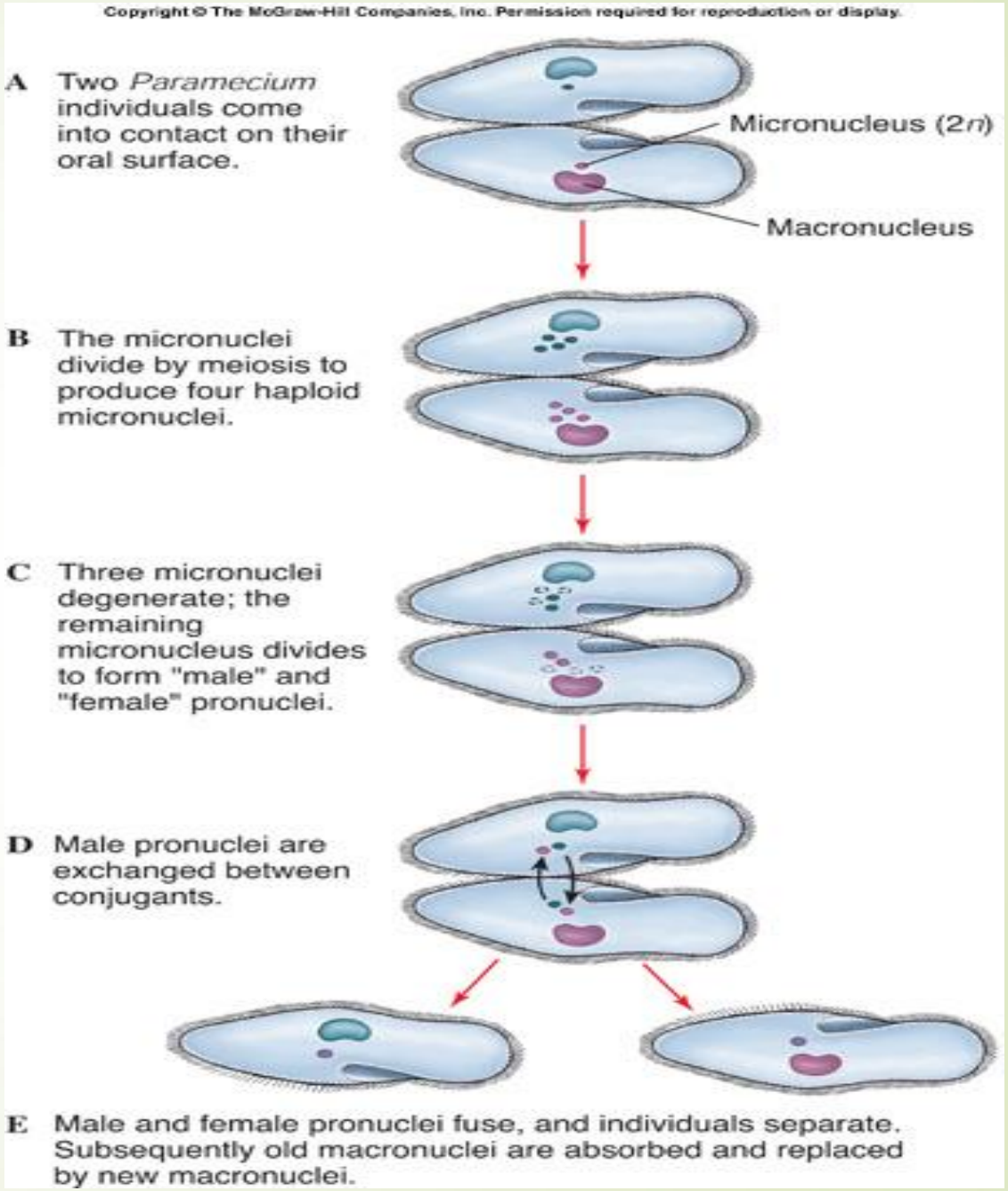


Sexual reproduction in protozoa

- All protozoa reproduce asexually, but sex is widespread in the protozoa too.

- In ciliates such as *Paramecium,* a type of sexual reproduction called conjugation takes place in which two paramecia join together and exchange genetic material

Sexual reproduction



Protozoan Parasites of Humans

Ciliates

- Protozoa that use cilia in their trophozoite stage
- *Balantidium coli*
  - Only ciliate known to cause disease in humans
  - Commonly found in animal intestinal tracts
  - Humans infected by food or water contaminated with feces containing cysts
  - Trophozoites attach to mucosal epithelium lining the intestine
  - Infections generally asymptomatic in healthy adults
  - Balantidiasis occurs in those with poor health
    - Persistent diarrhea, abdominal pain, and weight loss

Protozoan Parasites of Humans

- **Amoebae**
  - Protozoa with no truly defined shape
  - Move and acquire food through the use of pseudopodia
  - Found in water sources throughout the world
  - Few cause disease

Protozoan Parasites of Humans

- **Amoebae**
  - *Entamoeba*
    - Carried in the digestive tracts of humans
    - No animal reservoir exists
    - Infection occurs by drinking water contaminated with feces containing cysts
    - Maintaining clean water is important in prevention

Trophozoite of *Entamoeba histolytica*

Figure 23.2

Protozoan Parasites of Humans

- **Flagellates**
  - Protozoa that possess at least one flagellum
  - Number and arrangement of flagella important to determining the species
  - The flagellates include members of the genera *Trypanosoma, Leishmania, Giardi,* and *Trichomonas*

Protozoan Parasites of Humans

- **Flagellates**
  - *Trypanosoma brucei*
    - Causes African sleeping sickness
    - The insect vector is the tse tse fly
    - Humans usually infected when bitten by infected tse tse flies

The life cycle of *T. brucei*

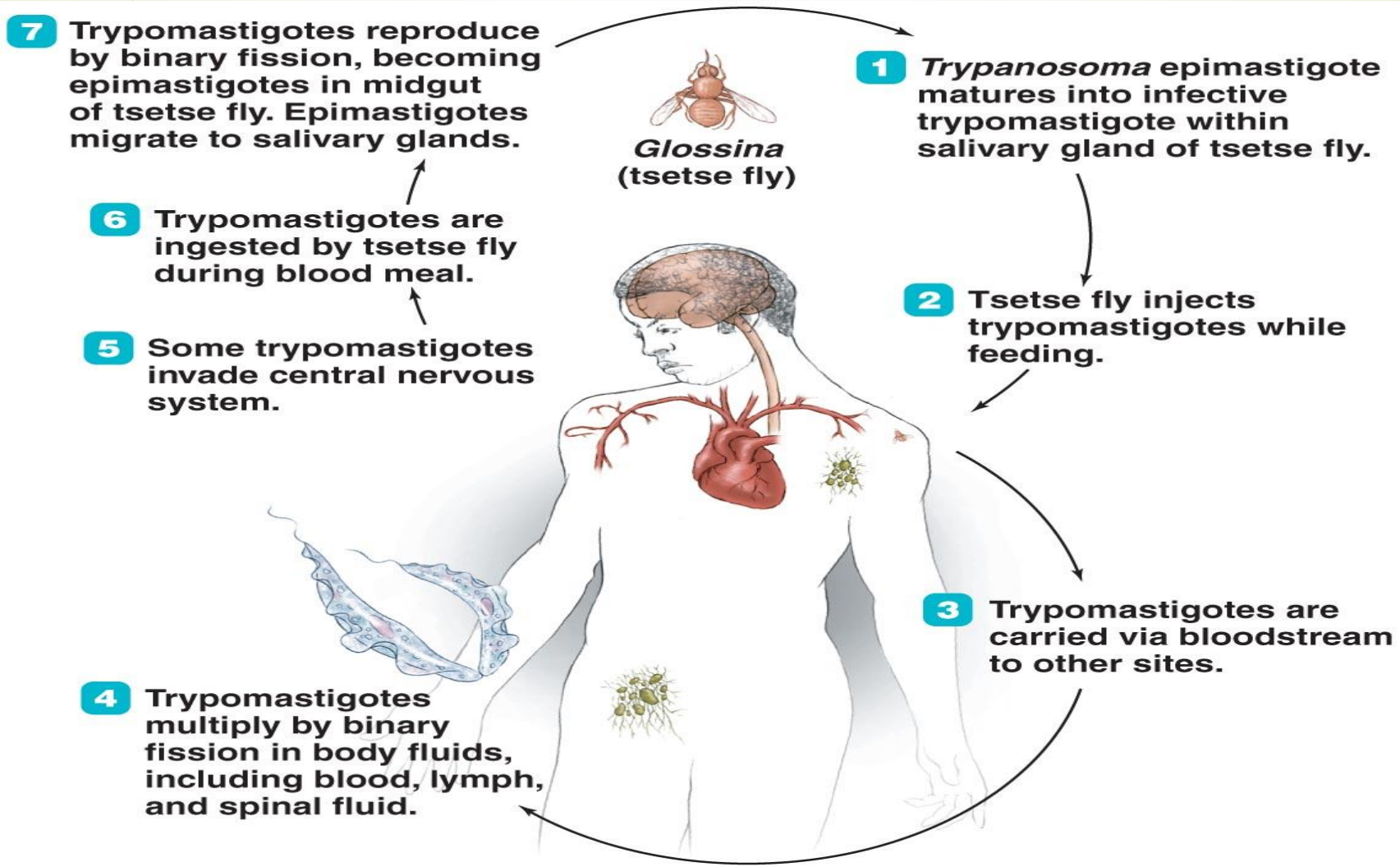


Figure 23.5

Protozoan Parasites of Humans

- **Flagellates**
  - *Trypanasoma brucei*
    - African sleeping sickness
      - Progresses through three stages if left untreated
        - Site of the fly bite becomes a lesion with dead tissue
        - Fever, lymph node swelling, and headaches
        - Meningo-encephalitis
      - Eliminating environments tsetse fly reduce the cases of disease

Protozoan Parasites of Humans

- **Flagellates**
  - *Leishmania*
    - Causes leishmaniasis
    - Endemic in parts of the tropics and subtropics
    - Wild and domestic dogs and small rodents are common hosts
    - *Leishmania* have two developmental stages
      - Amastigotes
        - Multiply in host's macrophages and monocytes
      - Promastigotes
        - Develop extracellularly within a vector's gut

The life cycle of *Leishmania*

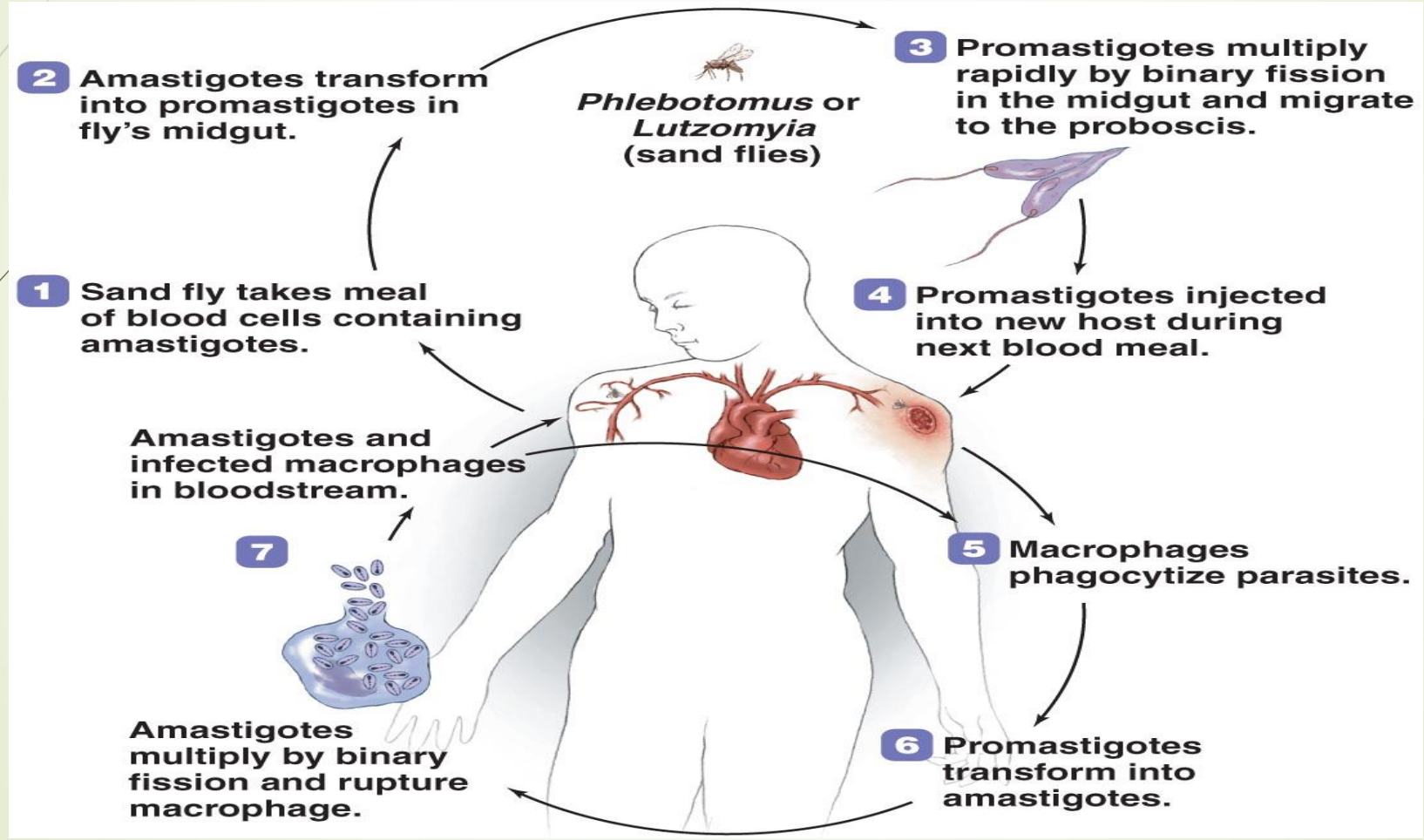


Figure 23.6

Protozoan Parasites of Humans

- **Flagellates**
  - *Leishmania*
    - Three clinical forms of leishmaniasis often observed
      - Cutaneous leishmaniasis
      - Mucocutaneous leishmaniasis
      - Visceral leishmaniasis
    - Most cases of leishmaniasis heal without treatment
    - Prevention limited to reducing exposure to reservoir and vector

Mucocutaneous leishmaniasis

Figure 23.7

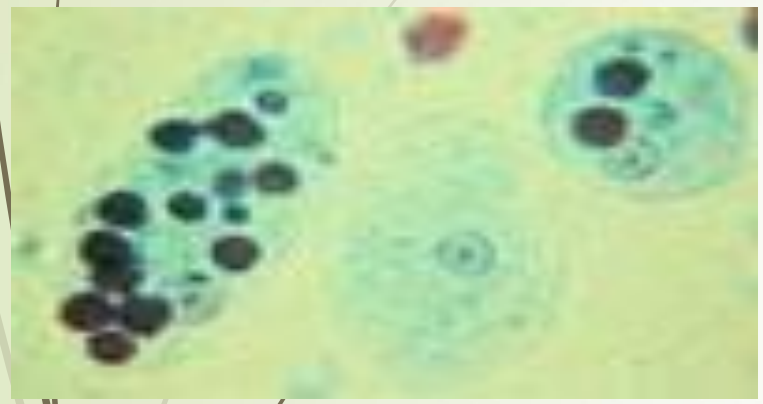
The Protozoa

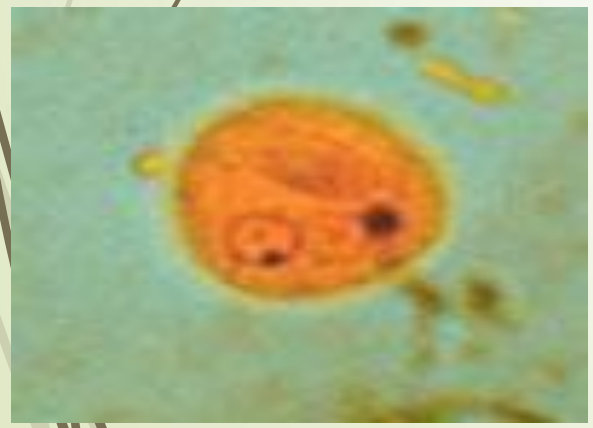
Intestinal Protozoa - The Amoebae

General Life cycle -

- The definitive host ingests the infective cyst stage from fecal contamination in environment.
- The cyst passes into the small intestine & excystation occurs with transformation to the trophozoite stage.
- Trophozoites colonize the host, multiplying asexually via binary fission. They can remain near the lumen (non-pathogens) or invade the wall of the intestine & multiply (pathogens).
- Cysts and trophozoites are passed in the feces of the infected host.

The Protozoa



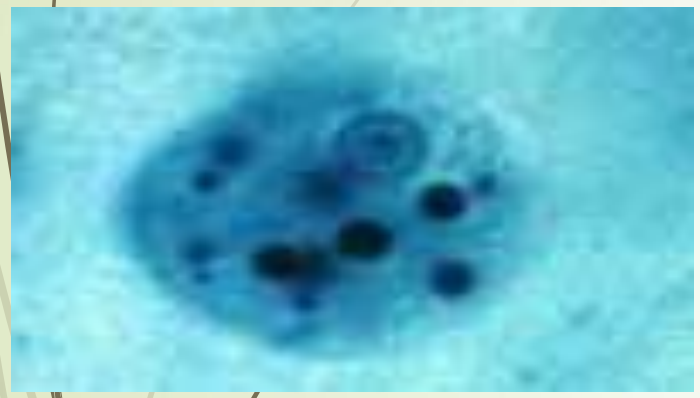


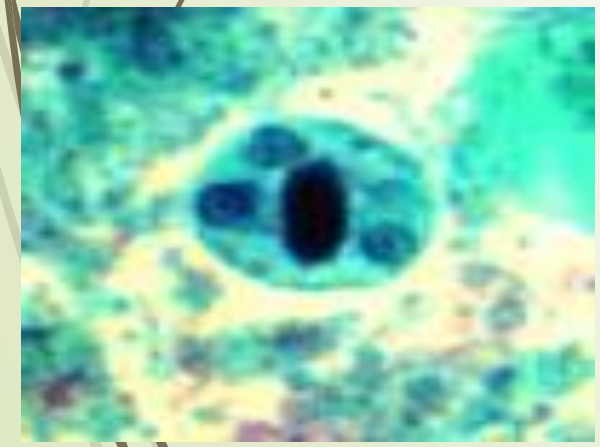
Intestinal Protozoa - The Amoebae

Entamoeba histolytica

- Epidemiology - Occurs worldwide; the highest incidence and prevalence is in areas with poor sanitation.
- Pathology and Clinical Manifestations - the most pathogenic of all; causes amoebic dysentery; can become extra-intestinal; can be fatal. Hepatic abscess is the most common and dangerous complication.
- Chronic infections may last for years; often confused with colitis, cancer.
- Distribution - worldwide, mostly in tropics and sub-tropics.

The Protozoa





Intestinal Protozoa - The Amoebae

Entamoeba histolytica

- **Morphology & Laboratory Identification - trophozoites range 12 to 30 microns in diameter; nucleus has an even distribution of peripheral chromatin and a small, compact, centrally located karyosome; cytoplasm is smooth and granular; inclusions, if present, are red blood cells; cysts range 10 to 20 microns in diameter and contains four nuclei when mature. Cigar-shaped chromatoid bars may be present in some cysts.**

The Protozoa

Superclass Mastigophora - the flagellates. Inhabit the mouth, bloodstream, gastrointestinal, or urogenital tracts.

Morphological Characteristics

- Flagellum(ae) - organelles of locomotion; an extension of ectoplasm; moves with a whip-like motion.
- Axostyle - a supporting mechanism, a rod-shaped structure; not all flagellates have these.
- Undulating membrane - a protoplasmic membrane with a flagellar rim extending out like a fin along the outer edge of the body of some flagellates.
- Costa - a thin, firm rod-like structure running along the base of the undulating membrane.
- Cytosome - a rudimentary mouth; also referred to as a gullet.

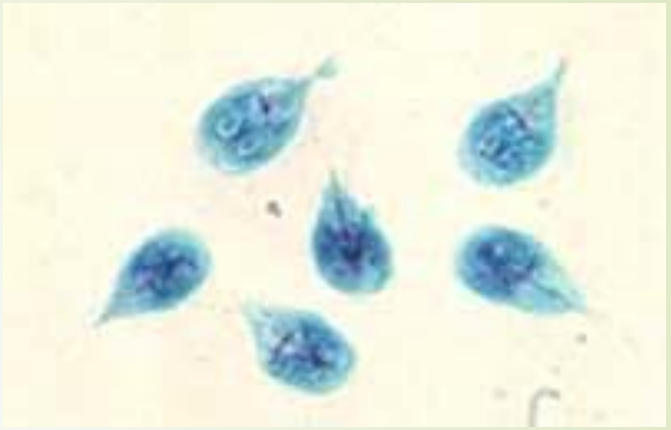
The Protozoa

Superclass Mastigophora - the flagellates.

Identification of a flagellate is based upon:

- Size.
- Shape.
- Motility.
- Number and morphology of nuclei.
- Number and location of flagellae.
- Location in the body of the host.

The Protozoa

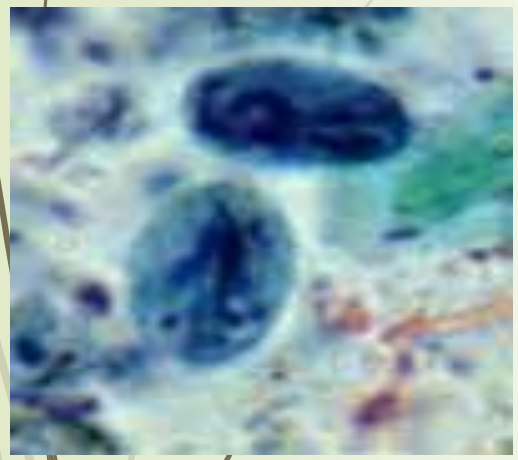


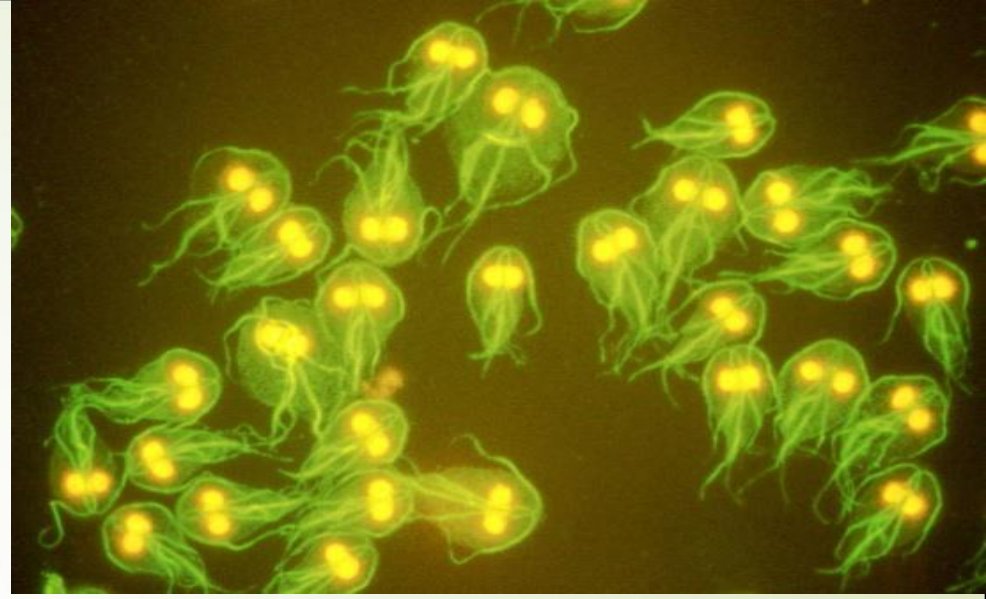
Intestinal flagellates

Giardia lamblia

- **Most common protozoan parasite in the U.S.A.**
- **Life cycle - man ingests cysts from fecally contaminated environment; the organism excysts in the upper intestine; trophozoites multiply and attach to the intestinal mucosa; often enter the gall bladder. Trophozoites and cysts are passed in the feces.**
- **Diagnosis - identification of cysts or trophozoites in stool specimens or duodenal contents.**

The Protozoa





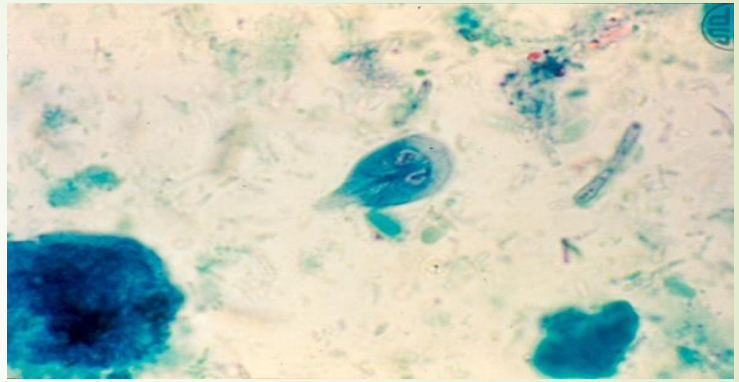
Intestinal flagellates

Giardia lamblia

Morphology - very distinctive. Dorsal-ventrally flattened, and Bi-laterally symmetrical.

- Cyst - 9 x 12 micrometers and contain 2 to 4 nuclei; parabasal bodies are present.
- Trophozoite - Four pairs of flagella - one pair located anterior, two pair located ventrally, and one pair located posteriorly. An axostyle and parabasal bodies are present.

The Protozoa



Intestinal flagellates

Giardia lamblia

- **Epidemiology - prevalence 1 to 30%, common in children's day care centers; can be transmitted in water. Sexual transmission has been well documented.**
- **Pathology and Clinical Manifestations - symptoms can be severe; diarrhea, foul-smelling, greasy, mucus-laden stools, flatulence, nausea, cramps. Most infections are asymptomatic; chronic cases experience weight loss, malabsorption of fat, protein, folic acid, and fat-soluble vitamins.**

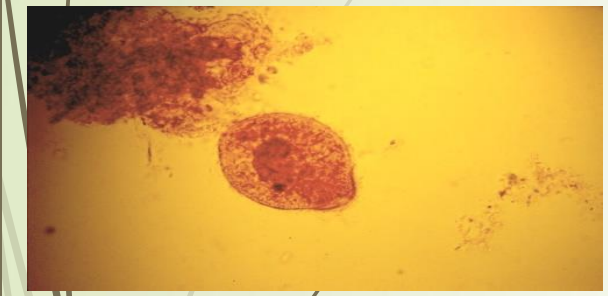
The Protozoa

Class Ciliophora - The Ciliates

Balantidium coli

- Epidemiology - Rarely found in USA. This is the only ciliate parasite of humans.
- Largest parasitic protozoan - trophozoite is 30-120 x 25-125 microns; the cyst averages 50 - 70 microns in diameter.
- Life cycle - The cyst is ingested via fecal contamination in environment; cysts excyst in the small intestine; trophozoites migrate to large intestine.

The Protozoa



Class Ciliophora - The Ciliates

Balantidium coli

- Pathology & Symptoms - Many infections are asymptomatic, organism feeding on bacteria at surface of mucosa. Severe infections - with the aid of hyaluronidase, the organism burrows into submucosa, producing ulcers. Symptoms - dysentery, abdominal pain, nausea & vomiting, fever, headache.
- Diagnosis - Diagnosed by observing cysts & trophozoites in fecal samples.

The Protozoa

Class Ciliophora - The Ciliates

Balantidium coli

- Morphology - Large, oval shape; two nuclei, 1 large kidney shaped (macronucleus) & 1 small micronucleus (micronucleus not often seen); body surface covered by longitudinal rows of cilia; cytostome present.
- Primary animal reservoir - pigs, monkeys.