PROTOZOA

Marlia Singgih Wibowo
**Introduction**

- “Protozoa” means “first animal”, the simplest form of animal life
- Protozoa are unicellular eucaryotic microorganisms that lack cell walls
- Can grow in marine habitat, or soil, fresh water, or symbiotic, or parasites in other organisms
- Protozoa depends on nutrition, temperature, pH and some depends on sunlight
Characteristic of Protozoa

- Eucaryotic unicellular: 1 – 150 μm
- No cell walls
- Mostly motile, with flagella or cilia, or amoeboid
- Chemoheterotrophs
- Similar to animal, only unicellular
- Feed by ingesting particulate matter (phagocytosis) and engulfing liquid or dissolved nutrition (pinocytosis)
Most protozoa are parasites and have two forms: Trophozoite and Cyst.

Protozoa are distinguished from prokaryotes by their eukaryotic nature, from algae by their lack of chlorophyll, from fungi by their lack of cell walls, and from slime molds by their inability to form fruiting bodies.
Two forms of protozoa
Classification of Protozoa

Old Classification is based on motality:

- Sarcodina (amoeboid) : i.e. *Entamoeba histolytica*
- Mastigophores (with flagella) : i.e. *Trypanosoma brucei var. gambiense, Trichomononas vaginalis*
- Ciliates (with cilia) : *Balantidium coli*
- Sporozoa (no mature form) : i.e. *Plasmodium, Toxoplasma*
Classification of Protozoa

New Classification (started 1986) is based on cellular structure by electron microscope:

- Phylum: **Sarcomastigophora**: *Trypanosoma*
  - Sub-phylum: **Mastigophora**
  - Sub-pyhlum: **Opalinata**
  - Sub-pyhlum: **Sarcodina**

- Phylum: **Labyrinthomorpha**: *Labyrinthula*

- Phylum: **Apicomplexa**: *Toxoplasma*

- Phylum: **Myxozoa**: *Ceratomyxa*

- Phylum: **Microspora**: *Encephalitozoon*

- Phylum: **Ascetospora**: *Marteilia*

- Phylum: **Ciliophora**: *Balantidium*
Sarcomastigophora

- With Flagella, pseudopodia, or both
- Sub-phylum Mastigophora (flagella at mature phase)
  - Class Phytomastigophorea: Flagellata resemble to plants, i.e. Euglena, Volvox
  - Class Zoomastigophorea: Flagellata which lack of chromoplast, i.e. Trichomonas, Trypanosoma
- Sub-phylum Opalinata: parasites
- Sub-phylum Sarcodina: pseudopodia
  - Class Rhizopoda: i.e. Amoeba, Entamoeba
  - Class Actinopoda: i.e. plankton
Trypanosoma

Fig. 1.1 Forms in the life cycle of a kinetoplastid flagellate. 
(a) Promastigote. (b) Epimastigote. 
(c) Trypomastigote. 
(d) Amastigote.

Fig. 1.2 Scanning electron micrographs of (A): Trypanosoma cruzi and (B): T. brucei. x2340. (Photograph (A) kindly given by Dr. D. Snary and (B) by Professor K. Vickerman.)
Life-cycle of Trypanosoma

Fig. 1.4 The life cycle of Trypanosoma brucei. The infection begins when trypanosomes are injected into the blood of a mammal by a tsetse fly when it feeds (a). The slender forms multiply by binary fission (b) until large numbers build up in the blood and the trypanosomes transform first into intermediate (c) and then stumpy (d) forms that are infective to a tsetse fly. In the slender forms, the mitochondrion is inactive but begins to become active in the stumpy forms. In the midgut of the tsetse fly, the trypanosomes begin to undergo division (e) and then enter the proventricular and salivary glands where they assume the epimastigote form (f) and undergo further division. The forms in the salivary glands infective to the mammal are known as metacyclic forms (g). In the tsetse fly, the mitochondrion is fully active. The blood stream forms are covered with a glycoprotein coat which is lost in the midgut of the tsetse fly and is reformed in the salivary glands. (After K. Vickerman 1983, British Medical Bulletin, 41, p. 107 and reproduced by permission of the publishers, Churchill Livingstone, Edinburgh.)
Internal Structure of Trypanosoma
Labyrinthomorphs

- Mostly living in marine habitat
- Parasites on algae
- example: *Labyrinthula*
Apicomplexa

- Apical complex: a set of organelles available at the end (tips) of cells.
- No flagella or cilia on mature/Grown-up phase.
- Example: *Plasmodium, Toxoplasma*
Myxozoa

- Multicellular Spores, capsul form with one or more polar
- Parasites on fish and invertebrates
- Example: *Ceratomyxa, Myxidium*
Microspora

- Parasites on invertebrates and low vertebrates
- Spores have thick cell walls containing infectious substances or sporoplasms, which is important in invasion processes.
- Example: *Encephalitozoon cuniculi*, *Enterocytozoon bieneusi*
Ascetospora

- Parasites on invertebrates and few vertebrates
- Multicellular spores, without capsul or filament
- All species are parasites
- Example: *Marteilia, Haplosporidium*
Ciliophora

- With cilia
- 2 forms of nucleus
- Heterotroph
- With contractile vacuole
- Example: *Paramecium*, *Balantidium*
- Parasites to pigs, rats, monkey, dog and also human.
Paramecium
Amoeba engulfed Paramecium
Parasites Helminths

- Parasites Metazoa
- Infect human, especially in tropical countries
- Consists of two Phyla: Platyhelminthes and Nematoda
Classification of Helminths

- **Phylum: Platyhelminthes**
  - Class Monogenea
  - Class Cestoda (example: *Taenia, a tapeworm*)
  - Class Aspidogastrea
  - Class Digenea

- **Phylum: Nematoda**
  - Class Rhabditida
  - Class Strongylida
  - Class Ascaridida (example: *Ascaris*)
  - Class Oxyurida
  - Class Spirurida
  - Class Enoplida
Helminth Worms

- Helminth worms attack the digestive tract and other internal organs of the vertebrate body and cause a wide variety of parasitic diseases. These worms include such diverse forms as the roundworms (nematodes), flukes (trematodes), tapeworms (cestodes), thorny-headed worms (acanthocephalans), and tongue worms (linguatuulids). Many species are only able to complete their life cycle by spending time in a variety of animal hosts.
Nematodes

- Commonly known as roundworms, these animals are one of the most diverse and geographically widespread invertebrate phyla. Free-living roundworms inhabit freshwater and marine habitats, as well as soil. Parasitic roundworms prey on both plants and animals, causing widespread agricultural damage and disease. Roundworms have long, cylindrical bodies with a mouth surrounded by lips and sensory papillae or bristles. Fluid in the body cavity distributes nutrients and oxygen—roundworms do not have special respiratory or circulatory systems. Roundworms prey on other invertebrates as well as diatoms, algae, and fungi. They reproduce sexually and larvae undergo at least four molts before reaching their adult size and shape.

- Examples: Ascaris, vinegar eels, cyst nematodes, heartworms, hookworms
Tapeworms are parasitic worms that infect the intestinal lining and other organs of vertebrates. Tapeworms, having no mouth or digestive tract, are able to absorb partially digested material through their body surface.
*Schistosoma mansoni*, one of the species of blood flukes that cause the disease known as schistosomiasis. The males are thick and blue; the females are thin and clear. A type of flatworm, while in larval form blood flukes enter the bloodstreams of people or animals exposed to contaminated water in tropical and subtropical climates, and then lay their eggs inside the host’s body.
Life-cycle of Bloodflukes

- Larvae leave snail as cercariae
- Cercariae enter human host
- Cercariae mature in human bloodstream
- Mature flukes settle in human gut
- Eggs hatch into larvae
- Fluke eggs pass to water
VECTOR

- Generally, parasites protozoa or helminths infect animals and human through vector
- Vector usually in the form of bugs/insect
- Mosquito, Flies, Bugs, Ticks, Mollusks
- Infect (transmition) from animal to animal, and from animal to human
Vector from Plasmodium
Life Cycle of the Malaria Parasite

1. Sporozoite injected by mosquito into human (A)
2. Sporozoite enters liver cell (B)
3. Liver cell becomes infected and multiplies (C)
4. Merozoites released into red blood cell (D)
5. Merozoites invade red blood cells, causing fever, chills (E)
6. Female and male gametocytes develop in red blood cells (F)
7. Male and female gametocytes unite (G)
8. Zygote enters mosquito gut (H)
9. Zygote develops into sporozoite in mosquito's digestive tract (I)

Encarta Encyclopedia, © Microsoft Corporation. All Rights Reserved.
Life Cycle of the Malaria Parasite

- Malaria is an infectious disease caused by *Plasmodium*. The parasite is transmitted to humans by the bite of the female *Anopheles* mosquito.
- The *Plasmodium* parasite spends its life cycle partly in humans and partly in mosquitoes.
- (A) Mosquito infected with the malaria parasite bites human, passing cells called sporozoites into the human’s bloodstream.
- (B) Sporozoites travel to the liver. Each sporozoite undergoes asexual reproduction, in which its nucleus splits to form two new cells, called merozoites.
- (C) Merozoites enter the bloodstream and infect red blood cells.
- (D) In red blood cells, merozoites grow and divide to produce more merozoites, eventually causing the red blood cells to rupture. Some of the newly released merozoites go on to infect other red blood cells.
Plasmodium invades red blood cells
(E) Some merozoites develop into sex cells known as male and female gametocytes.

(F) Another mosquito bites the infected human, ingesting the gametocytes.

(G) In the mosquito’s stomach, the gametocytes mature. Male and female gametocytes undergo sexual reproduction, uniting to form a zygote. The zygote multiplies to form sporozoites, which travel to the mosquito’s salivary glands.

(H) If this mosquito bites another human, the cycle begins again.
Difference between Culicine dan Anopheline

<table>
<thead>
<tr>
<th>Culicines</th>
<th>Anophelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culex</td>
<td>Aedes</td>
</tr>
<tr>
<td>Eggs</td>
<td></td>
</tr>
<tr>
<td>Larvae</td>
<td></td>
</tr>
<tr>
<td>Pupae</td>
<td></td>
</tr>
<tr>
<td>Heads</td>
<td></td>
</tr>
<tr>
<td>Resting stance</td>
<td></td>
</tr>
</tbody>
</table>
The South African tsetse fly is responsible for transmitting the parasitic protozoan that causes sleeping sickness, which can be fatal to humans and domestic cattle. The fly uses its mouth parts to bite and draw blood from its host. If it draws blood from an individual infected by sleeping sickness, the fly can then transmit the infection to other hosts in subsequent bitings.