Parasitic Protozoa
We will begin with the Phyla Euglenozoa, Sarcodina and Chromista (formerly the Sarcomastigophora)

1. Includes flagellates and amoebae

Previous Classifications
1. Mastigophora - divided into 2 classes
   a. Phytomastigophorea - plant like forms
      1. includes Dinoflagellata
         a. often have parasitic forms - or mutualistic ones.
   2. other orders that also have associations with plants, animals.

Previous Classifications
2. Zoomastigophorea - animal like forms
   a. many parasitic orders.
   b. we will mention them in turn.

Phylum Euglenozoa
General Characteristics
a. Cortical microtubules.
b. Flagellae with paraxial rod.
c. mitochondria with discoid cristae.
d. nucleoli persist during mitosis.

Phylum Euglenozoa
a. Cortical microtubules.
b. Flagellae with paraxial rod.
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d. Nucleoli persist during mitosis.
Phylum Euglenozoa
2. Many different orders.
a. Most are free living; often with chloroplasts.
b. Subphylum Kinetoplasta
1. Diverged from rest of group 1 billion years ago!
2. Distinct with unique mitochondrion.
3. Also usually with undulating membranes.

Order Kinetoplastida
1. Includes Trypanosomes
a. We will begin with this group because it is well known and serves to show diversity of parasitic forms.

Order Kinetoplastida
2. Evolution
a. Appear commonly in plants and sap-feeding insects.
   1. Phytomonas, Crithidia
b. Transmission appears mainly by transport within body of insects.
c. Variable stages occur within different hosts.

Host Shifts
d. This tendency to shift between hosts is described by 2 terms:
1. monoxenous - single host.
2. heteroxenous - more than one host.

Hemoflagellates
1. Current hypothesis is that parasitic forms on vertebrates evolved from ancestral insect gut parasites.
a. Forms specialized for vertebrate blood are called hemoflagellates.

Body Forms
1. Worth mentioning because these forms are typical of certain genera.
a. Also, some genera have these forms included in their development as parasites.
However,
1. These DO NOT necessarily represent an evolutionary progression!
2. The existence of certain stages within a life cycle suggests adaptation to particular environments.

**Amastigote - no flagellum**
1. But, retains kinetosome, kinetoplast and axoneme.
2. Example: *Leishmania*
   a. Parasite of humans, other mammals.

**Choanomastigote**
1. Flagellum emerges from a pocket
2. Example: *Crithidia*
   a. tiny intestinal parasite of insects.

**Promastigote**
1. Flagellum is located at anterior end.
2. Example: *Leptomonas*
   a. Parasite of insects and other invertebrates.
   b. Of no known medical importance.

**Promastigote to Amastigote**
2. However, in parasitic species in vertebrate hosts, this stage in parasitic species is phagocytized by macrophages.
   a. They transform into **amastigotes** that remain within the cell.
   b. e.g., *Leishmania*

**Epimastigote**
1. Flagellum on side of cell, sometimes with undulating membrane
   1. Example: *Blastocrithidia*
   a. Monoxenous parasite of insects
   b. Often found in guts of water striders
Opisthomastigote

1. Flagellum posterior with deep pocket.
2. Example: *Herpetomonas*
   a. Monoxenous in insects.
   b. Goes through other stages as well.

Trypomastigote

1. Flagellum posterior with undulating membrane.
2. Example *Trypanosoma*.
   a. Parasite in insects and vertebrates.

Trypanosomes of Importance to Humans

1. Two main genera:
   a. *Leishmania*
2. Known by various disease names (wherever the British army happened to be at the time).

Leishmaniasis: a.k.a

- a. kala azar
- b. oriental sore
- c. (Aleppo; Jerico; Delhi) boil.
- d. Baghdad button
- e. Dum-Dum fever.

Leishmaniasis

2. Tends to be intracellular - in tissues.
3. Produces lesions in skin or viscera.
Discovery of the Disease

Kala Azar or Black Fever has existed in India and China for centuries. In 1900 when William Leishman, a Scottish army doctor, found Leishmania donovani in stained smears from the spleen of a soldier suffering from a fever contracted at Dum-Dum in India.

His observations were published in 1903. At the same time Charles Donovan, a Professor of Physiology at Madras University, described a similar parasite in smears made from a splenic biopsy.

Prior to Leishman and Donovan’s discovery kala azar was considered to be a communicable malaria-like disease that showed relapses, emaciation, as well as enlargement of the liver and spleen, and spread slowly across the continents along the trade routes.

In 1924 the Kala-Azar Commission noted that the distribution of a sandfly (Phlebotomus argentipes) in India closely overlapped the distribution of the disease.

In 1939 Smith, Haldar and Ahmed discovered that if sandflies after taking a bloodmeal were fed on raisins instead of being given additional blood meals, the flagellates grew so numerous that they blocked the pharynx as happens with plague bacilli in fleas.

These workers then subjected hamsters to the bite of blocked sandflies and each became infected.

Human transmission of leishmaniasis was demonstrated in 1941 when Adler and Bar successfully infected volunteers with L. major by the bite of P. papatasi.

In 1942 Swaminath, Shortt and Andersen allowed 6 human volunteers to be bitten by infected P. argentipes and all developed kala-azar.
**Leishmania-like Parasites**

1. Life cycle is most similar to ancestral trypanosomes.
   1. *Leptomonas*
      a. monoxenous, replication of promastigotes in gut,
      b. formation of amastigote-like cysts that are evacuated in feces
      c. other insects ingest the cysts.

**Leishmania Vectors**

a. Heteroxenous, replication of promastigotes in insect gut.

1. Usually in blood sucking insects like sand flies.
2. Most common genus is *Phlebotomus* (Old World)
   a. also *Lutzomyia* (New World).

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**Sandflies**

![Sandflies Image]

**Life cycle of Leishmania**

A. Injection of promastigotes into vertebrate host.

1. These forms are phagocytised by macrophages.
   a. Within parasitophorous vesicles, become amastigotes
   b. Like viruses, take over cellular/organelle machinery.

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**Life cycle of Leishmania**

2. Additional replication occurs as amastigotes in tissues.

3. Transmission when another insect bites and picks up infected macrophages.

4. These enter the insect gut, turn into promastigotes, replicate,
   a. Then are transmitted in next bite.
**Pathology of Leishmania**

1. Varies depending on species  
   a. May be *cutaneous* - forming lesion on skin.  
   b. May be *mucocutaneous* - lesion on mucous membranes with subsequent tissue erosion.  
   c. Can be *visceral* - erosion of viscera, usually fatal.

**Species of Leishmania**

d. Lots of different species.  
1. Many in lizards, but also in mammals  
2. Some mammals (dogs, gerbils) serve as *reservoir hosts*.  
a. Can carry the infection and maintain it, permitting later infection of humans.

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**Leishmanias Infecting Humans**

1. *L. donovani* - visceral leishmaniasis  
   a. Also known as "kala azar" and dum-dum fever.  
   b. Named for co-discoverers (Leishman-Donovan) 1900-03  
   c. Diagnosis of "L-D bodies" is after them.

**Leishmania donovani**

1. Mainly restricted to Old World.  
2. Appears to have been transmitted to New World by slave trade?

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**L. donovani Pathology**

1. Slow onset of fever, later involvement of viscera,  
2. Later abdominal edema, splenic enlargement.  
a. Often fatal, but also can spontaneously clear.

**However,**

1. Cleared cases can lead to Post-kala-azar dermatoid.  
a. Horrible disfiguring  
b. Can be cured with drugs.
**Leishmanias Infecting Humans**

1. *L. tropica* - oriental sore - (Old World cutaneous).
   a. Widely distributed, mostly in Middle East
   b. Lesions on exposed areas - subject of sand fly bites.

**L. tropica, L. major**

Old World cutaneous
a. Widely distributed, mostly in Middle East
b. Lesions on exposed areas - subject of sand fly bites.

**CUTANEOUS LEISHMANIASIS:**

*Old World Cutaneous Leishmaniasis (CL)*

*L. major*
causes a moist, cutaneous, ulcerlike lesion at the site of the bite; it starts as a papule that runs an acute course (1-3 weeks) with early ulceration and a surrounding zone of inflammation, that usually heals in two months to a year leaving a depressed unpigmented scar, and lasting immunity.

It is transmitted by Phlebotomus spp. from gerbil, dogs or rodents to human or human-to-human. It is generally found in sparsely populated rural areas.

**Leishmanias Infecting Humans**

2. *L. braziliensis* (New World cutaneous).
   a. Mainly in the new world
   b. Also vectored by sand flies (*Lutzomyia*)
   c. Lesion usually heals up with no problem.
   d. But, occasionally metastasizes if it involves mucous membranes.
      1. can erode face, resp. structures
      2. conditions is known as "uta" or "espundia."

**L. braziliensis**

c. However, may not be true since few amastigotes are found here.
d. Often heals with lifetime immunity
d. Some cultures innoculate their kids.
**Leishmania mexicana**

1. Mainly in central Mexico, Caribbean.
   a. Responsible for a condition called "chiclero" after harvesters of gum tree, *chiclé* (Chicklets)

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**Leishmania Medications**

1. Usually with antimonials (mercury containing compounds).
   a. some plants are useful too (dogbanes, gentians).

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**Trypanosomes of Importance to Humans**

b. *Trypanosoma*
   1. More recent (DNA based) classification systems have suggested that there may be several genera here, but current classification system is familiar and accepted.

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**Trypanosomiasis**

2. Usually known as "sleeping sickness" or other chronic malaises.
   3. tends to be intercellular - a blood parasite.
Trypanosomiasis

c. Both are vectored by insects
a. Probably is the original source of the parasite.