

Medically Important Protozoa

Protozoa means "first animal" and refers to simple eukaryotic organisms composed of a single cell (e.g. amoebae). Reproduction may be through simple cell division (e.g. the ameboflagellates) or sexual involving the fusion of gametes in part of the life cycle (e.g. the apicomplexa) as described below. Some protozoa can form a protective cyst stage capable of withstanding harsh environmental conditions.

Ameboflagellates

These use pseudopodia or flagella for locomotion.

Amoebae. These are characterized by a feeding and dividing trophozoite stage that can form a temporary resistant cyst stage.

Entamoeba histolytica is the cause of amoebic dysentery producing severe infection of the intestines that can spread to the liver. The organism is characterized by a trophozoite and cyst stage. *E. histolytica* is an example of a true parasite in that the organism cannot multiply outside of the host. Other amoebae occur naturally in soil and water environments which is their preferred habitat for feeding and replication. These amoebae are termed "free-living" as they have no natural host in which parasitism occurs. They can infect man opportunistically producing severe and often fatal disease. Such free-living amoebae are the *Acanthameba*, *Naegleria fowleri* and *Balamuthia mandrillaris*, all of which can infect the central nervous system. In addition, *Acanthameba* species can also invade the eye.

Flagellates

These organisms have flagella in the trophozoite stage. *Trichomonas vaginalis* is a common sexually transmitted organism causing trichomoniasis infection of the vagina and urethra. *Giardia lamblia* causes giardiasis producing symptoms of diarrhea and other intestinal disturbances. Infection arises from the ingestion of cysts, usually through contaminated water.

Trypanosoma brucei gambiense and ***T. brucei rhodesiense*** cause trypanosomiasis, more commonly known as African sleeping sickness. The disease is an arthropod (insect)-borne infections and is spread by the bite of the tsetse fly in which part of the trypanosome life cycle is completed. The eventual invasion of the central nervous system by the trypanosomes gives rise a comatosed state from which the common name for the disease is derived.

Trypanosoma cruzi causes Chagas' disease (American trypanosomiasis). The intermediate host in this case are triatomid bugs that feed off the blood of man. Infection results from the inoculation of the bug's feces that contains the organism into the bite wound. Individuals who survive the acute stage of the disease are frequently left with chronic and progressive neuronal and smooth muscle lesions in the heart and gastrointestinal tract. *T. cruzi* has an extensive reservoir in wild and domestic mammals and therefore Chagas' disease is a zoonosis.

Leishmania species cause leishmaniasis. The disease is spread by the bite of sandflies in which part of the organism's life cycle is completed. In man, the promastigotes from the bite of the sandfly become ingested by macrophages and multiply within them as amastigotes. Cutaneous

leishmaniasis occurs if the region of infection remains localized to the dermis as an open sore. In the Old World (Southern Europe, the Middle East, India, former USSR and parts of Africa) *L. major*, *L. tropica*, *L. aethiopica* and certain subtypes of *L. infantum* are responsible. In the New World (Mexico southwards and through South America) species responsible include *L. braziliensis*, *L. mexicana* and *L. amazonensis*. If the organism spreads, then mucocutaneous leishmaniasis can occur in which the nose, mouth and palate becomes destroyed.

Infection with members of the *L. donovani-L.infantum* complex produce the systematic disease of visceral leishmaniasis often known as kala-azar that occurs with a global distribution seen in Old and New World leishmaniasis. The parasites multiply within the macrophages of the liver, spleen, bone marrow and other organs. Untreated, the disease is usually fatal. As with trypanosomiasis, leishmaniasis is a zoonosis as many mammals harbor the parasite.

Ciliates

These possess rows of cilia around the outside of the body that aid motility. The only member of this group known to infect man is *Balantidium coli*. This is a cyst forming parasite that is a commensal ("table-sharing" and meaning here a non-pathogenic parasite) of domestic and wild pigs. It does, however, cause severe diarrhea in humans.

Apicomplexa

This is a unique group because all members are parasitic. The group includes parasites causing malaria, cryptosporidiosis and toxoplasmosis. They lack any visible means of locomotion (most are intracellular) and have complex life cycles involving sexual and asexual reproduction.. The common feature of all members is the presence of an apical complex in one or more stages of the life cycle. Although the exact components of the apical complex varies among members, it contains enzymes used to penetrate host tissues.

Malaria. *Plasmodium* species cause malaria. The four principal species are *P. falciparum*, *P. vivax*, *P. ovale* and *P. malariae*. Malaria means "bad air" and dates from the time when the disease was thought to be spread from stagnant, foul smelling water. The disease is in fact transmitted by the female Anopheles mosquito that inhabits such environments. In the stomach of the female Anopheles male (micro-) and female (macro-) gametocytes fuse to form a zygote. This in turn forms a motile ookinete that penetrates the midgut wall and develops into an oocyst within which are many thousands of sporozoites. When mature, the sporozoites rupture the oocyst and penetrate the salivary glands. When the mosquito next feeds on man, the sporozoites are passed via the blood stream to infect parenchymal cells of the liver. Here they form pre-erythrocytic schizonts in which several thousand daughter cells, called merozoites. These merozoites enter red blood cells to start the asexual intraerythrocytic cycle and form new gametocytes. The asexual red cell stages are responsible for the pathological changes that occur in malaria (fever, chills, anemia, liver enlargement, encephalitis renal damage and death).

Cryptosporidiosis. *Cryptosporidium parvum* causes diarrhea disease mainly in infants and small children. It is normally self-limiting but in the immunocompromized host the disease can be severe. *C. parvum* is enzootic in young calves and is usually passed to man in water containing oocysts of the organism.

Toxoplasmosis. *Toxoplasma gondii* causes the multi-organ infection of toxoplasmosis. The domestic cat is the definitive host for *T. gondii* from which man and other mammals can become infected. Infection commonly arises from the consumption of under cooked meat and in the healthy adult is usually asymptomatic. The most devastating form of toxoplasmosis is seen in congenital infection when a pregnant mother passes the organism to the fetus. This can result in severe abnormalities at birth. The life-cycle of *T. gondii* is complex, involving both sexual and asexual reproduction. Three main life forms of *T. gondii* occur: (i) the oocyst which is produced from the sexual cycle in the small intestine of the cat and contains sporozoites; (ii) the tachyzoite of the asexual invasive form found in secondary hosts which are derived from pseudocysts; and (iii) the tissue cyst that contains bradyzoites.

Microsporans

The medical importance of microsporidial infections has only recently been highlighted by the frequent recognition of these obligate intracellular parasites in material from patients with HIV infection and AIDS. Examples are: *Encephalitozoon* species, *Nosema* species and *Septata intestinalis*. Multi-organ infections occur and *S. intestinalis* is found in about 2% of all AIDS patients with chronic diarrhea.

Source: University of Leicester

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