Introduction *:*

Medical Parasitology is the study of parasites and as such that does not include bacterial, fungal or viral parasites. Human parasites are separated into intestinal and blood borne parasites. For a parasite to be defined as intestinal it must have an intestinal life cycle stage, though it may have life-cycle stages in the heart, blood vessels, and lungs in the humans, other animals or the environment.

The association between two organisms may be one of the following:

Mutualism: mutual benefit is derived from the association.

Symbiosis: mutual benefit, but the two organisms cannot live independently.

Commensalism: one partner benefits (commensal) while the other (host) is unaffected. It may be called a non-pathogenic parasite.

When an animal lives on another organism from which it receives food and shelter without any compensation to it, and then this association is called **parasitism**. The animal, which enjoys advantages, is the **parasite.** All animals have parasites; hence there are more parasites than free-living animals. The habitat occupied by a parasite is very different from the environment of its free-living ancestors, hence it has either to adapt itself to this new habitat or perish.

Parasitism: one organism (parasite) lives at the expense of the other (host). The latter usually suffers from the association with pathogenic parasite).

Parasitism is the form of mutual relations between organisms of various kinds, from which one (parasite) uses another (host) as environment for living, and from which it obtains food causing him damage (disease).

Classification of Parasites

Each parasite belongs to a phylum, class, order, family, genus and species; the scientific designation of a parasite is binomial, a generic name (genus) and a specific name (species).

The parasites of humans in the phylum **protozoa** are now classified under three subphyla: **Sarcomastigophora** (containing the amoebae and flagellates); **Apicomplexa** (containing the sporozoan); and **Ciliophora** (containing the ciliates). The important human parasites are found within these great groups.

1. **Subphylum (Sarcodina)** is typically amoeboid and in represented in humans by class of ***Entamoeba, Endolimax, lodamoeba, Naegleria,*** **and** ***Acanthamoeba***.
2. **Subphylum Zoomastigophora,** the flagellates, have one or more whip-like flagella and, in some cases, an undulating membrane (e.g., trypanosomes). These include intestinal and genitourinary flagellates ***(Giardia, Trichomonas, Dientamoeba, Chilomastix)*** and blood tissue flagellates ***(Trypanosoma, Leishmania)***.
3. **Subphylum Sporozoa** undergoes a complex life cycle with alternating sexual and asexual reproductive phases, usually involving two different hosts (e.g., arthropod and vertebrate, as in the blood forms). The subclass **Coccidia** contains the human parasites ***Isospora, Toxoplasma***, and others. One of these, ***Cryptosporidium***, has been implicated as a cause of intractable diarrhea among the immunosuppressed. Among the **Haemosporina** (blood sporozoan) are the malaria parasite ***(Plasmodium*** **species)** and the subclass ***Piroplasmia***, which includes ***Babesia*** species. ***Pneumocystis*** has recently been shown to be a member of the Fungi rather than the Protozoa. It is another opportunistic parasite of immunosuppressed individuals.
4. **Subphylum Ciliata** is a complex protozoan bearing cilia distributed in rows or

patches, with two kinds of nuclei in each individual. Balantidium coli, a giant intestinal ciliate of humans and pigs, is the only human parasite representative of this group.

The Parasitic Worms, or helminths, of a human being, belong to two Subphyla:

1. **Subphylum Platyhelminths** (flatworms) lack a true body cavity (celom) and are characteristically flat in dorsoventral section. Medically important species belong to the classes **Cestoda** (tapeworms) and **Trematoda** (flukes). The tapeworms of humans are band-like and segmented; the flukes are typically leaf-shaped, and the schistosomes are narrow and elongate. The important tissue and intestinal cestodes of humans belong to the genera ***Diphyllobothrium***, ***Spirometra, Taenia, Echinococcus, Hymenolepis,*** and ***Dipylidium***. Medically important trematode genera include ***Schistosoma***, ***Paragonimus, Clonorchis, Opistorchis, Heterophyes, Metagonimus, Fusciolopsis,*** and ***Fasciola.***
2. **Subphylum Nemathelminths** (worm-like, separate-sexed, insegmented roundworms) include many parasitic species that infect humans.

Phylum Protozoa

General Features

The single protozoal cell performs all functions. Most of the protozoa are completely nonpathogenic but few may cause major diseases such as malaria, leishmaniasis, and sleeping sickness. Protozoa like *Cryptosporidium parvum* and *Toxoplasma gondii* are being recognized as opportunistic pathogens in patients affected with human immunodeficiency virus (HIV) and in those undergoing immunosuppressive therapy. Protozoa exhibit a wide range of a size (1- 150 µm), shape, and structure; yet all possess essential common features.

Single-celled microorganisms belonging to the animal kingdom are classified as Protozoa (Greek Protos—first; zoon—animal). Within its single cell, the protozoon contains all structures required for performing its various functions. Some free-living protozoa resemble plants containing green plastids that enable them to perform photosynthesis. It is believed that these represent the earliest forms of animal life. Numerous varieties of protozoa have evolved to suit all manner of environmental conditions.

Free-living protozoa are found in all habitats—in the deep ocean or in shallow freshwaters, in hot springs or in ice, under the soil, or in the snow on mountain tops. Parasitic protozoa have however adapted to different host species, with more restricted physicochemical requirements.

Protozoa exhibit a wide range of size, shape, and structure, yet all possess certain essential common features. The typical protozoan cell is bounded by a trilaminar unit membrane, supported by a sheet of contractile fibrils that enable the cell to change its shape and to move. The cytoplasm can often be differentiated into an outer rim of relatively homogeneous ectoplasm and a more granular inner endoplasm.

The ectoplasm serves as the organ of locomotion and for engulfment of food materials by putting forth pseudopodial processes. It also functions in respiration, discharging waste materials, and also as a protective covering for the cell. Within the endoplasm is the nucleus within a tough nuclear membrane. The nucleus is usually single but maybe double or multiple, some species having as many as a hundred nuclei in one cell. The nucleus contains one or more nucleoli or a central endosome or karyosome. The chromatin may be distributed along the inner surface of the nuclear membrane (peripheral chromatin) or as condensed masses around the karyosome. The endoplasm shows a number of structures-the endoplasmic reticulum, mitochondria, and Golgi bodies. Contractile vacuoles may be present which serve to regulate the osmotic pressure. Several food vacuoles also may be seen.

The active feeding and growing stage of the protozoa are called the trophozoite (G.trophos-nourishment). The cell may obtain nourishment from the environment by diffusion or by active transport across the plasma membrane. Larger food particles are taken in by phagocytosis through pseudopodia. Some species ingest food through

Protozoa: General Features of special mouth-like structures or cytostomes. Minute droplets of food may also enter by pinocytosis. Several species possess a resting or resistant cystic stage which enables prolonged survival under unfavorable conditions. The cystic stage may also involve reproduction by the nucleus dividing once or more to give rise to daughter trophozoites on excystation. The cyst is usually the infective stage for the vertebrate host.

Reproduction is usually asexual. The most common method is binary fission by the mitotic division of the nucleus, followed by the division of the cytoplasm. In amoebae, division occurs along any plane, but in flagellates, the division is along the longitudinal axis and in ciliates in the transverse plane. Some protozoa, as for

instance the malaria parasites exhibit schizogony in which the nucleus undergoes several successive divisions within the schizont to produce a large number of merozoites. Sexual stages are seen in ciliates and Sporozoa. In ciliates, the sexual process is conjugation in which two organisms join together and reciprocally exchange nuclear material. In Sporozoa, male and female gametocytes are produced, which after fertilization form the zygote giving rise to numerous sporozoites by sporogony.