

LECTURE 1: INTRODUCTION TO PROTOZOA

A quick reminder

Classification of medically important parasites

Protozoa

Sarcodina (Amoebae)

(a) Genus, Entameba:

E.g. *Entameba histolytica*

(b) Genus Endolimax

E.g. *Endolimax nana*

(c) Genus Iodameba

E.g. *Iodameba butchlii*

(d) Genus Dientmeba

E.g. *Dientameba fragilis*

Mastigophora (Flagellates)

(a) Genus Giardia

E.g. *G. lamblia*

(b) Genus Trichomonas

E.g. *T. vaginalis*

(c) Genus Trypanosoma

E.g. *T. brucei*

(d) Genus Leishmania

E.g. *L. donovani*

Sporozoa

(1) Genus Plasmodium

E.g. *P. falciparum*

(2) Genus Toxoplasma

E.g. *T. gondi*

(3) Genus Cryptosporidium

E.g. *C. parvum*

(4) Genus Isospora E.g. *I. belli*

Metazoa (Helminthes)

Platyhelminthes

Trematodea

(a) Genus Schistosoma

E.g. *S. mansoni*

(b) Genus Fasciola

E.g. *F. hepatica*

Cestoda

(a) Genus Diphylobotrium

E.g. *D. latum*

(b) Genus Taenia

E.g. *T. saginata*

(c) Genus Echinococcus

E.g. *E. granulosus*

(d) Genus Hymenolepsis

E.g. *H. nana*

Nemathelminthes

(a) Intestinal Nematodes

E.g. *A. lumbricoides*

(b) Somatic Nematodes

E.g. *W. bancrofti*

Ciliates

E.g. *Balantidium coli*

General characteristics of medically important parasites

Medically important protozoa, helminthes, and arthropods, which are identified as causes and propagators of disease have the following general features. These features also differ among parasites in a specific category.

Protozoa are single celled animals found worldwide in most habitats, most species are free living but all higher animals are infected with worms or more species of protozoa. The infection is ranged from asymptomatic to life threatening depending on the species, the strain of the parasites and the resistance of the host the parasites and the resistance of the host.

Protozoa

- Protozoan parasites consist of a single "cell-like unit" which is morphologically and functionally complete and can perform all functions of life.
- They are made up of a mass of protoplasm differentiated into cytoplasm and nucleoplasm.
- The cytoplasm consists of an outer layer of hyaline ectoplasm and an inner voluminous granular endoplasm.
- The ectoplasm functions in protection, locomotion, and ingestion of food, excretion, and respiration.
- In the cytoplasm there are different vacuoles responsible for storage of food, digestion and excretion of waste products.
- The nucleus also functions in reproduction and maintaining life.
- The protoplasmic body thus formed is known as a cyst. At this stage the parasite loses its power to grow and multiply. The cyst is the resistant stage of the parasite and is also infective to the human host.

Reproduction

The methods of reproduction or multiplication among the parasitic protozoa are of the following types:

1. Asexual multiplication

(a) Simple binary fission – in this process, after division of all the structures, the individual parasite divides either longitudinally or transversely into two more or less equal parts.

(b) Multiple fission or schizogony – in this process more than two individuals is produced, e.g. asexual reproduction in Plasmodia.

2. Sexual reproduction:

(a) Conjugation – in this process, a temporary union of two individuals occurs during which time interchange of nuclear material takes place. Later on, the two individuals separate.

(b) Syngamy – in this process, sexually differentiated cells, called gametes, unites permanently and a complete fusion of the nuclear material takes place. The resulting product is then known as a zygote.

Protozoa are divided into four types classified based on their organs of locomotion. These classifications are: amoebas, ciliates, flagellates, and sporozoans

Classification of protozoa

Protozoa of medical importance are currently classified into six phyla. Most species causing human disease are members of the phylum Sarcomastogophora and Apicopllexa

Classification of parasitic protozoa and associated diseases

Phylum	Sub phylum	Examples	Major disease in humans
1. Sarcomastigophora (with flagella pseudopodia or both	(i)-Mastigophora with flagella. (ii)-Sarcodina with pseudopodia	Leishmania Entamoeba	-Visceral, cutaneous, mucocutaneous infections -Dysentery -liver abscess

2. Apicomplexa (multipseudopodia)	Coccidia	-Plasmodium -Isospora -Sarcocystis -Cryptosporidium -Toxoplasma -Pneumocystis -Microspora -Babesia -Eimeria	-malaria -diarrhoea -diarrhoea -diarrhoea -toxoplasmosis -Pneumonia
4 Ciliophora (cilia)	-	Balantidium	Dysentery.

Characteristics

Sarcordina

- Consists of shapeless mass of moving cytoplasm which is divided into granular endoplasm and clear ectoplasm
- Move by pushing out the ectoplasm to form pseudopodia (false feet) into which the endoplasm then follows.
- Reproduce by simple dividing into two (Binary fission).
- Digested food substance are stored as glycogen or chromatoid bodies
 - They form cysts by which they are transmitted

Mastigophora

- Locomotion is mainly by a flagellum or flagella.
- Reproduce by simple binary fission.
- The trypanosomes and leishmania species possess a kinetoplast

Ciliophora

- Move by simple hair called cilia
- Have two dissimilar nuclei the macro and micro nucleus
- Reproduce by simple binary fission.

- Form cysts in which they are transmitted

Coccidia

- Reproduce asexually by a process called schizogony. And sexually by a process called sporogony.
- Malaria parasites are transmitted by mosquitoes and intestinal coccidia by ingestion of Oocysts.
- The following specimens can be received in parasitology laboratory i.e. stool, blood, urine for schistosoma haematobium, sputum for Paragonimus westermani

Helminthes

The helminthic parasites are multicellular, bilaterally symmetrical animals having three germ layers. The helminthes of importance to human beings are divided into three

Characteristic features

	Cestode	Trematode	Nematode
Shape	Tape like segmented	Leaf like Unsegmented	Elongated Cylindrical
Sexes	Not separate (monoecious)	not separate (monoecious) Except blood flukes are Dioecious	Separate (diecious)
"Head" End	Suckers with hooks	Suckers: no hooks	No suckers, and Hooks
Alimentary canal	Absent	Present and incomplete	present and complete
Body cavity	Absent	Absent	Present

Arthropods

- They form the largest group of species in the animal kingdom
- They are characterized by having a bilaterally symmetrical and segmented body with jointed
- Appendages.
- They have a hard exoskeleton, which helps enclose and protect the muscles and other organs. An open circulatory system, with or without a dorsally situated heart pumps the blood (hemolymph) via arteries to the various organs and body tissues. Blood is returned to the

heart through body spaces known as hemocoels. In addition, respiratory, excretory, and nervous systems are present.

- Arthropods affect the health of humans by being either direct agents for disease or agents for disease transmission.
- The arthropods of medical importance are found in Classes Insecta, Arachnida, and Crustacea which have their own distinguishing features.
- In Class insecta the body is divided into head, thorax, and abdomen, with one pair of antennae. Diseases like malaria, yellow fever, onchocerciasis, and trypanosomiasis are primarily transmitted by insects.

Review questions

1. Explain briefly the various types of parasites and hosts.
 2. Explain the three types of symbiotic relationships and give examples.
 3. Discuss the mechanisms by which parasites impose their effect on the host.
 4. Give examples of reactions that occur in the body of the host following parasitic infection.
- **Protozoa (singular, protozoan)**, from the Greek ‘protos’ and ‘zoon’ meaning “first Animal”, are members of eukaryotic protists. They may be distinguished from other eukaryotic protists by their ability to move at some stage of their life cycle and by their lack of cell wall.
 - This is the smallest animal which is unicellular and Eukaryotic that range in size from sub microscopic to macroscopic. Each protozoon has the capacity to produce, eat move, and find a suitable habitat where it can survive. They are equipped with escape mechanism that enables them to avoid hostile environment.

Occurrence of protozoa

- Protozoa are found in all moist habitats. They are common in sea, in soil and in fresh water. These organisms occur generally as a single cell.
- Colonies of protozoa might also occur in which individual cells are joined by cytoplasmic threads and form aggregates of independent cells.

- However, distinct types of protozoa include a resistant cyst (non-motile) stage to survive adverse environmental conditions, such as desiccation, low nutrient supply, and even anaerobiosis. For example, the soil amoeba, *Naegleria* is a resistant cyst in dry weather, a naked amoeba in moist soil, and becomes flagellated when flooded with water.

Morphology of protozoa

- Protozoa are predominantly microscopic, ranging in size from 2 to more than 100 μ m.
- Morphologically, they are within a mass of protoplasm, consisting of a true membrane – bound nucleus and cytoplasm.
- The nucleus contains clumped or dispersed chromatin and central nucleolus or karyosome, which are useful structures to distinguish protozoan species from one another based on the shape, size and distribution of these structures.

Importance of protozoa

- Protozoa serve as an important link in the food chain and ecological balance of many communities in wetland & aquatic environments.
- They are also important in biological sewage treatment, which involves both anaerobic digestion and/or aeration.
- Protozoa are important laboratory organisms in research areas, by which their asexual reproduction enables clones to be established with the same genetic make-up.
- These are useful in the study of cell cycles and nucleic acid biosynthesis during cell division.

Medical concern of protozoa

- Protozoa are ubiquitous in moist areas, including the human alimentary canal. From an ecological standpoint, protozoa may be divided into free-living forms and symbiotic forms. Some of the symbiotic ones are parasitic and may cause disease.
- Although most amoebas are free-living, several are found as commensal inhabitants of the intestinal tract in humans. One of these organisms *Entamoeba histolytica* may invade tissue and produce disease.
- The majority of ciliates is free living and seldom parasitizes humans. Flagellates of the genus *Trypanosomes* and *Leishmania* are capable of invading the blood & tissue of humans, where

they produce severe chronic illness. Others such as *Trichomonas vaginalis* and *Giardia lamblia* inhabit the urogenital and gastrointestinal tracts and initiate disease characterized by mild to moderate morbidity but no mortality.

- Sporozoan organisms, in contrast, produce two of the most potentially lethal diseases of humankind: malaria and toxoplasmosis.

Reproduction and regeneration of protozoa

- Protozoa multiply by asexual reproduction. This is not to say that sexual processes are absent in the protozoa. Some parasitic forms may have an asexual phase in one host and a sexual phase in another host

Transmission

- ✓ In most parasitic protozoa, the developmental stages are often transmitted from one host to another within a cyst.
- ✓ Pathogenic protozoa can spread from one infected person to another by:
 - Faecal – oral transmission of contaminated foods and water.
 - Insect bit inoculums or rubbing infected insect faeces on the site of bite.
 - Sexual intercourse

Pathogenesis

- ✓ Protozoan organisms are virtually always acquired from an exogenous source, and as such, they have evolved numerous ways to enter the body of the human host.
- ✓ Factors that are important for pathogenicity include:
 - Attachment to the host tissue followed by replication to establish colonization.
 - Toxic products released by parasitic protozoa.
 - Shifting of antigenic expression to evade the immune response and inactivate host defences.

Antiprotozoal agents

- The antiprotozoal agents target relatively and rapidly the proliferating, young, growing cells of the parasite. Most commonly, these agents target nucleic acid synthesis, protein synthesis, or specific metabolic pathways (e.g. folate metabolism) unique to the protozoan parasites.

3.1 Intestinal protozoa of medical importance

- Protozoa of medical importance are classified based on their morphology and locomotive system as described below:
- Amoebas - *Entamoeba histolytica*
- Flagellates - *Giardia lamblia*, *Trichomonas vaginalis*, *Trypanosoma* spp, *Leishmania* spp
- Ciliophora - *Balantidium coli*
- Coccidian - *Isospora belli*, *Cryptosporidium parvum*, *Toxoplasma gondii*, *Plasmodium* species

Protozoan pathogens can also be grouped according to the location in the body where they most frequently cause disease.

Important pathogenic protozoa and commonly caused diseases

Intestinal tract

<i>Entamoeba histolytica</i>	<i>Ambiasis</i>
<i>Giardia lamblia</i>	<i>Giardiasis</i>
<i>Cryptosporidium parvum</i>	<i>Cryptosporidiosis</i>
<i>Balantidium coli</i>	<i>Balantidiasis</i>
<i>Isospora belli</i>	<i>Isosporiosis</i>
<i>Cyclospora cayentanensis</i>	<i>Cyclosporiasis</i>

Urogenital tract

<i>Trichomonas vaginalis</i>	Trichomoniasis
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Blood and tissue

<i>Plasmodium</i> species	Malaria
<i>Toxoplasma gondii</i>	<i>Toxoplasmosis</i>
<i>Trypanosoma</i> species	Trypanosomiasis
<i>Leishmania</i> species	Leishmaniasis
<i>Naegleria</i> species	Amoebic Meningoencephalitis
<i>Acanthamoeba</i> species	Amoebic Meningoencephalitis
<i>Babesia microti</i>	Babesiosis

