University of Jordan
Faculty of Medicine

Medical Committee
The University of Jordan

Introduction to

Microbiology

Title :

Protozoa

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- ○ Slides
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In the last lecture we reached the classification of parasites. These parasites that we are talking about are the endoparasites. Ectoparasites are insects that we will not be talking about.

Endoparasites are classified into two main groups:

1. Protozoa

2. Metazoa

Metazoa is also called helminths.

Metazoan are multicellular organisms.

Protozoa are unicellular organisms. They range in size from as little as 3 **microns** to about 120 **microns.**

Note: how do we imagine an object measured in microns(**µm**) ?

The best way is to think of a red blood cell. We all have seen a RBC under the microscope which has a diameter of about 7 microns. So 3 microns is less than the normal size of a RBC while the biggest endoparasite (120 microns) is about 17 times its size.this could help with imagining the size of the parasite. Of course most of the parasites' sizes is in between 3-120 microns.

So if a parasite could be as small as 3 microns it means that some parasites can actually be inside the cells.

Therefore we have two varieties (kinds) of protozoa: we have intracellular pathogens, and extracellular pathogens. The large parasites that cannot be squeezed inside the cells are extracellular , while the small ones can be intracellular.

Ps. RBCs are about 7 microns, others like macrophages are about 15 or maybe 20. (have the possibility of housing intracellular parasites)

Ps. As far as the metazoa are concerned we do not have intracellular parasites. Intracellular parasites are only protozoa.

In general, when we talk about protozoa very often we use the word trophozoid (or trophozoite) . What is a trophozoite? It is the vegetative form of the organism. We mentioned before that these parasites usually have different morphologies. One morphology is that it exist in the primary host, another is that it exist in the intermediate host and even within the same host you can have more than one morphological states of the same organism.

So the vegetative is the form of the parasite that is alive; it moves, has metabolism, feeds, excretes, has vital different reaction , and it divides. It also causes disease.

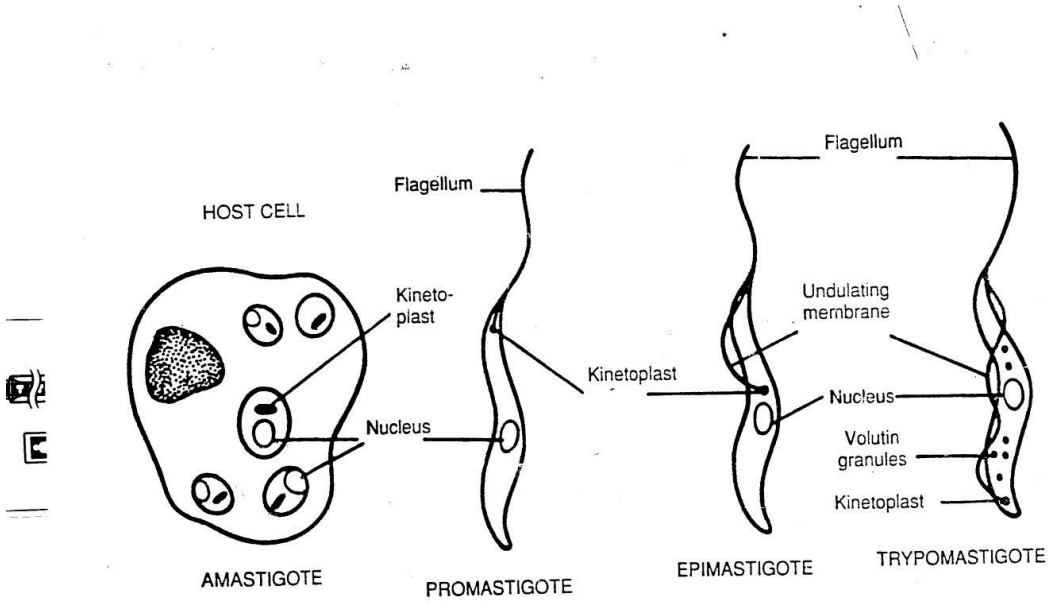

Figure 4–1. Developmental forms of Trypanosomatidae.

In the picture above we have a demonstration of intracellular and extracellular protozoa. The two on the left belong to the same organism (Leishmania) (different morphologies).The one on the left is not the organism itself, it is a macrophage. Inside the cytoplasm of the cell we have these circular organisms which are the parasites (intracellular). This is the morphology we see in the primary host (human beings and some animals(el jarabee3 wel klaab ☺)). The second from the left is the morphology seen in the intermediate host (sand fly) . usually it is found extracellular because it is large. The two on the right are related (both are

trypanosoma which cause the sleeping sickness disease). These are two different morphologies, both are extracellular(large). The one on the right is present in the primary host (humans and sometimes animals). And the second from the right side is present in the intermediate host. The carrier of this disease is the "tsetse fly".

Whether a parasite is found intra or extra cellular depends on the host and on the parasite itself.

The protozoa have four groups that can really cause diseases in human beings. And they are usually classified according to their locomotion organelles or the method of movement of these parasites. For example we have one group which is known as the RHIZOPODA (Rhizo means roots and poda means foot) which means they have pseudopodia (fake feet) which are extension of the cytoplasm. Just like the amoeba.

Another group is known as the FLAGELLATES (the organisms from above are flagellates). They have flagella (one or several). Some of them also have undulating membranes (which is a membrane extending on the side of the organism. It moves and helps with the movement of the organism).

The third group is the CILIATES. As the name implies this group have cilia which are hair like projections present on the surface of the cell and they move.

The last group is the APICOMPLEXA (old name is the sporozoa). These organisms have a complex apparatus in the anterior end of the organism which is rather complicated and is used for entry into cells.(hence the name api-complexa).

Slide 18 – on the upper left side (A), this organism is called Giardia. It has four pairs flagella coming from the sides. It has two nuclei with prominent nucleoli and that is why they look like two eyes. This is used for diagnosis sometimes and it is described as the owl-eye appearance.
On the lower right side (k), This organism is called Trichomonas. It has flagella on the anterior and on the posterior sides. it also had undulating membranes (check the right side of the organism near the top). These are examples of flagellates. some of them are luminal flagellates. Leishmania is a hemoflagellate or tissue flagellate.

Slide 19 – Ciliates. As you can see, this organism is Balantidium coli. It is a human parasite and it has cilia. The one in the left is the trophozoite. The one on the right is the Cyst (will explain cyst later on).

Slide 20 – upper left: Amoeba , Rhizopoda with pseudopodia. Upper Right: Flagellates. III & IV ciliates and apicomlexans respectively.

Now what about the transmission of protozoa ?
First of all, there is one exception in which the whole organism is transmitted directly from one person to another (Trichomonas vaginalis). In this case we only have trophozoite, There is no need for the cyst, Trophozoite is transmitted directly from one organism to another. However, once trophozoite is outside the body it usually die quickly, therefore; this is not the ideal way for transmission.
So most of the parasites, especially the luminal parasite or the protozoal parasites have another morphology which is known as the cyst.
The cyst is surrounded by a hard layer which protects it from adverse environmental conditions, and it can stay outside the body for a while to actually be transmitted from one person to another.

Slide 12- This is an example of cyst formation. This is the amoeba (or Entamoeba histolytica). It is pathogenic to humans, lives in the large intestines . Upper left (A) is the trophozoite. Occasionally some of the trophozoite will undergo morphological changes and eventually become a cyst. Bottom right (E) is a mature cyst and in between A & E are the stages of cyst development. So there will be reduction in size, appearance of nucleic acids -RNA & DNA and they will appear as sausages or cigar like dark parts- These are known as chromatoidal bodies) . Eventually to get to a mature cyst these bodies tend to disappear.
Note: Chromatoidal bodies are only found in maturing cysts. They are not present in mature cysts ,instead there are multiple nuclei (for the amoeba>four). The number of nuclei in a cyst depends on the species.

Entamoeba histolytica is a human parasite, luminal, lives in large intestines, pass with the feces. Normally cyst is found with the feces. Sometimes however trophozite is also found in feces, especially if there is diarrhea (watery stool).

Now these cysts can last outside the body for a while. The means of transmission is known as feco-oral. Which means that a person have eaten something which had been contaminated by feces from somebody who has the passing cyst.

Trophozoite don't cause disease in this case because they either die quickly outside the body or they are destroyed by stomach enzymes or acidity.

The cyst are resistant of the acids in the stomach so they go on to the intestines. In the small intestines, there are the hydrolytic enzymes which will disintegrate the shell of the cyst and the release the four nuclei (in case of amoeba) which will divide quickly and give rise to four amoebules which will then go on to the large intestines and then grow into amoebas. And this is where the cycle ends (feces>ingestion>stomach>small intestines>large intestines>feces) . This cycle is called the feco-oral cycle.

Many of the luminal parasites that live in the GI tract undergo the same cycle. This is a direct cycle.

Almost all the luminal parasites (except the Trichomonas vaginalis) are transmitted through cyst/feco-oral.

However sometimes there is an intermediate host. Mainly tissue parasites require an intermediate host. For example, the malaria is a disease in the blood (tissue parasite). In this case, how will the parasite leave the blood to infect another ? It needs a vector. This is an intermediate host. Most intermediate hosts are insects, eg. Sand flies for leshmania , tsetse fly for African sleeping sickness, mosquitoes for malaria). Here we do not have cyst, but usually there is a different morphology or state for the organism that is transmitted. For example, in malaria the trophozoite (or merozoites?! Record not clear) infects the RBCs.

The life cycle for plasmodium (which is the protozoa that causes malaria):

Slide 16

Upper right, the mosquito bites the human > spits into the wound (anticoagulant) and its salivary glands injects sporozoites (the plasmodium is from the api-complexa group/sporozoite) > sporozoite go in the bloodstream, specifically going to the liver> multiply within the liver> go out in the blood again and infect RBCs>Develop within and then rupture RBCs>infect other RBCs—and so on> inside the RBCs some trophozoite decides not to divide anymore and change into a

gametocyte (parasite within RBC). Gametocytes have two kinds, a large one called macrogametocyte, and a small one called microgametocyte. These two are the equivalent of the male and female gametes, the male is the micro while the female is the macrogamete. These stay in the RBC and do not rupture it nor do they develop any further. This is an example of a different morphology (they are not trophozoite and are not cysts).>another mosquito comes and feeds on the infected person, and when it sucks the blood it also take the RBCs which contain microgametes and macrogametes. In the gut of the mosquito, these micro and macro gametocytes fuse and give rise to a zygote and the zygote will further develop and eventually goes to the salivary glands of the mosquito.

This brings up the question of the multiplication of the organisms?

Usually, protozoa divide by binary fission (1>2>4>8…etc) otherwise known as asexual reproduction.

However, in malaria we have noticed that there is something sexual happening (the sexual development of micro and macrogametocytes, their fusion to produce a zygote). So some protozoa have sexual reproduction (not all , eg. Amoeba does not have sexual reproduction, only asexual rep. by binary fission).

Malaria (plasmodium) has two kinds of reproduction in different hosts :

- Asexual in human (in the liver, and in the RBCs when it divides by fission).
- Sexual in the mosquito (in reality , in the mosquito we have both kinds of reproduction , the fussion of gametocytes to produce a zygote is sexual, but then the zygote will divide asexually to give rise to more sporozoites.

In other parasites, the sexual reproduction might be in the primary host, while the asexual reproduction is in the intermediate host.

So remember, that some protozoa , especially the tissue parasites which are usually form the api-complaxia group and some are flagellates have two cycles (sexual and asexual) which occurs in which host doesn’t really matter right now.

and can have both cycles within the primary host or within the intermediate host.

Because we have the replication of an organism within the host, this can give rise to a lot of organisms in the host. This does not occur with the metazoa. The metazoa do not divide on the same terms. Probably with one or two exceptions, metazoa do not increase (for example if a person ingested 5 eggs of some warms ,

they will stay as five worms and will not increase, it is possible for them to lay eggs, but these will be passed outside the body of the host.)therefore, the possibility of serious disease is more likely with the protozoa.

I apologize for any mistakes

Good Luck

“People who succeed have momentum. The more they succeed, the more they want to succeed, and the more they find a way to succeed. Similarly, when someone is failing, the tendency is to get on a downward spiral that can even become a self-fulfilling prophecy.”

Tony Robbins