Crafted by: Lee Hui Cheng


# A221: Microbiology
## Problem 12: Little Animals
### WORKSHEET

**Question 1**

Watch the following video and fill in the blanks in the table below.

| Kingdom Protista | | | |
|---|---|---|---|
| **Identity** | Slime mold | Algae | Protozoa (amoeba/paramecium) |
| **Unicellular or Multicellular** | Unicellular | Unicellular or multicellular | Unicellular |
| **Prokaryotes or eukaryotes** | Prokaryotes | Eukaryotes | Eukaryotes |
| **Description of microorganism** | Fungi-like | Plant-like | Animal-like |
| **Form of metabolism** | Heterotroph/autotroph | Autotrophic | heterotrophic |

a) Highlight some unique features of Kingdom Protista that distinguish them from other kingdoms which you had covered so far.

- algae are not plants because they lack the tissue differentiation that the kingdom of plantae has.

b) With reference to the following link, discuss about the diverse nature of protozoan/ protists and how these diversity helps brings about the role they play in nature.
    - Some eat or consume bacteria, fungi and micro → consumers or predators,
    - Major decomposer when things die, serve ecosystem functions in terms of recycling nutrients and breaking things down,
    - Control bacteria population,
    - Serve as food (eaten by different macroinvertebrates), passing nutrients from bacteria and nutrients to other macroinvertebrates, or smaller organism that consume them

c) Based on the information gathered so far, deduce which of the following subcategory of Kingdom Protista would likely cause disease in human.
Protozoa

## Question 2

a) Recall how the Cordyceps infect the living ants in Problem 9, how would you term a group of microorganisms that depends on other living organisms for their food and in turn cause harm to the host?
Parasites

b) Let's take a look at some characteristics of these common microorganisms/ organisms that depend on human as their host.

| Parasites | | |
|---|---|---|
| | **Protozoa** | **Helminths** |
| Kingdom | Protista | Animalia |
| Nutritional type | (Chemo)Heterotrophs | (Chemo)Heterotrophs |
| Uni/multi-cellularity | Unicellular | Multicellular |
| Presence of cell wall | No | No |
| Size range | 10-55 µm | 1mm to 20 m |
| Formation of embryo | no | yes |

c) What are some unique features that distinguish protozoa from Helminths?

| **Protozoa** | **Helminths** |
|---|---|
| Unicellular | Multicellular |
| Seen only with microscope | Visible to the naked eye |
| Able to multiply within their definitive host | Not able to multiply within their definitive host |
| Does not form an embryo | Forms an embryo |
| Indefinite lifespan | Definite lifespan |
| No stages exist in the life cycle | 3 stages in the life cycle namely adult, egg and larva |

***Definitive host: the host in which the sexual reproduction of a parasite takes place

**Question 3**

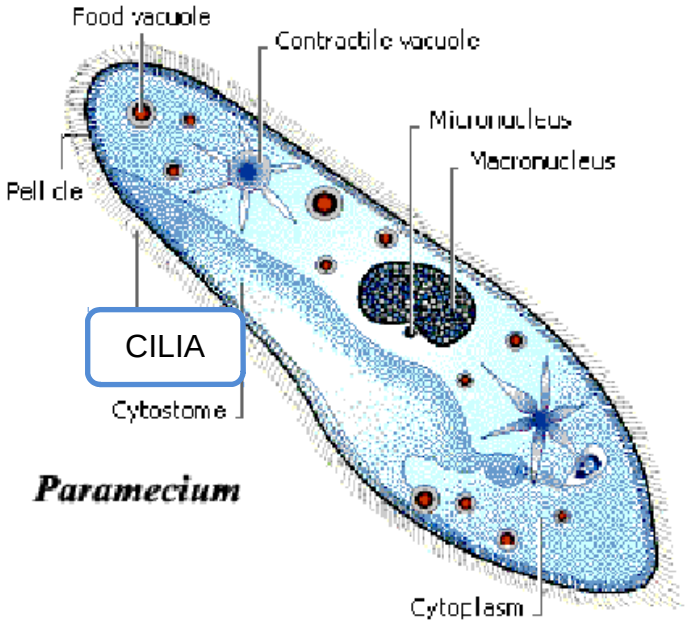
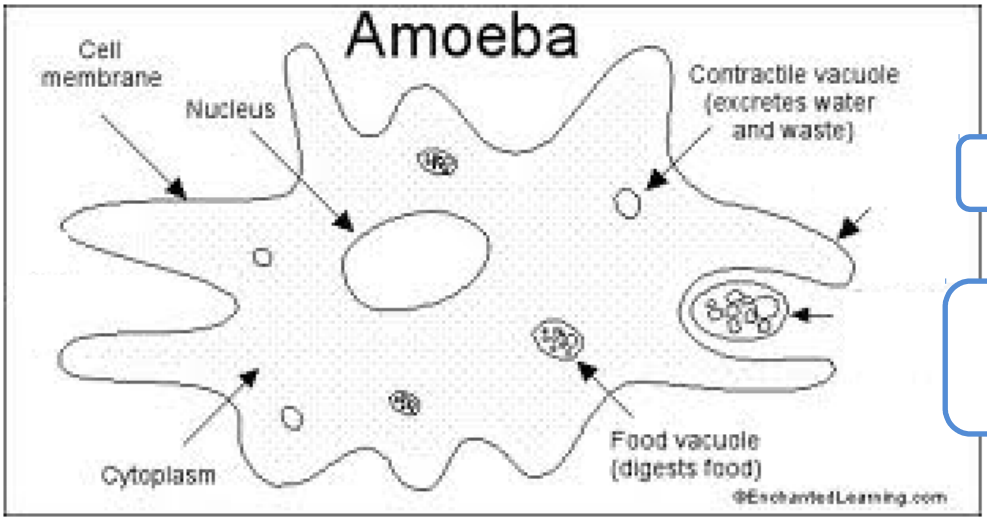
Let us now take a closer look at how protozoa are classified.

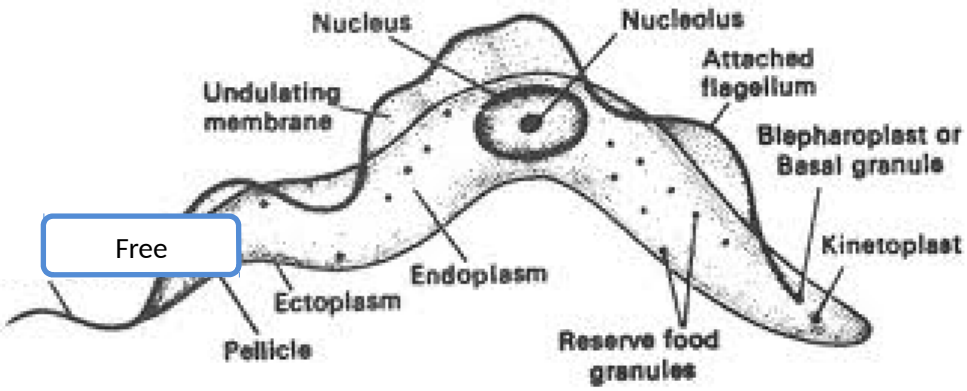
a) Protozoa are sub-classified into 4 phyla. Which are the 4 respective phyla?

- Mastigophora
- Sarcodina
- Apicomplexa
- Ciliophora/Ciliate

b) How are protozoa placed into each of the phyla that you listed above?
Based on how they move
    - Mastigophora ⇒ flagella
    - Sarcodina ⇒ Pseudopodia
    - Apicomplexa ⇒ Parasitic (latches onto host)
    - Ciliophora ⇒ Cilia

c) Fill in the blank in the diagrams below and identify which phylum the respective protozoan belongs to and reason why each protozoan is classified in the specific phylum.

| Examples of protozoa | Phylum |
|---|---|
|  | Ciliate (rowing a boat; like dragon boating)<br><br>requires water to move<br><br>- Presence of cilia on the surface of the organisms to help in motility<br>- 2 kinds of nuclei present (micronucleus and macronucleus ) |
|  <br>pseudopodia<br>Food being engulfed by pseudopods | Sarcodina<br><br>- Presence of pseudopodia for locomotion and feeding.<br>- Irregular in ape.<br>ood digested in food vacuole. |



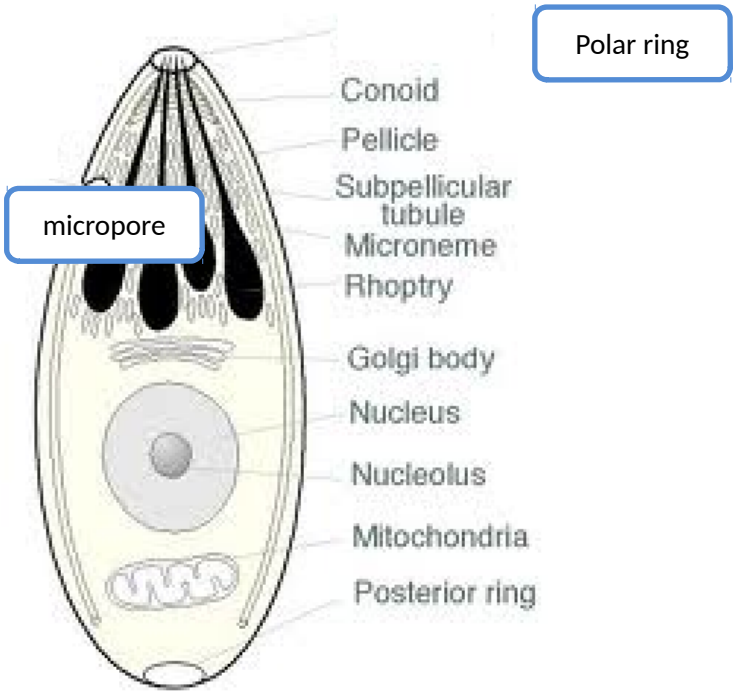

Trypanosoma gambiense

Mastigophora

- presence of flagellum for motility, self-propelled movement

Some can extend their interior contents (cytoplasm) outward in an arm-like protrusion (pseudopodia)

- Temporary structures that serve to entrap and direct food into the microorganism.
- Flexible and capable of collapsing back to form the bulk of the wall that bounds the microorganism.




Apicomplexa

- does not move
- polar rings

**Question 4**

What are the major modes of reproduction that protozoa undergo?

Asexual reproduction:

- **Multiple fission**: nucleus first undergoes a series of divisions, result in a number of daughter nucleus which usually arrange themselves at the periphery. Afterwards, body cytoplasm will divide into many parts as there are daughter nuclei, resulting into formation of several daughter individuals
    - schizogony: formation of numerous daughter nuclei is followed by the formation of cytoplasmic buds, each contains a nucleus
- **Binary fission**: involves mitotic division of nucleus, which is immediately followed by cytokinesis. In ciliates, during fission, meganucleus divides amitotically and micronucleus usually by mitotic division.
    - longitudinal binary fussion
    - irregular binary fission
    - transverse binary fission
    - oblique binary fission

- **Plasmotomy**: a type of asexual reproduction in the multinucleate cells which divides into 2 (or more) daughter cells without having to undergo mitosis.
- **Budding**: develop from an outgrowth or bud, a modified form of fission
    - Monotomic: when a parental body produce only one bud
    - Multiple budding: when a parental body produce several buds simultaneously
- **Plasmogamy**: A sexual reproduction of fungi where the mycelium. A type of reproduction in which the cytoplasm of two or more parent cells fuse together without the fusion of nuclei. After separation, they remain unchanged. It usually serves for the purpose of digestion of large prey
-

Sexual reproduction (e.g mosquitoes → plasmodium)

- **Syngamy**: fusion of two gametes resulting in the formation of zygote. Fused nucleus of zygote is called as synkaryon.
    - Hologamy: where two premature protozoa individuals do NOT form gametes, behave as gametes and fuse together to form a zygote
    - Isogamy: when two fusing gametes are morphologically similar but differ in behaviour, they are called as isogametes and their union is called as isogametes and their union is called as isogamy ((usually produced by multiple fission))
    - Anisogamy: two fusing gametes are differ in morphology as well as in behaviour, they are called as anisogamy and their union is anisogamy. Usually small or motile gametes are male or microgametes and large or non-motile ones are female or macrogametes
    - Autogamy: involves the fusion of gametes derived from the same parent cell

- **Conjugation**:
    - Aka amphimixis
    - temporary union of 2 individuals where exchange of genetic materials take place by direct cell-to-cell contact.
    - Only takes place between same groups of individuals
    - Organisms that participates in conjugation are known as conjugants

**Question 5**

Protozoa that cause gastrointestinal infections are capable of producing cyst forms as well as trophozoites. State why is this essential to these pathogens.

Cyst form: dormant stage of protozoa → it is highly infective and very resistant to harsh conditions (does not reproduce)

Trophozoites: proliferative, vegetative stage of protozoa: stage where protozoa is able to absorb nutrients from host and gain motility ( It reproduce )

**Question 6**

People living in the rural areas/ developing countries have to take extra precautionary measures in their daily life.

a) One of them includes enclosing their bed with a net (as shown above) when they sleep. Why is this necessary?

It is necessary to prevent parasitic organisms (which can be seen by the naked eye), like mosquitoes carrying malaria diseases from attacking/entering their sleeping areas.

b) Another common preventive measure taken would be to filter and boil the water before they consume it. Is filtration and boiling sufficient to get rid of all form of protozoa?

Yes, filtration and boiling are sufficient to get rid of all form of protozoa because protozoa are too big for it to pass through the filter.

**Question 7**

Protozoa can cause a variety of diseases in human. The outcome of such infection can be detrimental, as illustrated in the link below.
http://www.rt.com/usa/226419-braineating-amoeba-tap-water/

a) State the kind of environment in which protozoa usually found. State some examples of medically important protozoa.
Aquatic/moist environment

b) Explain why there is no treatment for some protozoan diseases in humans.
   - the usefulness of the developed drug will eventually decrease due to the protozoa being able to develop resistance.\
   - Protozoa are similar to our human cells. Thus, immune system unable to differentiate protozoa from our human cells and eliminate them

**Question 8**

Protozoa are not always bad. What are some situations where protozoa play a useful role in the ecosystem?

- Protozoa plays a major role in the ecological system as a decomposer and food for some organisms (some aquatic animals feed on protozoa for food).
  - Decomposing returns nutrients and minerals back to the environment
- Some inhibits in the other organism to help such as, Termite. Protozoans digest the cellulose in the wood eaten by the Termites and converts to carbohydrates.

## Going further

## Question 9

What are some virulence factors that promote the colonization of protozoans in the host?

Virulence factors that allows:

- colonisation of a niche in the host (including attachment to cells)
- evading of the host's immune system
- suppressing of the host's immune system
- entry in and out of cell
- obtaining nutrients from hosts

Adhesins, invasins, antiphagocytic factors ⇒ assist colonization
Toxins, hemolysins, proteases ⇒ bring damage to host

Why is a protozoa so hard to kill?
→ Able to move around
→ White blood cells cannot kill

a. Some protozoa, such as *Entamoeba histolytica*,*Trichomonas vaginalis*, *Giardia lamblia*, and *Balantidium coli* use **pseudopodia, flagella or cilia to swim through mucus and contact host cells**.

b. Protozoa use **adhesins** *(def)* associated with their cytoplasmic membrane to **adhere to host cells, colonize, and resist flushing**.

c. Some protozoa, such as the apicomplexans (*Plasmodium (inf)*, *Toxoplasma gondii (inf),* and *Cryptosporidium (inf)*) possess a complex of organelles called **apical complexes at their apex that contain enzymes used in penetrating host tissues and cells**.

d. Protozoans such as Trypanosoma *brucei gambiense (inf)* and *Plasmodium* species *(inf)* are **able to change their surface antigens** *(def)* during their life cycle in the human. As the protozoa change the amino acid sequence and shape of their surface antigens, **antibodies** *(def)* **and cytotoxic T-lymphocytes** *(def)* **made against a previous shape will no longer fit and the body has to start a new round of adaptive immunity against the new antigen shape**.

e. Some protozoa, such as *Entamoeba histolytica (inf)* **shed their surface antigens so that antibodies made by the body against these surface antigens are tied up by the shed antigens**.

## Question 10

How are protozoa identified in a laboratory?
Polymerase-chain reaction (PCR) techniques → allows identifications below the genus level.

Serological tests →
rapid card tests →

**~End of worksheet~**