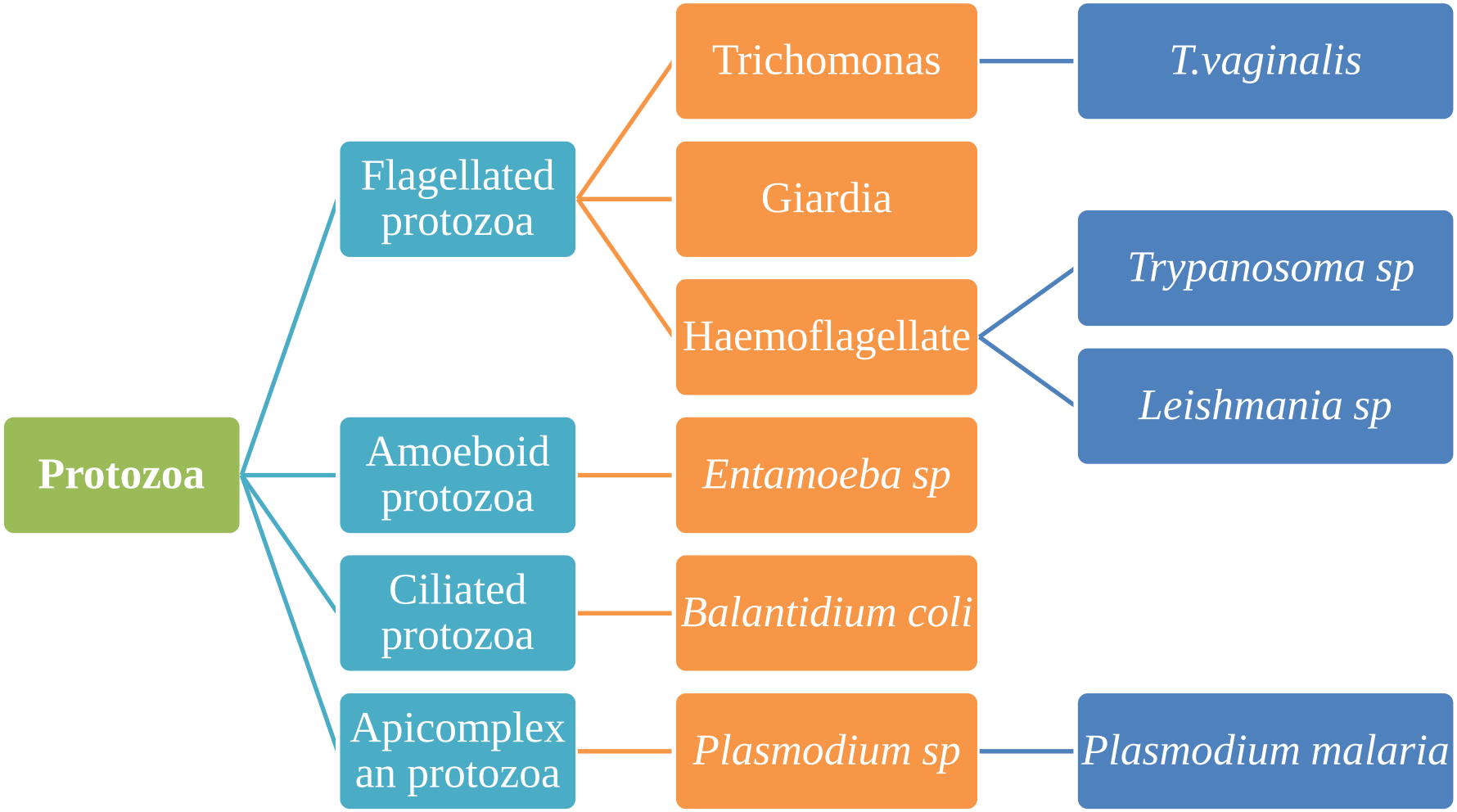
Physiology of Parasites
(512) Zoo 3(2+1)
Metabolic characteristics of different protozoa

Mind map

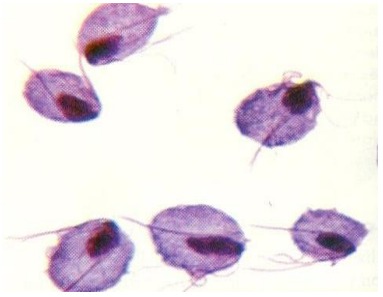

Protozoa
Flagellated protozoa
Trichomonas
T.vaginalis
Giardia
Haemoflagellate
Trypanosoma sp
Leishmania sp
Amoeboid protozoa
Entamoeba sp
Ciliated protozoa
Balantidium coli
Apicomplexan protozoa
Plasmodium sp
Plasmodium malaria

1- Physiology of Trichomonads

Trichomonas is a small, pear-shaped cells 4 anterior flagella & an undulating membrane. Exists only in trophozoite form. 3 species infect humans,

T. vaginalis,T. tenax,T. hominis

Trichomonads are anaerobic organisms, deriving much of their energy from the **incomplete degradation** of **simple sugars** accompanied by the production of **lactic acid** and **acetic acid** the presence of oxygen has little effect on this process.



***T. vaginalis* lacks mitochondria and other necessary enzymes and cytochromes to conduct oxidative phosphorylation**. However, it has been suggested that the **hydrogenosome** may be **a modified mitochondrion**, since it shows morphological and functional similarities to mitochondria, such as a double membrane and regulation of cell calcium.

The organism is able to maintain energy requirements (ATP) by the use of a **small amount of enzymes** to provide energy via **glycolysis** of **glucose to glycerol and succinate** in **the cytoplasm**, followed by further conversion of **pyruvate and malate** to **hydrogen and acetate** in an organelle called the **hydrogenosome.**

T. vaginalis obtains nutrients by **transport through the cell membrane** and by **phagocytosis.**

T. vaginalis has many enzymes that catalyze many chemical reactions making the organism relevant to the study of protein function.

Glucose and maltose are the most effective growth stimuli *in vitro*.

In culture, *T. viginalis* feeds on bacteria and, occasionally, erythrocytes. The predilection for bacteria suggests a mechanism for the breakdown of the normal pH of the infected vagina, since the lactic acid bacilli act to maintain normal pH levels.

Adherence

- One of the hallmark features *T. vaginalis* are the adherence factors that allow cervico-vaginal epithelium colonization in women.
- The adherence that this organism illustrates is specific to vaginal epithelial cells (VECs) being pH, time and temperature dependent.
- A variety of virulence factors mediate this process, some of which are the microtubules, microfilaments, adhesions (4), and cytseine proteinases.
- The adhesions are four Trichomonad proteins called :

AP65, aP51, AP33 and AP23 that mediate the interaction of the parasite to the receptor molecules on VECs. Cysteine proteinases may be another virulence factor because not only do these proteins bind to host cell surfaces but also may degrade extracellular matrix proteins like hemoglobin, fibronectin or collagen IV.

2-Physiology of *Giardia lamblia*

- Giardia is a Unique symmetrical heart shaped cells.
- Cysts are small, compact, and multinucleate.
- Cysts can survive for 2 months in environment.
- Cysts enter duodenum, germinate, & travel to jejunum to feed & multiply
- Spread through contaminated water & food.

An *in vitro* study to determine the method of uptake of **macromolecular markers such as ferritin** by Giardia indicates rapid transfer of the marker from the host's intestinal lumen into vacuoles close to the surface of the protozoan, suggesting a means by which Giardia obtains nutrients. Other studies using radiolabeled sugars show that Giardia is capable of incorporating certain monosaccharides into glycogen.

Giardia has **no mitochondria** but can use oxygen when available.There is no evidence of either an electron transport system or a Krebs cycle. The organism relies on **substrate level phosphorylation** as its major means of obtaining ATP.

Ethanol, CO_2, and acetate are principal end products of carbohydrate metabolism in Giardia.

The organism excretes mostly acetate in the presence of oxygen and ethanol in the absence of oxygen.

HemoFlagellated protozoa

- Live in blood & tissues of human host
- Obligate parasites
- Incite life-threatening and debilitating zoonoses
- Spread by blood-sucking insects that serve as intermediate hosts
- Acquired in specific tropical regions
- Have complicated life cycles & undergo morphological changes
- *Trypanosoma* *T. brucei* (causes sleeping sickness)
  T. cruzi (causes Chagas disease)
- *Leishmania* (causes Leishmaniasis)

3-Physiology of African trypanosomes

The physiology of the long, slender trypamastigote found in the circulatory system of the vertebrate host differs from that of the epimastigote observed in the insect vector. Morphological changes related to metabolic characteristics occur in the mitochondrion of each form.

For example,

Epimastigote

Has a well-developed mitochondrion

synthesizes ATP through oxidative phosphorylation as well as glycolysis

Trypamastigote

obtains energy-rich compounds

Regardless of the morphologhical stage of the parasite, glycolysis occurs in specialized organelles called glycosomes.

Reduced nicotinamide adenosine dinucleotide (NAD) is oxidized indirectly in the glycosome by an α-glycerophosphate oxidase system, part of which is localized in the mitochondrion.

4-Physiology of American Trypanosomiasis (*T. cruzi*)

Trypanosoma cruzi differs physiologically from the African trypanosomes

The occurrence of well-developed mitochondrial cristae in all stages of the life cycle of T. cruzi suggests that there is little difference in oxygen metabolism in the various stages

Oxygen consumption is the same in the intracellular amastigote, the blood- stream trypamastigote, and the insect stages.

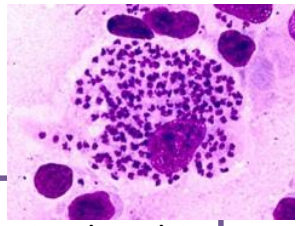
Also, at least some intermediates of a functional Krebs cycle have been reported in all stages.

Of the glucose that is consumed, some is oxidized to carbon dioxide while some is incompletely oxidized to organic acids, such as succinic acid and acetic acid.

5-Physiology of Leishmania

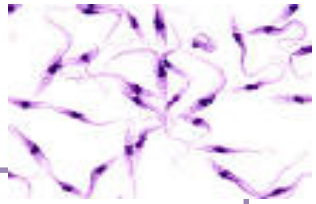
Carbohydrate metabolism

Amastigote form



- Poor developed of mitochondria
- neither cytochrome system nor functional Krebs cycle.
- process carbohydrates incompletely by anaerobic metabolism by substrate level phosphorylation)
- occur in glycosomes and cytosol
- producing
  - → ATP
  - → Short chain organic acid O_2

Promastigote form

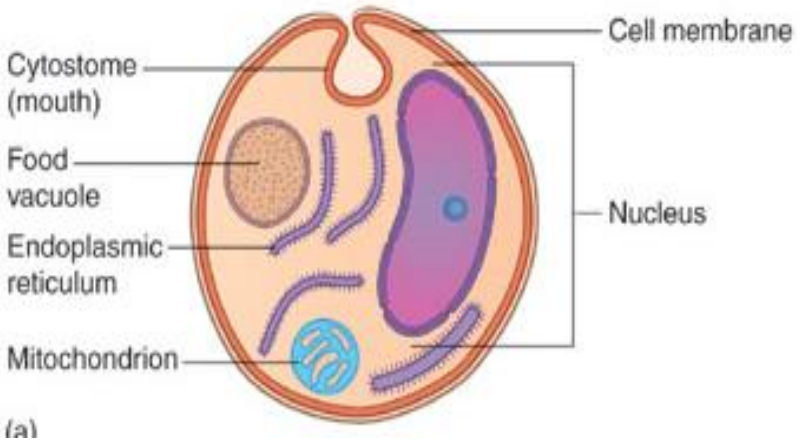


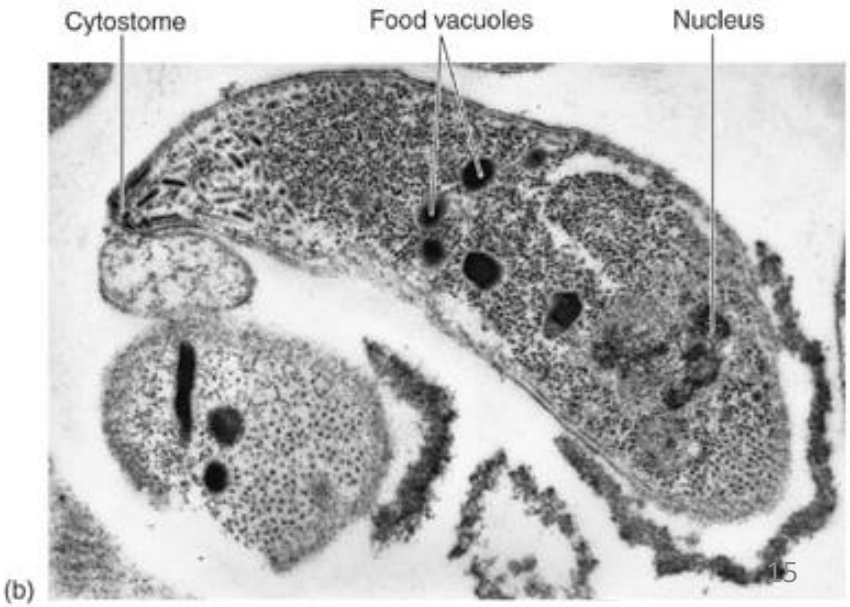
- Well developed mitochondrion
- developed functionally & morphologically an active cytochrome system & a functional Krebs cycle
- the cell utilize aerobic metabilis & produce ATP by oxidative phosphorylation .
- Producing ATP

such mitochondrial growth is controlled by kinetoplastic DNA (give reason)

Apicomplexan protozoa

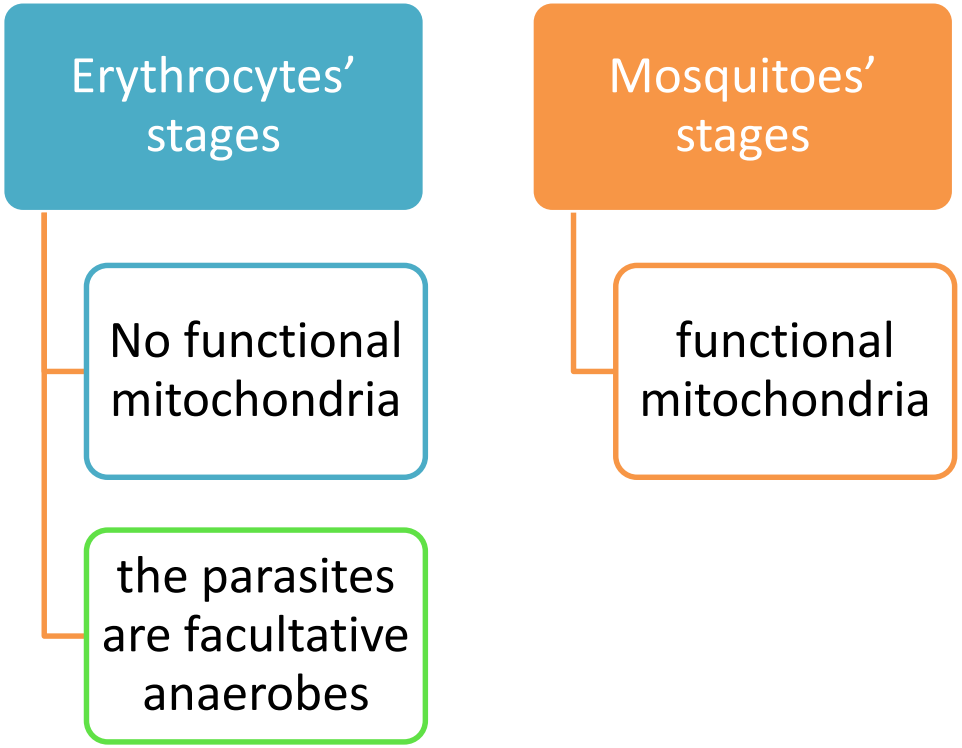
- Non-motile in mature stage
  - Male gametes are motile
- Alternate between sexual & asexual phases & between different animal hosts
- All members are parasitic
- Most form specialized infective bodies that are transmitted by arthropod vectors, food, water, or other means
  - *Plasmodium*
  - *Toxoplasma*
  - *Cryptosporidium*





6-Physiology of Plasmodium

- Glucose is the chief carbohydrate required by the parasite, which appears to derive most of its energy from glycolysis.



- The end-products of carbohydrate metabolism are

  -Lactic acids

  -Formic acid and

  - Acetic acid (limited amount).

The parasite does fix carbon dioxide, and the enzymes that catalyze this process are believed to be vulnerable to quinine and chloroquine.

- Hemoglobin is essential for the parasite's development, although it is uncertain precisely which components are required.
- The parasite digests hemoglobin intracellularly, producing an insoluble by-product hemogoin in addition to its possible disruption of carbon dioxide fixation, chloroquine appears to interfere with the intracellular digestive process of the partasite.
- Chloroquine and quinine are both weak bases that raise the pH of the lysosomal compartment, reducing the ability of the parasite to digest host hemoglobin efficiently.

Although the malarial parasite depends on host erythrocytes for many essential molecules, it does have the ability to synthesize folic acid, a key compound in pyriumidine synthesis, from basic molecules.

Host cells, on the other hand, require outside sources of folic acid. Therefore, drugs that block the synthesis of folic acid (antifols) by the parasite possess immense chemotherapeuitic potential

Amoeba

- Trophozoite is motile
- Facultative anaerobe
- Uses glucose as energy source
- Uses anaerobic metabolic pathways
- Trophozoites have single nucleus and lysozomes
- Cysts are smaller, no more than 4 characteristic nuclei