PHYLUM - SARCOMASTIGOPHORA

Subphylum - Mastigophora

Class - Zoomastigophorea

Characters:

- Flagellate protozoa possessing one or more thread like flagella .
- Some also have pseudopodia.
- In some forms, a flagellum may pass along the body, being attached to it by an undulating membrane (eg. *Trypanosoma, Trichomonas*).
- The nucleus is usually vesicular.
- Reproduction by longitudinal binary fission.
- The neuromotor apparatus consists of a granular blepharoplast or basal granule from which axoneme arises.
- Axoneme forms the axial structure of the flagellum & consist of 2 central and 9 peripheral fibrils surrounded by a flagellar sheath, which extent to the distal end of the axoneme.
- Closely posterior to the blepharoplast, there is a deeply staining granule, the kinetoplast. The kinetoplast contains DNA & is a part of mitochondria, which in the case of trypanosomes run the whole length of the body.

	Zoomastigophorea	**Phytomastigophorea**
1)	Lack chromatophores	Possess chromatophores, which contain chlorophyll, responsible for the synthesis of organic compound from inorganic materials.
2)	Nutrition is holozoic	Nutrition is holophytic
3)	Having veterinary and medical importance	No veterinary or medical importance

Order : 1. Kinetoplastida (*Trypanosoma* and *Leishmania*)

2. Retortamonadida (*Cochlosoma*)
3. Diplomonadida *(Hexamita* and *Giardia*)
4. Trichomonadida (*Trichomonas* and *Histomonas*)

Order - Kinetoplastida
Family - Trypanosomatidae

1. Includes all **haemo flagellates**.
2. They are **leaf like** in shape or somewhat containing single nucleus.
3. Having **Single flagellum** attached to the body by **undulating membrane**, supporting the flagellum at its outer margin.
4. The single flagellum arises from the basal granule or **blepharoplast** and passes anteriorly to become free in front of the body.
5. **Kinetoplant** posterior to the basal granule.
6. *Trypanosoma* have no months, feed by absorption of food in solution in their environment through the pellicle.
7. 10 genera but only two genera are of important genera. ***Trypanosoma* & *Leishmania***.
8. Have 4 developmental stages during their life cycles. "**Mastigote**" a Greek word that means **whip** (flagellum), has been used as new terminology of 4 types of developmental stages.

Developmental stages:

(i) **Trypomastigote** (With complete undulating membrane and free flagellum).
   a) The body is leaf like or blade like.
   b) Kinetoplast posterior to nucleus, and usually near the posterior extremity.
   c) An undulating membrane is well developed and a free flagellum is often present.
   d) This stage is usually found in the vertebrate host but also found in arthropods as the infective stage for the vertebrate host.

(ii) **Epimastigote** (with small free flagellum and short undulating membrane)
   a) The kinetoplast and axoneme lie anterior to the nucleus.
   b) Undulating membrane is short.
   c) It is principally a stage in arthropods.
   d) It is found in vertebrate as part of vertebrate development cycle.

(iii) **Promatigote** (with only a short free flagellum)
   a) The kinetoplast and axoneme are at the anterior tip of body.
   b) No undulating membrane.
   c) Found in arthropods.

(iv) **Amastigote** (without flagellum)
   a) The body is rounded.
   b) A flagellum is absent or the flagellum has degenerated into a tiny fibril inside the body.

c) Kinetoplast is present
d) The stages are found in vertebrates & arthropods.

Genera : **only 2 genera parasitic in domestic animals & man .**

Most of the members of the family undergo cyclical development is their invertebrate hosts and a few are transmitted mechanically. There is only asexual multiplication and no sexual stages occur.

(i) ***Trypanosoma*** : member of the genus are heteroxenous, occurs in vertebrate and arthropods, development may include the trypomastigote, epimastigote, promastigote and amastigote stages. In some species only trypomastigote stage occurs in the vertebrate host, but in some primitive forms amastigote and epimastigote stages occur in the vertebrate.

(iii) ***Leishmania*** : Heteroxenous, found in vertebrate and arthropods.The development stages include amastigote in their vertebrate host and promastigote stage in their invertebrate host or culture.

Genus :- *Tryponosoma*

1. Occur in vertebrates principally in the blood and tissue fluids as intercellular parasite (extra cellular).
2. Few may invade the tissue & occur as intracellular parasites ie *Trypanosoma cruzi* found within the cells of reticuloendothelial system.
3. The species of the genus causes Surra, Nagana, Dourine in animals & sleeping sickness of man.
4. They are transmitted by blood sucking arthropods either biologically or mechanically.
5. Multiplication by binary fission

Morphology:

1. Trypanosome are elongated **leaf shaped** with single nucleus near the center of the cells.
2. **Single flagelleum** arising from kinetoplast attached to the body by **undulating membrane** and extend freely at the anterior end.
3. In fresh blood trypanosomes are very active and jostle the RBC as they swim amongst them with a rippling movement.
4. Transmitted by blood sucking arthropods in which there may be cyclical development. Few species are transmitted mechanically.
5. Cyclical development in arthropods is of 2 types (section).
   A. Anterior station (section salivaria) and
   B. **Posterior station (section stereoraria)**

	Section :Stereoraria	**Section : Salivaria**
1.	Kinetoplast large not terminal	Kinetoplast small terminal or subterminal
2.	Posterior extremity tapering	Posterior extremity blunt
3.	Metacyclic trypomastigote in posterior station in arthropod host transmitted by contamination through faces.	Metacyclic trypomastigote in the anterior station of the arthropod host and and and transmitted by inoculation.
4.	Often non pathogenic	Frequently highly pathogenic
5.	Subgenera : Megatrypanum Herpetosoma Schizotrypanum Endotrypanum	Sub genera : Duttonella Nannomonas Pycnomonas Trypanozoon

Starcoraria

Subgenus	Species	Vertebrate Host	Arthropod host	Stage in which multiplication occur in vertebrate host
Megatrypanum	*T. theileri*	Cattle	Tabanid flies	Epimastigote (binary fission)
	T. melophagium	sheep	*Melophagus ovinus* (Sheep ked)	Uncertain
Herpetosoma	*T. lewisi*	Rats	Fleas	Epimastigote (multiple fission)
Schizotrypanum	*T. cruzi*	Man. Dog, Cat	Bugs	Amastigote (binary fission)

Salivaria

Subgenus	Species	*Vertebrate host*	Arthropod host	Character
Duttonella	*T. vivax*	Cattle, sheep, Goat, antelope	*Glossina* sp. (proboscis	Kinetoplast terminal poorly developed

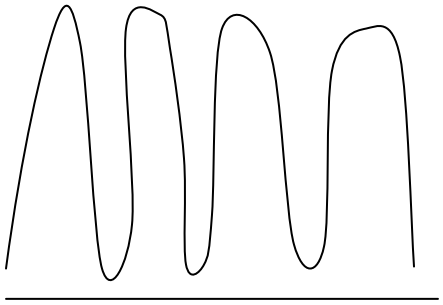
			only)	
	T. uniforme	Cattle, sheep, Goat, antelope	-do-	Undulating membranes monomorphic flagella Present
Mannomonas	*T. congolanse*	Cattle, sheep, Horse, pig	*Glossina* sp. (midgut, then Proboscis)	Kinetoplast marginal no free flagella, undulating membrane
	T. dimorphon	Cattle, sheep, Horse, pig	-do-	moderately developed
	T. simiae	Cattle, Horse, pig	-do-	Mono & polymorphic
Pycnomonas	*T. suis*	Pig	*Glossina* sp. (midgut, and Salivary glands)	Monomorphic, kinetoplast small & subterminal, free flagella short
Trypanozoon	*T. brucei*	Domestic animals and antilope	Glossina (midgut, and Salivary glands)	Mono & polymorphic Long, intermediate & stumpy form.
	T. rhodesiense	man	-do-	long free flagellum, Short & no free
	T. gambiense	man	-do-	flagellum respectively
	T. evansi	Equine, Camel Cattle, Dog etc.	non cyclical	undulating membrane well develop,
	T. equinum	Equines	non cyclical	kinetoplast small subterminal
	T. equiperdum	Equines	non cyclical	

Biology of trypanosomes

In definitive host : No sexual process has been observed in the life cycle of trypanosomes and all multiplication is by binary or multiple fission (*T. lewisi*). Division commences at the kinetoplast followed by the nucleus and then cytoplasm. In salivarian trypanosomes division chiefly occur in trypomastigote stage in the blood or in lymph glands. *T. cruzi* multiplies intra cellularly within the cells of the RE system and striated muscle specially the heart, being filled with amastigote form.

Immunological aspects

The salivarian trypanosomes can evade the immune response of the host by the production of relapse strains with different antigenic characteristic resulting in successive waves of parasitaemia at intervals of a few days, each waves representing the multiplication of a population of a new antigenic type.



The decreasing phase of the wave represents the destruction of this population by antibody. Thus the persistence of an infection is due to the **evation of the immune response** by a repeated change in antigenic character.

The antigens responsible for relapse populations are the **variant antigens** which are located on the surface of the organisms, but may also be found in the plasma of the infected animals. In distinction to the 'Variant antigens' are the **'Stable antigen'** which are probable structural protein, enzyme etc. are shared by the various developmental stages of a trypanosomes. The stable antigens are not concerned with the relapse phenomenon and are not thought to be concern with protective immunity. The antigenic variation in Trypanosomes are due to sequential expression of alternative cell surface glycoproteins. There are about thousands number of alternation antigens expressed by a clone.

The **'varient glycoprotein'** is the major component of the surface coatwhich is 15 nm thick. This surface coat absent from forms in the midgut of the tsetse fly and in culture but is acquired during transformation to infective metacyclic forms in the tsetse salivary gland. The variable antigens elicit a strong immune response but, because of the instability of their attachment to the cell membrane, they are shed in an Ag-Ab complex before compliment action

and membrane damage can occur. The variant antigens are associated with protective immunity, but only against the homologous antigenic type.

Suppression of the immune response to a variety of antigens or infections occurs in animals infected with the pathogenic trypanosomes due to exhaustion of the immune system.

In insect vector : The majority of trypanosomes undergo cyclical development in an arthropod vector. When non cyclical (mechanical) transmission occurs in case of *T. evansi* and *T. equinum*, it is by the biting flies, *Stomoxys* and *Tabanus*. The fly are having the habit of intermittent feeding. The fly is immediately infective but it remain for a short period of 15 minutes only and must be feed very soon on an another animal if the trypanosome are to be transmitted. *T. equiperdum* is transmitted mechanically through coitus. Even the cyclical forms may be transmitted mechanically and even by the arthropod in which they also develop cyclically. In cyclical development, the trypomastigote form along with mammalian blood taken into the intestine of the arthropod and subsequent development depends on whether 'anterior', or 'posterior' station development occurs

Anterior station development (Salivarian trypanosomes)

Trypanosoma brucei - Pleomorphic, 3 forms slender, intermediate and stumpy
T. gambiense, T. rhodesiense, T. vivax. T. congolense

Ingested forms localized in the posterior part of the midgut of G*lossina* where multiply in trypomastigote stage for the first 10 days. By days 10 – 11, migrate posteriorly enter the space around peritrophic membrane & penetrate into proventriculus being found here 12 – 20 days post infection. Then migrate anteriorly to esophagus & pharynx and then to the hypo pharynx & salivary glands. In salivary glands epimastigote forms are produced & further multiplication take place. In another 2 – 5 days, metacyclic or infective forms produce. There metacyclic stumpy form are injected into the host along with saliva when the fly bites, several thousands being injected with each bite. The developmental cycle of *T. brucci* in *Glossina morsitans* takes 25 days or more and flies are not infective untill the metacyclic forms have been produced.