

CHAPTER I

INTRODUCTION

Protozoa are **unicellular** mostly **microscopic** organisms and are classified under sub-kingdom protozoa of the kingdom protista. Protozoa are **eukaryotic cells** having a **distinct nucleus** as well as endoplasmic reticulum, golgi apparatus, mitochondria etc. in the cytoplasm. According to Levine (1985) about 65,000 species of protozoa have so far been named of which mostly are free living. Nearly 7000 protozoan sp. are parasitic both in vertebrate and invertebrate animals. Those parasitic protozoa which infect domesticated animals and birds & those, which are zoonotic are important to us.

Literally, 'Proto' means first and 'zoan' means animals – first animal life which appear in this universe. The flagellates are the most primitive form of animal life and the ciliates are the most highly organized form of protozoa.

Morphological structure of protozoa

Protozoa are **unicellular microscopic** organism varies greatly in shape and size. Through unicellular, some contain multiple nucleus.

A. **Nucleus** : Protozoa are having **well defined nucleus**, enclosed in a nuclear membrane.

Generally **two types** of nucleus are found – **Vesicular & Compact**.

Vesicular nuclei : Contain large amount of nucleoplasm and small amount of chromatin material.

Vesicular nuclei consist of a nuclear membrane which binds the nucleoplasm in which **endosome** (Karyosome) or the **nucleolus** located centrally. The **endosome** is devoid of DNA whereas the nucleolus possess it (DNA). The chromatin material (Feulgen positive for DNA) frequently occurs on the inner surface of the nuclear membrane and may also be seen as strands radiating from the inner surface of the nuclear membrane. This type of nucleus is mostly seen in sub-phyllum Mastigophora (*Trypanosoma*) and Sarcodina (*Entamoeba*). The other type of nucleus possesses a DNA positive **nucleolus** instead of endosome as an intra nuclear body and chromatin material distributed throughout the nucleus. This type of nucleus is mostly seen in sub-phyllum sporozoa.

Compact nuclei : Contain large amount of chromatin material and small amount of nucleoplasm. The chromatin material is scattered throughout the nucleus and the shape of

nucleus vary, it may be spherical, oval, cylindrical, sausage-shaped or horse-shoe-shaped or may take other form.

Some species contain more than one nucleus and they are of two types.

- (a) Species having two similar nuclei as in case of *Giardia & Hexamita*
- (b) Species having two dissimilar nuclei as in case of *Balantidium* (ciliophora) where the Macro nucleus govern the cytoplasmic function and the Micro nucleus help in sexual function.

In case of trypanosomes, the nucleus (triphonucleus) govern the general life of the cells and another chromatinic body (kinetocore) regulate the movement of the locomotory organelle.

B. Cytoplasm : this is the extra nuclear part of the protozoan cell. It may be differentiated into an **outer ectoplasm** lies immediately under the wall of the parasite and an **inner endoplasm** immediately surround the nucleus. The former often being homogeneous and hyaline in nature and the latter are granular and frequently containing granules, vacuoles and sometime pigments. The cytoplasm may also have golgi apparatus, mitochondria, ribosome, lysosome and other sub cellular organelles. (A pellicle serves the purpose to separate the ecto and endoplasm.)

Contractile vacuole mainly occur in free living aquatic protozoa. They are extremely small rounded floating vacuoles appear in the cytoplasm which coalesce to form a contractile vacuoles having osmoregulatory function and maintain the water balance in the body.

Food vacuoles are the sites where food particle passes and digestion take place. Food vacuole are having the seats of enzymatic activity. Occurs in *B. coli & E. histolytica*.

Nutrition : in case of protozoa nutrition are of three types **holophytic, holozoic (phagotrophic) and saprozoic.**

Holophytic Protozoa are those synthesize carbohydrate with the help of chlorophyll carried in chromatophores and in the presence of light. They are free living protozoa (phyto flagellates)

Holozoic protozoa utilized preformed food material either by pseudopodia or through a permanent opening called cytostome. Pseudopodia encircle solid particles and enclose them in the cytoplasm inside food vacuoles into which digestive enzyme secreted .

Saprophytic protozoa absorb organic food material dissolved in solution through the general surface of the body by diffusion.

Excretion : The metabolic waste products are eliminated by **diffusion** through the body surface membrane or by **contractile vacuole**.

Respiration : Two types - **aerobic or anaerobic** according to the availability of oxygen.

Aerobic respiration occurs in case of malaria parasite, *Leishmania* organisms Eimerian oocysts & some trypanosomes.

Anaerobic respiration occurs in case of *Trichomonas* sp & intestinal amoebae.

Locomotion : Protozoa move either by **gliding** or by means of **pseudopodia, flagella & cilia**. **Gliding** movement seen in *Toxoplasma* & *Sarcocystis* and other forms which do not possess any flagella or cilia (organelles). **Pseudopodia** are characteristic of Sarcodina protozoa. They are temporary organelles which are formed and retracted as per need. **Flagellum (flagella)** is a whip like filamentous protoplasmic extension which arises from a basal granule or blepharoplast in the cytoplasm. It is composed of a central axial filament, the axoneme surrounded by a contractile cytoplasmic sheath. Axoneme composed of two central filaments surrounded by 9 double peripheral filaments. Flagella create current & help in movement. There may be one or more flagella. In some form, flagella may be attached to the body of the protozoa by an undulating membrane. It occurs in subphylum Mastigophora. **Cilium (cilia)** is a fine protoplasmic eyelash like organelle originating from a basal granule embedded in the pellicle or ectoplasm. It occurs in ciliates (*B. coli*) and also aid in ingestion of food.

Reproduction : Life cycle of protozoan are varied, may be direct or indirect. It includes some form of sexual and some form of asexual reproduction. Typically a species multiply asexually for a variable period and follows a sexual process. The asexual phase may be repeated or omission of either sexual or asexual phase. The vegetative forms of the parasitic protozoa which feed, grow and divide are called the trophozoites.

1. **Asexual reproduction** : It is simple mitotic division without fusion of gametes. Amitosis is more common than mitosis. The following are the asexual reproduction.

i) **Binary fission**: Asexual division of the individual into two parts is called binary fission. There is nuclear division (karyokinesis) followed by division of cytoplasm (cytokinesis). Division occurs in a plane parallel to the long axis of the cell body called longitudinal binary fission as in case of flagellated protozoan (zoomastigophorea) or division occurs in transverse axis called

transverse binary fission as in case of ciliates. However protozoa having asymmetrical body like amoeba undergo binary fission in any plane of the body.

ii) **Budding** : In this type of asexual multiplication a small daughter individual separates from the side of the mother cell and grows to full size. This is amitotic division. **Internal budding** or **endodyogeny** – two daughter cells are formed within the mother cell and then breakout after destroying it. It occurs in case of *Toxoplasma*. If more than two daughter cells are formed by internal budding, it is called **endopolygeny**.

iii) **Multiple fission (schizogony or merogony)** : It occurs in Apicomplexa. The nucleus divides several times mitotically before cytoplasm divides. The dividing cell is known as a schizont, agamont, meront or segmenter and the daughter cells are called merozoites or schizonts.

iv) **Sporogamy** : This is an asexual multiplication which usually follows sexual reproduction. A number of sporozoites are formed in a cyst commonly called oocyst.

2. **Sexual reproduction** : During this type of reproduction, the number of chromosomes is reduced and the gametes are haploid. It is a more complex phenomenon. The following two types of sexual reproduction are seen in protozoa.

(a) **Conjugation** : Two individuals come together temporarily and fuse along part of their length. There is temporary contact between them during which time the exchange of some nuclear material takes place after which they again separate. This type of nuclear reorganization revitalizes the organism eg. *Balantidium coli*.

(b) **Syngamy** : Two individuals called gametes fuse to form a zygote. If the gametes are similar (isogametes), the process is called **isogamy**. If the gametes are dissimilar (anisogametes), the process is called **anisogamy**. In case of anisogamy the smaller gamete is male gamete and known as **micro gamete** and the larger gamete is female gamete and known as **macro gamete**. They are produced from special cells (gamonts) called the micro gametocytes (microgamonts) & the macro gametocytes (macrogamonts) respectively. The process of gamete formation is called gametogony which follows asexual process of reproduction by sporogony.