UG CBCS Semester-1

Phylum: Protozoa

A protozoan is a complete organism in which all life activities are carried on within the limits of a single plasma membrane. Protozoan phyla do demonstrate a basic body plan or grade—the single eukaryotic cell and they amply demonstrate the enormous adaptive potential of that grade. Over 64,000 species have been named, and over half of these are known only from fossils. Although they are unicellular, protozoa are not simple. They are functionally complete organisms with many complicated microanatomical structures.

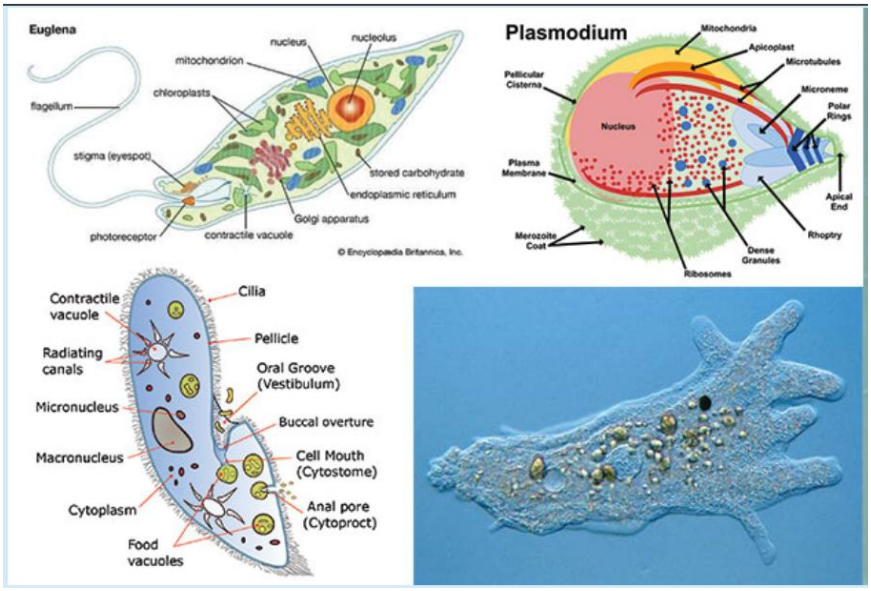
Their various organelles tend to be more specialized than those of an average cell in a multicellular organism. Particular organelles may perform as skeletons, sensory structures, conducting mechanisms, and feeding structures. The traditional phylum Protozoa contained four classes: flagellates, amoebas, sporozoans (an important parasitic group including malarial organisms), and ciliates.

Protozoa are found wherever life exists. They are highly adaptable and easily distributed from place to place. They require moisture, whether they live in marine or freshwater habitats, soil, decaying organic matter, or plants and animals. They may be sessile or free swimming, and they form a large part of the floating plankton. Some species may have spanned geological eras of more than 100 million years. Protozoa play an enormous role in the economy of nature.

Their fantastic numbers are attested by the gigantic ocean and soil deposits formed by their skeletons. About 10,000 species of protozoa are symbiotic in or on animals or plants, or sometimes even other protozoa. The symbiotic relationship may be **mutualistic** (both partners benefit), **commensalistic** (one partner benefits without affecting the other), or **parasitic** (one partner benefits at the expense of the other). Some of the most important diseases of humans and domestic animals are caused by parasitic protozoa.

Position relative to the animal kingdom

A protozoan is a complete organism in which all life activities are carried on within the limits of a single cell membrane. Because their protoplasmic mass is not subdivided into cells, protozoa sometimes have been termed “acellular,” but most people prefer “unicellular” to emphasize the many structural similarities to the cells of multicellular animals. Evidence from electron microscopy, life-cycle studies, genetics, biochemistry, and molecular biology has shown that the former phylum Protozoa encompassed numerous subphyla of varying evolutionary relationships.



Biological contributions

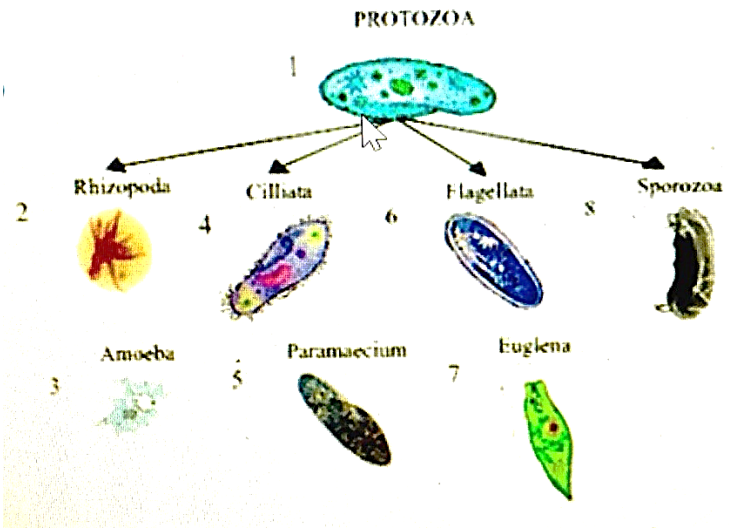
1. **Intracellular specialization** (division of labor within the cell) involves the organization of functional organelles in the cell.
2. The simplest example of **division of labor between cells** is seen in certain colonial protozoa that have both somatic and reproductive zooids (individuals) in the colony.
3. **Asexual reproduction** by mitotic division appears in unicellular eukaryotes.
4. **True sexual reproduction** with zygote formation is found in some protozoa.
5. The responses (taxes) of protozoa to stimuli represent the **simplest reflexes and instincts** as we know them in metazoans.
6. The simplest animal-like organisms with **exoskeletons** are certain shelled protozoa.
7. **All types of nutrition** are developed in protozoa: autotrophic, saprozoic, and holozoic. **Basic enzyme systems** to accomplish these types of nutrition are developed.
8. Means of **locomotion** in aqueous media are developed.

Characteristics of protozoan phyla

1. **Unicellular;** some colonial, and some with multicellular stages in their life cycles
2. **Mostly microscopic,** although some are large enough to be seen with the unaided eye
3. All symmetries represented in the group; shape variable or constant (oval, spherical, or other)
4. **No germ layer present**
5. No organs or tissues, but **specialized organelles** are found; nucleus single or multiple
6. Free living, mutualism, commensalism, parasitism all represented in the groups
7. Locomotion by **pseudopodia, flagella, cilia,** and direct cell movements; some sessile
8. Some provided with a **simple endoskeleton** or **exoskeleton,** but most are naked
9. **Nutrition of all types:** autotrophic (manufacturing own nutrients by photosynthesis), heterotrophic (depending on other plants or animals for food), saprozoic (using nutrients dissolved in the surrounding medium)
10. Aquatic or terrestrial habitat; free-living or symbiotic mode of life
11. Reproduction **asexually** by fission, budding, and cysts, and **sexually** by conjugation or by syngamy (union of male and female gametes to form a zygote)

Classification of protozoan phyla

This classification primarily follows Hyman (1940), Hickman (1961) and Storer (1965) with few exceptions.



SUBPHYLUM I: SARCOMASTIGOPHORA (Gr. Sarcodes=fleshy; mastix=whip; phoros=bearing)

The locomotion in this subphylum is brought about by flagella or pseudopodia or both. Other important feature of this subphylum is the presence of monomorphic nuclei. This subphylum is further divided in to 3 super classes:

Superclass 1: Mastigophora (Gr. Mastix=whip; phoros=bearing)

The body of the animals belonging to this super class is covered by pellicle. The locomotory organelles are flagella. In this super class the asexual reproduction occurs by longitudinal binary fission. This super class includes 2 classes:

Class 1: Phytomastigophora *(Gr. Phyton=plant; Mastix=whip; phoros=bearing)*

They have chromatophores with chlorophyll. The nutrition in these organisms is mainly holophytic which takes place by phototrophy. These are free living organisms. The reserve food in these organisms is starch or paramylon. These organisms may have 1 or 2 flagella.
Ex: *Euglena, Ceratium, Noctiluca*

Class 2: Zoomastigophora (Gr. Zoon=animal; Mastix=whip; phoros=bearing)

These organisms do not have chlorophyll bearing chromatophores. These are mostly parasitic. The nutrition in these organisms is holozoic or saprozoic. The reserved food is glycogen. They may have one to many flagella.
Ex: *Leishmania, Trypanosoma, Trichomonas, Trichonympha*

Superclass 2: Opalinata

The organisms belonging to this super class live as commensals or parasites in the gut of anurans. Their body is covered by oblique rows of cilia-like flagella. These organisms may have 2 or many nuclei also the nuclei are monomorphic. They undergo asexual reproduction by binary fission or by syngamy. Sexual reproduction takes place by anisogamy.
Ex: *Opalina, Zelleriella*

Superclass 3: Sarcodina (Gr. Sarcode=fleshy)

The locomotion in the organism belonging to this superclass is brought about by pseudopodia. Their body is amoeboid without definite pellicle. The nutrition is holozoic or saprozoic. This super class is further divided into 3 classes:

Class 1: Rhizopodea (Gr. Zoon=animal; Mastix=whip; phoros=bearing)

The pseudopodia of the animals in this class are in the form of lobopodia, filopodia or reticulopodia without axial filaments. This class includes amoebas, foraminiferans and mycetozoans. These animals are mostly free living and a few are also parasitic. In amoebas, the body is naked; in foraminiferans the body is covered by porous calcareous shell.
Ex: *Amoeba, Entamoeba, Elphidium*

Class 2: Piroplasmea

The animals belonging to this class are parasitic. Locomotory structures are absent in this class. Spores are also absent. These are the small parasites in the red blood cells of vertebrates.
Ex: *Babesia*

Class 3: Actinopodea (Gr. Actis=ray; podos=foot)

The pseudopodia of the animals belonging to this class are in the form of axopodia with axial filaments, radiating from the spherical body. These are planktonic. This class includes Heliozoans, Radiolarians and acanthareans. Radiolarians and acanthareans are marine forms whereas heliozoans are both marine and fresh water forms. Skeletons of radiolarians have siliceous shells. The shells of dead radiolarians accumulate on the ocean floor to form radiolarian ooze.

Ex: *Collozoum, Actinophrys, Acanthometra*

SUBPHYLUM II: SPOROZOA (Gr. Actis=ray; podos=foot)

The animals belonging to this subphylum are exclusively endoparasites. Special locomotory organelles are absent in these animals. Sometimes pseudopodia are present which are useful only for ingestion of food. Sporozoites are merozoites bear anterior apical complex that helps penetrate host cells. This subphylum includes 3 classes:

Class 1: Telosporea

The Sporozoites are long in these animals. Reproduction is both asexual and sexual. They are blood and gut parasites of vertebrates. Sexual reproduction is by isogamy or anisogamy.

Ex: *Monocyctis, Eimera, Plasmodium*

Class 2: Toxoplasmea

In this class reproduction is only asexual type which takes place by internal budding where two daughter cells are produced within the mother cell and the mother cell is finally destroyed in the process of reproduction. Spores are absent.

Ex: *Toxoplasma*

Class 3: Haplosporea

The spores in this class are amoeboid. Also reproduction is only asexual type taking place through multiple fissions.

Ex: *Haplosporidium, Ichthyosporidium*

SUBPHYLUM III: CNIDOSPORA (Gr. Knide=nettle; spora=seed)

The animals belonging to this subphylum are parasitic. Special kind of locomotory organelles are absent in these animals. Spores are present with one or more polar filaments. Polar filaments are special and unique features of these animals. When these spores infect a host, the polar filament is discharged and it gets attached to the host tissue. This subphylum includes 2 classes:

Class 1: Myxosporidea

The spores of the animals of this class are large and develop from several nuclei. These are generally extracellular parasites. The spores of this class have two polar filaments and have two to three valves

Ex: *Myxobolus*

Class 2: Microsporidea

The spores of the animals of this class are small and are developed from only one nucleus. These spores have single valve. These are generally intracellular parasites. Many of the animals of this class have a single polar filament. Ex: *Nosema bombycis*

SUBPHYLUM IV: CILIOPHORA (La. Cilium=eye lid with lashes; phoros=bearing)

Ciliophorans are complex of all the protozoans. The locomotory organelle of all the animals of this subphylum is cilia. These cilia also help in feeding at some stage of the life cycle of the animals. The nuclei of these organisms are dimorphic. Macronucleus is vegetative and polyploid. Micronucleus is reproductive and diploid. Asexual reproduction takes place by binary fission. Sexual reproduction takes place by conjugation. Only one class is included in this subphylum:

Class 1: Ciliatea

The locomotory organelles of these animals are numerous hair-like cilia. One or more contractile vacuoles are present in these forms. The nucleus is dimorphic including both macro nucleus and micronucleus.

Ex: *Paramoecium, Vorticella, Balatidium*

Reproduction

Sexual phenomena occur widely among protozoa, and sexual processes may precede certain phases of asexual reproduction, but embryonic development does not occur; protozoa do not have embryos. The essential features of sexual processes include a reduction division of the chromosome number to half (diploid number to haploid number), development of sex cells (gametes) or at least gamete nuclei, and usually a fusion of the gamete nuclei.

Asexual Reproduction

The cell multiplication process that results in more individuals in protozoa is called **fission.** The most common type of fission is **binary,** in which two essentially identical individuals result. When a progeny cell is considerably smaller than the parent and then grows to adult size, the process is called **budding.** This process occurs in some ciliates.

Sexual Processes

Fertilization of an individual gamete by another is **syngamy,** but some sexual phenomena in protozoa do not involve syngamy. Examples are **autogamy,** in which gametic nuclei arise by meiosis and fuse to form a zygote within the same organism that produced them, and **conjugation,** in which an exchange of gametic nuclei occurs between paired organisms (conjugants).

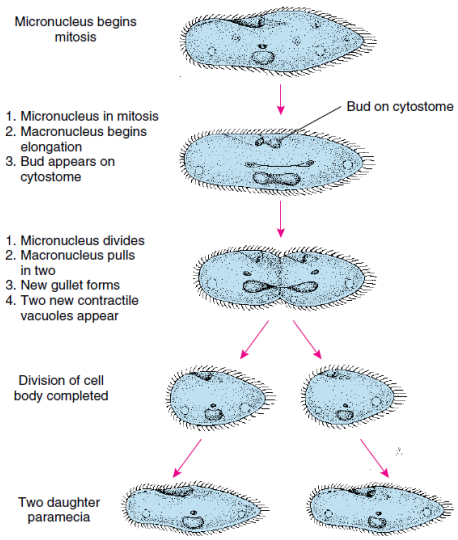


Figure: Binary fission in a ciliophoran (*Paramecium*). Division is transverse, across rows of cilia.