Eukaryotes

They have a true nucleus and membrane-bound organelles. There are three groups of eukaryotes which cause human diseases: protozoa, fungi, and helminths.

1. Protozoa

They are the largest unicellular microorganisms, and they contain organelles that carry out locomotion, nutrition, respiration, and excretion.

There are four (4) phyla based on their type of locomotion:

a. Rhizopoda

They move by pseudopodia ("false feet") which are long, fingerlike projections which allow the cytoplasm to flow forward and pull the rest of the organism after them.

The active or vegetative form is referred to as a trophozoite. They feed by surrounding the food with the pseudopodia. The food is ingested and once inside it is taken into a food vacuole, where it is digested. Wastes are removed through the cell membrane.

Asexual reproduction occurs when the nucleus divides by mitosis and the organism splits in two (binary fission).

During unfavorable conditions, the trophozoite becomes round and the membrane thickens. The resulting structure is a cyst which is a resistant resting stage.

Diseases of the human intestinal tract are caused by Entamoeba, Iodamoeba, and others which results in dysentery.

b. Ciliophora (ciliates)

They move by short, hair-like structures, called cilia, which cover the surface of the organism.

Ciliates have a mouth, gullet with cilia to move the food ingested, food vacuoles, an excretory pore, and two types of nuclei.

(1) micronucleus - small and functions in cell reproduction.

(2) macronucleus - large and functions in growth and metabolism.

When conditions are unfavorable, some may form cysts. Balantidium coli causes dysentery when it infects the human intestinal tract.
c. **Zoomastigina (flagellates)**

They move by long, whiplike structures called **flagella**.

There are two groups of flagellates that infect humans:

1. **Intestinal flagellates** - Organisms such as *Giardia* which causes diarrhea, and *Trichomonas* which causes vaginal inflammation, are normally found in the human body but when conditions allow them to multiply they cause disease.

2. **Hemoflagellates** (blood and tissues) - They enter the body through insect bites and migrate to various parts of the body such as the liver, brain, or other organs. Two major hemoflagellates are *Trypanosoma* (African sleeping sickness) and *Leishmania* (causes skin lesions).

d. **Apicomplexa (sporozoans)**

They are non-motile and live in cells, tissues and body fluids as parasites.

Their life cycle is complex, with several forms (trophozoites, sporozoites, merozoites), and they may require more than one host.

*Plasmodium* causes malaria and is transmitted to humans by mosquitoes. The mosquito may become infected by biting a human that has malaria.

2. **Fungi**

Most fungi are composed of long branching filaments called **hyphae** which form a complex network known as a **mycelium**.

There are four (4) Divisions based on type of hyphae, and the type of sexual spores produced:

a. **Zygomycota**

The hyphae are not divided into compartments by partitions or walls called **septa**. Sexual reproduction occurs between hyphae which have a chemical difference. Fusion between the hyphae produce a sexual spore called a **zygospore**.

Asexual reproduction produces **sporangiospores** within a **sporangium** which is located on a stalk called a **sporangiophore**.
b. **Ascomycota** (sac fungi)

The hyphae are divided by septa which contain pores. The cytoplasm flows through the pores which allows for the exchange of nutrients between the compartments. Sexual spores are called **ascospores** (usually 8) and are formed in a sac called an **ascus**. Asexual spores are called **conidiospores** and they are found in chains at the top of a stalk called a **conidiophore**. Two important ascomycetes are **Penicillium** and **Aspergillus**.

**Yeast**, which is a single-celled organism, reproduces asexually by forming a **bud** which eventually breaks off from the parent cell.

c. **Basidiomycota** (club fungi)

The hyphae are similar to those found in ascomycetes and the asexual spores are **conidiospores**. Sexual spores are called **basidiospores** (usually 4) and they are found in a club-shaped structure called a **basidium** at the end of a stalk called a **basidiophore**.

d. **Deuteromycota** (imperfect fungi)

They have no known form of sexual reproduction in their life cycle. Asexual spores are **conidiospores** and they produce infections of the skin and mucous membranes.

3. **Helminths** (worms)

The majority of their body contains reproductive structures, but they may have muscle tissue, nervous, respiratory, excretory, and digestive structures.

There are two major groups of helminths:

a. **Nemathelminthes** (roundworms)

They are cylindrical in shape and tapered or pointed at both ends. Their body is covered by a **cuticle** which protects them from the host's defense mechanisms. Human diseases of the digestive tract are caused by hookworms and **Ascaris**. The larva of the **trichina** worm (**Trichinella**) encysts in skeletal muscle and **filarial** worms live in the blood and various tissues.
b. **Platyhelminthes** (flatworms)

There are two groups based on their shape:

1. **Cestodes** (tapeworms)

   They are segmented and elongated. The individual segments are called proglottids and they mainly contain sex organs and excretory and nervous structures. The head is referred to as the **scolex** and it may contain hooks and/or suckers for attachment to the intestinal wall. They usually have two host organisms in their life cycle. The **definitive host** contains the adult forms which produce the eggs. The eggs are shed in the feces and picked up by another organism such as cattle, pigs and fish which are known as **intermediate hosts**. The eggs develop into a larva stage which become encysted in the hosts' muscle tissue. If improperly cooked beef, pork, or fish is eaten the larva are released, migrate to the intestine and develop into sexually reproducing adults.

2. **Trematodes** (flukes)

   They are covered by a **cuticle** and they have two suckers: one for feeding and the other for attachment to the host. They have a complex life cycle in which the adult forms live and produce eggs in various parts of the body (definitive host) and the various larval stages require an aquatic host or hosts (intermediate hosts).

   Trematodes include the blood (**Schistosoma**), liver (**Clonorchis**), intestinal (**Fasciolopsis**) and lung (**Paragonimus**) flukes.

   Blood flukes are bisexual, elongated and round. The other types of flukes are ovoid or leaf-shaped and hermaphroditic (both sexes in one individual).