9.1: Characteristics of Protozoa

Skills to Develop

After completing this section you should be able to perform the following objectives.

1. Briefly describe protozoa.
2. Briefly describe 3 ways protozoans may reproduce asexually.
3. Define the following:
   A. trophozoite
   B. protozoan cyst.

Protozoa are unicellular eukaryotic microorganisms lacking a cell wall and belonging to the Kingdom Protista. Although there are nearly 20,000 species of protozoa, relatively few cause disease; most inhabit soil and water. Protozoa reproduce asexually by the following means:

1. **fission:** One cell splits into two.
2. **schizogony:** A form of asexual reproduction characteristic of certain protozoa, including sporozoa, in which daughter cells are produced by multiple fission of the nucleus of the parasite followed by segmentation of the cytoplasm to form separate masses around each smaller nucleus.
3. **budding:** Buds form around a nucleus and pinch off of the parent cell.

Some protozoa also reproduce sexually by fusion of gametes (Figure \(\PageIndex{1}\)).
Figure \(\PageIndex{1}\): Life Cycle of Plasmodium, the Protozoan that causes Malaria. (1) A female Anopheles mosquito carrying malaria-causing parasites feeds on a human and injects the parasites in the form of sporozoites into the bloodstream. The sporozoites travel to the liver and invade liver cells. (2) Over 5-16 days*, the sporozoites grow, divide, and produce tens of thousands of haploid forms, called merozoites, per liver cell. Some malaria parasite species also produce hypnozoites in the liver that remain dormant for extended periods, causing relapses weeks or months later. (3) The merozoites exit the liver cells and re-enter the bloodstream, beginning a cycle of invasion of red blood cells, known as asexual replication. In the red blood cells they develop into mature schizonts, which rupture, releasing newly formed merozoites that then reinvade other red blood cells. This cycle of invasion and cell rupture repeats every 1-3 days* and can result in thousands of parasite-infected red blood cells in the host bloodstream, leading to illness and complications of malaria that can last for months if not treated. (4) Some of the merozoite-infected blood cells leave the cycle of asexual replication. Instead of replicating, the merozoites in these cells develop into sexual forms of the parasite, called male and female gametocytes. In some malaria species, young gametocytes sequester in the bone marrow and some organs while late stage (stage V) gametocytes, circulate in the bloodstream. (5) When a mosquito bites an infected human, it ingests the gametocytes. In the mosquito midgut, the infected human red blood cells burst, releasing the gametocytes, which develop further into mature sexual forms called gametes. Male and female gametes fuse to form diploid zygotes, which develop into actively moving oocinates that burrow through the mosquito midgut wall and form oocysts on the other side. (6) Growth and division of each oocyst produces thousands of active haploid forms called sporozoites. After 8-15 days*, the oocyst bursts, releasing sporozoites into the body cavity of the mosquito, from which they travel to and invade the mosquito salivary glands. The cycle of human infection re-starts when the mosquito takes a blood meal, injecting the sporozoites from its salivary glands into the human bloodstream. (7) The vegetative, reproducing, feeding form of a protozoan is called a trophozoite. Under certain conditions, some protozoa produce a protective form called a cyst that enable them to survive harsh environments. Cysts allow some pathogens to survive outside their host. \textit{Image used with permission from NIAID}.

Exercise: Think-Pair-Share Questions

1. Protozoa that cause gastrointestinal infections are capable of producing cyst forms as well as trophozoites. State why this is essential to these pathogens.

The Role of Protozoan Cytoplasmic Membrane Components in Initiating

https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Kaiser)/Unit_4%3A_Eukaryotic_Microorganisms...
Body Defense

Initiation of Innate Immunity

In order to protect against infection, one of the things the body must initially do is detect the presence of microorganisms. The body does this by recognizing molecules unique to microorganisms that are not associated with human cells. These unique molecules are called pathogen-associated molecular patterns or PAMPs. (Because all microbes, not just pathogenic microbes, possess PAMPs, pathogen-associated molecular patterns are sometimes referred to as microbe-associated molecular patterns or MAMPs.)

Components of protozoa that function as PAMPs include GPI-anchored proteins (GPI = Glycosylphosphatidylinositol) and mannose-rich glycans (short carbohydrate chains with the sugar mannose or fructose as the terminal sugar) that function as PAMPs. These mannose-rich glycans are common in microbial glycoproteins and glycolipids but rare in those of humans. These PAMPs bind to pattern-recognition receptors or PRRs on a variety of defense cells of the body and triggers innate immune defenses such as inflammation, fever, and phagocytosis.

Initiation of Adaptive Immunity

Proteins associated with protozoa function as antigens and initiate adaptive immunity. An antigen is defined as a substance that reacts with antibody molecules and antigen receptors on lymphocytes. An immunogen is an antigen that is recognized by the body as non-self and stimulates an adaptive immune response. The body recognizes an antigen as foreign when epitopes of that antigen bind to B-lymphocytes and T-lymphocytes by means of epitope-specific receptor molecules having a shape complementary to that of the epitope. The epitope receptor on the surface of a B-lymphocyte is called a B-cell receptor and is actually an antibody molecule. The receptor on a T-lymphocyte is called a T-cell receptor (TCR). This will be discussed in greater detail in Unit 6.

We will now briefly look at some medically important protozoa classified into phyla based on their motility. Illustrations can be found in your Lab Manual in Lab 20.

Summary

Protozoa are unicellular eukaryotic microorganisms lacking a cell wall and belonging to the Kingdom Protista. Protozoa reproduce asexually by fission, schizogony, or budding. Some protozoa can also reproduce sexually. Relatively few protozoa cause disease. The vegetative, reproducing, feeding form of a protozoan is called a trophozoite. Under certain conditions, some protozoa produce a protective form called a cyst. Components of protozoa that function as PAMPs include GPI-anchored proteins and mannose-rich glycans. These PAMPs bind to PRRs on various defense cells and trigger innate immunity. Protozoan molecules can also trigger adaptive immunity such as the production of antibody molecules against protozoan antigens.

Contributors

- Dr. Gary Kaiser (COMMUNITY COLLEGE OF BALTIMORE COUNTY, CATONSVILLE CAMPUS)