8.16E: Cell Structure, Metabolism, and Motility

Protists are an incredibly diverse set of eukaryotes of various sizes, cell structures, metabolisms, and methods of motility.

Learning Objectives

• Describe the metabolism and structure of protists, explaining the structures that provide their motility

Key Points

• Protist cells may contain a single nucleus or many nuclei; they range in size from microscopic to thousands of meters in area.
• Protists may have animal-like cell membranes, plant-like cell walls, or may be covered by a pellicle.
• Some protists are heterotrophs and ingest food by phagocytosis, while other types of protists are photoautotrophs and store energy via photosynthesis.
• Most protists are motile and generate movement with cilia, flagella, or pseudopodia.

Key Terms

• amorphous: lacking a definite form or clear shape
• multinucleate: having more than one nucleus
• pellicle: cuticle, the hard protective outer layer of certain life forms
• taxis: the movement of an organism in response to a stimulus; similar to kinesis, but more direct
• **phagocytosis**: the process where a cell incorporates a particle by extending pseudopodia and drawing the particle into a vacuole of its cytoplasm

• **phagosome**: a membrane-bound vacuole within a cell containing foreign material captured by phagocytosis

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**Cell Structure**

The cells of protists are among the most elaborate and diverse of all cells. Most protists are microscopic and unicellular, but some true multicellular forms exist. A few protists live as colonies that behave in some ways as a group of free-living cells and in other ways as a multicellular organism. Still other protists are composed of enormous, multinucleate, single cells that look like amorphous blobs of slime, or in other cases, similar to ferns. Many protist cells are multinucleated; in some species, the nuclei are different sizes and have distinct roles in protist cell function.

Single protist cells range in size from less than a micrometer to thousands of square meters (giant kelp). Animal-like cell membranes or plant-like cell walls envelope protist cells. In other protists, glassy silica-based shells or pellicles of interlocking protein strips encase the cells. The pellicle functions like a flexible coat of armor, preventing the protist from external damage without compromising its range of motion.

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**Metabolism**

Protists exhibit many forms of nutrition and may be aerobic or anaerobic. Protists that store energy by photosynthesis belong to a group of photoautotrophs and are characterized by the presence of chloroplasts. Other protists are heterotrophic and consume organic materials (such as other organisms) to obtain nutrition. Amoebas and some other heterotrophic protist species ingest particles by a process called phagocytosis in which the cell membrane engulfs a food particle and brings it inward, pinching off an intracellular membranous sac, or vesicle, called a food vacuole. The vesicle containing the ingested particle, the phagosome, then fuses with a lysosome containing hydrolytic enzymes to produce a phagolysosome, which breaks down the food particle into small molecules that diffuse into the cytoplasm for use in cellular metabolism. Undigested remains ultimately exit the cell via exocytosis.
Figure: **Protist metabolism**: The stages of phagocytosis include the engulfment of a food particle, the digestion of the particle using enzymes contained within a lysosome, and the expulsion of undigested materials from the cell.

Subtypes of heterotrophs, called saprobes, absorb nutrients from dead organisms or their organic wastes. Some protists function as mixotrophs, obtaining nutrition by photoautotrophic or heterotrophic routes, depending on whether sunlight or organic nutrients are available.

**Motility**

The majority of protists are motile, but different types of protists have evolved varied modes of movement. Protists such as euglena have one or more flagella, which they rotate or whip to generate movement. Paramecia are covered in rows of tiny cilia that they beat to swim through liquids. Other protists, such at amoebae, form cytoplasmic extensions called pseudopodia anywhere on the cell, anchor the pseudopodia to a surface, and pull themselves forward. Some protists can move toward or away from a stimulus; a movement referred to as taxis. Protists accomplish phototaxis, movement toward light, by coupling their locomotion strategy with a light-sensing organ.
Figure: Different types of motility in protists: Protists use various methods for transportation. (a) A paramecium waves hair-like appendages called cilia. (b) An amoeba uses lobe-like pseudopodia to anchor itself to a solid surface and pull itself forward. (c) Euglena uses a whip-like tail called a flagellum.