

Summary

Life Is Cellular

Since the 1600s, scientists have made many discoveries that have showed how important cells are in living things. Such discoveries are summarized in the cell theory, a fundamental concept of biology. The cell theory states:

- All living things are composed of cells.
- Cells are the basic units of structure and function in living things.
- New cells are produced from existing cells.

All cells have two characteristics in common. They are surrounded by a barrier called a cell membrane. And, they contain the molecule that carries biological information—DNA. Cells fall into two broad categories, depending on whether they contain a nucleus. The nucleus is a large membrane-enclosed structure that contains the cell's genetic material in the form of DNA. The nucleus controls many of the cell's activities. Prokaryotes are cells that have genetic material that is not contained in a nucleus. Bacteria are prokaryotes. Eukaryotic cells contain a nucleus in which their genetic material is separated from the rest of the cell. Some eukaryotes live as single-celled organisms. Others form multicellular organisms. Plants, animals, fungi, and protists are eukaryotes.

Eukaryotic Cell Structure

Cell biologists divide the eukaryotic cell into two major parts: the nucleus and the cytoplasm. The cytoplasm is the portion of the cell outside the nucleus. Eukaryotic cells contain structures that act as if they are specialized organs, and these structures are known as organelles.

The nucleus contains nearly all the cell's DNA and with it the coded instructions for making proteins and other important molecules. The nucleus is surrounded by a nuclear envelope composed of two membranes. Inside the nucleus is granular

material called chromatin, which consists of DNA bound to protein. Most nuclei also contain a small, dense region known as the nucleolus.

Ribosomes are small particles of RNA and protein found throughout the cytoplasm. Proteins are assembled on ribosomes. Eukaryotic cells contain an internal membrane system known as the endoplasmic reticulum, or ER. The ER is where lipid components of the cell membrane are assembled, along with proteins and other materials that are exported from the cell. The portion of the ER involved in the synthesis of proteins is called rough ER. Smooth ER, which does not contain ribosomes, is involved in the making of lipids. The function of the Golgi apparatus is to modify, sort, and package proteins and other materials from the ER for storage in the cell or secretion outside the cell.

Other organelles include lysosomes, vacuoles, mitochondria, and chloroplasts. Mitochondria are organelles that convert the chemical energy stored in food into compounds that are more convenient for the cell to use. Chloroplasts are organelles that capture the energy from sunlight and convert it into chemical energy.

Eukaryotic cells have a structure called the cytoskeleton that helps support the cell. The cytoskeleton is a network of protein filaments that helps the cell to maintain its shape. The cytoskeleton is also involved in movement.

Cell Boundaries

All cells are surrounded by a thin, flexible barrier known as the cell membrane. The cell membrane regulates what enters and leaves the cell and also provides protection and support. The composition of nearly all cell membranes is a double-layered sheet called a lipid bilayer. Many cells also produce a strong supporting layer around the

membrane known as the cell wall. Cell walls are present in plants, algae, fungi, and many prokaryotes. The main function of the cell wall is to provide support and protection for the cell.

One of the most important functions of the cell membrane is to regulate the movement of dissolved molecules from the liquid on one side of the membrane to the liquid on the other side. The cytoplasm of a cell contains a solution of many different substances in water. The concentration of a solution is the mass of solute in a given volume of solution.

In a solution, particles move constantly. Particles tend to move from an area where they are more concentrated to an area where they are less concentrated, a process called diffusion. When the concentration of a solute is the same throughout a solution, the solution has reached equilibrium. Because diffusion depends upon random particle movements, substances diffuse across membranes without requiring the cell to use energy. Water passes quite easily across most membranes. Osmosis is the diffusion of water through a selectively permeable membrane. Many cell membranes have protein channels that allow certain molecules to cross the membranes. In such cases, the cell membrane protein is said to facilitate, or help, the diffusion of the molecules across

the membrane. This process is called facilitated diffusion. It does not require use of the cell's energy. Active transport does require the cell's energy. Active transport is when cells move materials from one side of a membrane to the other side against the concentration difference. Types of active transport include endocytosis, phagocytosis, pinocytosis, and exocytosis.

The Diversity of Cellular Life

An organism that consists of a single cell is called a unicellular organism. Unicellular organisms carry out all the essential functions of life that larger organisms do. Organisms that are made up of many cells are called multicellular organisms. Cells throughout a multicellular organism can develop in different ways to perform different tasks. This process is called cell specialization.

The levels of organization in a multicellular organism are individual cells, tissues, organs, and organ systems. Individual cells are the first level. Similar cells are grouped into units called tissues. A tissue is a group of cells that perform a particular function. Groups of tissues that work together form an organ. A group of organs that work together to perform a specific function is called an organ system.