History and Anatomy of a Cell

**Background:**

What do you see when you hold up a blade of grass to the sun, or a butterfly with a flashlight held up against its wing? You see many tiny lines running up and down, side to side, and some even at different slants and angles. This is because that is the vascular construction of what is visible to the human eye; however, a view that can only be seen deeper with a microscope will reveal that there are tiny little cells clustered together that make up the view you saw when looking at the sun. These cells are what the makeup of every living thing is.

Before the invention of the microscope, no one could see what a cell embodied. It was in the 1600s when scientists utilized microscopes to observe and view living things. Robert Hooke is the scientist that was looking at the cork of a plant when he initially realized that the cork had different empty chambers, so he then named it a cell after “they reminded him of a monastery’s tiny rooms.” Many years later we know that cells are not empty chambers, but have living matter within them. Following Hooke there were many biologists who used microscopes to study and explore the cell. It was not until fluorescent light was added to the microscope that it could be seen that there was movement in living cells, and that the structure could be seen; however, the radiation that passes through the matter under the scope makes it impossible to see the microscopic structures such as viruses and even proteins. Many microscopes have been invented since the initial ones, but nothing was good enough to see what was truly happening on the inside of the cell until the 1990s when researchers produced a new type of microscope that could “produce images by tracing the surface of samples with a fine probe.” It is understandably important that this completely revolutionized the study of cells and the living things inside of them, including protein molecules and DNA.

Cells come in a multitude of sizes and shapes to fit like a glove to whatever function or organization feature they are providing to the overall living organism. All cells have two things in common, they are fully enclosed in by a cell membrane, and at any given time in their lives they carry biological information, also understood as DNA. There are more determining factors that put the cell into different broad categories, having a nucleus and lacking a nucleus, better established as Eukaryotes and Prokaryotes. Both are words are of Greek origin. Karyon meaning “kernel”, or nucleus, and “Eu” means true, “pro” meaning before. When evaluating these words, it can be seen that the idea of prokaryotic cells came prior nuclei progression. An easy way to differentiate the two is if it starts with Eu, it sounds like yoo, and yoo have a nucleus. Prokaryotes on the other hand do not have a nucleus under any circumstances. Eukaryotic cells are usually larger in size and more complex than prokaryotic cells, their genetic material is separated from the rest of the cell, and they have internal membranes and many structures. Prokaryotes on the other hand are usually smaller in size and much simpler; they have genetic material, just not in a nucleus like the eukaryotic cells. They reproduce, grow, and even respond to environmental stimuli. An example of a prokaryote is a bacterium.

**Eukaryotic Cell:**

The eukaryotic cell is very similar to a factory, divided up into different areas with different functions and jobs to provide to the overall host, similar to an assembly line. Anything in the cell that acts as a specialized organ is considered an organelle. “Cell biologists split the eukaryotic cell with two major parts: the cytoplasm and the nucleus.” The cytoplasm is what fills the cell up with liquid. In a sense, imagine when your stomach feels full after you drink a lot of water; that feeling is what the cell is always having by the help of the cytoplasm. The nucleus is the overall controlling center of the cell- it is where the cell’s entire DNA is and has the information needed to produce proteins. The nucleus is then enclosed by a nuclear envelope made of two different membranes. The nuclear envelope has many pores in it so that material can move in and out, furthermore, it signals instructions and messages to be sent either in to the nucleus or out into the cell. An example of what is being sent out into the cell is RNA. Chromatin is a granular material in the nucleus that when it divides in cell division it creates chromosomes. Chromosomes are structures that contain genetic material. Most nuclei also have a nucleolus, the location where the gathering of ribosomes begins.

Ribosomes have one of the most important jobs in the cell because proteins are assembled on them. They produce proteins by following precise coded instructions that come from the nucleus through the nuclear pores. Each and every ribosome is a little different because it brings proteins out of the nucleus, its controlling center. The cells that are lively in protein synthesis are generally filled with ribosomes. Eukaryotic cells also embody an internal membrane called the endoplasmic reticulum, composed of the smooth and rough endoplasmic reticulum. This is the site where the lipid components of the cell membrane are put together, as well as proteins and whatever other material is being exported from the cell. The rough endoplasmic reticulum is what is associated with the synthesis of proteins. It got its name by having the ribosomes on its actual surface. Chemical modification of proteins occurs in the rough endoplasmic reticulum. They produce large quantities of protein to export. There is also a “free” ribosome, which other cellular proteins are made from; these are not attached to membranes, hence free. The other portion is the smooth endoplasmic reticulum. They are considered smooth because ribosomes are not established on its surface. Most of the time, the smooth endoplasmic reticulum has large amounts of enzymes that have very specific tasks. Some of these tasks are: drug detoxification, synthesis of membrane lipids, and liver cells that help to detoxify drugs.

Following the path already made for us and cells, the proteins that are produced in the rough endoplasmic reticulum are now ready to move into the Golgi apparatus. The sole function of this apparatus is to sort, adjust, modify and package proteins for storage in the cell or secretion outside of the cell. This is the last stop for a protein before being sent out to its final destination inside or outside of the cell. Now we have to think of what does the cleaning up of the mess in a cell, and that is called a lysosome. A lysosome is a small organelle that breaks down or digests lipids, proteins, and carbohydrates so that they can be used by the rest of the cell. They are also involved in breaking down organelles that have fulfilled their purposes. If a lysosome does not function properly, it can lead to serious and life threatening diseases. You may wonder what stores the salts, water, proteins, and carbohydrates. Vacuoles are what store these things. Plants differ from humans in the sense that they only have a large vacuole whereas humans do not.

The energy of the cell is provided by two things: food molecules and the sun. “Mitochondria is an organelle that converts chemical energy stored in food into compounds that are more convenient for the cell to use.” These organelles are enclosed by an outer membrane and an inner membrane. An interesting fact about mitochondria is that it comes from the cytoplasm of the ovum, also known as egg cell. Chloroplasts are mainly in plants, but also in other cells too. Their job is to “collect sunlight’s energy and transform it into chemical energy in a process called photosynthesis.” Both mitochondria and chloroplasts have their own genetic information. American biologist, Lynn Margulis suggests that these two organelles are descendants of prokaryotes.

The big question now is what holds the shape of the cell so all of these organelles discussed do not escape into the empty space? This is called a cytoskeleton. It holds the shape of the cell and is also involved in the movement of the cell. The cytoskeleton is made up of microtubules and microfilaments. Microfilaments are made of a protein called actin, they form extensive networks and help provide framework for the cell. Microtubules are hollow structures made of proteins called tubulins. Tubulin forms centrioles that aid in cell division. A fun fact about centrioles is that they are not found in plant cells, just animal.

**Boundaries of the Cell:**

Every cell is 100% surrounded by an extremely flexible barrier known as the cell membrane, and what surrounds the cell membrane for protection is the cell wall, it is a supporting layer. The cell membrane determines what can enter and leave the cell, while providing support and protection. A double-layered membrane is called a lipid bilayer, which gives the cell flexibility and forms a polar and non-polar barrier to the cells surroundings. Sometimes a lipid monolayer is formed; however it creates more rigidness in the cell. Scientists call the bilayer a “mosaic” because it has many pieces that operate as one unit. Proteins form different channels to pump in and out of the bilayer. The carbohydrates on the exterior of the bilayer help different organelles to recognize one another.

**Movement for the Cell’s Benefit**

Cell walls are outside of the cell membrane for support. They are generally porous enough to tolerate water, carbon dioxide, and oxygen to pass through. The majority of the cell wall is composed of fibers of carbohydrates and proteins. These carbohydrates and proteins are made inside the cell and pushed to the exterior to help the cell wall. Plant cell walls are made of mostly cellulose. Another example of cellulose is paper.

Diffusion is the movement of molecules from an area of higher concentration to an area of lower concentration. When there is no difference in concentration, the overall system is in equilibrium. Energy is not required for diffusion to occur because diffusion relies on random particle movements. At equilibrium the particles still move about the cell, just at the same rate as one another to maintain the status of equilibrium.

“Osmosis is the diffusion of water through a selectively permeable membrane.” This means that proteins and other inorganic matter can be subject to denied entrance. When substances cannot cross a border they are considered impermeable. Osmotic pressure is what causes hypertonic and hypotonic solutions. Hypertonic is when a solution has a higher solute concentration than the cell, forcing the water out. Hypotonic is when a solution has a lower solute concentration than the cell, forcing water to come into the cell. Isotonic is where there is equilibrium of the solute and the surrounding cell. Cell walls have the ability to prevent a cell from expanding that is if the cell wall is strong enough to do so.

Facilitated diffusion is through the help of a carrier molecule to aid in the movement across the cell. It works by utilizing protein channels that make it easier for specified molecules to move across the membrane’s barrier. This is not just a few protein channels, but in all actuality it is hundreds that make this process possible. This type of diffusion also does not need energy to continue its process. There is still a net movement of molecules from a higher concentration to a lower one.

Active transport is the movement of cells against the concentration gradient. This process does require energy because it is pumping molecules large and small across the cell by endocytosis and exocytosis. Imagine lifting a weight in the normal gym atmosphere; now imagine lifting the weight against a water current, which is what active transport is. Endocytosis is the process of taking material into the cell by in-folding; there are two examples of endocytosis: phagocytosis and pinocytosis. Phagocytosis ultimately means “cell eating” because it surrounds a particle and engulfs it. Engulfing material is considered to be highly taxing, thus the reason it fits into the category of active transport. Pinocytosis is when a cell takes up liquid from the surrounding environment, forms a pocket along the membrane, fill with liquid and then pinch off to form its own vacuole in the system. Exocytosis is the coming together of the vacuole and the cell membrane, pushing water out of the cell.

**Diversity:**

Cells can be more than just a unit of life; they can be the entire organism. A unicellular organism is a single-cell organism. They are capable of doing everything a living cell can do including: growth, response to environmental stimuli, and reproduction. Multicellular organisms are made of many cells and have much greater variety than unicellular organisms. The way these cell grow and specialize is called cell specialization. For example, red blood cells transport oxygen because they have a protein that binds to oxygen in the lungs and then transport its contents wherever needed to be released. Another example is how humans move. These cells use overdeveloped cytoskeleton with skeletal muscles that are tightly packaged. The fibers are actin microfilaments and a cytoskeletal protein called myosin. When there is contraction, chemical enegy is used to pull the fibers past one another, creating force. Size of muscle does not matter when creating the act of force.

There are levels of organization in multicellular organisms. From decreasing to increasing in size it goes: individual cells, tissues, organs, and organ systems. A tissue is a collection of same cells that perform a certain function, for example, digestive enzymes in the pancreas. Organs are made from many tissues working together as a group. Organ Systems is a group of organs performing in congruence for a particular task. The further one develops knowledge into biology it can be appreciated that there are so many aspects that go into what makes our bodies function on a day to day basis.

**Conclusion:**

Life is an abundance of something growing from another thing to give an end result, also known as a cell. Cells are what not only make up the human body but also every living thing that exists in life. It is important to understand and learn to draw connections between what cells do, what organelles do, how things interact, and why cells and organelles have specific functions throughout not only our life, but their life as well. This chapter is to provide the basic knowledge of how a cell and its inner units work as one. Learning the pathways and interactions is what will lead to a successful understanding of this subject of Biological Science.

**References:**

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