Cytology Script

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1. Squamous cells are flat and thin.

2.. Cuboidal are cube shaped. Their sides have relatively equal lengths. Even though they are cubed shape, sometimes the corners are rounded and they appear to be ball-shaped.

3. Columnar are generally tall and thin.

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Cytology is the study of cells. In the hierarchy of body organization, cells are the first level to display the characteristics of life. There are several components to every cell: the cell membrane, the cytoskeleton and the cytoplasm. The membrane encapsulates the cell and the cytoplasm is everything inside of the cell. The cytoskeleton is a network of supportive proteins that provide internal support. The cytoplasm is divided into two components: the cytosol and organelles. They cytosol is the fluid inside the cell (often referred to as intracellular fluid) and the organelles are the structures that facilitate cellular function.

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The cell membrane, also referred to as the plasma membrane, has a number of functions.

1. Shape and Protection.

2. Communication: the membrane allows cells to communicate with one another.

3. Semi-permeable/Selectively permeable: this means that the membrane allows some things to enter or leave the cell while prohibiting others.

The membrane is formed by two layers of phospholipids, often referred to as a phospholipid bilayer

Remember that phospholipids are amphiphilic. They have a hydrophilic portion and a hydrophobic portion. Because the ECF and ICF contain water, the phospholipid heads are arranged so that they are in contact with water and the fatty acid tails from each layer are in contact with each other. Phospholipids do not attach to each other, but move independently next to each other. This allows the membrane to be fluid and somewhat flexible.

The phospholipid bilayer is semipermeable (selectively permeable) which means that it allows some substances to pass freely through its two layers but prevents other substances from passing. The substances that can pass freely through the membrane are: small substances, neutral substances and lipid-soluble substances, such as vitamins and steroids. Substances that cannot pass easily through the membrane are: large molecules and charged substances, such as water, glucose, proteins and ions.

Cholesterol molecules found between the phospholipids provide some rigidity to the membrane. In addition, combinations of carbohydrates and lipids, known as glycolipids, extend from the extra cellular surface and provide a variety of functions.

There are also a number of different types of proteins found in the membrane. Some of the proteins in the membrane are exposed on the inside and the outside of the cell. These are known as integral or transmembrane proteins. Others are exposed to just the ECF or the ICF. These are known as peripheral proteins.

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Membrane proteins have numerous functions:

Receptors: function in communication by acting as receptors for neurotransmitters and hormones from other cells and tissues.

Second-messengers: act as second-messengers by relaying signals from the outside of the cell to the inside of the cell

Enzymes: break down chemical messengers and nutrients

Channel proteins: allow water and other hydrophilic solutes to pass through the membrane. Some are always open and others are gated by electrical changes.

Carrier proteins: shuttle large molecules, electrolytes and other substances through the membrane. Some carriers require ATP

Cell-identity markers: typically glycoproteins that identify cells as “self”

Cell-adhesion molecules: physically connect adjacent cells

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Some cells have extensions from their surfaces that can serve a variety of functions. Here are a few common examples:

Microvilli are small, numerous projections that increase the surface area of a cell. They function, for example, in the absorption of nutrients

Cilia are small, hair-like extensions. Some don’t move (non-motile) and have sensory functions (in the ear, for example). Other cilia move and help propel fluid in a specific direction (in the respiratory tract, for example).

Flagella are only found on sperm cells, in humans, and are responsible for sperm movement.

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Here is a diagram of a cell membrane. Notice that the phosphate heads form the internal and external surfaces, which are in contact with fluid.

Due to the phospholipid orientation, the membrane is semipermeable. Small particles such as water, oxygen, and carbon dioxide can slip between the phospholipids without any problem. Also, nonpolar (like carbon dioxide) and hydrophobic (like many lipids) molecules can pass between the phospholipids as well. Think a like "dissolves" like kind of concept. Substances that are more similar to phospholipids will meld into the membrane and pass through more easily than substances that are different. Substances that have a harder time passing through can be large in size, have a charge or are hydrophilic. These molecules will need the help of channels or carrier proteins to get into the cell.

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Several membrane transport mechanisms allow substances to pass through the membrane.

There are two ways we can categorize membrane transport: passive transport and active transport.

Passive Transport does not require ATP (energy). There are a few types of passive transport we need to think about.

1. Filtration is transport that uses hydrostatic pressure to move particles. Pressure from water drives water and particles across the membrane.

2. Simple Diffusion is the movement of particles down a concentration gradient from areas of high concentration to low concentration. A drop of red dye, for example, dropped in a bowl of water would diffuse so that they would eventually be evenly distributed

3. Osmosis is diffusion of water. It follows the same principles of simple diffusion and moves water down the concentration gradient from areas of high water concentration to areas of low water concentration.

4. Carrier-Mediated Transport is movement through a membrane with the aid of transmembrane proteins. There are two common examples:

> **Facilitated Diffusion** is the movement of substances from areas of higher concentration to areas of lower concentration through a membrane protein. This process does not require ATP
>
> **Active transport** is the movement of substances though a protein, sometimes from areas of lower concentration to areas of higher concentration. The proteins involved in active transport require ATP

5. Vesicular Transport is a process that is frequently used to move large molecules across a membrane. This process requires ATP. Endocytosis is the specific process that moves substances into the cell and exocytosis is the process that moves substances out of the cell.

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The cytoplasm of a cell includes all of the contents inside of the cell. The cytosol is the fluid everything floats in, sometimes referred to as intracellular fluid (ICF). It is primarily water. The organelles within a cell are the various structures that are responsible for helping a cell carry out its specific functions. The next series of slides will describe the most common organelles found in human cells.

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The first organelle to discuss is the nucleus. I think of the nucleus as the control center. It is the center of the cell and holds the DNA, or the blue prints for our bodies. The nucleus is also surrounded by a bi-layer membrane, similar to the plasma membrane, called the nuclear envelope. The nucleus also contains nucleolus, which produces other organelles called ribosomes.

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Here is the nucleus and the nuclear envelope that surrounds it. The darker region in the picture on the left is the nucleolus.

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The endoplasmic reticulum (ER) of a cell consists of extensive channels know as cisternae.

There are two types of the ER, Rough and Smooth. Rough ER is continuous with the nuclear envelope and is named because it contains ribosomes. Ribosomes are responsible for peptide and protein synthesis. Smooth ER is continuous with rough ER, but does not contain ribosomes. Smooth ER detoxifies the cytoplasm.

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These pictures show the contrast between rough and smooth endoplasmic reticulum

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Ribosomes are small organelles that are produced by the nucleolus of the nucleus. As noted, they are found in large numbers on rough ER. Ribosomes read genetic material and produce peptides and proteins based on the specific segment of DNA code that is read.

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The Golgi Complex is made of a collection of flat sacs called cisternae. The Golgi complex puts the final touches on peptide and protein synthesis and also synthesizes carbohydrates. Finished proteins are packaged in Golgi vesicles and are then transported within the cytoplasm. Vesicles sometimes export products out through the cell membrane by the process of exocytosis.

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The cisterns and the Golgi vesicles are visible in both the illustration and the photomicrograph.

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Lysosomes are a specialized type of Golgi vesicle that travel around the cell and break down organelles and particles. White blood cells use them to break down bacteria inside the cell and liver cells use them to release stored glucose into the blood. They are small pockets, or bubble like structures, and contain digestive enzymes (about 50 different types) to break down the various types of materials they encounter.

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Peroxisomes resemble lysosomes but are not produced by the Golgi complex, but the ER. They detoxify cells by producing hydrogen peroxide to break down particles.

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Here are the lysosomes and peroxisomes.

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Mitochondria are oval organelles that have numerous internal folks known as cristae. Mitochondria synthesize ATP using a variety of starting materials. Due to their function, they are often referred to as the “power house” of the cell.

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Here are some mitochondria. Note the extensive cristae which increase the surface area for ATP production.

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Centrioles are paired organelles that are arranged in a perpendicular fashion. Each centriole contains numerous microtubules. Microtubules are proteins that function during cell division.

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The illustration depicts two centrioles. Note their perpendicular arrangement. Each orange rod represents a microtubule. During cell division, microtubules are responsible for moving and arranging the components within the cytosol to insure that the cell divides equally.