Name _____ Hr ___

INSTRUCTIONS:

Underline main ideas or important facts

Circle difficult or hard to understand words

Answer the questions after each section

Cells

All living things have five characteristics in common. Cells are the basic units of life because they are the smallest entities on Earth to have all five of the attributes of Life. The Five Basic Attributes of Life, Round Two:

1. Complexity and organization. Cells are complex and highly organized.
2. The ability to acquire and use matter and energy. Cells eat and drink substances that provide them with energy.
3. Homeostasis. Cells maintain a constant internal environment.
4. The ability to reproduce. Cells reproduce all on their own.
5. The abilities to adapt and evolve. Cells adapt to new environments and evolve through time.

Cells live and behave in a variety of ways. Some cells require the services of other cells to survive. The cells in your liver, and every other part of your body for that matter, require red blood cells to deliver oxygen. Without red blood cells, all the other cells in your body would die.

Other cells are able to grow and reproduce without the services of other cells. Many bacteria fall into this category. The entire bacterial "organism" is just a single cell. The human "organism," in contrast, is estimated to have between 10 and 100 trillion cells. You read that right: trillions of cells. What's more, some biologists estimate that there are 20 times more bacterial cells living inside the human body than there are actual human cells making up the body. We hope you aren't a germophobe, and if you are, this unit just might cure you.

There are two major types of cells: Prokaryotic cells & Eukaryotic cells

While both types of cells have some attributes in common, we usually focus on the differences, like the fact that eukaryotic cells are generally larger and more complex than prokaryotic cells. The defining difference between the two cell types, however, is that eukaryotic cells have membrane-bound organelles (if you are thinking "mini organ," you are on the right track), including the nucleus. The name "eukaryote" means "true kernel," where "kernel" refers to the nucleus. "Prokaryote," on the other hand, means "before or without a kernel." In the end, it is the presence or absence of a membrane-bound nucleus that determines whether a cell is classified as prokaryotic or eukaryotic.

What is the difference between prokaryotes and eukaryotes? _____

_____

While you're here, we might as well give you the back story of the cell's discovery. A couple of geeks (a term of endearment around these parts), going by the names of Robert Hooke (in 1665) and Anton van Leeuwehoek (in 1673), were spending their days waiting around for the invention of DVR and YouTube. In an attempt to kill 300+ years of time, Bob used optical lenses to magnify the parts of a tree: the cork, the bark, the stems, the roots, and so on. He found these parts had little "boxes" in common that reminded him of the cells that the monks lived in. Hence, the name.

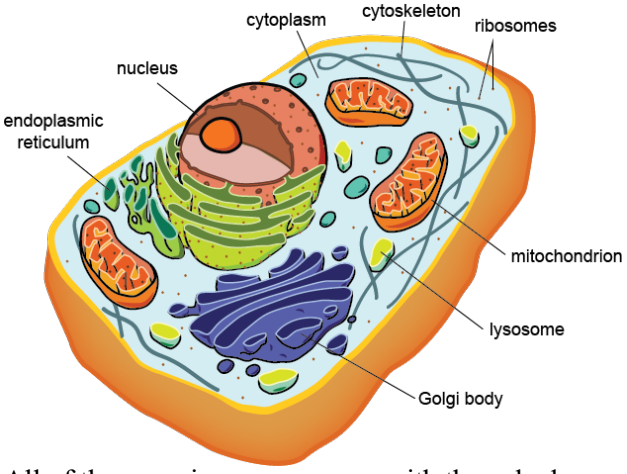
Also needing to occupy his hours, Anton ground the lenses further to produce more magnification (10x) so that he could observe the germs in pond water. Yep, you read that correctly. Someone wanted to study pond water.

These boxes were consistently observed in many living organisms over the next few years, and eventually, the cell theory was developed. With continued technological development and dedication to cell theory, scientists were able to decipher the inner workings of the cells. And so began a revolution that has fascinated scientists ever since. And… has saved hundreds of millions of lives every day through the practice of modern medicine.

Structures in all Eukaryotic Cells

We're going to start with eukaryotic cells even though they tend to be more complex than prokaryotic. But, there is a method to our madness: you are a eukaryote and have eukaryotic cells, so we thought you might relate better.

A cell is defined as eukaryotic if it has a membrane-bound nucleus. Any organism composed of eukaryotic cells is also considered a eukaryotic organism. Case in point: You. Biologists do not know of any single organism on Earth that is composed of both eukaryotic and prokaryotic cells. However, many different types of prokaryotic cells, usually bacteria, can live inside larger eukaryotic organisms. Creepy, but true.



We humans, for example, have trillions of bacteria living in our colons, not to mention in our mouths and stomachs and small intestines and…you get the picture. Despite the fact that we have gobs of prokaryotic cells living inside and on us, humans are still categorically eukaryotic organisms. Deal with it. This means that all human cells, including those found in the brain, the heart, the muscles, and so on, are also eukaryotic.

OK, we are slightly impressed. That is a lot of stuff jam-packed into something we can't see too well with the naked eye.

All of the organisms we can see with the naked eye are composed of one or more eukaryotic cells, with most having many more than one. This means that most of the organisms we are familiar with are eukaryotic. However, most of the organisms on Earth, by number, are actually prokaryotic.

Here are some examples of eukaryotes: Animals, Plants, Fungi (mushrooms, etc.), Protists (algae, plankton, etc.)

Most plants, animals, and fungi are composed of many cells and are, for that reason, aptly classified as multicellular, while most protists consist of a single cell and are classified as unicellular. Funny how that works.

List the eight structures o Eukaryotic Cells _____

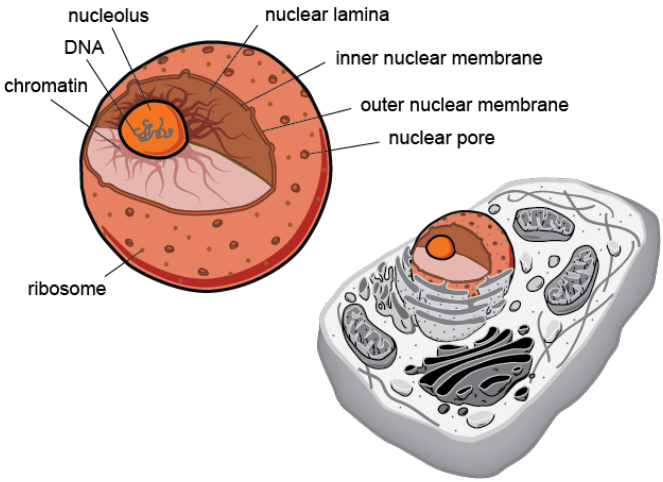
_____

Structures found in ALL eukaryotic cells

<u>The Nucleus and Eukaryotic Genetic Material</u>

The nucleus in the cell is analogous to the brain in the body. It is a control center for a cell.

The nucleus stores all the information the cell needs to grow, reproduce, and function. This information is contained in long but thin molecules of deoxyribonucleic acid, or DNA. One of the functions of the nucleus is to protect the cell's DNA from damage, but that is not all that it does. The nucleus is basically a large membranous sac.



Describe the function of the nucleus: _____

_____

The nucleus also contains a small round body called a nucleolus that holds nucleic acids and proteins. The nuclear membrane has pores through which the contents of the nucleus communicate with the rest of the cell. The nuclear membrane tightly controls what gets into the nucleus and what gets out. This regulation of communication by the nuclear membrane has a great effect on what a cell looks like and what it does.

Chromosomes are also located in the nucleus and are basically organized structures of DNA and proteins. In eukaryotes, the chromosomal DNA is packaged and organized into a condensed structure called chromatin. Chromosomes are single pieces of DNA along with genes, proteins, and nucleotides, and chromatin is a condensed package of chromosomes that basically allows all the necessary DNA to fit inside the nucleus.

We will dive deeper into the world of chromosomes in another section, but just know that eukaryotic and prokaryotic cells each have genomes, which is what we call the entire set of an organism's genetic and hereditary information. Genomes are entirely encoded in either the DNA or the RNA. In the case of eukaryotes, multiple linear pieces of DNA comprise its genome.

What is the function of chromosomes? _____

Where in the cell are chromosomes located? _____

In eukaryotic organisms, the DNA inside the nucleus is also closely associated with large protein complexes called histones. Along with the nuclear membrane, histones help control which messages get sent from the DNA to the rest of the cell. The information stored in DNA gets transferred to the rest of the cell by a very elegant process—a process so common and so important to life on Earth that it is called the central dogma of biology.

In eukaryotic cells, the first stage of this process takes place in the nucleus and consists of specific portions of the DNA, called genes, being copied, or transcribed, into small strands of ribonucleic acid, or RNA. RNA containing a copy, or transcript, of DNA is called messenger RNA, or mRNA. These mRNA molecules are then physically transported out of the nucleus through the pores (holes) in the nuclear membrane and into the cytoplasm where they are eventually translated into proteins by ribosomes.

Therefore, the central dogma of biology is simply: DNA → RNA → Protein

It all starts in the nucleus! Warning: This does NOT apply to prokaryotes. You are in eukaryote-only territory, and don't you forget it.

Most eukaryotic cells have a nucleus throughout their entire life cycles, but there are a few notable exceptions. Human red blood cells, for example, get rid of their nuclei as they mature. With their nuclei removed, red blood cells have more space to carry oxygen throughout the body.

Describe what this means: The central dogma of biology is DNA → RNA → Protein

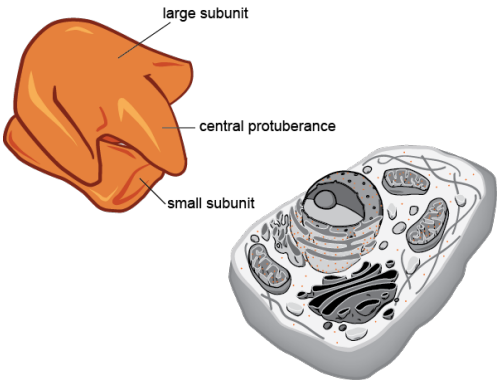
_____

_____

<u>Eukaryotic Plasma Membrane</u>

The plasma membrane in eukaryotic cells is responsible for controlling what gets into and out of the cell. A series of proteins stuck in the membrane help the cell communicate with the surrounding environment. This includes: Sending and receiving chemical signals from other eukaryotic cells & interacting with the cells of prokaryotic organisms during the process of infection. Keep in mind that the plasma membrane is universal to all cells, prokaryotic and eukaryotic.

Eukaryotic Ribosomes



Ribsomes are small cellular machines made of proteins and ribosomal RNA. All cells, both eukaryotic and prokaryotic, have ribosomes.
Eukaryotic ribosomes are larger and have a slightly different shape and composition than those found in prokaryotic cells. Eukaryotic ribosomes, for instance, have about twice the amount of ribosomal RNA (rRNA) and one third more ribosomal proteins (~83 vs. 53) than prokaryotic ribosomes have. Despite these differences, the function of the eukaryotic ribosome is virtually identical to the prokaryotic version. This is a remarkable example of what we call evolutionary unity. Ribosomes translate mRNA into protein, or the last step in the central dogma of biology described earlier.

Describe the function of eukaryotic ribosomes: _____

_____

Eukaryotic Cytoplasm and Cytoskeleton

The cytoplasm in eukaryotic cells is a gel-like, yet fluid, substance in which all of the other cellular components are suspended, including all of the organelles. The underlying structure and function of the cytoplasm, and of the cell itself, is largely determined by the cytoskeleton, a protein framework along which particles in the cell, including proteins, ribosomes, and organelles, move around.

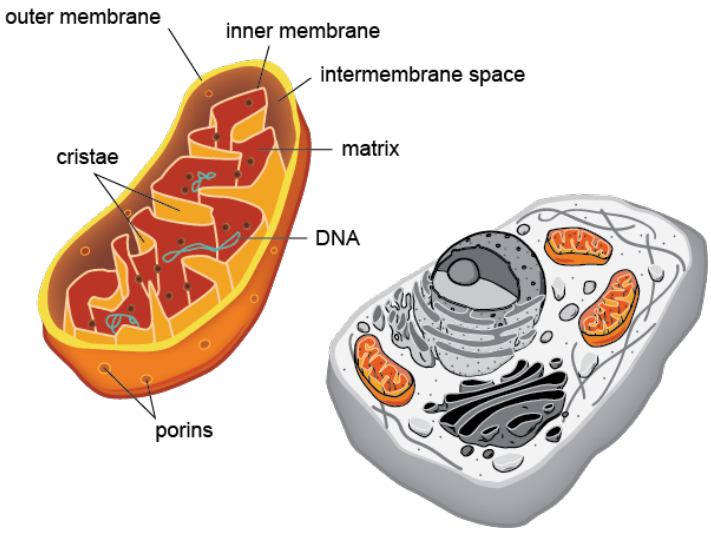
You can think of the cytoskeleton as a type of 3D "highway system" with roads running in every direction, including up and down. The cytoplasm is the thick fluid in which the "highway system" is suspended and through which cellular materials are transported. Helpful tip: Whenever you see "cyto" as part of a word, think "inside the cell."

Structures in MOST eukaryotic cells - Most eukaryotes have these, but some don't.

Mitochondria

All cells need energy to grow, reproduce, and function. Like the organisms they comprise, cells must "eat" in order to get the energy they need. One of the most important types of cellular food is a molecule called glucose, which is a type of sugar and a carbohydrate. Eukaryotic cells take in glucose through proteins that cross the plasma membrane and then transport it through the cytoskeleton to the mitochondria (mitochondria is plural; the singular is mitochondrion) in the cytoplasm. The mitochondrion is often called the cell's powerhouse.

In the cytoplasm just outside the mitochondria, glucose is broken down into smaller molecules through a process called glycolysis (literally "sugar breaking"), which releases chemical energy. This energy is temporarily captured by specialized molecules and transported through the mitochondrial membranes into the mitochondria. There it is used to make an important molecule called adenosine triphosphate (ATP) through a process known as cellular respiration.



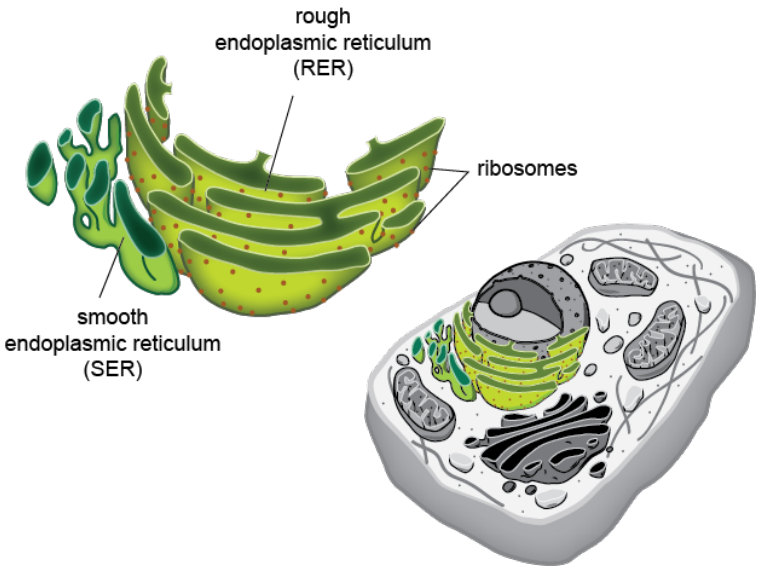
What is the nick name for mitochondria?

_____

Mitochondria can convert a single molecule of glucose into ~38 molecules of ATP! You can think of each ATP molecule as a unit of stored energy ready to be used by the cell whenever needed. The main function of all mitochondria, then, is to make ATP, which is the energy source for nearly all cellular functions and processes.

Endoplasmic Reticulum

There are two types of endoplasmic reticulum (ER) in eukaryotic cells: Smooth ER (SER) & Rough ER (RER)



Both ER types are involved in making important cellular components. Through endoplasmic reticulum (RER) is mainly responsible for the synthesis and processing of proteins that are either secreted from the cell or that end up stuck in the plasma membrane. Proteins marked for secretion are sent from the RER to the Golgi body for further processing. Insulin is an example of a secreted protein processed by the RER. This very large protein is secreted in huge quantities from the pancreas cells in mammals and aids in the uptake and digestion of glucose.

The smooth endoplasmic reticulum (SER) is primarily involved in the synthesis of lipids (fatty fat fats) and steroids, both very important components of cell membranes. The lipids made in the SER are combined with phosphorous to make phospholipids, the most abundant component of cell membranes. The steroids, including cholesterol, made in the SER are also important components of cell membranes because they provide the rigidity and structure needed for the membrane to keep its general shape.

Describe the difference between the Rough ER and the Smooth ER:

_____

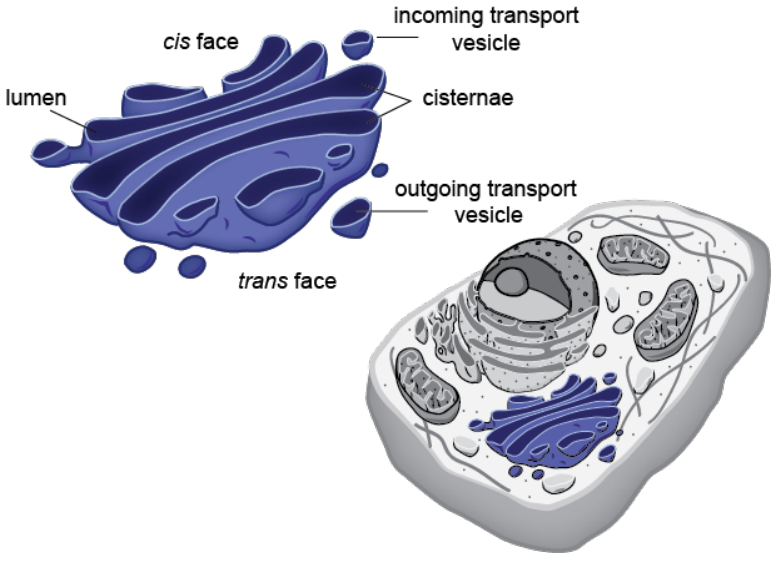
_____

_____

Golgi Bodies

The Golgi body is simply a flattened stack of membrane disks.

In these membranous stacks, called cisternae, proteins that have been marked for secretion in the RER are packaged into vesicles that transport them to the plasma membrane where they are secreted from the cell. The Golgi body also packages the lipids and steroids made in the SER into vesicles. Packaged lipids and steroids are transported to the edge of the cell, as well as to all organelles within the cell, where they are used to build or repair the cell and organelle membranes. Just remember that the Golgi body likes sticking things into vesicles; in a way, it's like the post office.



Lastly, small portions of the Golgi body cisternae often bud off into small spheres to create lysosomes. Just in case you're wondering, the incessant capitalization of the "G" in "Golgi" is not a word processor error, but a result of the fact that this interesting organelle was named after its discoverer, the preeminent Italian physician Dr. Camillo Golgi.

Describe the function of the Golgi Body: _____

_____

Lysosomes

Lysosomes are small spheres of phospholipids made by the Golgi bodies and are responsible for breaking down cellular debris and material taken into the cell through the process of phagocytosis (the cell's swallowing up of things). The interior of a lysosome contains many enzymes and is slightly acidic so that material can be digested without harming the rest of the cell. Lysosomes maintain their acidity by pumping protons (hydrogen ions, or H+ ions) across their membranes through integral channel proteins.

Helpful tip: When you see "lys" as part of a word, think of cutting, chopping up, or breaking down. Lysosomes chop things up, glycolysis is the breaking down of sugar, and so on.

Describe the function of lysosomes: _____

_____

Vesicles

Vesicles are small spheres of phospholipids made by the Golgi bodies and are responsible for transporting proteins, lipids, and steroids to various places throughout the cell, especially to the plasma membrane. The interior conditions of a vesicle are similar to the conditions of the surrounding cytosol so that transported proteins and lipids are not damaged en route to their destinations.

Describe the function of vesicles: _____

_____

Vocabulary Review

Find seven words in the article you circled as difficult or you didn't understand. List and then define these words.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____