Purpose:
The main objective of this exercise is to introduce participants to cells and the organelles that compose them. This lesson will be a coloring page handout to explain the structure of a eukaryotic cell. The lesson will be part of the STEM10+ STEM online curriculum uploaded to the CREATE at UC San Diego website and the “CREATE STEM10+” YouTube channel.

Materials
- Colored pencils OR colored markers OR crayons
- Printout of the attached “Cell Biology” coloring page.

What Are Cells?
All living things have cells. These tiny building blocks work together to create simple bacteria as well as more complex organisms, such as people and animals. Cells types are categorized based on complexity and include prokaryotic and eukaryotic:

- **Prokaryotic:** The simplest organisms that have only one cell, like bacteria, are prokaryotic. These cells do not have a nucleus or internal compartments.
- **Eukaryotic:** Plant and animal cells are more complex and classified as eukaryotic because these cells have identifiable internal components in addition to a genuine nucleus. Yeast is one type of single-celled eukaryotic organism. Most others are multicellular.

In complex organisms — such as plants, animals and people — cells are made up of several organelles. These are the parts of the cell that perform various functions and allow for the cell's independent operation.

For the purposes of this activity, we will be focusing on eukaryotic cells.
Parts of a Cell, also called “Organelles”

**Step 1: Color the following structures**
- **Plasma Membrane**: The exterior of the cell, the plasma membrane is a flexible wall that keeps the contents of the cell inside while still allowing for materials to move through the membrane.
- **Cytoplasm**: All organelles inside the cell float in the cytoplasm.

**Step 2: Color the following structures**
- **Nucleus**: The nucleus provides the brains of the cell and runs all other cell operations. It contains the nucleolus as well.
- **Nucleolus**: The nucleus holds the nucleolus. The nucleolus makes ribosomes, which are where the cell creates proteins.

**Step 3: Color the following structures**
- **Endoplasmic Reticulum**: Also known as the ER, this membrane transports materials throughout the cell. Rough ER contains ribosomes to make proteins while smooth ER makes fats, also called lipids.
- **Ribosomes**: Structures made of nucleic acids and proteins are in charge of protein synthesis.
- **Golgi Body or Complex**: Lipids from the ER move to the Golgi body where they get delivered to the plasma membrane.
- **Vesicles**: A structure within or outside a cell, consisting of liquid or cytoplasm enclosed by a lipid bilayer. They are used to transport proteins and other materials from one part of a cell to another.

**Step 4: Color the following structures**
- **Mitochondria**: Mitochondria make energy for the cell's operations. Some people call these organelles the powerhouses of the cell. They create cellular energy known as ATP.

**Step 5: Color the following structures**
- **Lysosomes**: These cell organelles help the cell get rid of waste.
- **Peroxisome**: have two functions:
  1. break down fatty acids to be used for forming membranes and as fuel for respiration
  2. transfer hydrogen from compounds to oxygen to create hydrogen peroxide and then convert hydrogen peroxide into water
- **Endosome**: Their function is the sorting and delivery of material from the cell surface and the transport of materials from the Golgi to the lysosome.
Both plant and animal cells have all the above organelles, but plant cells differentiate themselves from animal cells with the addition of some other parts.

Differences Between Plant and Animal Cells

The most significant differences between plant and animal cell organelles are the cell wall, vacuoles and chloroplasts.

For this portion of the, please follow the instructions to draw in the following structures to your coloring page.

1. Draw a cell wall by drawing a rectangle around your cell.

Plant cells have a rigid cell wall surrounding the plasma membrane. This wall gives the cells their rectangular structure and helps plants stand upright without the need for an internal reinforcing structure, such as bones or an exoskeleton.

2. Draw a “stack of pancakes” to resemble chloroplasts. Draw it close to the mitochondria so you remember that they have similar functions.

Chloroplasts in plant cells generate energy through photosynthesis. The process takes sunlight and water and converts them into energy for the cell and plant. Animal cells do not have chloroplasts.

3. Draw an oval or “kidney bean” in the cytoplasm of your cell to resemble a vacuole.

Plant cells also have a single, large vacuole. This function of this organelle is to store water and sap. The vacuole increases and decreases in size depending on the amount stored in them. When plants lack water, the vacuole shrinks, making the cell cave in on itself and causing the plant to droop. Animal cells can have vacuoles, but they are smaller, more numerous and have a different function.

4. Draw “squiggly hair” around the plasma membrane to resemble the cilia and a “long tail” or “tentacle” coming out of the plasma membrane to resemble a flagella.

Animal cells, as well as microorganisms, also have exterior protrusions that help them to move. The cilia look like tiny hairs on the outside of animal cells, and there are many of them. The flagella is a long, single projection that acts like a whip to propel the cell forward. Cells have either cilia or flagella. Plant cells generally don’t have cilia or flagella.
5 E Lesson Plan

Engage:

Students will follow step by step instructions in order to color and draw important structures, or organelles, that compose a eukaryotic cell. Solutions and see the color changes. Students will use a coloring printout to engage their attention while coloring and listening.

Explore:

Students will be able to see the difference in colors, from starting to ending solution, from all the various available substances. Students will understand how an indicator works to help guide what the final solution is. Students will be able to see a Neutralization reaction take place.

Explain:

Begin lecture by having the students have a seat, and inform them not to touch anything they see until further instructions are given. Give an intro about wearing personal protective equipment (PPE). This is important because PPE can protect you from the harm of chemicals when dealing in experiments. In a lab, the use of a laboratory coat must cover up to the knees and all buttons must be buttoned, which is the proper way to wear a coat. Goggles are necessary to protect our eyes from splashes and other bad fumes that can damage our eyes. Gloves are required to protect our hands from chemicals that can cause damage to the skin. Lastly, the clothes underneath of the PPE must be jeans, closed toe shoes, and a well covered shirt. The more layers you have on the better you will be from chemicals contacting your skin. (PPE is not required for this lesson).

Elaborate:

Have students give other examples that could be Acidic or Basic. Ask questions to the students on how or what are other ways that pH can help to understand a bit more about Acids and Bases. Question the students if they can find out if there are other vegetables/fruits that can have similar indicator traits to perform this same experiment with another indicator. Lastly, challenge students if they can come up with another neutralization process.

Evaluate

Ask the students information about any portion of the experiment to your criteria.