Building Cellular Organelles

Purpose: To learn about the morphology and function of cellular organelles by building them.

Materials:

- Pipe cleaners
- Paper clips
- Clothes pins
- Plastic caps
- Rubber bands
- Wire
- Pipe cleaners
- Blocks
- Buttons
- Fish tank tubing

Procedure:

1. Using the information below, build a nucleus, making sure to represent all the elements listed as well as any that you know that are not included in the description.
2. Nucleus - The nuclear membrane is a double membrane. In this membrane, there are holes, called nuclear pores, which regulate the passage of materials into and out of the nucleus.

Question: What materials enter the nucleus? What materials leave the nucleus?

_____

_____

_____

The nucleus contains DNA, which is organized into chromatin. When the cell prepares to divide, the chromatin begins to condense into recognizable structures called chromosomes. However, chromatin is not only composed of DNA. It also contains histone proteins that organize the DNA.
In the micrograph of a nucleus, the most recognizable structure is the nucleolus, an area of condensed chromatin that is responsible for the production of ribosomes.

Question: What materials does the nucleus need to produce ribosomes?

_____

_____

_____

One of the main functions of the nucleus is to control the production of proteins in the cell. Thus, DNA is transcribed into mRNA, which can then travel out of the nucleus and into the cytoplasm. There, the mRNA is translated into proteins by the ribosomes.

To produce mRNA, certain enzymes and building blocks are needed. RNA polymerases are needed to pull the strands of DNA apart. In addition, these enzymes bind together the RNA nucleotides as they base-pair along the DNA. However, transcription cannot occur anywhere along a strand of DNA. There are specific regions that code for proteins. Thus, proteins called transcription factors help the polymerases find where to start transcribing the DNA.

Question: Where do the RNA nucleotides come from?

_____

_____

_____

3. Using the information below, build a mitochondrion.
4. Mitochondrion - The mitochondrial outer membrane is a double membrane. The outer membrane is smooth, but the inner membrane is folded, like an accordion. These infoldings are called cristae.

Question: What is the purpose of the cristae?

_____

_____

_____

The two membranes produce two inner compartments, the intermembrane space between the outer and inner membranes and the region enclosed by the inner membrane, the mitochondrial matrix.

Some of the steps of cellular respiration occur in the matrix of the mitochondrion. Thus, there are many enzymes found in the matrix as well as on the inner membrane. The enzymes imbedded in the inner membrane are mainly those involved with the electron transport chain, and they are listed below.

1. Cytochrome A
2. Flavoprotein
3. Q - cytochrome
4. Iron-sulfur protein
5. Cytochrome C
6. Cytochrome A_3
7. Cytochrome C_1
8. Cytochrome B

To help you organize the enzymes involved in the electron transport chain, your instructor has copies of figures from your textbook that show the relative positions of the enzymes in the inner membrane.

Question: Generally, what do the enzymes involved in the respiratory chain do?

_____

_____

_____

5. With the information below, build a lysosome.
6. Lysosome – The lysosomal membrane is a single membrane. The membrane encloses a number of hydrolytic enzymes. These hydrolases break down nucleotides, proteins, lipids, phospholipids, and also remove carbohydrate, sulfate, or phosphate groups from molecules. However, these enzymes only function at an acidic pH. Thus, the membrane of a lysosome contains a hydrogen ion ATPase that pumps in H+ ions into the lysosome to produce the environment required for the function of the enzymes.

Question: If the lysosome breaks open or leaks its contents, why is the containing cell not digested?

_____

_____

_____

7. With the information below, build a chloroplast.
8. Chloroplast – A chloroplast is surrounded by a double membrane. These two membranes create a thin intermembrane space between the membranes, and a larger space surrounded by the inner membrane. Within the larger space is another membrane system arranged into flattened sacs called thylakoids. The thylakoids are surrounded by a fluid called the stroma.
The thylakoid membranes of the chloroplast contain the two photosystems that function in photosynthesis. Your instructor has diagrams of both photosystems. These will help you to identify the molecules involved in these reactions as well as their relative positions in the membrane.

Question: How is the transfer of electrons between photosystem II and photosystem I like the reactions in cellular respiration that produce most of the ATP?

_____

_____

_____

Question: In which photosystem is oxygen produced?

_____

_____

_____

The reactions of the Calvin cycle utilize the ATP and NADPH produced by the reactions of the photosystems and the electron transport chain to produce sugars. These reactions occur in the stroma of the chloroplast. A molecule of CO_2 enters the

cycle and is bound to a 5-carbon sugar by an enzyme called rubisco. The product of this reaction is an unstable 6-carbon compound that immediately breaks apart into two 3-carbon compounds. Each of these compounds is then phosphorylated by an enzyme that transfers the phosphate groups from two molecules of ATP. Next, electrons from NADPH are used to reduce the carboxyl group of 1,3 bisphosphoglycerate to the carbonyl group of G3P, a three carbon sugar. This sugar is the end product of the reactions of the Calvin cycle, and can be used to build glucose and other organic compounds. Your instructor also has a diagram of the Calvin cycle to help you understand and organize the reactions occurring during this process.

9. With the information below, build rough endoplasmic reticulum.
10. Rough ER – The ER membrane is single, separating the internal compartment of the ER, the cisternal space, from the cytosol of the cell. The membrane of the ER is organized into a network of membranous tubules and sacs called cisternae. Rough ER is rough because of the presence of ribosomes on the surface of its membrane. Within the ER, there are enzymes that modify the proteins that are translated by the ribosomes. For example, some of these enzymes add sugars to the forming proteins to form glycoproteins.

11. Now that you have constructed a number of cellular organelles, your instructor will give you a specific organelle to construct. Then, all the groups will come together with their organelles and build a cell. Thus, you should think about how your organelle interacts with the other organelles in the cell.

Question: What molecules are shared?

_____
_____
_____

Question: How do the different organelles communicate with each other?

_____
_____
_____

12. After the cell is constructed, we will discuss the interactions of its organelles. Make any notes below.

_____
_____
_____
_____
_____
_____