**Unit Essential Question:** *How do our bodies produce and use the energy needed to move objects?*

**Introduction**

In the last task, students began to zoom in to explore the human body on a microscopic scale, discovering that as living things, we are made up of different types of cells. This task continues their exploration of the microscopic scale by diving into the function of a cell as a whole and the ways in which parts of the cell contribute to the function. This provides the final link for students to think about why their bodies are able to put objects in motion in different activities. By using and developing different types of models, students discover that there is a specific part of the cell that produces energy for the cell, allowing it to function. This is the energy that students eventually see in the movement of objects in their chosen activity for their culminating project.

**Alignment Table**

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Expectations** | **Science and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.**[Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [*Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.*] | **Developing and Using Models**   * Develop and use a model to describe phenomena. | **LS1.A: Structure and Function**  Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. | **Structure and Function**   * Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. |
| **Equity and Groupwork**   * Discuss and compare models with a partner. * Participate in group roles to analyze an analogy and come to consensus on matching terms. * Participate in a structured partner routine to give and receive feedback. | | | |
| **Language**   * Compare and contrast different types of models. * Match scientific definitions to an analogy. * Represent relationships in visual and written models. * Use the Stronger Clearer method to strengthen and clarify a model. | | | |

**Learning Goals**

This learning task asks students to develop models to show how parts of a cell interact in order for the whole cell to function. More specifically, the purpose is to:

* Examine different types of models with a simple and familiar example.
* Match new scientific definitions to an analogy for cell parts and function.
* Develop a visual model to show the relationships amongst cell parts.
* Use the Stronger Clearer method to gather and receive feedback to improve their models.
* Apply knowledge of cells parts and function to explain where the energy in a moving object initially comes from.

**Content Background for Teachers**

In this task, students learn about cell parts and their functions, as well as how they contribute to the functioning of the cell as a whole. While there are many different cell parts, this task focuses on three main ones: the nucleus, the mitochondria, and the cell membrane.

The nucleus is one of the most important structures in the cell. It acts as the command center because it has all the instructions that decide what protein products are made in the cell. These instructions are in the form of DNA. Various sections of the DNA can be copied and sent out of the nucleus to the ribosomes, like recipes, where they are translated into protein products. These protein products may remain in the cell or may be sent out to other cells. Each type of cell creates different kinds of products.

The mitochondrion is often referred to as the powerhouse of the cell because it produces the energy the cell needs to function. When a cell takes in food molecules, also known as sugar or glucose, it is the job of the mitochondrion to break these down into a form of energy the cell can use—ATP. This energy conversion process, known as cellular respiration, also requires oxygen and releases carbon dioxide and water as byproducts.

The cell membrane is essential to both of the above cell parts. It holds in all the parts of the cell and acts as a gatekeeper for what materials can come into and out of the cell. For example, the cell membrane allows in the oxygen and sugar that the mitochondria needs to make energy. It also lets out the carbon dioxide and water that are produced in the mitochondria, as well as the protein products produced by the ribosomes.

Because this unit’s culminating project focuses on humans, we only emphasize the relevant animal cell parts. However, you may also choose to show examples of plant cells and point out the additional main cell parts in plant cells (cell wall and chloroplasts).

**Academic Vocabulary**

* Model
* Labeled Diagram
* Flowchart
* Mind Map
* Analogy
* Cell Part
* Mitochondria
* Nucleus
* Cell Membrane
* Sugar
* Proteins
* Energy

**Time Needed (Based on 45-Minute Periods)**

4 Days

* Engage: 0.5 period
* Explore: 0.5 period
* Explain: 1 period
* Elaborate: 1 period
* Evaluate and Reflection: 1 period

**Materials**

* Unit 1, Task 5 Student Version

Explore

* *Cell Definition Cards,* cut (1 per group)
* *Cell Analogy* (1 per group)
* Blank Piece of Paper (to draw factory)

Evaluate

* Project Organizer Handout
* Computers/Tablets to Conduct Research

**Instructions**

**Engage**

1. Introduce Task 5: In Task 4, you zoomed in on various specimens to learn that all living things, like yourself, are made up of different types of cells!
   * Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 5: How do these cells allow us to do the things we like to do? How do they provide the energy our bodies need to move objects?
   * Now pass out their Task 5 student guide.
3. Because modeling may be a new practice for students, this task begins with an examination with a few different types of models using a simple and familiar example—a smartphone battery draining in power throughout the day.
4. In their Student Guides, students are shown three different kinds of models: a labeled diagram, a flowchart or mind map, and an analogy.

* We recommend introducing the context and reviewing the three kinds of models as a class first before students compare them in pairs.
* Pairs of students then use the discussion questions in their Student Guides to help them compare the different kinds of models and think about what the purpose of a model is and which one is best for this particular scenario.

1. Below are some sample student responses to the discussion questions:

* 1: The purpose of a model is to represent an idea or system in a way that is easier to understand.
* 2: The labeled diagram actually shows what the object looks like. The flowchart/mindmap describes the process or relationship between the different parts. The analogy compares it to something similar and easier to understand.
* 3: I think the labeled diagram is the most helpful because it actually shows the battery draining and all the reasons why. The flowchart/mind map might not actually always work in that order.

1. Debrief these discussion questions as a class.
   * We encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

**Explore**

1. In many science classes, students will be told everything they need to know about cell parts and they then use the information to write an analogy. This activity flips that process, allowing the analogy to be the method in which students learn about cell parts and functions.

* This gives students practice at the SEP of **Developing and Using Models** as students engage with an analogy model to provide evidence of cell parts and functions.

1. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Recorder.
   * Ask the Facilitator to read the directions and to make sure everyone understands the task.
   * Ask the Materials Manager to gather the materials needed to complete the task.
   * Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
   * Ask the Recorder to make sure the group is recording their analogy matches and reasoning in their Student Guides.
2. Distribute a set of *Cell Definition Cards,* the *Cell Analogy,* and a blank sheet of paper to each group of students.

* Students cut the *Cell Definitions* into actual cards.
* Each group reads the analogy aloud and draws the factory. They can then place the *Cell Definition Cards* in the right places on their drawing.
* Students should record their analogy matches and reasoning in the Student Guides. A sample is provided below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Cell Part or Substance** | …is/are like… | **Part of the Analogy** | **Because…** |
| The Mitochondria… | Power generators | They both make energy. |
| The Nucleus… | Factory control center | They both decide what products are made and give instructions. |
| The Cell Membrane… | The Shipping/Receiving Department and Workers | They both monitor what goes into and out of the factory/cell. |
| Sugar… | Fuel | Both come into the factory/cell to be used to make energy. |
| Proteins… | Products | They are both specific items made by the factory/cell and are shipped out of the factory/cell. |

1. As a class, debrief each cell part/substance and its associated part of the analogy. Try to come to consensus on all cell parts and substances by asking students who disagree to share their reasoning.
   * This is also a great time for students to discuss limitations of using a factory as a model for a cell.
   * Again, we encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

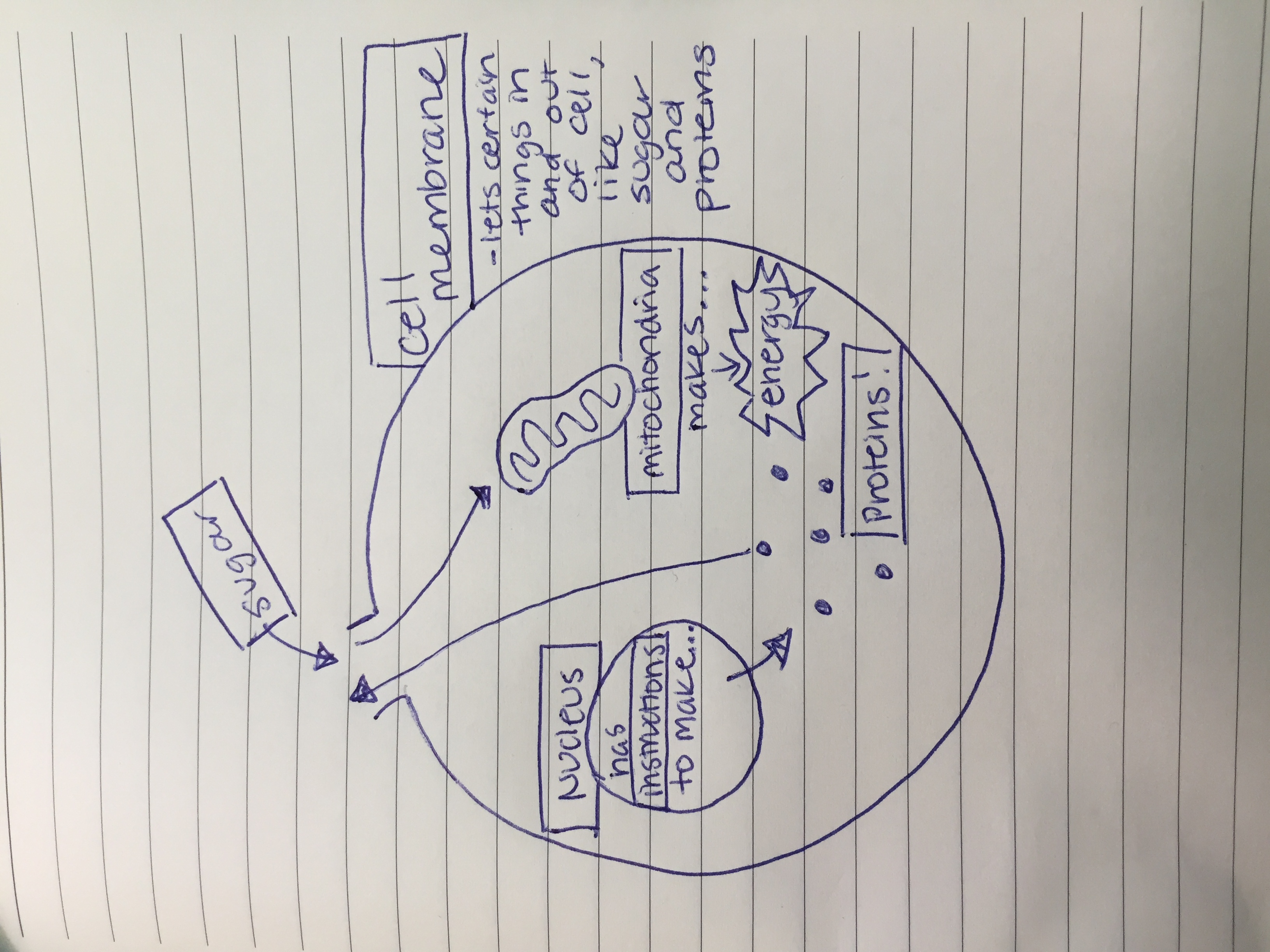
**Explain**

1. While the above analogy was helpful to show students the function of a cell and each of its parts, often times a visual model is better for showing relationships within a system, like a cell. This emphasizes to students that while multiple kinds of models can be used, some are more helpful than others, depending on the purpose.

* This again allows practice of the SEP of **Developing and Using Models** as students develop a model to provide evidence of the interaction between cell parts.

1. Emphasize to students that the purpose of this model is to show all the connections between the main cell parts

* In their Student Guides, students are given a box of key terms they must use in their visual model, but they may always add more as necessary. We recommend having students write the key terms on post-its first, so they can move them around as they decide how to structure their model.
* For students who are struggling with the format, you may want to encourage them to use arrows between parts and corresponding labels to describe these connections.
* At the bottom of the models, students are asked to explain how each of the cell parts contributes to the cell’s overall function. This emphasizes the CCC of **Structure and Function** as students focus on how relationships between cell parts can be analyzed to determine the function of a cell.

1. We recommend students do this activity independently because they will be using the *Stronger Clearer* method in the next activity to gather feedback from multiple partners.

* Though there will be great variation in the format of students’ models, the image to the right shows what one may look like.

**Elaborate**

1. Students will now participate in a language routine known as *Stronger Clearer*. This activity gives students the opportunity to share their ideas, gather feedback, and revise their models. This protocol is especially useful at this stage since the practice of modeling is likely new to many students.
2. Students will share with three different partners, allowing them to discuss feedback and record any notes each time. Once complete, students should be given time to individually revise their models based on their discussions. A protocol is provided in their student guide.
3. This revised model can be a good option for formative assessment. Collect student work to identify trends in students’ ability to develop models that provide evidence of the interaction between cell parts for cell function. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
4. Return to the whole-class concept map from the Lift-Off Task.
   * In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
     + Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
     + Draw circles around each question and boxes around each concept.
     + Write connector words to describe connections between the concept boxes.
     + For this task, students may begin to connect some of their previous question circles to concept boxes about the following: cell parts and functions, where energy is created in the body.
   * Have students analyze the additions to the class concept map for as many examples of this task’s crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
     + **Structure and Function**: These could be phrases such as, “its shape affects its function by,” “structure causes it to,” “functions this way because of,” etc.

* Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

**Evaluate: Connecting to the Culminating Project**

1. Students independently complete the Task 5 section of the Unit 1 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. Students have been asked to teach people how their bodies make the movement of objects possible in a specific activity. Their prompt is as follows: We know from Task 1 that your activity requires energy to move an object.

* Now that you have learned about cells and their parts, describe where this energy comes from.
* Pick one body system involved in your activity and do research to fill out the flowchart below. This will show how energy from your body is able to move your object!

**Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:

* At the beginning of this task, you examined different types of models you might use in science. Based on what you learned in this task, when do you think each type of model should be used (diagram vs. flowchart vs. analogy)?
* In this task, we focused on the crosscutting concept of **Structure and Function**:Relationships between parts can be analyzed to determine how systems function. Where did you see examples of **Structure and Function** in this task?
* Now that you have learned more how cells function, what questions do you still have?

1. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

**Assessment**

1. You may collect students’ Project Organizer and assess using:

* *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
* This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

1. You may also give students time to make revisions with one of the two options:

* Students may make changes to their Project Organizer according to your comments OR
* Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.