MIDDLE SCHOOL STEM PROJECT

SCIENCE 3D

RIVER DRAGONS: NILE CROCODILES

In this packet, sample student answers are provided in red and notes to teachers are in blue.

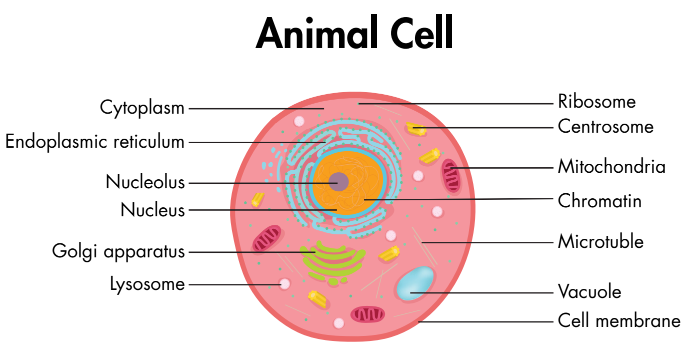
In this **STEM Project**, students focus on the use of models in science. They will explore and analyze diagrammatic models of plant and animal cells, and diagrammatic and mathematical models of ecosystems and energy flow. Then, they will create their own diagrammatic model (with a possible extension to create a physical model) of their own design that aims to keep both people and crocodiles safe.

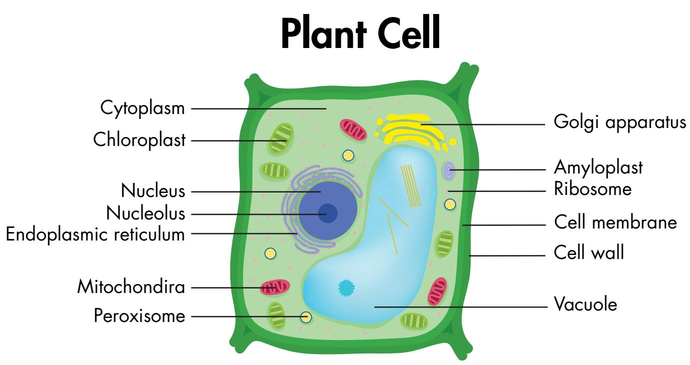
Models are critical in science and engineering. They represent a system or part of a system. Models can be used to help develop questions and explanations, better understand systems, make predictions, and communicate ideas and information.

There are many types of models including diagrams, physical replicas, mathematical representations, computer simulations, and even analogies. Some models are made to be very similar to real-world objects or processes. For example, a computer simulation of an airplane needs to be very realistic to accurately test if it will fly. Other models are less realistic but help people understand patterns.

Often, models are developed and refined many times. After making a model, it can be compared to the real world. Then, the model can be updated based on the comparison. Once it is updated, it can be tested again. Let's explore some different models that help us with our mission to the Okavango!

ACTIVITY 1: MODELS OF CELLS AND BODY SYSTEMS





1. Are the models above physical models, diagrams, computer simulations, or mathematical models?

   Diagrams

2. **Describe** ways that these models are like real cells.

   The models show the different parts of the cell.

3. **Describe** ways that these models are not like real cells.

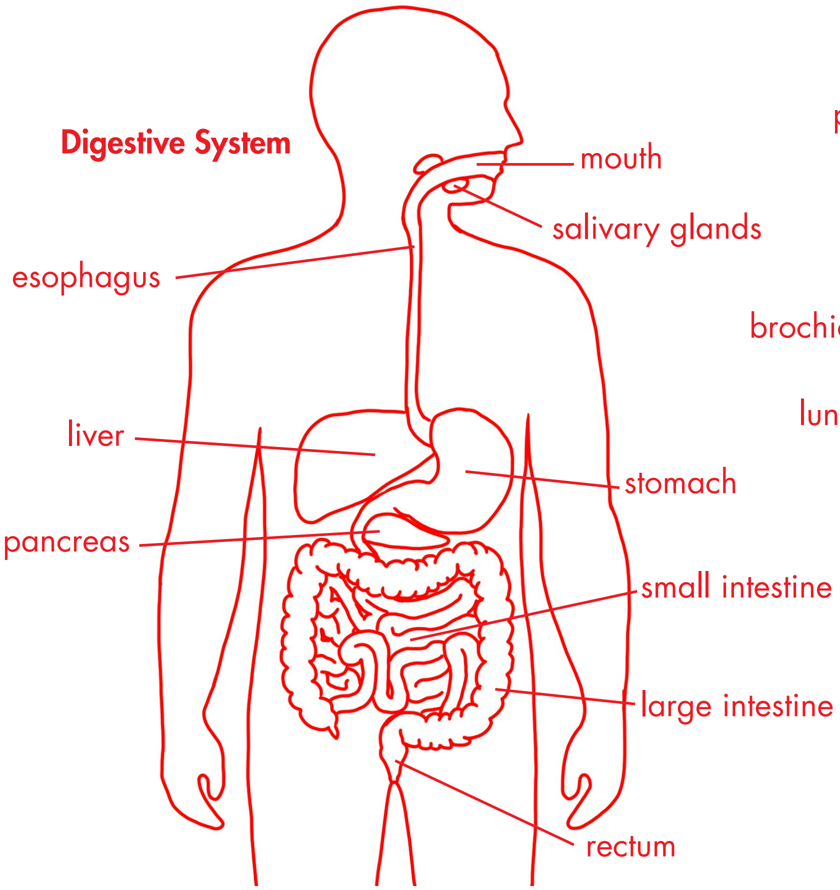
   Answers may vary. Students might point out the following: Their sizes are very different from real cells. The colors are not what they are in real cells. They are simpler and not three-dimensional.

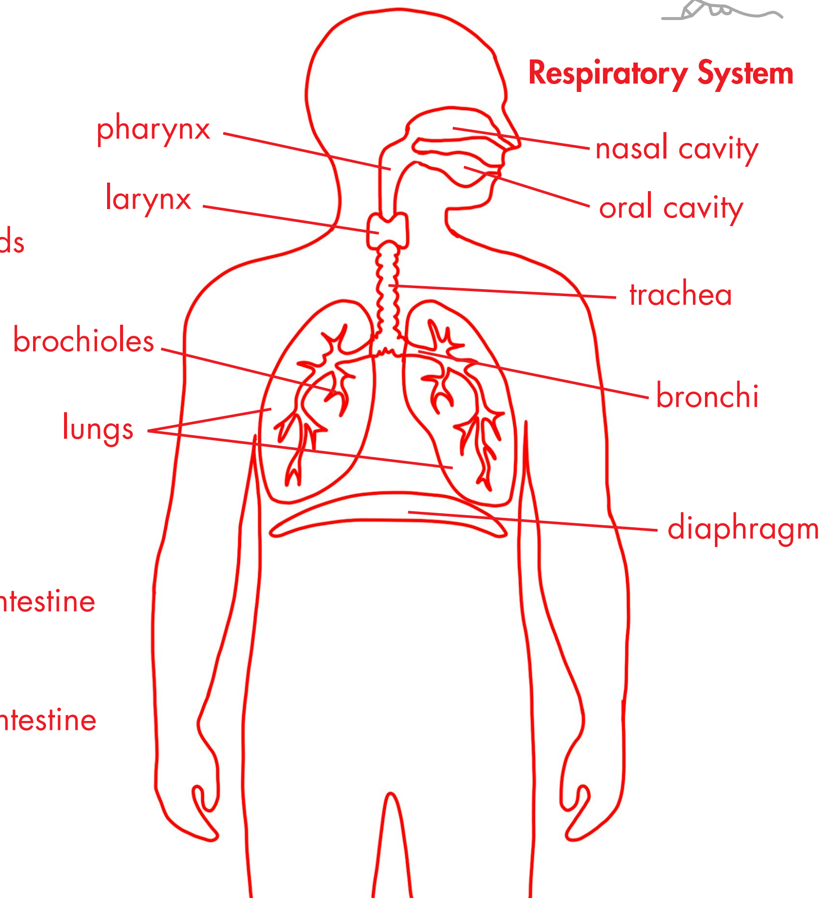
4. **Describe** what you can learn from the models.

I can learn about the parts of plant and animal cells. I can learn how they are similar and how they are different to one another.

5. **Draw** diagrams of two body systems in either a person or a crocodile.

Diagrams will vary. Good diagrams will show two body systems.



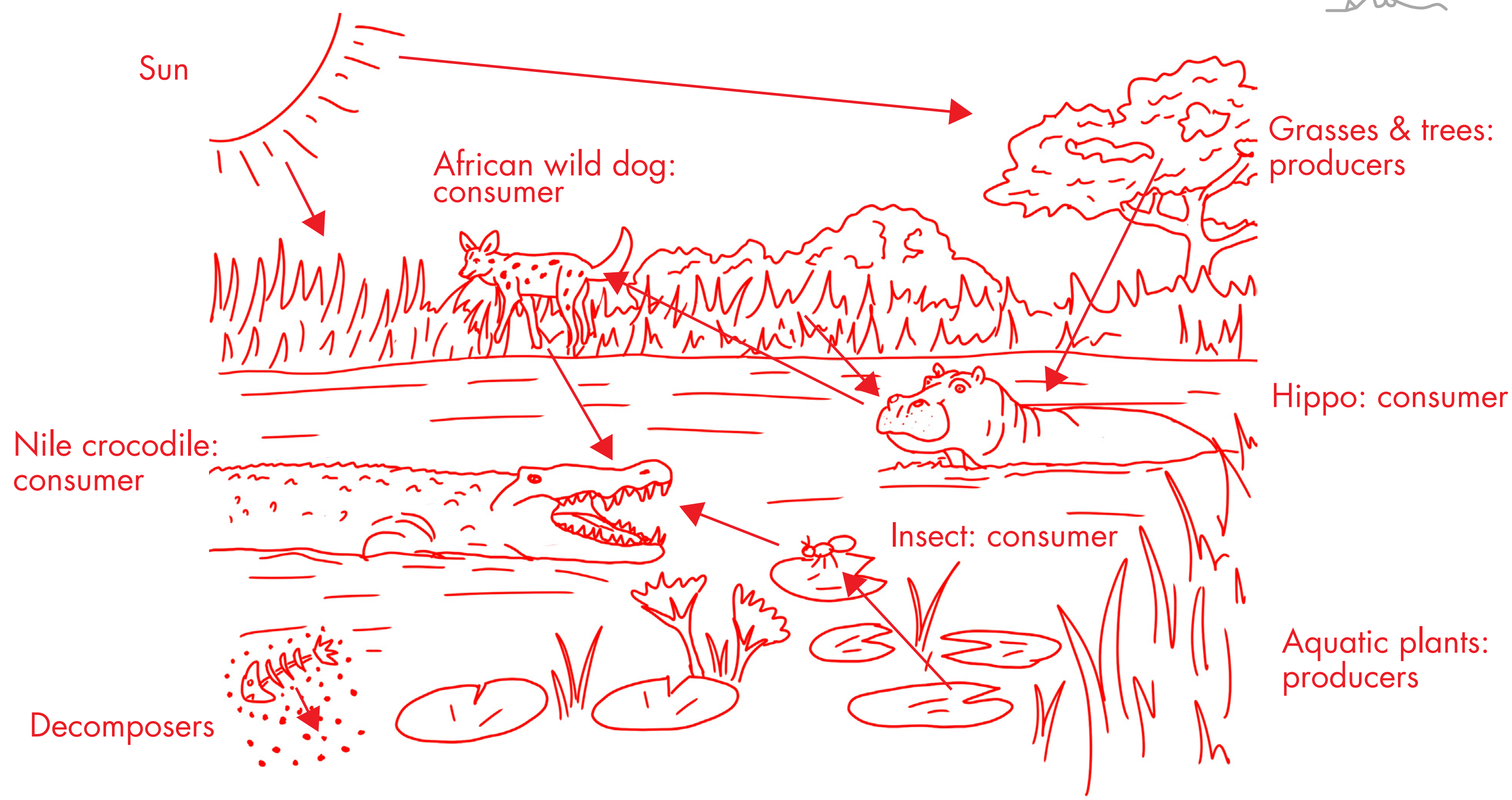


6. **Describe** the information you were trying to communicate with your diagrams.

Accept reasonable answers. Answers may include: the parts of the body system, how body systems interact, or the shape of organs in body systems.

ACTIVITY 2: ECOSYSTEM MODELS

1. **Draw** a diagram model of some species you learned about in the Okavango ecosystem. Use arrows to show the flow of energy. Make sure your model includes the following: At least one producer, the sun, Nile crocodiles, decomposers, and two consumers that are not Nile crocodiles.



2. **Describe** what you are trying to communicate with your model.

I am trying to communicate how energy flows through the ecosystem.

3. **Describe** ways your model could be updated to be more realistic.

Accept reasonable answers. For example: I could include more species. This model only has a few of the species found in the Okavango delta.

Here is another model of ecosystems and energy flow that you have learned about:

$\mathbf{E_x = t^{(x-1)} \bullet E_1}$, where

x is the step in the food chain of a particular species. For example, producers are step 1 (x=1). Herbivores, that eat producers, are step 2 (x = 2).

E is the energy available at a particular step in the food chain. $\mathbf{E_x}$ is the energy available to a particular level in the food chain. $\mathbf{E_1}$ is the energy available to producers.

t is the proportion of energy that is transferred from one step in the food web to the next.

4. Is this model a physical model, diagram, computer simulation, or mathematical model?

Mathematical model

5. **Calculate** how much energy would be available at step 3 in the food web (x = 3) if there are 10,000 units of energy at step 1 (E_1 = 10,000) and t = 0.1. This value of t says that 10% of the available energy passes to the next level! Show your work.

$E_3 = 0.1^{(3-1)} \bullet 10{,}000 = 0.01$ $0.01 \bullet 10{,}000 = 100$ units

6. **Predict** whether the amount of energy going to step 3 in the food chain would increase or decrease if the value of t was 0.05 instead of 0.1. Use the equation to answer your question.

Based on the equation, the value would go down because E_1 would be multiplied by a smaller number.

Extend the Lesson: Have students use the model to explain why top predators are rare and why there are usually only five steps in food webs. The basic idea is that there isn't enough energy to support food chains that are too long.

7. **Describe** how the model could be used.

This model could be used to determine how much energy will get to different levels in the food chain. It could be used to predict what happens if conditions change. The answer here does not have to be perfect. The idea is to have students think about how the model can be used to predict or estimate.

8. **Describe** ways the model could be updated to be more realistic.

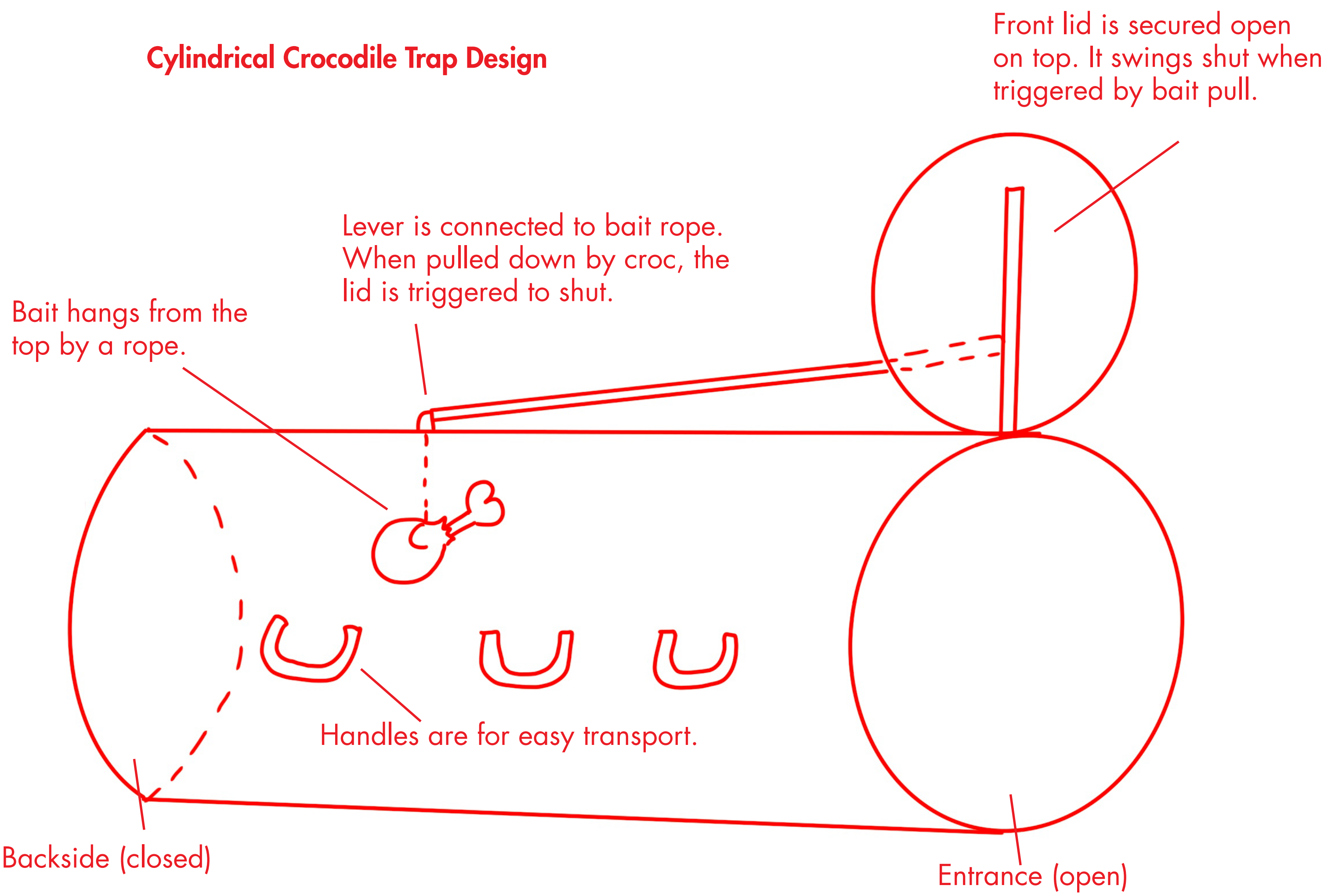
There are many possible options including the idea that that species might feed on more than one type of prey or that the amount of energy that passes between steps in the food chain may not always be the same.

ACTIVITY 3: MODELING CROCODILE SOLUTIONS

It's time to get creative and build some diagram models of your own!

1. **Design** a crocodile trap that is different from the one that you saw in the video. Make sure that your trap will catch a crocodile and not break when the crocodile tries to get away. **Draw** a diagram of your solution. **Label** the different parts.

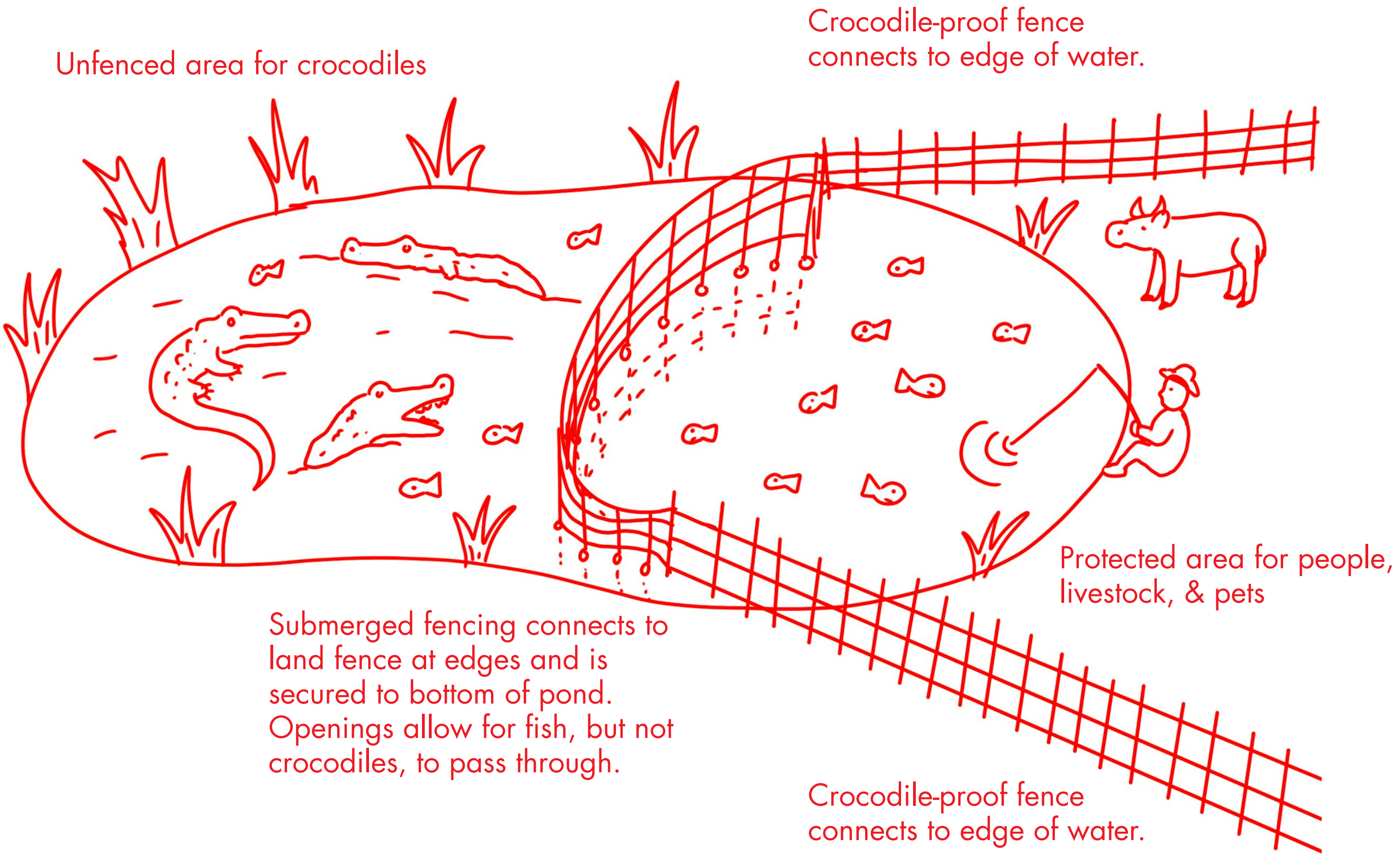
Answers will vary. One example is shown below.



What if there are too many crocodiles to trap, but people or livestock still need to use the water?

2. **Design** a solution to protect people, pets and livestock from crocodiles in a river or lake. A critical design criteria is that no crocodiles can be hurt or killed! **Draw** a diagram of your solution. **Label** the different parts.

Answers will vary. One example is shown below.



3. Use your diagram to **identify** places where the design might fail. **Circle** the places on your diagram you are worried might not work or might break. **Describe** how they might fail.

Answers will vary. For the above example: If they walk far enough or the fence isn't long enough, crocodiles might make it into the protected side. If there is a wet season with floods, crocs might be able to swim over the fence. The fence could get damaged, allowing passage through it.

4. **Present** your diagram to your class. Describe how your solution works and what might fail. **Ask** for suggestions on how to improve your design.

5. **List** the best design improvements your classmates suggested.

   Answers will depend on classmate feedback.

6. **Redraw** your model incorporating suggestions from the class. **Label** the new aspects of your design.

   Answers will depend on classmate feedback.

Extend the Lesson: You could have students make physical models of some of the processes that they learned about in this video. For example, you could have students use clay and sand to build a model of a habitat. Make sure they build the habitat so there is a slope. Then, have them pour water into one location and watch how it erodes and deposits sediments. Have them compare their model to how the Okavango floods. Or, have them research deltas and try to build a model that replicates these Earth processes. You could also have students attempt to build a model crocodile trap out of materials in their homes or the classroom.

Links to Other Missions: Students can get more experience coding computer simulation models of their own. The **STEM Projects** for **Black Panther** and **Rainforest Biodiversity Missions** have instructions on creating models of natural selection and population growth, respectively. Students will find many models throughout the Science 3D experience. When they encounter models you can ask students to identify the type of model, the reason for creating the model, and what it helps us learn or do.