Lesson 4.4
End-of-Unit Assessment Part 2
Lesson Overview

Students’ Designs

This lesson, in which students design and test tooth-like grinding parts for their robot mouths for the engineering firm, serves as Part 2 of the end-of-unit assessment. To begin, students learn about the tooth structures in a giraffe’s mouth that help it get and grind its food. Students are introduced to the RoboGrazer Simulation and explore its features. Then, students use inspiration from what they learned to plan their designs for the RoboGrazer mouth. Pairs test their designs, using the RoboGrazer Simulation, and then share with another pair to reflect on their test results and discuss how well their mouth designs met the criteria. Next, students revise their mouth designs in order to better meet the criteria and then return to the Test phase of the design cycle with the second iteration of their designs. The purpose of this lesson is for students to give and receive peer feedback and to engage in the phases of the design cycle multiple times in order to create solutions that better meet the criteria.

Design Problem: Design a robot that can remove and grind up invasive plants.

Students learn:

- Giraffes have different types of teeth in the different parts of their mouths. These teeth structures serve different functions that help the giraffe meet its needs.
- Engineers figure out what kinds of changes need to be made to their designs by testing and revising their designs to better meet the criteria.
Students read Part 2 of the *Giraffe Structures for Getting Food* article in order to get inspiration for designing their robot teeth.

### Instructional Guide

1. **Introduce the activity.** Let students know that they will now focus on their designs for the mouth of the RoboGrazer. First, they will learn about the giraffe traits and structures that will inspire their designs.

2. **Introduce Part 2 of the *Giraffe Structures for Getting Food* article.** Have students turn to page 63, *Giraffe Structures for Getting Food*, in their notebooks. Let students know that they will read Part 2: Giraffe Teeth.

   - As you read Part 2: Giraffe Teeth, think about how the things you learn about the structure of the teeth will help design your RoboGrazer’s mouth.

3. **Partners read.** Give partners a few minutes to read. Support students as necessary.

4. **Project Design Cycle.** Point out the Learn and Plan phases of the design cycle and have pairs discuss the following questions.

   ![Design Cycle Diagram]

   - Learn
   - Test
   - Make
   - Plan

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What did you learn about giraffe teeth?

How will you use what you learned about a giraffe’s mouth to plan your design of the mouth for the RoboGrazer?

If time allows, invite pairs to share their ideas with the class.

**Teacher Support**

**Instructional Suggestion**

*Providing More Experience: Today’s Daily Written Reflection*

Think about your robot neck design. How did knowing about giraffe traits help you with your design? This prompt (on page 69 in the Investigation Notebook) asks students to think about how they used biomimicry when designing their robots. Reflecting in this way will allow students to connect the activities in which they have been engaging to those of engineers and scientists in the field.

**Background**

**Science Note: Understanding Giraffe Mouth Structures**

Students may notice that the giraffe mouth has a different placement of teeth than the teeth represented in the RoboGrazer mouth. Students only need to understand that different shapes of teeth can be used for different purposes. If students see other images or video footage of giraffes eating, they may also notice that giraffes use their long tongues to grab plants. Explain that students are studying the mouth structures of giraffes to help them understand how different types of teeth can work. Also explain that their robot mouths will have simplified mouth structures that may be similar to those of giraffes or other animals, but they won’t be the same.

**Background**

**Science Note: Herbivore Mouth Structures**

If students become curious about the lack of upper teeth in the front of the giraffe’s mouth or the gap between front and back teeth, you may wish to offer an additional explanation. Giraffes and other herbivores often have a dental pad on the front part of the roof of their mouths. This acts like a cutting board against which the sharp bottom teeth cut pieces of plant material. Herbivores often have a gap between the front and back teeth to allow space for repositioning plant tissue as the plant is chewed. This is because plants require more chewing in order to be broken down into smaller pieces than other food sources.

**Instructional Suggestion**

*What One Teacher Did: Having Students Explore Their Own Teeth*

One teacher distributed baby carrots to students in order to provide them with an opportunity to explore the function of the various tooth structures within their own mouths. Students were asked to pay attention to which teeth they used to bite the carrot, which teeth they used to chew the carrot, and what these teeth felt like. Then, students read the article about giraffe mouth structures and reflected on similarities between the structures of the teeth they used to bite and chew carrots and those used by giraffes to eat leaves.
Exploring the RoboGrazer Simulation

Students engage in free exploration of the RoboGrazer Simulation.

Instructional Guide

1. **Project the RoboGrazer Simulation.** Go to the Student Apps Page. Select the unit and then the Simulation. Explain that the RoboGrazer Simulation is where students will design their robot mouths by selecting the tooth structures that will go in the jaw. (Keep this projected as students explore.)

   Before you begin designing your RoboGrazer mouths, you will have a few minutes to explore the Simulation with your partners.

2. **Distribute digital devices.** Give students a few minutes to explore the RoboGrazer Simulation. Circulate and offer support as necessary.

3. **Collect digital devices.** Let students know that they will work with the RoboGrazer Simulation later in the lesson.

4. **Project the RoboGrazer Simulation and review the features.** Ask students to point out some of the features and functions they discovered. As they share their observations, demonstrate on the projected Simulation. If these features aren’t mentioned, demonstrate some of the following:

   - Point out where students will enter data, including the version number of the design, the neck length in centimeters (cm), and the neck test score. Explain that students will get the data for their neck lengths and their best neck test scores from page 67, RoboGrazer Data, in their notebooks.

   - Show students where they will try out different types of teeth. Demonstrate by dragging different types of teeth into the spaces in the jaw. Point out that once a tooth is placed in the space, the Sim will automatically place that same tooth in the top and the bottom.

   - Point out where students can enter data and where data will be returned to them. Also point out that students will select the EAT button to try out their designs. The robot in the Simulation will eat the plants and then return data to them about how small the pieces of plant material get (quality) and how much plant material the robot was able to eat (amount).
Teacher Support

Background

Science Note: Use of the Word *Eat* in the RoboGrazer Simulation

Students may notice that the word *eat* is used in the RoboGrazer Simulation. You may want to point out that robots can’t really eat the way that people and other organisms can eat. The plant-eating robots in the Simulation aren’t literally eating in the way that we do, which involves food moving through the digestive system. The word *eat* is used in the Simulation for the sake of simplicity; the robots are only gathering and processing plant material by chopping it into small pieces.

Instructional Suggestion

Classroom Management: Class Exploration of the RoboGrazer Simulation

To save time, this activity could be done as a class, rather than having partners explore the Simulation. You may wish to project the Simulation and review its features with the class rather than distributing digital devices to partners. You could also invite several students to come up and “drive” the RoboGrazer Simulation while it is projected. When students are driving the Simulation for the class, encourage them to think aloud and share what they notice with their peers.
Planning Robot Teeth

Students plan their first test versions of their robot mouth designs and explain how their designs mimic the giraffe traits.

Instructional Guide

1. Introduce the Plan phase of the design cycle for the robot mouth.

Now that you have learned about giraffe teeth, you will use what you’ve learned to inspire your designs for the RoboGrazer mouth.

First, you and your partner will make a plan for what your first test version will look like. You’ll use what you learned about giraffe traits to help you decide which tooth types to use in each space of the RoboGrazer’s mouth.

2. Distribute the End-of-Unit Designs: Designing a Mouth for the RoboGrazer student sheet. Distribute one student sheet to each student. Review the directions.

   • Emphasize that partners will decide which type of tooth to use for each space in the RoboGrazer’s mouth, and each student will record the letter for each tooth on their planning sheet.
   • Then, partners will discuss the question at the bottom of the page, and each student will record their answers to the question independently.

3. Review available resources for planning. Remind students that they can refer back to the Giraffe Structures for Getting Food article (pages 62–63 in their notebooks) to aid them in planning their designs for the RoboGrazer mouth.

4. Pairs discuss and record their designs for their first test versions of the RoboGrazer mouth. Have pairs discuss their ideas. As students work, circulate and ask them how their choices for tooth structures relate to the giraffe traits they read about in the article.

5. Students record answers to the question. As pairs finish their designs, allow five to seven minutes for students to write their individual explanations about how their designs for the mouth were inspired by giraffe traits.
6. **Have students set aside their designs.** In the next activity, students will transfer the letters of the tooth types to page 67, RoboGrazer Data, in their notebooks before entering that data into the Sim.
**Designing Robot Teeth**

Students use the Sim to complete their first test versions of their robot mouth designs and input their test results for the robot mouth.

**Instructional Guide**

1. **Project Design Cycle.** Remind students of the activities from the previous lesson and ask them what phase of the design cycle they are about to work through in their role as biomimicry engineers. [Make and test phases.]

You’ve already completed and tested the first and second versions of your robot necks. You’ve also designed your first test versions of your robot mouths. You will now use the RoboGrazer Simulation to test the robot neck and mouth you’ve designed.
2. Project Criteria. Review the design criteria. Let students know they should continue to refer to the projected criteria as they work through the design cycle so they can keep their goals in mind.

Criteria

We are working to design a plant-eating robot called the RoboGrazer.

The criteria are:
- The robot neck helps the robot reach plants that are high up and plants that are down on the ground.
- The robot neck helps the robot reach a lot of plants quickly.
- The robot teeth can grab plants and break them down into very small pieces.

3. Project page 67, RoboGrazer Data, in the notebook. Have students turn back to page 67 in their notebooks.

First, you are going to transfer the letters representing the types of teeth you recorded on your End-of-Unit Design planning sheet to the RoboGrazer Data for Test Version 1.

Even though many of you may have revised your neck designs, you will enter the neck length, best neck test score, and mouth data from Test Version 1 into the Simulation. The RoboGrazer Sim will test both your neck and mouth designs, and the results will show how well your designs meet the criteria.

- Entering data in the Simulation. Remind students that after they enter the data for neck length and best neck test score, they will choose the type of teeth (the same types they recorded in their notebooks) and then press EAT. The Sim will provide information about the quality and amount of the plant material the robot is making.

  Quality refers to how small and chewed-up the plant material is. Amount refers to how much plant material the robot is able to chew up. This amount will be shown in kilograms (kg).

  Remember that according to the criteria, you want the quality of the chewed-up plant material to be as high as possible, and you want the robot to chew up as much plant material as possible.

- Recording data in the notebook. Point out where students will record the RoboGrazer Sim output data for Test Version 1.

4. Distribute digital devices and have students use the RoboGrazer Simulation to test their first designs.

  Remind students to transfer the letters representing the types of teeth from their End-of-Unit Design planning sheets to page 67, RoboGrazer Data, in their notebooks in the section for Test Version 1.
5. Have students set aside digital devices.

6. **Select Partner A and Partner B within pairs.** Assign, or have students choose, who within each pair will be Partners A and B.

7. **Assign each pair to another pair.** Have pairs join with another pair to make a group of four students.

8. **Project notebook page 70, Sharing RoBoGrazer Designs and Test Results.** Explain that students will now share their mouth designs and test results with another pair. Have students turn to page 70 in their notebooks and follow along as you review the directions.

   - **Step 1:** With your partner, share your design with another pair. One pair will share, while the other pair listens. Then, you will switch roles.
   - **Step 2:** Record your ideas for how to improve your design.

Remember that as you listen to other pairs explain their designs, you may get new ideas for your own designs. Later, you will have the chance to revise your designs, based on your new ideas.

Go over the directions for the Sharing Pair and Listening Pair. Make sure students understand the sharing and listening roles. Be sure to read aloud the questions the Listening Pair will ask.

9. **Have students begin sharing.** Circulate and support students as necessary. If needed, signal a time for the Sharing Pairs to switch from Partner A to Partner B and then for the Sharing Pairs to switch roles with the Listening Pairs. Remind students to record any new ideas they have, based on their discussions.

10. **Prompt pairs to revise their mouth designs.** Let students know that they will now revise their mouth designs, based on the data from the RoBoGrazer Sim and the feedback they got from the other pair.

   Share your new ideas about your mouth design with your partner. Then, work together to decide what you will change and what you will keep the same about your RoBoGrazer mouth.

11. **Students use the RoBoGrazer Sim to test their second designs.** Prompt students to return to the Sim to test their new designs. Provide support as needed, ensuring that students are inputting the correct information (from their notebooks) into the Sim and recording the correct data output from the Sim in the section for Test Version 2 in their notebooks (page 67, RoBoGrazer Data).
12. **Prompt class discussion about the two test versions.** Ask the following questions to guide the class discussion about students’ experience working through the design cycle.

You’ve now made and tested two versions of your design for the RoboGrazer neck and mouth structures. How did your designs change as you went through the phases of the design cycle? Did your designs improve? How do you know?

Invite a few students to share their reflections with the class.

13. **Conclude the lesson and collect all digital devices.** Remind students to turn off their devices. Let students know that in the next lesson, they will have the opportunity to share their RoboGrazer designs with their fellow biomimicry engineers.

### Teacher Support

#### Instructional Suggestion

**Providing More Support: Reviewing RoboGrazer Simulation Outputs**

If students seem unclear about how to interpret the output data from the RoboGrazer Simulation, you may wish to review the process with students by providing an example. You can project the Sim, enter example neck length and neck test score data, quickly configure a set of teeth, and press EAT. After entering the data, you will get to the output screen. Then, you can point out how the outputs relate to the design criteria.

#### Instructional Suggestion

**Providing More Experience: Creating a Third Iteration of the Design**

Some students may work through the design cycle more quickly than others. You may wish to provide more time for all students to create a third test version of their designs, or you can offer this opportunity to early finishers. Some students may want to revise their neck designs, their mouth designs, or both. (For instance, if students are satisfied with their neck designs, they may use their best neck test scores and focus only on redesigning the teeth to try to better meet the criteria.) If students do create a third iteration, be sure they record data for their final designs.

#### Instructional Suggestion

**Providing More Experience: Peer Testing**

If you feel that your students would benefit from more testing and peer feedback, you may want to have pairs test each other’s designs and give positive and constructive feedback. This may also help students if the test results are consistent when another pair tries out their design for the neck and mouth. Students may need to be reminded to be careful when handling and testing one another’s designs and to frame feedback in a positive and helpful way.
Giraffe Structures for Getting Food

Giraffes are animals that eat only plants. Giraffes have very long necks that bend and move easily so they can reach plants that are up high (like trees) and closer to the ground (like grass).

Part 1: Giraffe Necks

Stand on your tiptoes and reach your hands above your head. From the tips of your toes to the tips of your fingers is about the same length as a giraffe’s neck. A giraffe’s neck and head can weigh about as much as eight third graders. How does the giraffe support so much weight and hold its head up?
Giraffe Structures for Getting Food (continued)

so high? A giraffe’s neck bones are shaped like ours. However, the giraffe’s neck bones are much longer and bigger than ours. They are thicker toward the bottom to help support the weight of the neck and head.

Feel the back of your neck. What do you notice? Your neck is wrapped in muscles that help hold up your head. Giraffes also have muscles that help hold up their heads. The muscles are also thicker and stronger toward the bottom. Giraffes even have a section of muscle that acts as a balance to help hold up the neck.

This all helps make the giraffe’s neck strong, stable, and easy to move around.

Part 2: Giraffe Teeth

Use your tongue to feel the teeth in your mouth. What shapes do you feel in the front of your mouth? In the back? Like us, giraffes have different kinds of teeth in the different parts of their mouths.

In the front of their mouths, they have teeth that have a sharp edge. These sharp teeth are only on the bottom of the mouth. They help the giraffe grab plants to eat. Then the giraffe breaks off the plants against the top surface of the mouth, which is hard like a plate. The teeth in the back of the mouth are larger and more square in shape. These teeth help chew up the plants and break them down into smaller pieces.

All animals have certain structures that help them get food, eat, and survive. A giraffe has a long, strong neck and teeth with special shapes for grabbing and eating plants. What structures do you have?
Students read Part 2 of the *Giraffe Structures for Getting Food* article in order to get inspiration for designing their robot teeth.

**Instructional Guide**

1. **Introduce the activity.** Let students know that they will now focus on their designs for the mouth of the RoboGrazer. First, they will learn about the giraffe traits and structures that will inspire their designs.

2. **Introduce Part 2 of the *Giraffe Structures for Getting Food* article.** Have students turn to page 63, *Giraffe Structures for Getting Food*, in their notebooks. Let students know that they will read Part 2: Giraffe Teeth.

   Cuando lean la Parte 2: dientes de jirafa, piensen en cómo lo que aprenden acerca de la estructura de los dientes les ayudará a diseñar su boca de RoboGrazer.

3. **Partners read.** Give partners a few minutes to read. Support students as necessary.

4. **Project Design Cycle.** Point out the Learn and Plan phases of the design cycle and have pairs discuss the following questions.
If time allows, invite pairs to share their ideas with the class.

Teacher Support

Instructional Suggestion

Providing More Experience: Today’s Daily Written Reflection

Think about your robot neck design. How did knowing about giraffe traits help you with your design? This prompt (on page 69 in the Investigation Notebook) asks students to think about how they used biomimicry when designing their robots. Reflecting in this way will allow students to connect the activities in which they have been engaging to those of engineers and scientists in the field.

Background

Science Note: Understanding Giraffe Mouth Structures

Students may notice that the giraffe mouth has a different placement of teeth than the teeth represented in the RoboGrazer mouth. Students only need to understand that different shapes of teeth can be used for different purposes. If students see other images or video footage of giraffes eating, they may also notice that giraffes use their long tongues to grab plants. Explain that students are studying the mouth structures of giraffes to help them understand how different types of teeth can work. Also explain that their robot mouths will have simplified mouth structures that may be similar to those of giraffes or other animals, but they won’t be the same.

Background

Science Note: Herbivore Mouth Structures

If students become curious about the lack of upper teeth in the front of the giraffe’s mouth or the gap between front and back teeth, you may wish to offer an additional explanation. Giraffes and other herbivores often have a dental pad on the front part of the roof of their mouths. This acts like a cutting board against which the sharp bottom teeth cut pieces of plant material. Herbivores often have a gap between the front and back teeth to allow space for repositioning plant tissue as the plant is chewed. This is because plants require more chewing in order to be broken down into smaller pieces than other food sources.

Instructional Suggestion

What One Teacher Did: Having Students Explore Their Own Teeth

One teacher distributed baby carrots to students in order to provide them with an opportunity to explore the function of the various tooth structures within their own mouths. Students were asked to pay attention to which teeth they used to bite the carrot, which teeth they used to chew the carrot, and what these teeth felt like. Then, students read the article about giraffe mouth structures and reflected on similarities between the structures of the teeth they used to bite and chew carrots and those used by giraffes to eat leaves.
Exploring the RoboGrazer Simulation

Students engage in free exploration of the RoboGrazer Simulation.

Instructional Guide

1. **Project the RoboGrazer Simulation.** Go to the Student Apps Page. Select the unit and then the Simulation. Explain that the RoboGrazer Simulation is where students will design their robot mouths by selecting the tooth structures that will go in the jaw. (Keep this projected as students explore.)

   Antes de comenzar a diseñar sus bocas de RoboGrazer, van a tener algunos minutos para explorar la Simulación en parejas.

2. **Distribute digital devices.** Give students a few minutes to explore the RoboGrazer Simulation. Circulate and offer support as necessary.

3. **Collect digital devices.** Let students know that they will work with the RoboGrazer Simulation later in the lesson.

4. **Project the RoboGrazer Simulation and review the features.** Ask students to point out some of the features and functions they discovered. As they share their observations, demonstrate on the projected Simulation. If these features aren't mentioned, demonstrate some of the following:

   - Point out where students will enter data, including the version number of the design, the neck length in centimeters (cm), and the neck test score. Explain that students will get the data for their neck lengths and their best neck test scores from page 67, RoboGrazer Data, in their notebooks.

   - Show students where they will try out different types of teeth. Demonstrate by dragging different types of teeth into the spaces in the jaw. Point out that once a tooth is placed in the space, the Sim will automatically place that same tooth in the top and the bottom.

   - Point out where students can enter data and where data will be returned to them. Also point out that students will select the EAT button to try out their designs. The robot in the Simulation will eat the plants and then return data to them about how small the pieces of plant material get (quality) and how much plant material the robot was able to eat (amount).
Teacher Support

Background

Science Note: Use of the Word Eat in the RoboGrazer Simulation
Students may notice that the word *eat* is used in the RoboGrazer Simulation. You may want to point out that robots can’t really eat the way that people and other organisms can eat. The plant-eating robots in the Simulation aren’t literally eating in the way that we do, which involves food moving through the digestive system. The word *eat* is used in the Simulation for the sake of simplicity; the robots are only gathering and processing plant material by chopping it into small pieces.

Instructional Suggestion

Classroom Management: Class Exploration of the RoboGrazer Simulation
To save time, this activity could be done as a class, rather than having partners explore the Simulation. You may wish to project the Simulation and review its features with the class rather than distributing digital devices to partners. You could also invite several students to come up and “drive” the RoboGrazer Simulation while it is projected. When students are driving the Simulation for the class, encourage them to think aloud and share what they notice with their peers.
Planning Robot Teeth

Students plan their first test versions of their robot mouth designs and explain how their designs mimic the giraffe traits.

Instructional Guide

1. Introduce the Plan phase of the design cycle for the robot mouth.

Ahora que han aprendido sobre los dientes de la jirafa, van a usar lo que aprendieron para inspirar sus diseños para la boca de RoboGrazer.

Primero van a hacer un plan en parejas sobre cómo va a ser su primera versión de prueba. Van a usar lo que han aprendido sobre los rasgos de las jirafas para que les ayude a decidir qué tipos de dientes van a usar en cada espacio de la boca de RoboGrazer.

2. Distribute the End-of-Unit Designs: Designing a Mouth for the RoboGrazer student sheet. Distribute one student sheet to each student. Review the directions.

- Emphasize that partners will decide which type of tooth to use for each space in the RoboGrazer’s mouth, and each student will record the letter for each tooth on their planning sheet.
- Then, partners will discuss the question at the bottom of the page, and each student will record their answers to the question independently.

3. Review available resources for planning. Remind students that they can refer back to the Giraffe Structures for Getting Food article (pages 62–63 in their notebooks) to aid them in planning their designs for the RoboGrazer mouth.

4. Pairs discuss and record their designs for their first test versions of the RoboGrazer mouth. Have pairs discuss their ideas. As students work, circulate and ask them how their choices for tooth structures relate to the giraffe traits they read about in the article.

5. Students record answers to the question. As pairs finish their designs, allow five to seven minutes for students to write their individual explanations about how their designs for the mouth were inspired by giraffe traits.
6. Have students set aside their designs. In the next activity, students will transfer the letters of the tooth types to page 67, RoboGrazer Data, in their notebooks before entering that data into the Sim.
Designing Robot Teeth

Students use the Sim to complete their first test versions of their robot mouth designs and input their test results for the robot mouth.

Instructional Guide

1. Project Design Cycle. Remind students of the activities from the previous lesson and ask them what phase of the design cycle they are about to work through in their role as biomimicry engineers. [Make and test phases.]

Ya han completado y probado la primera y segunda versiones de sus cuellos de robot. También han diseñado sus primeras versiones de prueba de sus bocas de robot. Usen ahora la Simulación RoboGrazer para probar el cuello y la boca de robot que han diseñado.
2. **Project Criteria.** Review the design criteria. Let students know they should continue to refer to the projected criteria as they work through the design cycle so they can keep their goals in mind.

**Criterios**

Estamos trabajando para diseñar un robot que come plantas llamado RoboGrazer.

Los criterios son:
- El cuello del robot ayuda al robot a alcanzar plantas que están en lo alto y plantas que están abajo sobre la tierra.
- El cuello del robot ayuda al robot a alcanzar muchas plantas rápidamente.
- Los dientes del robot pueden agarrar plantas y cortarlas en pedazos muy pequeños.

3. **Project page 67, RoboGrazer Data, in the notebook.** Have students turn back to page 67 in their notebooks.

Primero van a transferir las letras que representan los tipos de dientes que apuntaron en su hoja para planear el diseño al fin de la unidad a los Datos del RoboGrazer para la versión de prueba 1.

Aunque tal vez varios de ustedes hayan revisado sus diseños de cuello, van a ingresar a la Simulación el largo del cuello, el mejor puntaje para el cuello y los datos de la boca de la versión de prueba 1. La Simulación RoboGrazer va a probar sus diseños tanto para el cuello como para la boca, y los resultados van a mostrar qué tan bien sus diseños cumplen con los criterios.

- **Entering data in the Simulation.** Remind students that after they enter the data for neck length and best neck test score, they will choose the type of teeth (the same types they recorded in their notebooks) and then press EAT. The Sim will provide information about the quality and amount of the plant material the robot is making.

  - *Calidad* tiene que ver con lo pequeño y triturado que está el material de planta. *Cantidad* tiene que ver con cuánto material de planta puede masticar el robot. Esta cantidad aparecerá en kilogramos (kg).

  - Recuerden que de acuerdo con los criterios, la calidad del material de planta masticado debe ser lo más alta posible, y el robot tiene que masticar la mayor cantidad de material de planta posible.

- **Recording data in the notebook.** Point out where students will record the RoboGrazer Sim output data for Test Version 1.

4. **Distribute digital devices and have students use the RoboGrazer Simulation to test their first designs.**
• Remind students to transfer the letters representing the types of teeth from their End-of-Unit Design planning sheets to page 67, RoboGrazer Data, in their notebooks in the section for Test Version 1.

• Next, students should input the data for Test Version 1 into the Simulation.

• Finally, students should record the Simulation output—the quality and amount of the plant material—on page 67, RoboGrazer Data, in their notebooks.

• Provide support as needed, ensuring that students are inputting and recording the correct data into the Sim and their notebooks.

5. Have students set aside digital devices.

6. Select Partner A and Partner B within pairs. Assign, or have students choose, who within each pair will be Partners A and B.

7. Assign each pair to another pair. Have pairs join with another pair to make a group of four students.

8. Project notebook page 70, Sharing RoboGrazer Designs and Test Results. Explain that students will now share their mouth designs and test results with another pair. Have students turn to page 70 in their notebooks and follow along as you review the directions.

   • Step 1: With your partner, share your design with another pair. One pair will share, while the other pair listens. Then, you will switch roles.

   • Step 2: Record your ideas for how to improve your design.

Recuerden que al escuchar a otras parejas explicar sus diseños, pueden sacar ideas nuevas para sus propios diseños. Más adelante tendrán la oportunidad de revisar sus diseños basándose en sus nuevas ideas.

Go over the directions for the Sharing Pair and Listening Pair. Make sure students understand the sharing and listening roles. Be sure to read aloud the questions the Listening Pair will ask.

9. Have students begin sharing. Circulate and support students as necessary. If needed, signal a time for the Sharing Pairs to switch from Partner A to Partner B and then for the Sharing Pairs to switch roles with the Listening Pairs. Remind students to record any new ideas they have, based on their discussions.

10. Prompt pairs to revise their mouth designs. Let students know that they will now revise their mouth designs, based on the data from the RoboGrazer Sim and the feedback they got from the other pair.

Compartan en parejas sus ideas nuevas del diseño de la boca. Luego, trabajen juntos para decidir qué van a cambiar y qué van a dejar igual para su boca de RoboGrazer.
11. **Students use the RoboGrazer Sim to test their second designs.** Prompt students to return to the Sim to test their new designs. Provide support as needed, ensuring that students are inputting the correct information (from their notebooks) into the Sim and recording the correct data output from the Sim in the section for Test Version 2 in their notebooks (page 67, RoboGrazer Data).

12. **Prompt class discussion about the two test versions.** Ask the following questions to guide the class discussion about students’ experience working through the design cycle.

   - Han hecho y probado dos versiones de su diseño para la estructura del cuello y la estructura de la boca de RoboGrazer. ¿Cómo fueron cambiando sus diseños a medida que iban pasando por las fases del ciclo de diseño? ¿Mejoraron sus diseños? ¿Cómo saben?

   Invite a few students to share their reflections with the class.

13. **Conclude the lesson and collect all digital devices.** Remind students to turn off their devices. Let students know that in the next lesson, they will have the opportunity to share their RoboGrazer designs with their fellow biomimicry engineers.

**Teacher Support**

**Instructional Suggestion**

**Providing More Support: Reviewing RoboGrazer Simulation Outputs**

If students seem unclear about how to interpret the output data from the RoboGrazer Simulation, you may wish to review the process with students by providing an example. You can project the Sim, enter example neck length and neck test score data, quickly configure a set of teeth, and press EAT. After entering the data, you will get to the output screen. Then, you can point out how the outputs relate to the design criteria.

**Instructional Suggestion**

**Providing More Experience: Creating a Third Iteration of the Design**

Some students may work through the design cycle more quickly than others. You may wish to provide more time for all students to create a third test version of their designs, or you can offer this opportunity to early finishers. Some students may want to revise their neck designs, their mouth designs, or both. (For instance, if students are satisfied with their neck designs, they may use their best neck test scores and focus only on redesigning the teeth to try to better meet the criteria.) If students do create a third iteration, be sure they record data for their final designs.

**Instructional Suggestion**

**Providing More Experience: Peer Testing**

If you feel that your students would benefit from more testing and peer feedback, you may want to have pairs test each other’s designs and give positive and constructive feedback. This may also help students if the test results are consistent when another pair tries out their design for the neck and mouth. Students may need to be reminded to be careful when handling and testing one another’s designs and to frame feedback in a positive and helpful way.
Estructuras de la jirafa para obtener alimento

Las jirafas son animales que solo comen plantas. Las jirafas tienen cuellos muy largos que se doblan y se mueven fácilmente para alcanzar plantas que están en lo alto (como los árboles) y cerca de la tierra (como el pasto).

Parte 1: cuellos de jirafa

Párate de puntas y alza tus manos por encima de la cabeza. Desde las puntas de los dedos de tus pies hasta las puntas de los dedos de tus manos es aproximadamente el mismo largo que el cuello de una jirafa. El cuello y la cabeza de una jirafa pueden pesar tanto como ocho estudiantes de tercer año. ¿Cómo es que la jirafa sostiene tanto peso y mantiene la cabeza levantada tan alto? Los huesos del cuello de una jirafa tienen la misma forma...
Estructuras de la jirafa para obtener alimento (continuación)

que los nuestros. Sin embargo, los huesos del cuello de la jirafa son mucho más largos y grandes que los nuestros. Son más gruesos hacia la parte inferior para ayudar a sostener el peso del cuello y la cabeza.

Siente la parte de atrás de tu cuello. ¿Qué notas? Tu cuello está envuelto en músculos que ayudan a sostener tu cabeza. Las jirafas también tienen músculos que ayudan a sostener sus cabezas. Los músculos también son más gruesos y fuertes hacia la parte inferior. Las jirafas incluso tienen una sección de músculo que actúa como contrapeso para ayudar a sostener el cuello.

Todo esto ayuda a hacer que el cuello de la jirafa sea fuerte, estable y fácil de moverse.

**Parte 2: dientes de jirafa**

Usa tu lengua para sentir los dientes en tu boca. ¿Qué formas sientes en la parte delantera de tu boca? ¿Y en la parte trasera? Igual que nosotros, las jirafas tienen diferentes tipos de dientes en las diferentes partes de sus bocas.

En la parte delantera de sus bocas, tienen dientes con un borde afilado. Estos dientes afilados solo están en la parte inferior de la boca. Ayudan a la jirafa a agarrar plantas para comer. Luego la jirafa corta las plantas contra la superficie superior de la boca, que es dura como un plato. Los dientes en la parte trasera de la boca son más grandes y con forma más cuadrada. Estos dientes les ayudan a masticar las plantas y cortarlas en pedazos más pequeños.

Todos los animales tienen ciertas estructuras que les ayudan a obtener alimento, comer y sobrevivir. La jirafa tiene un cuello largo y fuerte y dientes con formas especiales para agarrar y comer plantas. ¿Qué estructuras tienes tú?