NATIONAL GEOGRAPHIC KIDS

EDUCATOR'S GUIDE

Ages: 7-10
Grades: 2-5

▶ COMMON CORE ALIGNED FOR GRADES 2-7

2nd GRADE: ELA. RI.2.1-4, 7-9; W.2.1, 2, 6-8; SL.3.1-4; L.2.4-6

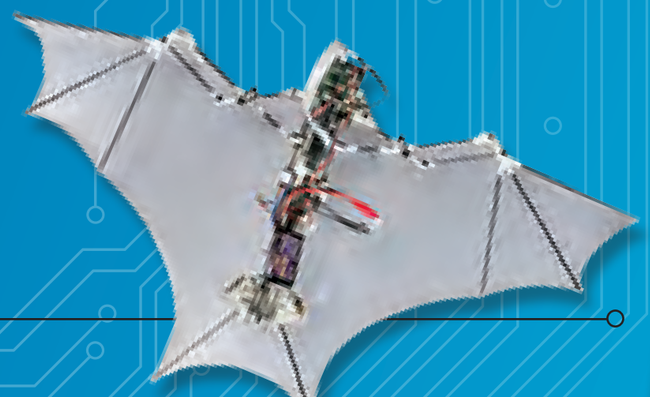
3rd GRADE: ELA. RI.3.1-4, 7-9; W.3.1, 2, 4, 6-9; SL.3.1-4; L.4.4

4th GRADE: ELA. RI.4.1-4, 7-9; W.4.1, 2, 4, 6-9; SL.4.1-4; L.4.4

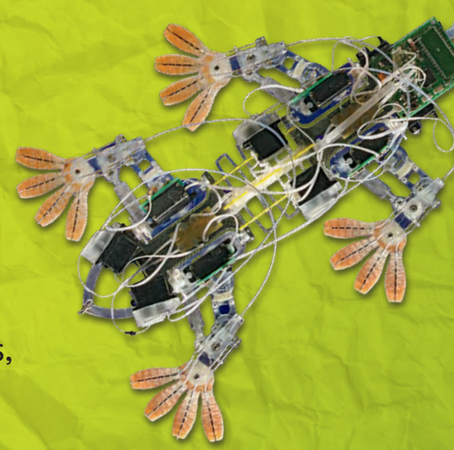
5th GRADE: ELA. RI.5.1-4, 7-9; W.5.1, 2, 4, 6-9; SL.5.1-5; L.5.4

6th GRADE: ELA. RI.6.1-8; W.6.1-2, 4, 6, 9; SL.6.1-5; L.6.4; RST.6-8.1-3, 7, 9; WHST.6-8.7, 8, 9

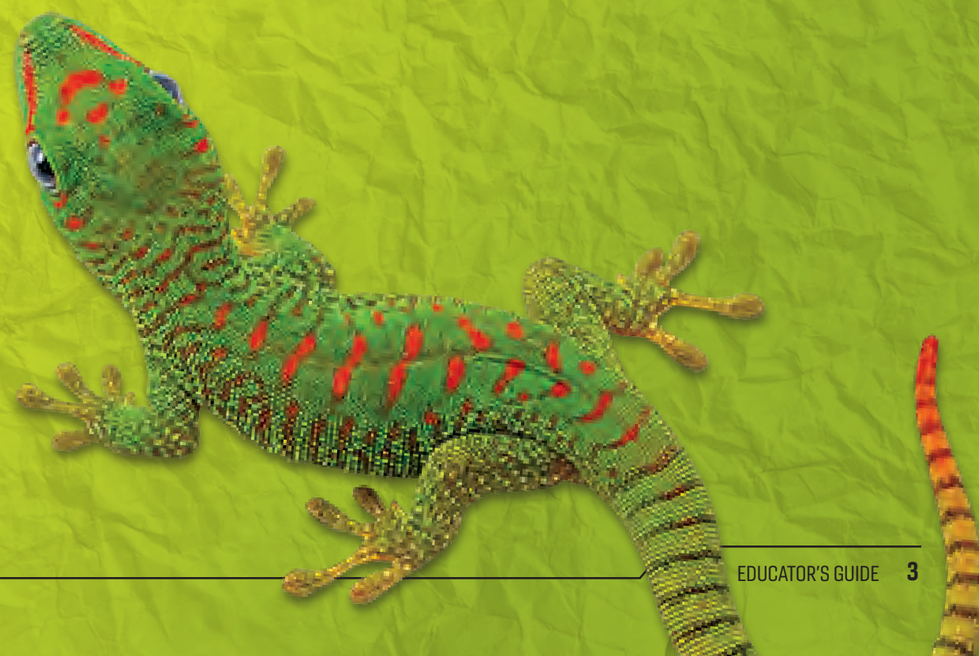
7th GRADE: ELA. RI.7.1-6, 8; W.7.1-2, 4, 6, 7, 8; SL.7.1-5; L.7.4; RST.6-8.1-3, 7, 9; WHST.6-8.7, 8, 9



INTRODUCTION



1. Explain the following terms in your own words, using the text for reference.
   - Bionics
   - Biomimicry
   - Biomimetics
2. Imagine that you are an inventor who has read the information in the introduction to Beastly Bionics. Write a letter to an engineer describing what you have read about bionics, biomimicry, and biomimetics. Ask for specific help creating a robot that could help you clean your room. What animal(s) would you like to fashion your robot after?
3. On page 5, the text reads "Because nature has already solved some challenges humans face, it's the perfect place to find ways to help." Explain what this quote means in your own words, using the definitions of bionics, biomimicry, and biomimetics on page 5.



CHAPTER 1

BEASTLY SOLUTIONS

1. Chapter one introduces several biomimetic inventions. Record what is presented in the following table.

Animal	Problem engineers were faced with	How engineers used biomimetics to solve the problem
Spider		
Kingfisher		
Sea Star		
Turtle		
Woodpeckers		
Manta Ray		
Frogs		
Bats		
Cats		

2. What do you think is meant by the statement "the best part about the robot spider is that it can be created using a 3D printer?" What would be the benefit in this?
3. Why would a shoe company want to make running shoes that are mostly biodegradable?
4. How do you think the Starfish robot could help humans adapt to life on Mars? List at least three ways. Use what you know about sea stars (often called starfish) and biomimetics to support your answers.
5. Engineers have used their understanding of the materials in a woodpecker's beak and skull to create an indestructible black box. But humans can also learn from the feet of the woodpecker. How could the woodpecker's special zygodactyl toes help solve a problem?
6. On page 23, the author writes, "failure is not something that prevents engineers from moving forward—sometimes it is the answer to the question." Explain what you think this quote means, in your own words.
   a. Can you think of a time when you failed? Describe the situation.
   b. How can you turn this failure into a learning experience?
   c. Thinking back to when you failed, did you give up or keep trying? Do you think you made the right decision? Why or why not?
   d. Create a poster to encourage yourself and others to "use failure to your advantage!"
7. As described on page 25, the Bat Bot could be used to deliver small items throughout a hospital or construction site, or even in your own home. List up to 10 ways you would use a Bat Bot in your own home.

Get Outside and Start Inventing!

MATERIALS NEEDED: a journal or notebook, pencil, patience, and imagination

Go outside, somewhere you will be able to observe animals.

Observe It!

Ask yourself:
- What is the coolest thing this animal does?
- How can this feature or ability be used to create something that will help humans?

Answer these questions in your journal.

Draw It!

Draw a picture of the animal in your journal.
Draw a picture of the animal's helpful attribute.
Be sure to show how this attribute can be turned into something that can help a human.

Design It!

Gather materials and see if you can make a model of your idea. It can be made of building blocks, paper, cardboard, or whatever supplies you have. If you have access to robotics materials, and can code something, that works, too.

Test It!

See if it works. Then present your idea to the class or someone at home. Ask them if they understand how it's useful to the world and if they'd use it.
Gather feedback and then make adjustments (just as an engineer would).

CHAPTER 2

BEASTLY HELPERS

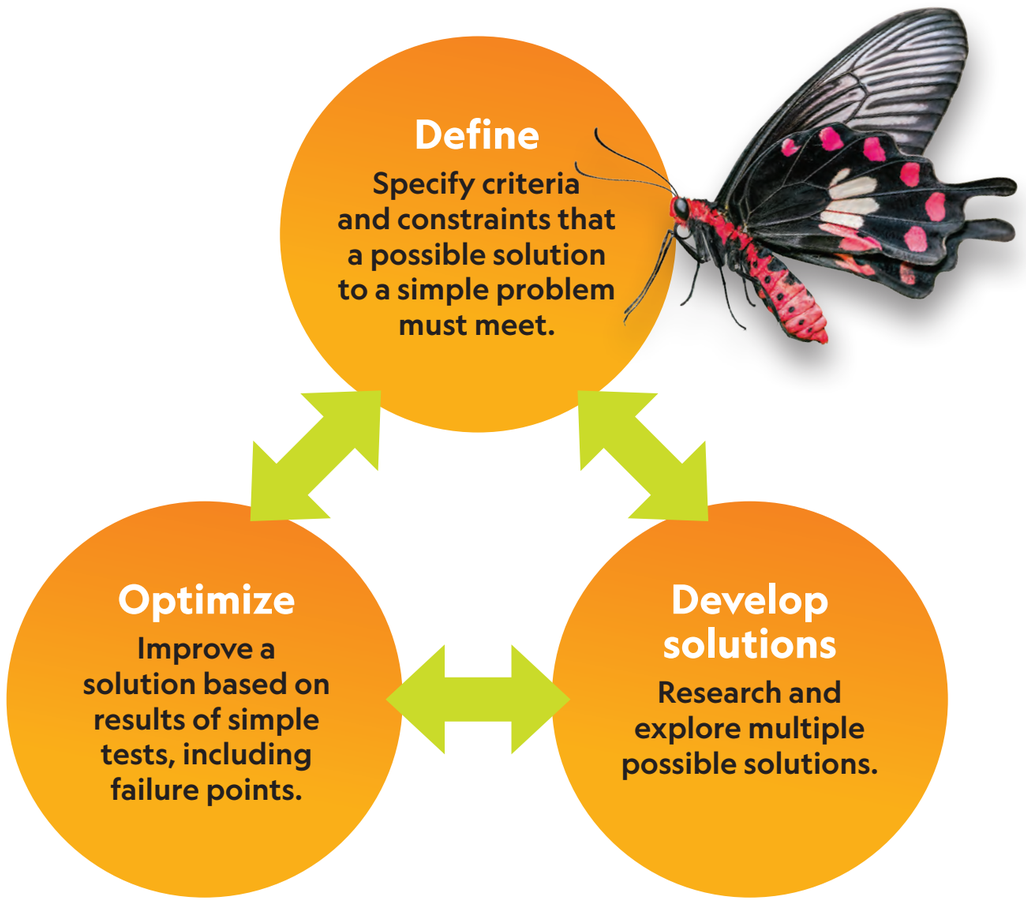
1. Modern technology and nature come together in the bionic inventions introduced in chapter two. Record what is presented in the following table.

Animal	Problem engineers were faced with	How engineers used bionic technology to solve the problem
Elephant		
Cephalopod		
Boa Constrictor		
Bees		
Fish		
Inchworms		
Termites		
Dolphins		

2. Imagine you have the opportunity to own a robotic elephant trunk or Bionic Handling Assistant. The only thing you have to do is convince its creator to give it to you. Write a persuasive letter in which you explain exactly why you want a Bionic Handling Assistant and how you would use it in your daily life.
3. On page 32 the text describes how mimicking the color-changing capabilities of cephalopods can help the military. It also discusses how researchers are developing similar technology to change textures. How, and for whom, do you think changing the texture of clothing would be helpful? Explain and use evidence from the chapter to support your answer.
4. Page 35 explains how scientists are able to retrieve pieces of coral from the ocean floor without hurting it. Humans are not able to handle coral without hurting it. Why might it be beneficial to scientists to be able to sense the texture of the coral?
   a. Brainstorm a way to enhance the boa constrictor–inspired, soft gripper "fingers" to allow scientists to sense the texture.
   b. Draw a picture to illustrate the changes you would make to allow for the sense of touch.
5. Bees are incredibly important to our ecosystem, yet their population is threatened.
   a. Create a list of the many benefits from bees.
   b. What are some of the threats to the bee population?
   c. Conduct research on the internet on ways to be an advocate for the bee population.
   d. Then, using your findings, design a poster to educate others about saving the bee population and to encourage people to take action.
6. Why did scientists create a robotic fish skeleton?
   a. Think of another animal you would like to research by creating a fake version? Why?
7. Imagine that you are a superhero called "the Inchworm." What would your superpowers be?
   a. Design your own super suit using what you have learned about bionics.
   b. How would the Inchworm battle villains? Write a newspaper article about the Inchworm's latest victory.
8. Why would it be beneficial to be able to use 3D printers to make special buildings for people to live or sleep in?
9. Watch the following video from Nat Geo Wild about the language of dolphins: https://www.youtube.com/watch?v=PH35b1lKQTo.
   Take notes of any new information you hear.
   a. Additionally, you can listen to several different dolphin sounds here: https://www.youtube.com/watch?v=q9NLDqi5Qkc.

The Engineering Design Process

The Engineering Design Process is a process that engineers, scientists and inventors use to problem solve.



Design a Candy Grabber

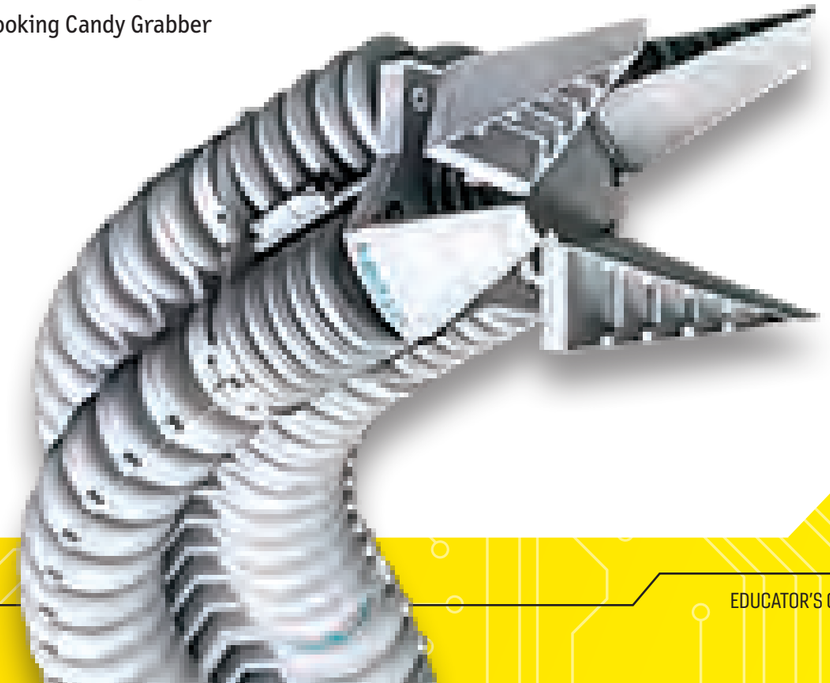
This challenge allows students to test out the engineering design process for themselves as they problem solve a way to build a **Candy Grabber** that really works! Of course, a little imagination is going to go a long way here, too!

- Explain to students that they will be building a working Candy Grabber.
- Provide the students with several craft items (paper, paper clips, stapler and staples, rubber bands, etc.)
- Each Candy Grabber must:
  - Be able to reach a distance of three feet.
  - Be able to pick up and retrieve a piece of wrapped candy from three feet away.
  - Be a construction, not merely a stick.
- Each student must create a Design Notebook for their Candy Grabber and carefully document their use of the engineering design process in building their Candy Grabber.

Once all Candy Grabbers have been built, test them out one by one as a class.
Did they work? Retest. If they didn't work, head back to the drawing board like a real inventor.

Offer up awards to increase the competition.

- Longest Pick-up
- Highest Pick-up
- Most Materials Candy Grabber
- Least Materials Candy Grabber
- Best-Looking Candy Grabber



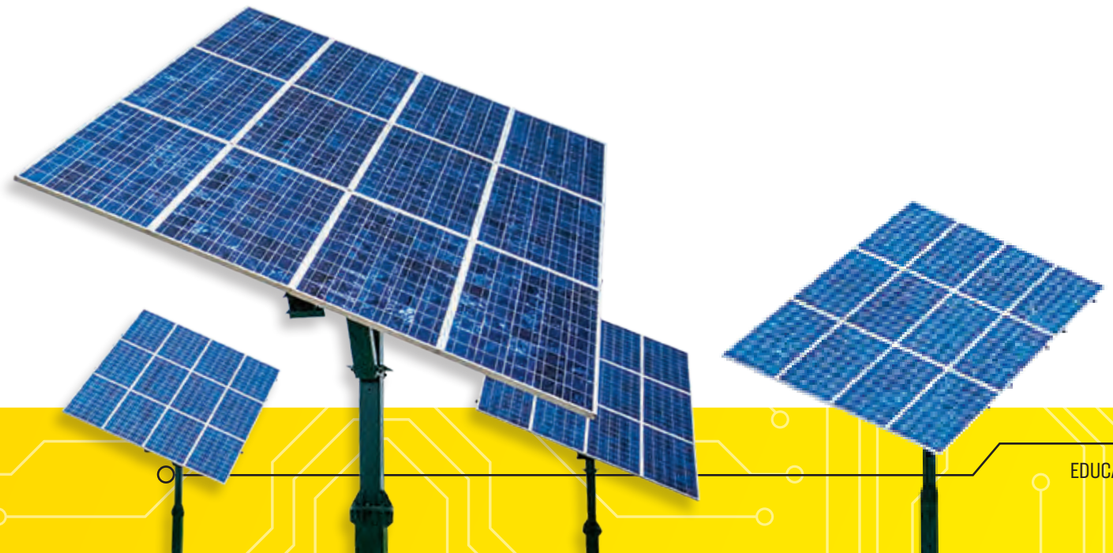
CHAPTER 3

BEASTLY ENERGY

1. This chapter is packed with ways to improve energy efficiency through biomimetic research. Record what is presented in the following table.

Animal	Problem engineers were faced with	How engineers used biomimetic technology to improve energy efficiency
Rose Butterflies		
Owls		
Humpback Whales		
Fireflies		
Canadian Geese		
Namib Desert Beetles		
Coral		
Emperor Penguins		
Sharks		

2. One criticism of solar power is that it is very expensive. Conduct internet research to find out how much it would cost to put solar panels on your house.
   a. Then compare this to the average monthly cost of heat and electricity with your current energy provider.
   b. What is the difference?
   c. What small changes can you and your family make to afford solar power?
3. Sit quietly for five minutes and note all of the sounds you hear.
   a. Then, when time is up, look over your list.
   b. Do any of these noises have a negative effect on you? Do any of these noises have a positive effect on you? Please explain.
   c. Which sounds would you consider noise pollution?
4. Fireflies are bioluminescent, meaning they are living organisms that give off light. Research videos and pictures of other bioluminescent creatures.
   a. Brainstorm other inventions that could result from the biomimicry of bioluminescence.
5. Given what you know about "drafting" from page 59, develop a strategy for winning a speed skating race. What position would you take at various times of the race to maximize your chance of winning?
6. Based on the information on page 61, how would you suggest scientists harvest water on a large scale? Explain your answer.
7. With increased carbon dioxide today, oceans are becoming more acidic and less healthy. Conduct research on how to save the oceans from this fate.
8. "Burning fuel just to refuel hardly makes sense." Explain this statement in your own words.
   a. Can you think of any other circumstance in which fuel is burned in order to refuel? And how can you work to change that?



Make a Solar Pizza

Solar Panels/Photovoltaics replace the traditional ways of heating a home. Solar panels are attached to the south side of roofs, where most of the sun's rays hit. Panels can also be placed in open fields and arranged in large groupings. Are there any solar farms in your area? Solar energy is an active renewable energy source because it uses equipment to capture energy, unlike passive housing design.

The goal of this activity is not only to eat pizza but also to learn about solar energy and how it can replace fossil fuels. Using a solar cooker is not as efficient as using a conventional oven, but this project will start you thinking about how you might change that.

Follow these steps to assemble your solar pizza oven.

1. Begin by lining the inside of a pizza box with aluminum foil; make sure the foil is firmly glued down. Do not cover the top of the box.
2. With a marker and ruler, draw a square on the top flap, starting one inch from the edge. Cut along three of the sides. The fourth line will act as a hinge.
3. Glue tin foil onto the inside of the newly created flap.
4. Glue black construction paper to the bottom of the box.
5. Wrap plastic wrap over the opening of the box to help seal in the air.
6. Find a flat, level surface outside and place the box there. Place your food inside!
7. Use a piece of string to tie back the reflector flap so the greatest amount of sunlight can enter the box.
8. Cook up your pizza and enjoy!

CHAPTER 4

BEASTLY HEALERS

1. This chapter is packed with biomimetic inventions that can heal and protect the human body. Record what is presented in the following table.

Animal	Problem engineers were faced with	How they can be used to heal and protect human bodies
Slugs		
Ormia Ochracea Fly		
Hippos		
Octopuses		
Spiny-Headed Worms		
Geckos		
Sandcastle Worms		
Clanger Cicada		
Jellyfish		

2. Brainstorm a list of uses for a slug slime bandage.
3. Why do you think it is important that scientists create hearing aids and microphones that minimize background noise?
4. Create a poster educating others about the danger of sunscreen to coral reefs. Include information on brands that are widely available and are reef safe.
5. Challenge yourself to do activities using only one arm. Try the following, for example:
   a. Making your bed.
   b. Walking out your front door.
   c. Making lunch.
   d. Taking a bath.

   How would the octopus arm help you in these situations?
6. Have you (or anyone you know) ever needed stitches? Describe.
7. Why do you think scientists are trying to create wall-climbing pads? How would you use these gecko-inspired pads?
8. Why might it be helpful for humans to be able to see color in the dark? Explain your answer.
9. Besides public bathrooms, where would you want to use the cicada-inspired bacteria killer? Why?
   a. Do you think you would still have to wash your hands if this kind of antibacterial material was used? Why or why not?
10. In addition to finding cancer cells, what uses might there be for the bioluminescence of jellyfish? Make a list of possibilities.

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Guide written by Marcie Colleen.