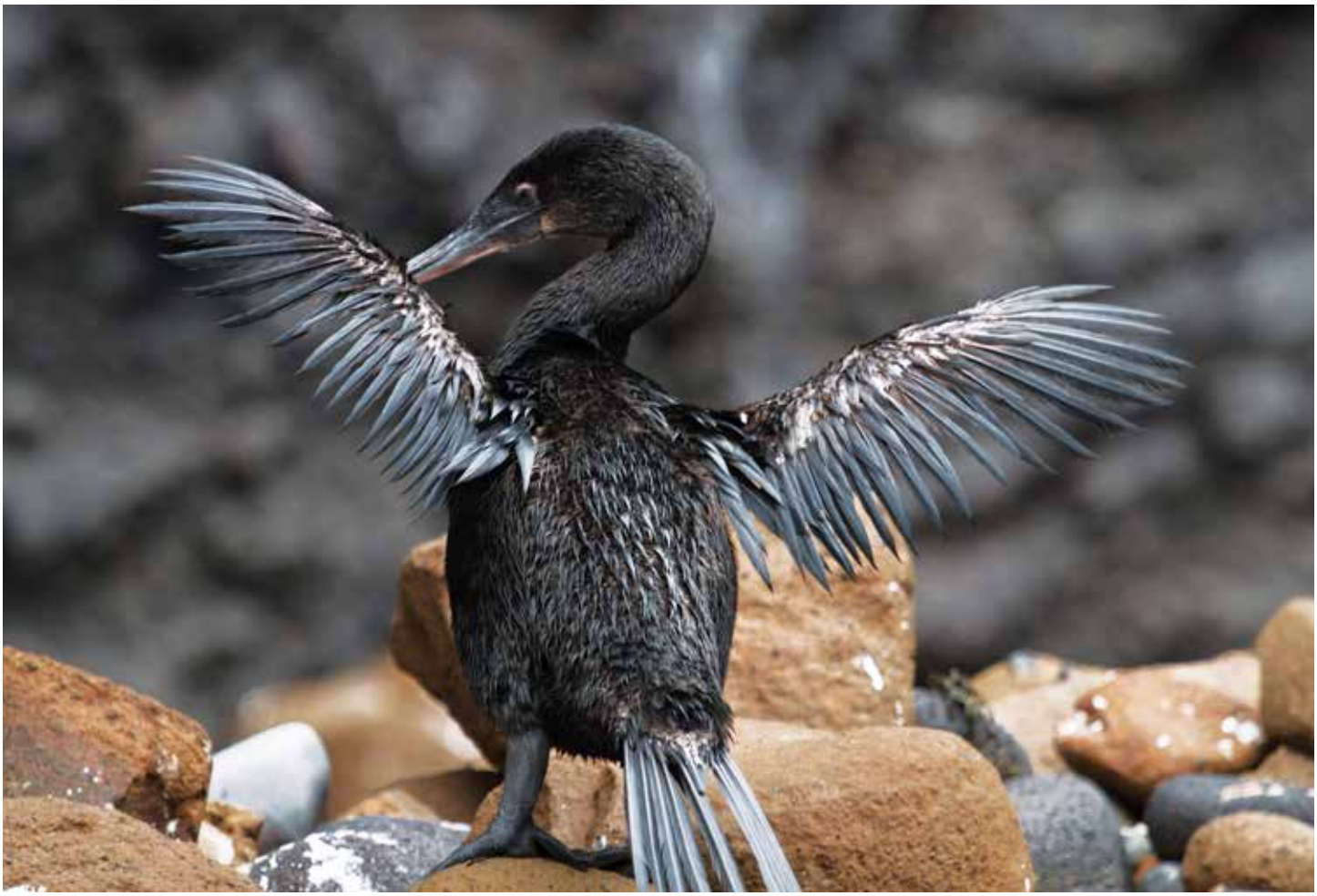
ScienceNews

IN HIGH SCHOOLS | EDUCATOR GUIDE



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JUNE 11, 2016 ISSUE

SOCIETY FOR
SCIENCE & THE PUBLIC

SN EDUCATOR GUIDE

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About the Guide

This guide includes comprehension and analysis questions, as well as discussion prompts, for the following stories:

Space dreams get real PAGE 4

Molecular biologist Kate Rubins is heading to the International Space Station at the end of June, where she'll conduct about 100 experiments over five months.
Blackline Master 1

Aging moon mission still going strong PAGE 10

NASA's Lunar Reconnaissance Orbiter has been studying the moon for nearly seven years — finding evidence of water ice and mapping craters.
Blackline Master 2

How a Galápagos bird got tiny wings PAGE 11

Broken cellular antennae may explain why Galápagos cormorants have stunted wings too small for flight, a new study suggests.
Blackline Master 3

Mitochondria go missing in microbe PAGE 14

Scientists have identified a eukaryote that appears to defy textbook biology by living without mitochondria.
Blackline Master 4

Nano for the heart PAGE 22

Scientists are designing minuscule particles to target clogged arteries, clearing a path for smoother blood flow.
Blackline Master 5

This guide can be used across a wide range of curricula with a focus on **earth sciences**, **space sciences**, **biology** and **health** and can be used to support the following education standards:

Next Generation Science	Common Core
From Molecules to Organisms: Structures and Processes: HS-LS1-1, HS-LS1-2	ELA Standards: Reading Informational Text (RI): 1, 2, 4
Heredity: Inheritance and Variation of Traits: HS-LS3-2, HS-LS3-3	ELA Standards: Writing (W): 2, 4, 9
Biological Evolution: Unity and Diversity: HS-LS4-2, HS-LS4-4	ELA Standards: Speaking and Listening (SL): 1, 4
Earth's Place in the Universe: HS-ESS1-6	ELA Standards: Language (L): 1, 2, 4
Engineering Design: HS-ETS1-3	ELA Standards: Reading for Literacy in Science and Technical Subjects (RST): 1, 2, 4, 5, 6
	ELA Standards: Writing Literacy in History/Social Studies and Science and Technical Subjects (WHST): 1, 2, 4, 6, 9

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Space dreams get real

Comprehend

1. **What has Kate Rubins learned to do in preparation for her trip to space?** *(Fly a jet, speak Russian, conduct a spacewalk and fix the International Space Station's toilet, for example.)*
2. **In what way will Rubins be an experimental subject?** *(Her bones will be tested before and after the mission to document the effects of living in space on the human body.)*
3. **Why, according to the article, is it useful to understand how fluids move in space?** *(It will help NASA plan for explorations of Mars.)*

Analyze

1. **Why is Kate Rubins, a U.S. researcher, traveling to the International Space Station on a Russian spacecraft?** *(Since the retirement of NASA's space shuttles, the Russian Federal Space Agency and its Soyuz rockets offer the only way to get astronauts to and from the International Space Station.)*
2. **In what way will Kate Rubins be the "hands, eyes and ears" of other scientists?** *(Rubins has her own lab and research agenda at the Whitehead Institute, but as a scientist at the I.S.S. she will be carrying out about 100 experiments that explore many different scientific areas. She will run the tests and collect the data that will benefit other scientists in other fields.)*
3. **Why might bone cells in a lab dish behave differently in space than on Earth?** *(Answers will vary, but students should point to the different environmental conditions in space. Earth's gravity has less of an effect in space, which may influence how the cells grow and respond to stimuli. Fluids flow differently, which may affect how materials flow into and out of cells. Day and night on the International Space Station are different from day and night on Earth, which could influence a cell's behavior.)*

Discuss

1. In seventh grade, Kate Rubins wanted to be an astronaut. By high school, however, she concluded that it "wasn't a realistic job." Why do you think Rubins came to this conclusion? Were these reasons valid? What is required to be an astronaut? Does anyone in the class want to be an astronaut? Why? What obstacles will they have to overcome to pursue this career path?
2. Imagine what life would be like for someone living at the International Space Station. How would life be different from here on Earth? Encourage students to brainstorm how the environment would affect their bodies and their daily routine, but also their social lives and family relationships.

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Analyze

1. **Why is Kate Rubins, a U.S. researcher, traveling to the International Space Station on a Russian spacecraft?**

2. **In what way will Kate Rubins be the "hands, eyes and ears" of other scientists?**

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Aging moon mission still going strong

Comprehend

1. **What is the main topic of the story?** *(The Lunar Reconnaissance Orbiter has been studying the moon for nearly seven years and continues to collect interesting data.)*
2. **What discovery surprised mission scientists?** *(The discovery of water ice under soil that sits in direct sunlight.)*
3. **What is the orbiter's "laser altimeter"?** *(The laser altimeter is a beam of light that scans and maps the surface of the moon.)*

Analyze

1. **How does studying the moon help researchers understand Earth's past?** *(The moon's craters provide a history of the objects that were pummeling our region of the solar system. Similar signatures have been wiped away on Earth because of weather and geologic forces.)*
2. **Why was it surprising that not all evidence of water was found in the shadows?** *(Scientists had suspected that water ice could endure for billions of years in shadowed areas that were incredibly cold, but it is surprising to find water ice under soil that sits in direct sunlight where it could have evaporated into space.)*
3. **What can you observe from the map that appears in the article?** *(The moon's south pole has many craters. The moon's surface appears much more cratered than Earth's surface. Some craters are in shadows and some are not. The craters vary greatly in size. Some craters have smoother sides, appearing newer than others.)*

Discuss

1. NASA's Lunar Reconnaissance Orbiter launched in 2009. Ask students to think about what has happened in the world since the launch. How might our knowledge be different today than it was in 2009? How has technology changed? What might be different about the mission if the spacecraft was designed and launched today? Encourage students to relate this to other missions that have to travel even farther to reach their destinations, such as the New Horizons mission to Pluto (see "A world like no other comes into view" along with the accompanying educator guide).

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How a Galápagos bird got tiny wings

Comprehend

1. **What, according to the article, is responsible for Galápagos cormorants' small wings?** *(There are two parts to this answer: Students might point to genetic changes or broken primary cilia, or a fuller answer would be that the genetic changes lead to broken primary cilia.)*
2. **Why did the researchers compare the DNA of the flightless cormorants to close relatives that can fly?** *(Comparing the DNA allowed the researchers to look for differences in genes that might be linked to the inability to fly.)*
3. **Why do the researchers think the gene *CUX1* can no longer do its job well in flightless cormorants?** *(Because the protein it produces has lost four of its amino acids, which are the building blocks of proteins. Also, a defective form shrinks wings in chickens.)*

Analyze

1. **What role did computers play in the research described in this article?** *(The scientists relied on computers to narrow their search to the most relevant data. Information on 23,000 gene differences would be overwhelming, but the computer programs were able to sort that data to find the patterns and their relevance.)*
2. **Why is it interesting to study the genetic changes behind the cormorants' small wings?** *(Studying the genetic changes offers a window into the birds' evolutionary past. Finding the genes responsible also offer clues to the mechanism or biological signals responsible for the change. Understanding the genes involved in this wing change can offer clues to wing evolution and development more broadly.)*

Discuss

1. The research described in this article combined many lines of evidence to reach its conclusions — including genetic analyses, functional investigations, studies of birds, knowledge from humans, and experiments with cells in lab dishes. Ask students to list the types of data gathered. Why is gathering multiple types of data in different ways important in science? How did the scientists use their data to build a case that dysfunctional primary cilia were involved in cormorant flightlessness? Ask students to consider the strengths and weaknesses of the scientists' argument. What additional data might they want scientists to investigate?

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Mitochondria go missing in microbe

Comprehend

1. **What is surprising about the gut microbe discussed in the article?** *(Even though it is a eukaryote, a complex cell with organelles, it appears to lack any signs of mitochondria.)*
2. **How might the cell survive without mitochondria?** (*The research suggests that the gut microbe steals genetic material from bacteria, which also survive without mitochondria.)*
3. **What does the finding reveal about the function of mitochondria?** (*The finding supports the idea that mitochondria don't have a single function, contrary to textbooks, which often call them the cell's "powerhouses.")*

Analyze

1. **Why are mitochondria generally considered necessary for complex life?** *(Because they have been found in almost all complex cells, and in particular in life that is most familiar to us — life that thrives on oxygen. Also, they generally supply energy for cells.)*
2. **A study coauthor says that the microbe appears to have "done away" with mitochondria. What can you infer from this statement?** *(The study coauthor thinks that the ancestors of this microbe had mitochondria. Most likely, then, the mitochondria were lost over time because they were no longer favored by natural selection.)*

Discuss

1. Ask students to think about the nature of biology as it relates to this finding. What can they infer about biology or biological organisms? Encourage students to think broadly. Like other sciences, for example, the field of biology depends on patterns. Researchers identify these patterns and come up with basic rules for how things behave and function. But biology is also messy, and often there are exceptions to rules. Students might discuss the nature of evolution — that it doesn't have any plan nor work toward some end goal but instead is an emergent phenomena. Students might talk about how organisms are flexible: The same feature might be co-opted for multiple roles, or one role might be filled by multiple features. Ask students to categorize and evaluate their inferences. Do the issues they have discussed make studying biology harder or easier? More challenging or more interesting? How does the nature of the field affect how scientists do their work?

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Nano for the heart

Comprehend

1. **How do atherosclerotic plaques cause heart attacks?** *(If plaques grow large enough or pieces chip off, they can block blood flow. Blocking blood flow can lead to stroke or heart attack.)*
2. **How do statins work?** *(They lower the amount of cholesterol in the blood to slow the growth of plaques.)*
3. **What is the distinction between a macrophage and a foam cell?** *(A foam cell is a macrophage that has become swollen with fats.)*

Analyze

1. **Name a few things that nanoparticles might carry in the body.** *(Drugs to block inflammation or break apart plaques, dyes to track the particles' movements, tags to locate plaques in the blood vessels.)*
2. **Describe a nanoparticle that is activated by a physical rather than chemical stimuli.** *(The approach by the Wyss Institute used particles that release a drug when they enter a part of a vessel that is narrowed. They are activated by differences in pressure, which is a physical change.)*
3. **Why haven't nanoparticles for the heart been tested in humans?** *(This is a new class of medicines and testing is still being conducted in animals. When new drugs are developed, they have to go through the proper safety and efficacy testing before they can be tested in human trials.)*

Discuss

1. Ask students to research causes and risk factors associated with atherosclerosis. Consider having them categorize the risk factors into factors that they can and can't control. What actions or choices can someone take throughout life to prevent atherosclerosis? Will those actions ensure that a person doesn't get the disease? Why or why not? Encourage students to think about how to make healthy choices in their lives and discuss the concept of preventative medicine.
2. The term "nanoparticle" applies to any material that is at the nanometer scale, billionths of a meter. Encourage students to think of other contexts in which they have heard the term "nanoparticle." Nanoparticles, for example, appear in sunscreens and beauty products. They are often used in scratch-proof eyeglasses or crack-resistant paints. Nanoparticles are also talked about in the context of pollution (nanoparticle aerosols, for example). And then there are a whole range of medical uses, beyond treating atherosclerosis. Encourage students to think about these various uses as they relate to the debate over whether nanoparticles are safe. Is it possible to talk about the risks and benefits of nanoparticles as a whole, or is it necessary to explore specific products and applications?

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