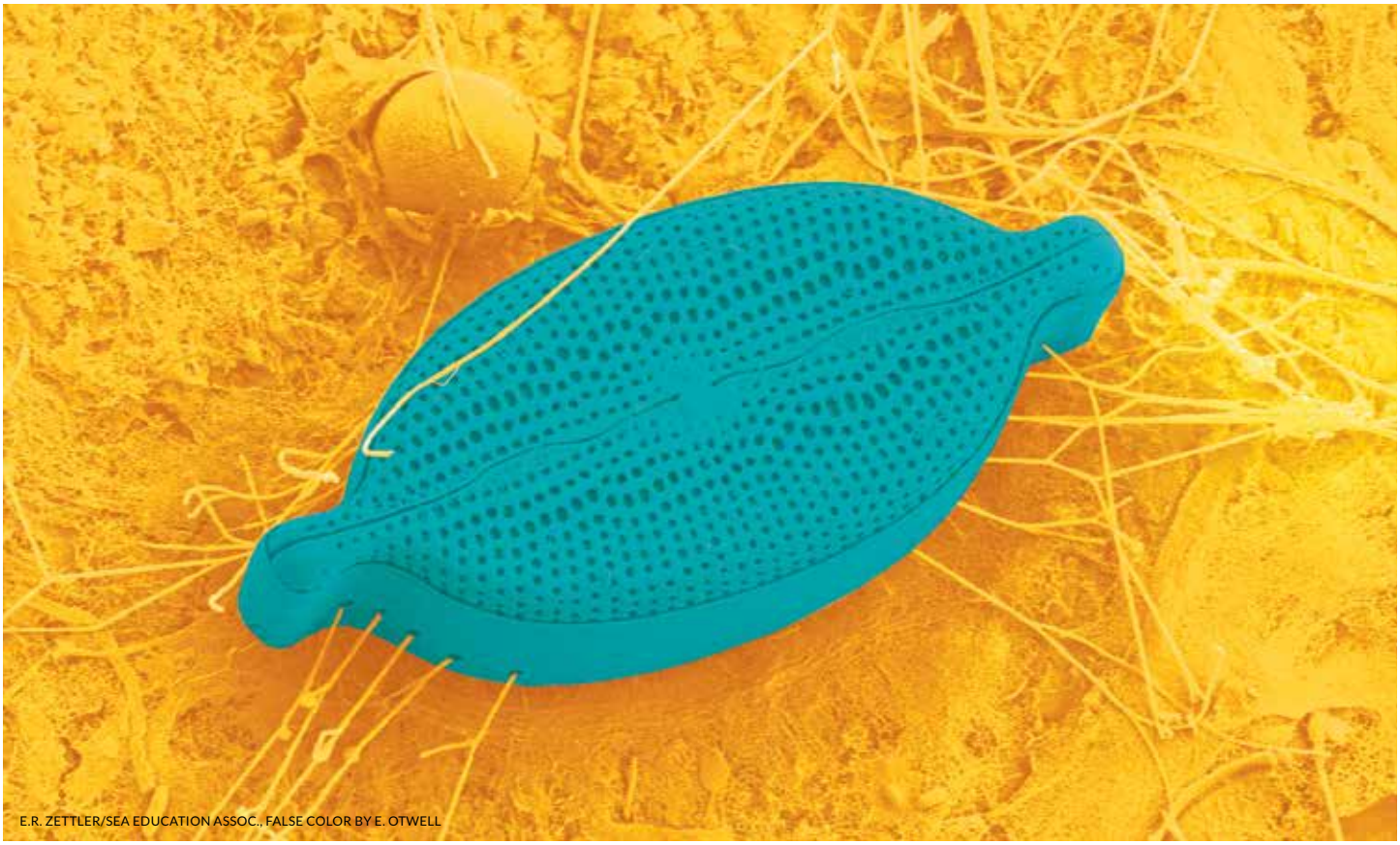
ScienceNews

IN HIGH SCHOOLS | EDUCATOR GUIDE



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FEBRUARY 20, 2016 ISSUE

SOCIETY FOR
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EDUCATOR GUIDE

FEBRUARY 20, 2016 ISSUE

About the Guide

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

Hunt for Planet Nine heats up PAGE 6
A giant planet might lurk somewhere beyond Neptune. Though no one has discovered it yet, the orbits of six icy objects, along with computer simulations, add evidence for its existence.
Blackline Master 1

Massacre hints at early origin of war PAGE 9
Skeletons unearthed in East Africa suggest that some 10,000 years ago, ancient hunter-gatherers carried out deadly group raids.
Blackline Master 2

Signs of food allergies seen at birth PAGE 13
Babies born with overactive versions of immune cells known as monocytes may be more likely to have food allergies later in life.
Blackline Master 3

Rapid spread of Zika virus raises alarm PAGE 16
A mosquito-borne virus spreading across South and Central America has been linked to a birth defect that leaves babies with abnormally small heads.
Blackline Master 4

Floating fortress of microbes PAGE 20
Plastic pollution floating in the ocean makes a suitable home for microbes, creating a new ecosystem known as the "plastisphere."
Blackline Master 5

This guide can be used across a wide range of curricula, with a focus on **biology** and **earth science** and with connections to **health** and **history**. It can be used to support the following education standards:

Next Generation Science	Common Core
From Molecules to Organisms: Structure and Processes: HS-LS1-3	ELA Standards: Reading Informational Text (R1): 1, 2
Ecosystems: Interactions, Energy and Dynamics: HS-LS2-1, HS-LS2-2, HS-LS2-3, HS-LS2-6, HS-LS2-7	ELA Standards: Writing (W): 1, 2, 7, 9
Biological Evolution: Unity and Diversity: HS-LS4-5, HS-LS4-6	ELA Standards: Speaking and Listening (SL): 1, 3, 4
Earth's Place in the Universe: HS-ESS1-4	ELA Standards: Language (L): 1, 4, 6
Earth and Human Activity: HS-ESS3-4	ELA Standards: Reading for Literacy in History/Social Studies (RH): 1, 2, 3, 4
	ELA Standards: Reading for Literacy in Science and Technical Subjects (RST): 1, 2, 4, 9
	ELA Standards: Writing Literacy in History/Social Studies and Science and Technical Subjects (WHST): 2, 4, 5, 9

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Hunt for Planet Nine heats up

Comprehend

After reading the article "Hunt for Planet Nine heats up," answer these questions:

1. **What are some predictions scientists have made about Planet Nine?**

2. **What is the Kuiper belt? What role does it play in the prediction of Planet Nine?**

3. **How does the prediction of Planet Nine compare to earlier predictions about the existence of Neptune?**

Analyze

1. **Create a timeline based on information mentioned in the story. Be sure to include an entry for the most recent finding (2016). Based on this timeline and the details of the story, when do you think Planet Nine may be found? Defend your prediction, or explain why making an accurate prediction is so difficult.**

2. **The alignments of the orbits of six Kuiper belt objects add evidence for the existence of Planet Nine. Planetary scientist Renu Malhotra compares the alignments to "pencils scattered around a desktop" that are all pointing in the same direction. Can you come up with another metaphor to convey the likelihood of these alignments?**

3. **Why would scientists want to use a ground-based telescope (Victor Blanco Telescope, Subaru Telescope or LSST, for example) rather than a space-based telescope to search for Planet Nine?**

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Hunt for Planet Nine heats up

Answer Key

Comprehend

1. **What are some predictions scientists have made about Planet Nine?** *First of all, they predict it exists. But, more specifically, they predict it would be roughly 10 times as massive as Earth. It would come no closer to the sun than 200 times the distance between the sun and the Earth. It would have originated closer to the sun but then been kicked farther away because of gravitational interactions among it and the other planets.*

2. **What is the Kuiper belt? What role does it play in the prediction of Planet Nine?** *The Kuiper belt is a ring of frozen bodies circling the sun out where Pluto lives. It is the orbital alignments of some of these bodies that suggest there's an unknown force helping to hold the bodies in place.*

3. **How does the prediction of Planet Nine compare to earlier predictions about the existence of Neptune?** *In both cases, scientists have predicted a planet's existing using calculations before the planet is found with observations. But the existence of Neptune was much clearer based on the speedup and slowdown of Uranus' orbit. The existence of Planet Nine relies on more nuanced inferences.*

Analyze

1. **Create a timeline based on information mentioned in the story. Be sure to include an entry for the most recent finding (2016). Based on this timeline and the details of the story, when do you think Planet Nine may be found? Defend your prediction, or explain why making an accurate prediction is so difficult.** *1846: Neptune is found. 2014: First hints of Planet Nine. 2016: Additional evidence for Planet Nine comes to light. 2023: Large Synoptic Survey Telescope comes online. There is no correct answer for when Planet Nine will be found, but educators should look for students to support their predictions with details and examples. Plenty of uncertainty exists in the timing of discovery: A discovery from archival data depends on how likely Planet Nine is to be there in the first place, and how many people are looking. Discovery with a telescope depends on the size of Planet Nine, how quickly it orbits and where it is in its orbit. There's also a lot of luck: Gravitational waves were discovered as soon as Advanced LIGO came online, but other big scientific projects have had to wait awhile to see their signal.*

2. **The alignments of the orbits of six Kuiper belt objects add evidence for the existence of Planet Nine. Planetary scientist Renu Malhotra compares the alignments to "pencils scattered around a desktop" that are all pointing in the same direction. Can you come up with another metaphor to convey the likelihood of these alignments?** *Answers will vary, but students should be encouraged to be creative and specific. One example: It's like flipping a coin over and over again and always getting heads. It's like opening your drier to find your clothes folded. And so on.*

3. **Why would scientists want to use a ground-based telescope (Victor Blanco Telescope, Subaru Telescope or LSST, for example) rather than a space-based telescope to search for Planet Nine?** *The ground-based telescopes mentioned have wide fields of view, making it easier to find on object with an uncertain location. They are also large (because they don't have to be launched into space), making it easier to see faint objects. There are also more ground-based telescopes available, so it is often easier to get observing time. Researchers can even piggyback on existing programs.*

Discussion

1. Encourage your students to think about how our understanding of the solar system has changed over millennia, from ancient times when scientists and naturalists thought the Earth was the center of the solar system, to the discovery of Uranus, Neptune and Pluto and then the Kuiper belt. Now we believe that there might be a hundred or many more dwarf planets in the solar system. Introduce or revisit the idea of the heliosphere, which is the bubble around the sun created by the solar wind. It extends 100 times the distance from the sun to the Earth. You might note that the gravitational influence of the sun continues well past the heliosphere. The Oort cloud, for example, is loosely bound to our planetary system. If it does exist, Planet Nine's orbit would be outside the heliosphere. Ask students how they would define the solar system? How big is it? What is included and what is excluded? Is there a clear boundary? To support the discussion, consider asking students to briefly research Voyager I, a probe that reportedly left the solar system in 2013, though some researchers think that announcement was premature. *Science News* has a collection of stories devoted to this probe available online at this link.

2. "Hunt for Planet Nine heats up" highlights the gap between theoretical prediction and direct detection. Ask students if they know the difference between the two. Why is one type of conclusion stronger than the other? Despite their weaknesses, why are theoretical predictions important in science? Can the students think of examples where theoretical predictions have helped scientists find more direct evidence? *(The discovery of Neptune is mentioned in the story, but another great recent example is the detection of gravitational waves.)* You might ask students to apply the distinction to their own lives. What do they know to be true about their family, friends or the world around them because they have observed it directly? What do they merely believe to be true though they don't have direct evidence?

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Massacre hints at early origin of war

Comprehend

After reading the article "Massacre hints at early origin of war," answer these questions:

1. **What is the main finding highlighted in the story?**

2. **What evidence supports this finding?**

3. **Does the evidence settle the debate over when war originated? Why or why not?**

Analyze

1. **The story mentions the concept of "group identity"? From context clues, what do you think this term means?**

2. **What series of events might have led one group of nomadic peoples to attack another group at Nataruk?**

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Massacre hints at early origin of war

Answer Key

Comprehend

1. **What is the main finding highlighted in the story?** *Ancient hunter-gatherers were capable of deadly group raids OR an ancient group of hunter-gatherers killed 12 members of another group in a planned assault some 10,000 years ago.*
2. **What evidence supports this finding?** *Excavations show 10 of 12 skeletons at one location with signs of lethal wounds. Several have what appear to be arrow wounds; several were hit with clubs. Clubs of at least two sizes were used, suggesting multiple attackers. Obsidian points, not commonly found in this area, were used, suggesting the attackers came from somewhere else.*
3. **Does the evidence settle the debate over when war originated? Why or why not?** *It adds to the debate, but it does not settle it definitively. It is hard to draw broad conclusions from just one example. Also, scientists have pieced together the story of what happened at Nataruk, but they can't be entirely sure if all the details are correct.*

Analyze

1. **The story mentions the concept of "group identity"? From context clues, what do you think this term means?** *Group identity is the shared sense of belonging and even loyalty to a group. It might include the particular customs and habits shared by the group, as well as the world view, language and values. Group identity is the sum of the defining characteristics that make one group of people different from another. Group identity might affect how individuals see themselves and how they behave.*
2. **What series of events might have led one group of nomadic people to attack another group at Nataruk?** *First, hunter-gatherers established long-term camps and then, thanks to an abundance of food and water, populations grew. But this growth might have overshot the resources available, leading to competition. Competition can lead to conflict between groups as well as intergroup conflict. When there are limited resources, everyone wants to make sure they get their share.*

Discussion

1. The article mentions the concept of "group identity." Ask students what group or groups they belong to? What are the defining characteristics of this group? Is it possible to define their group by describing it alone, or is it necessary to draw a comparison with other groups? You can encourage students to think of themselves as members of the larger group of humanity, but also as members of a country, a state, a school, a family and a club. Do they feel more kinship with members in their group than with outsiders? Why or why not? Does this kinship affect their behavior?
   Next, ask students to put themselves in someone else's group, and consider the world from the perspective of members of that new group. Perspective shifts can be a challenging and eye-opening experience for students. How would this new membership affect their behavior? What would they do differently in their daily lives? How would they see themselves differently? How would it affect their interactions with others? Encourage students to explore, from this unfamiliar perspective, the role of group membership in sociopolitical and geopolitical disputes.
2. People tend to represent hunter-gatherers as peaceful and at one with nature, but this article suggests that they too are capable of violence. Ask your students to consider what it means to be human, as it relates to this article: Is competition inevitable in human society? What about conflict? What about war? Is violence learned? Or, are humans innately violent? Encourage students to use specific examples to argue one way or the other. After the initial discussion, ask students if the arguments they have heard change the way they understand the world. Can a society ever hope to end violence? Does the discussion inform how a society might try to prevent it, or react to it? Should it inform how we treat people who have committed violent crimes?

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Signs of food allergies seen at birth

Comprehend

After reading the article "Signs of food allergies seen at birth," answer these questions:

1. **If there are 75 million children in the United States, how many of them have allergies to foods such as milk, eggs, peanuts and shellfish?**

2. **Use words and arrows to create a diagram showing the series of events that scientists believe led to allergies in babies in the study described in the story.**

3. **Why is the finding that a strong immune response in babies led to allergies contrary to existing beliefs?**

Analyze

1. **The Barwon Infant Study collects stool, blood and urine samples from infants, as well as data on lung function, heart function and behavioral and cognitive abilities. The study also looks at environmental exposure to toxins. Based on this data, what other questions might scientists use the Barwon Infant Study to investigate?**

2. **Based on the information in the article, what are three things you can infer about the immune system?**

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Signs of food allergies seen at birth

Answer Key

Comprehend

1. **If there are 75 million children in the United States, how many of them have allergies to foods such as milks, eggs, peanuts and shellfish?** *Three million to 4.5 million, based on multiplying 75 million by .04 and .06.*

2. **Use words and arrows to create a diagram showing the series of events that scientists believe led to allergies in babies in the study described in the story.**
   Overactive monocytes → More cytokines → T cells become allergy provoking
   → T cells don't make IL2 → More allergy inducers

3. **Why is the finding that a strong immune response in babies led to allergies contrary to existing beliefs?** *Usually a strong inflammatory reaction in babies is associated with a healthy immune response not with the development of allergies.*

Analyze

1. **The Barwon Infant Study collects stool, blood and urine samples from infants, as well as data on lung function, heart function and behavioral and cognitive abilities. The study also looks at environmental exposure to toxins. Based on this data, what other questions might scientists use the Barwon Infant Study to investigate?** *Answers will vary but students might highlight that scientists can study the role of early exposure to toxins in later development, including cognitive development. They might also ask how lung development is related to heart development. Students might be aware of the microbiome research that can be studied using fecal samples. Scientists could, for example, explore how a baby's mix of microbes influences weight gain and digestive health later in life.*

2. **Based on the information in the article, what are three things you can infer about the immune system?** *Answers will vary, but some examples include: A baby's immune system is greatly influenced by mom's immune system. Each person's immune system is slightly different, reacting to the environment in different ways. The immune system is complex, with many cellular players. The basis for the immune system is set early in life. The immune system is important in keeping us healthy. The immune system has to be trained.*

Discussion

1. Ask students if they know someone with a food allergy? What is the allergy? How does the person's body react to the allergy? Has the person had the allergy for their entire lives, or did it develop as they aged? Ask students to consider what precautions a person with a severe allergy has to take daily to stay healthy. What precautions do friends and family take when they are around a person with an allergy?

2. Some schools have banned peanut butter and other peanut-related products because of the increasing number of students with peanut allergies. Has your school instituted any bans or limitations? Do students think it should — why or why not? This is a good way to explore the freedom of many versus the needs of a few. Ask students to consider at what point such a ban would become appropriate, if ever. Does it depend on the number of students with the allergy and/or the severity of the allergy? Would students consider such a ban fair? Would it impinge on their freedom? Are fairness and freedom the most important factors, or does safety rank higher? As a way to explore the negative consequences of the ban, ask students to consider why peanut butter is so popular in schools. (*Peanut butter, for example, is a cheap alternative to sandwiches with cold cuts. It is appropriate for people who don't eat meat. It is also easy to carry and store because it doesn't require refrigeration.)* Ask students to think of other examples in life where the needs of a subset of the population affect the lives of the majority of the population.

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Rapid spread of Zika virus raises alarm

Comprehend

After reading the article "Rapid spread of Zika virus raises alarm," answer these questions:

1. **Make a list of viruses mentioned in the article. Put a star next to the ones that are spread by insects.**

2. **Which was the first country in the Americas to have a Zika outbreak?**

3. **Why do scientists think Zika might be a cause of microcephaly?**

Analyze

1. **Look at the map titled "Zika's potential risk." Based on the number of travelers from at-risk regions and the risk of local transmission, which cities do you think are at the greatest risk of a Zika outbreak? Defend your decision.**

2. **Near the end of the story, the author mentions that Brazil is already working on projects that would release mosquitoes that can't reproduce into the wild. How would this curb the spread of Zika?**

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Rapid spread of Zika virus raises alarm

Answer Key

Comprehend

1. **Make a list of viruses mentioned in the article. Put a star next to the ones that are spread by insects.** *Dengue*, West Nile*, chikungunya*, Zika*, yellow fever*, Ebola.*
2. **Which was the first country in the Americas to have a Zika outbreak?** *Brazil.*
3. **Why do scientists think Zika might be a cause of microcephaly?** *The cases of microcephaly in Brazil appear to have increased dramatically just as Zika arrived in the country. Genetic traces of Zika have also been found in the amniotic fluid of pregnant women carrying babies with the birth defect. The virus is also known to break down nerve cells and brain tissue in mice and might be the cause of neurological problems seen in some infected adults.*

Analyze

1. **Look at the map titled "Zika's potential risk." Based on the number of travelers from at-risk regions and the risk of local transmission, which cities do you think are at the greatest risk of a Zika outbreak? Defend your decision.** *Answers will vary, but cities might include: Orlando and Miami, which both have a lot of travelers from Brazil and year-round transmission risks. Year-round transmission puts these cities at a greater risk than places with only seasonal transmission. Students might also mention New York City and Buenos Aires, which have only seasonal risk of transmission but also a lot of travelers from Brazil.*
2. **Near the end of the story, the author mentions that Brazil is already working on projects that would release mosquitoes that can't reproduce into the wild. How would this curb the spread of Zika?** *Releasing mosquitoes that can't reproduce would help cut the mosquito population, giving the Zika virus fewer opportunities to spread. In this strategy, healthy mosquitoes would mate with engineered mosquitoes that can't produce offspring. These matings would not lead to any new mosquitoes. The idea is the unsuccessful matings would swamp the successful ones and drive mosquito numbers down. For more on using mosquitoes to curb disease transmission, check out the recent article and educator guide on gene drives.*

Discussion

1. After reading and discussing the article, predict what will happen next in the Zika outbreak. Do students think Zika will be identified as a cause of microcephaly? If so, what kind of evidence would be required? What data would be most convincing? Do students think scientists will look for and find other potential causes? Students can do additional research on Zika news coverage at www.sciencenews.org to see if their predictions play out.
2. As the Zika virus spreads, some governments have suggested that women avoid getting pregnant until 2018. Do students think this is an appropriate precautionary step? Why or why not? Next, ask them to explore whether this is feasible advice. Why are or why not? They might consider the role of women in these countries. How much control do women have over their reproductive choices? How do social, cultural, religious and economic factors come into play?
3. Ask students to pretend that they are designing a public service announcement to inform people about the spread of Zika. What information would they include? What would they leave out? How would they convey the information without causing widespread panic? Use this opportunity to explore the importance of communication that is both accurate and sensitive. Will the student PSAs make an argument or be more explanatory? Will they try to dispel any false information or focus only on conveying known facts? Will they appeal more to emotion or reason? Will they suggest any specific actions?

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Floating fortress of microbes

Comprehend

After reading the article "Floating fortress of microbes," answer these questions:

1. **Why do plastics provide a good environment for microbes?**

2. **Name two potential consequences of the plastisphere that would be negative for the environment?**

Analyze

1. **Look at the maps on Page 21, titled "Plastic waves." Why do you think some areas of the ocean have more garbage than other areas?**

2. **Study the Venn diagram on Page 22, titled "Different neighborhoods." What percentage of all microbe species found are only found on plastics? Come up with two hypotheses for where these microbes originate.**

3. **Why is the plastisphere considered a new ecosystem?**

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Floating fortress of microbes

Answer Key

Comprehend

1. **Why do plastics provide a good environment for microbes?** *The microbes latch onto the plastic pieces as a floating home, and plastics also concentrate nutrients from the water, which attach to the hard surface. It's like a buffet for microbes.*

2. **Name two potential consequences of the plastisphere that would be negative for the environment?** *Other organisms might be more likely to eat these plastics, which work their way up the food chain. Plastics can destabilize feces, keeping the feces from reaching the ocean floor intact, where it would store away carbon dioxide. Because plastics can travel so far, they might move disease-causing microorganisms from one ecosystem to another.*

Analyze

1. **Look at the maps on Page 21, titled "Plastic waves." Why do you think some areas of the ocean have more garbage than other areas?** *Answers will vary, but students should point to circulation patterns. Plastic and other trash tends to move with ocean currents and get caught in gyres, areas where ocean currents rotate. Students might also point out that plastic waste accumulates off the coast of countries with large populations and nearby cities — off the eastern coast of North America for example, and to the south and east of Asian nations including China and Japan.*

2. **Study the Venn diagram on Page 22, titled "Different neighborhoods." What percentage of all microbe species found are only found on plastics? Come up with two hypotheses for where these microbes originate.** *Students should add up the number of microbes found only on plastics (799+297+413=1509), and then divide by the total number of microbes (1509+117+53+16+1789=3484). This gives 0.43 or 43 percent. Scientists aren't sure where these plastic-specific microbes come from, but hypotheses might include: They are microbes that resided on the plastic before it entered the water. These microbes are found only on solid surfaces, such as the sea floor or boat wreckage, but not in the water column itself. These microbes originate in the seawater but they congregate around the plastics over time. These microbes might be new species that evolved from seawater microbes.*

3. **Why is the plastisphere considered a new ecosystem?** *Answers will vary, but students should note that the plastics collect nutrients for microbes to feed on. Often the plastics contain many types of microbes that rely on those nutrients and each other in different ways. The mix of microbes varies depending on the water and where the plastic originated. The makeup also changes with the seasons.*

Discussion

1. Have students brainstorm a list of the plastic products they use. Based on their answers, ask them to estimate their plastic usage per week (in mass or volume units). What about per year? They can work independently or calculate the plastic waste as a class. How much of that plastic is reused? Recycled? How much ends up in a landfill? Do they think any of their waste makes it into the ocean? Why or why not? This blog from Columbia University's Earth Institute might provide some useful stats as students think about these questions. Once students have explored their own usage, ask them to brainstorm ways to curb their usage.

2. Ask students to consider the approach for cleaning up ocean plastics proposed by Dutch inventor Boyan Slat. What are the benefits of this approach? What are the potential difficulties? Do students think the approach will work? Can they think of alternative approaches that might complement Slat's effort, or improve on it? Ask students to come up with their own ocean-cleaning effort. It can be local or global, machine-driven or human-powered. Students should critique one another's ideas in a friendly and productive way.