

## An Unwelcome Newcomer

*This article is provided courtesy of the American Museum of Natural History.*

### Invasion of the Zebra Mussels

The zebra mussel is a small aquatic animal with two shells like a clam, named for its striped shell. This tiny creature may look harmless, but it can cause big problems. The zebra mussel is an invasive species, a species that's brought from its native area to a new place where it thrives and causes changes in the local habitats and communities.

Zebra mussels once lived only in freshwater lakes and rivers of Europe and Asia. But in the 1980s, they appeared in the Great Lakes between the United States and Canada. Scientists think the tiny animals were carried across the ocean inside of cargo ships. Within a few years, the mussels were found along waterways from Wisconsin to Arkansas.

How do these mussels spread so quickly? A single female can lay up to one million eggs each year. Then the young mussels float easily along water currents. When they're older, they attach themselves to hard surfaces like rocks on the riverbeds and the bottom of boats. They form dense colonies, with as many as 10,000 mussels in a single square foot. Each mussel clings with a mass of thread-like strands, making these colonies nearly impossible to remove.



#### **ZOOM IN**

*Zebra mussels pump water through their gills to filter out particles of food (primarily phytoplankton).*



*A ship passing under a bridge on the Hudson.*

Zebra mussels can cling to any hard surface—including native mussels and other shelled animals. These animals die because they can't feed. Zebra mussels can upset food webs in other ways, too. These filter feeders pump water through their gills and strain out microscopic organisms called plankton. Zebra mussels can quickly clear out huge bodies of water, removing food for the native invertebrates and small fish.



### **STICK TO IT**

*Zebra mussels have tiny tentacle-like appendages called “byssal threads” that are coated in a sticky foam that help the mussel stick to almost any hard surface!*

Zebra mussels can also affect humans — and cause millions of dollars in damage. The mussels clog water pipes to businesses and power plants. They damage boats, docks, buoys, and other structures. And their shells wash up in huge numbers on beaches.

### **JUST THE FACTS...**



*Zebra mussels usually grow to about the size of your thumbnail.*



*Cargo ships carry extra water (called ballast) to help balance the boat in oceans and rivers. Zebra mussels can be transported in this ballast water.*



*Zebra mussels can typically live for 2-5 years and start reproducing by their second year.*



*Zebra mussels love to eat plankton (microscopic organisms) and survive in both cold and warm water.*

### **The Hudson River Invasion**

The Hudson River flows south through New York State, from the mountains to New York City. The scientists described in this study began monitoring the river's ecosystem in 1986. At that time, no zebra mussels lived in the river. But a series of waterways and canals connect the river to the Great Lakes, so scientists predicted it was just a matter of time before the zebra mussel would arrive in the Hudson.

The Hudson River's ecosystem is very different from the Great Lakes. Lake water settles into layers, with cool water near the bottom and warm, clear

**UP THE RIVER**

*The Hudson River connects the Atlantic Ocean to the Great Lakes through a series of artificial waterways, including the Erie Canal. Hundreds of cargo ships use this “water highway” to transport important materials, like gasoline, metal, and wood.*

water above. But water in the Hudson is affected by tides from the Atlantic Ocean. These tidal currents mix the water from top to bottom. Tides also stir up silt from the riverbed, making the water turbid or cloudy. Little sunlight can pass through the murky water. Less sunlight means fewer plants and phytoplankton.

Scientists wondered how zebra mussels might affect the Hudson River ecosystem. Soon they would find out.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What is a zebra mussel?

- A a small striped fish found in rivers and lakes
- B a small animal with two shells that lives in water
- C a large animal with one shell that lives in water
- D a large plant with striped leaves that lives in water

2. How can zebra mussels cause native mussels and other shelled animals to die?

- A The zebra mussels feed on the native mussels and other shelled animals.
- B The zebra mussels rest on top of native mussels and shelled animals and crush them.
- C The zebra mussels force native mussels and shelled animals to move out of the habitat.
- D The zebra mussels cling to native mussels and shelled animals and prevent them from eating.

3. Scientists predicted that the zebra mussel would arrive in the Hudson River. What evidence supported their prediction?

- A Zebra mussels cling to hard surfaces, forming colonies that are almost impossible to remove.
- B Zebra mussels came to the Great Lakes from the freshwater lakes of Europe and Asia.
- C Zebra mussels are able to survive in cold and warm water, and the Hudson River has both.
- D Zebra mussels were in the Great Lakes, and waterways connect the Great Lakes to the Hudson River.

4. The scientists wondered how zebra mussels might impact the Hudson River ecosystem. What is one example of information that might help them understand the zebra mussels' impact?

- A the amount of plankton in the river before and after zebra mussels arrive
- B the number of boats traveling on the river before and after zebra mussels arrive
- C the amount of time it takes for zebra mussels to travel to the Hudson River
- D the strength of the tides that come from the Atlantic Ocean after zebra mussels arrive

5. What is the main idea of this article?

- A Zebra mussels are the most dangerous invasive species because of the effects they can have on humans.
- B Zebra mussels are an invasive species that can affect food webs and new habitats, and were expected to arrive in the Hudson River.
- C Zebra mussels can upset food webs by clinging to shelled animals and removing food from large bodies of water.
- D Scientists started monitoring the Hudson River's ecosystem in 1986, even though the river had no zebra mussels at the time.

6. Read the following sentence from the text.

"The zebra mussel is an invasive species, a species that's brought from its **native area** to a new place where it thrives and causes changes in the local habitats and communities."

What does the phrase "**native area**" mean in this sentence?

- A the food source of a species
- B the animals or plants related to a species
- C the new habitat to which a species moves
- D the place where a species is naturally found

7. Choose the answer that best completes the sentence.

Zebra mussels can affect humans and cause millions of dollars in damage. \_\_\_\_\_, the mussels clog water pipes to businesses and power plants.

- A For example
- B Consequently
- C However
- D Therefore

8. What do zebra mussels feed on?

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**9.** The Hudson River has murky water, which means that only a little sunlight can pass through. How does this affect the things that live in the river?

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**10.** How might the number of fish in the Hudson River be impacted by the arrival of zebra mussels? Use evidence from the text to support your answer.

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## The Short-Term Impact of the Zebra Mussel Invasion

*This article is provided courtesy of the American Museum of Natural History.*

Zebra mussels first appeared in the Hudson River in May 1991. Within a year, scientists estimated their numbers had reached 500 billion, an enormous amount! In fact, if you had a huge balance and put zebra mussels on one side, they would outweigh all the other consumers in the ecosystem combined: all the fish, zooplankton, worms, shellfish, and bacteria.

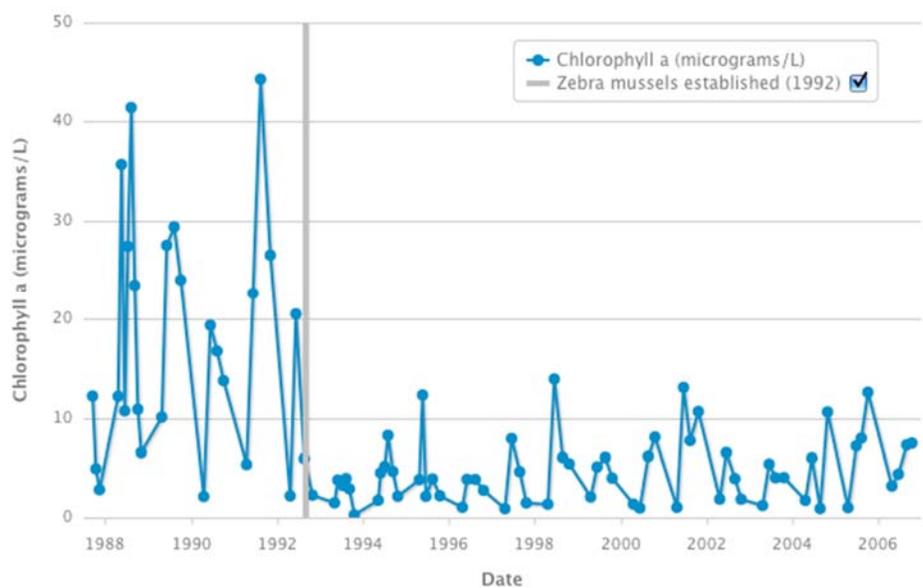


### Phytoplankton and zooplankton populations drop sharply

Before the invasion, scientists developed computer models to predict the effect of the zebra mussels. But they were still

surprised by what happened. By 1992, there were so many zebra mussels, scientists estimate they were filtering a volume of water equal to all of the water in the estuary every 1–4 days during the summer. In the years right after the invasion, phytoplankton fell by 80 percent. Zooplankton (which eat phytoplankton) declined by half. And the smallest zooplankton (called micro-zooplankton), fell by about 90 percent.

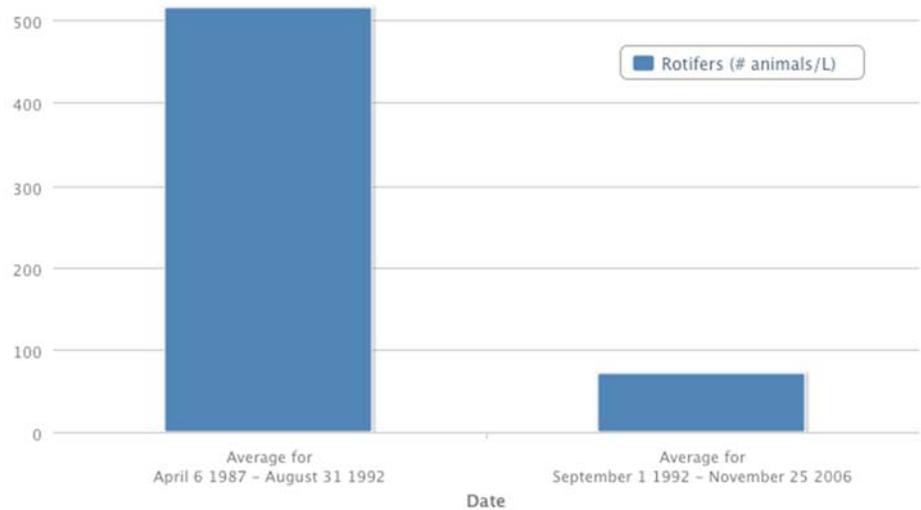
*An estuary is a dynamic body of water where freshwater and saltwater meet. The Hudson River is more than a river: it's a tidal estuary, where the saltwater from the Atlantic Ocean meets the freshwater running off the land.*



### WATCH WHAT HAPPENS

*This graph shows the change in the amount of phytoplankton (represented by the blue line) over 18 years in the Hudson River. (The amount of phytoplankton is measured by the amount of chlorophyll they contain.) Look at the gray line above: there's a big change in the blue line when the zebra mussels first arrived in the river. What do you think happened?*

By 1994, scientists hypothesized that zebra mussels were responsible for these changes. The mussels were filtering huge amounts of phytoplankton from the water. Less phytoplankton meant less food for zooplankton, so their numbers were shrinking too. Competition was taking place and the zebra mussels seemed to be winning.



#### ***A BIG CHANGE***

*This bar graph shows the change in the average number of rotifers (a type of zooplankton) in the Hudson River before and after the zebra mussels became established in 1992.*

#### **The food web changes**

In the next few years, the data supported their hypothesis. Scientists made other findings too. They observed that the decrease in phytoplankton and zooplankton had effects that rippled throughout the food web. With less food available, there were fewer — and smaller — fish in the open river. The population of native mussels, which also eat plankton, shrank from more than one billion to almost none.



#### ***ALONG THE RIVER***

*The Hudson River flows 315 miles (507 km) through New York with over 1,000 cubic feet of water passing by every second (or 600 cubic meters per second). Scientists want to understand how the river changes over time and space.*

But some populations increased — likely due to the change in the river's turbidity, or cloudiness. With far less phytoplankton, the water got clearer. During the summertime, visibility went from 3–4 to 4–8 feet. Since sunlight reached deeper into the water, rooted aquatic plants such as water celery increased by up to 40 percent. Populations of fish living in these shallow weeds increased. Another surprising result was that dissolved oxygen in the river fell by about 15 percent. The drop wasn't enough to endanger any

aquatic animals, but it was still a huge amount of oxygen. Scientists think the enormous zebra mussel populations were consuming a lot of oxygen very quickly. At the same time, the mussels were removing the phytoplankton that produce oxygen.

**Questions about the long-term impact**

What happens once an invasive species becomes established in an ecosystem? The invader's population might evolve to adapt to its new home. Or native species might evolve to better tolerate or even feed on the invader. Or other species might arrive that are more resistant to the effects of the invasion. Once scientists had a clear picture of the invasion's immediate impact, they started to wonder about long-term consequences like these.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. How many zebra mussels were there in the Hudson River within a year of their first appearance?

- A 500 billion
- B 500 million
- C 500 thousand
- D 500

2. This text explains a cause-and-effect pattern in the Hudson River ecosystem that began with the zebra mussel invasion. What effect did the zebra mussels have on the phytoplankton in the Hudson River?

- A The number of phytoplankton in the river rose by a little.
- B The number of phytoplankton in the river fell by a little.
- C The number of phytoplankton in the river rose by a lot.
- D The number of phytoplankton in the river fell by a lot.

3. Phytoplankton are one of the most important parts of the food web in the Hudson River. What evidence supports this conclusion?

- A The population of phytoplankton dropped sharply soon after zebra mussels invaded the river.
- B The decrease in phytoplankton caused a decrease in the river's zooplankton, fish, and native mussel populations.
- C The decrease in phytoplankton meant that the river's turbidity, or cloudiness, decreased.
- D Zebra mussels caused oxygen levels in the river to drop, partly by removing the phytoplankton that produce oxygen.

4. Which population was helped by the invasion of the zebra mussels?

- A phytoplankton
- B zooplankton
- C water celery
- D native mussels

5. What is the main idea of this text?

- A In the years right after the invasion, zebra mussels evolved and adapted to the Hudson River ecosystem.
- B In the years right after the invasion, zebra mussels caused a number of changes in the Hudson River ecosystem and food web.
- C In the years right after the invasion, zebra mussels did not have a major impact on the Hudson River ecosystem or food web.
- D At first, zebra mussels did not have any impact on the Hudson River ecosystem, but their impact increased over time.

6. Read these sentences from the text.

"In the years right after the invasion, phytoplankton fell by 80 percent. Zooplankton (which eat phytoplankton) **declined** by half. And the smallest zooplankton (called micro-zooplankton), fell by about 90 percent."

Based on these sentences, what does the word "**decline**" most nearly mean?

- A to drop in number
- B to fall over
- C to increase
- D to stay the same

7. Choose the answer that best completes the sentence.

With far less phytoplankton, the water got clearer. \_\_\_\_\_, rooted aquatic plants such as water celery increased by up to 40 percent.

- A In contrast
- B However
- C As a result
- D Similarly

8. What are two populations that decreased as an immediate result of the zebra mussel invasion?

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9. One direct effect of the zebra mussel invasion was a decrease in the cloudiness of the water. How did this affect species in the Hudson River ecosystem?

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10. Once scientists understood the short-term impact of the zebra mussel invasion, they started to wonder about the invasion’s long-term impact on the ecosystem. Why might the Hudson River ecosystem look different many years after the zebra mussel invasion than it did just a few years after the invasion? Use evidence from the text to support your answer.

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## A New Neighborhood Farmers Market



Across the street from a sandwich shop and a fried chicken joint, a greenmarket sprouts up every Wednesday in the Mott Haven section of the Bronx in New York City. The market is a welcome sight in an area that does not have many options for people to buy fresh fruit and vegetables.

“The lettuce is not as fresh at the grocery store; that’s why I come here,” said Jennifer Gillette as she paid for four heads of lettuce. Gillette is a vegetarian who lives in the neighborhood.

Mott Haven, a neighborhood in the South Bronx, is located in one of the poorest areas in the country. In other New York City neighborhoods greenmarkets are more common, but in the South Bronx there are not many places to buy healthy, organic food.

The summer of 2012 was the first time that the Youthmarket set up shop in this section of the Bronx, on 3rd Ave. between E. 148th and E. 149th Streets. The Youthmarket is part of a larger organization called GrowNYC, which helps make neighborhoods better by setting up farmers markets, community gardens, and recycling in the city.

Since opening in July 2012, the market has attracted a lot of attention from local residents who live in the area. Many people are excited that there is now a fresh produce market nearby.

When the wind shifts, the smell of cilantro floats across the sidewalk, calling attention to the bright red radishes, purple potatoes, and juicy plums. At the market you can also buy red and green peppers, mushrooms, squash, and apples. The food comes from nearby farms just outside the city limits.

There is one whole table just for corn, which people buy in bulk, sometimes 10 or 15 ears at a time. Corn is the most popular item. The market sells 400 to 500 pounds of produce each Wednesday.

Ryan Morningstar, who helps run the Youthmarket, said that about 12 to 18 percent of the money they make comes from government assistance like food stamps. Food stamps help people buy food if they can't afford it themselves. On its opening day, the market made \$216.50 from food stamps alone, a record high for GrowNYC Youthmarkets across the city. The Mott Haven market makes a total of around \$700 a week.

"When you bring in fresh food, people want it," said Morningstar.

The market also accepts other government food assistance, such as the Farmers' Market Nutrition Program, which allows low-income residents to get "fresh, unprepared, locally grown fruits and vegetables," explains the United States Department of Agriculture's Food and Nutrition Services website.

Greysie Johnson's four-year-old daughter loves apples and bananas, but until recently Johnson wasn't using her government checks because she didn't know what they were for. She said that she started getting the checks in the mail, but since she didn't know what they were she didn't use them.

Then she found out that the checks were like free coupons for her to buy fresh fruit and vegetables. She learned that once her daughter turns five years old, she will stop getting the checks. Johnson didn't want the money to go to waste, so she started using the checks to buy fresh vegetables and fruit for her daughter.

"It's an easier way to give her what she wants," said Johnson. When the checks stop coming, though, she said she will go back to shopping at grocery stores, where the vegetables and fruit are not as fresh and healthy.

Delphia Omborura, a hair stylist who works in the area, loves to shop at the farmers market in Mott Haven. On a Wednesday afternoon last September she bought four bushels of large red beets to juice in a blender at home. She said that beets are more expensive in a regular grocery store. Omborura had a water bottle filled with homemade beet juice in her purse.

Mamie Jackson also likes going to the farmers market. She said that she likes the fresh look of the produce at the market, which looks different from what the grocery stores sell. "I'd rather wash the dirt off a cucumber," she said. "The ones at the grocery store are sprayed with a lot of stuff to make them look shiny."

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What kinds of food can people buy at the farmers market in the Mott Haven neighborhood?

- A fried chicken and sandwiches
- B hot dogs and hamburgers
- C chicken and fish
- D fruits and vegetables

2. What does this passage describe?

- A This passage describes a grocery store where people can buy cheap organic food.
- B This passage describes a market where people can buy fresh, healthy food.
- C This passage describes a poor neighborhood in the South Bronx where it is dangerous to shop.
- D This passage describes a man who uses food stamps from the government to buy apples.

3. Government assistance encourages some people to shop at the farmers market in Mott Haven.

What evidence from the passage supports this statement?

- A Jennifer Gillette shops at the farmers market because the lettuce there is fresher than the lettuce at her grocery store.
- B Greysie Johnson uses checks from the government to buy fruit and vegetables at the farmers market.
- C Delphia Omborura buys bushels of large red beets at the farmers market to juice in a blender at home.
- D Mamie Jackson likes the fresh look of produce at the market and washes dirt off the cucumbers she buys there.

4. Based on information in the passage, what is a reason that some people shop at the farmers market in Mott Haven?

- A The fruits and vegetables at the farmers market are fresher than the fruits and vegetables at grocery stores.
- B There are not enough grocery stores in the Mott Haven neighborhood to supply the people there with all the food they need.
- C People in Mott Haven are tired of food from sandwich shops and fried chicken joints, so they are going to the farmers market instead.
- D The produce from grocery stores in the Mott Haven neighborhood is making people sick, so they are looking for new places to shop.

5. What is this passage mainly about?

- A food stamps and other government food assistance
- B a vegetarian named Jennifer Gillette who likes fresh lettuce
- C a farmers market in a neighborhood of New York City
- D the health risks of eating fruit and vegetables from grocery stores

6. Read the following sentence: "Mamie Jackson also likes going to the farmers market. She said that she likes the fresh look of the **produce** at the market, which looks different from what the grocery stores sell."

What does the word **produce** mean in the sentence above?

- A food that has been grown by farming
- B items that have been made in factories
- C meat or fish that has been cooked by a chef
- D products that are built and sold in large numbers

7. Choose the answer that best completes the sentence below.

The farmers market in Mott Haven sells several different kinds of vegetables, \_\_\_\_\_ lettuce, green pepper, and squash.

- A instead
- B consequently
- C previously
- D including

8. What is the Youthmarket?

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9. Name at least two reasons given by people in the passage for shopping at the Mott Haven farmers market instead of at a grocery store.

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10. Suppose that the Youthmarket set up a farmers market in another neighborhood where there was no farmers market before. Would people living in that neighborhood be likely to eat more fresh fruits and vegetables because of the farmers market? Explain why or why not, using evidence from the passage.

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## The Meteor



Sergei Bobunets, lead singer of a Russian rock band, had just stepped outside when the sky fell apart.

"I looked up, and suddenly the sky lit up with a bright light, and something that looked like the sun fell," Bobunets said, trying to make sense of one of the most powerful events on Earth: a meteor strike. Bobunets was standing 125 miles north of Chelyabinsk, a city in Russia which on February 15, 2013, witnessed perhaps the best-documented meteor fall in human history.

Eyewitnesses recorded the fireball with their phones and digital cameras. A European weather satellite took a photo of the meteor as it streaked through the atmosphere, and a Chinese satellite captured the meteor's vapor plume. Thousands of people saw the flash of light and felt the shock wave after the meteor crashed into Earth.

"I looked out the window and saw a huge line of smoke, like you get from a plane, but many times bigger," Sergei Serskov, an office worker in Chelyabinsk, told the BBC. "A few minutes later the window suddenly came open, and there was a huge explosion, followed by lots of little explosions. It felt like a war zone."

The meteor was not very big. It was about 57 feet long, a little longer than a normal city bus. But it was super dense, weighing about 11,000 tons—more than the Eiffel Tower. And it was moving extremely fast. Scientists estimated its speed at 41,000 miles per hour, or about 50 times the speed of sound. Its tremendous speed was the main factor in its enormous destructive power. When the meteor exploded 14 miles above the Earth it released a bright flash of light, a powerful heat wave, and a shock wave with roughly 20 to 30 times more energy than the atomic bomb detonated at Hiroshima. The explosion damaged 7,200 buildings in six cities and about 1,500 people were injured, mostly from flying glass.

“My eyes are still hurting,” an eyewitness wrote on an Internet forum soon after the impact. “Oh, my God, I thought the war had begun.”

The widespread destruction caused by the Chelyabinsk meteor gives proof to the rule of physics that the faster an object is moving, the more energy it has. A bus on the street that loses control could slam into a building and kill a few people. A bus flying through space at 50 times the speed of sound could wipe out an entire city.

The Chelyabinsk meteor is also an example of how energy moves. First there was the meteor itself, which was moving energy simply by its movement through space. As it encountered Earth’s atmosphere, the meteor ran into increased resistance from air and dust molecules, which released some of its energy in the forms of heat and light. And when it exploded, the meteor radiated its energy over the Russian sky in the forms of blinding light, piercing sound, a shock wave strong enough to collapse buildings and knock people off their feet, and continued physical motion in the form of thousands rocks falling to the ground. The only known type of energy the meteor did not give off was electricity.

While the Chelyabinsk meteor was the best-documented in history, it was not especially large or powerful as meteors go. The most destructive event in recorded history is believed to have been a meteorite that crashed into Earth above Russia’s Tunguska River in 1908. Scientists estimate the object was about 330 feet across. It flattened 80 million trees over 830 square miles of forest, and created a destructive force 1,000 times more powerful than the atomic bomb dropped over Hiroshima. The shock wave shook buildings and knocked people off their feet hundreds of miles away. For the next few nights, night skies across Europe and Asia glowed, possibly caused by sunlight bouncing off particles left by the meteor’s tail and dust raised by its impact.

Widespread casualties were avoided because the area was so thinly populated, but there were eyewitnesses to the explosion. “The sky split in two, and fire appeared high and wide over the forest,” a witness named S. Semenov told a researcher. “At that moment I became so hot that I couldn’t bear it, as if my shirt was on fire...I wanted to tear off my shirt and throw it down, but then the sky shut closed, and a strong thump sounded, and I was thrown a few meters.”

No other object visible to humans travels as fast or carries as much energy as meteors do. As the world fills with electronic cameras and sensors, we may be able to learn more about smaller meteors such as the one at Chelyabinsk before once more facing the destructive power of a mammoth meteor like the one at Tunguska.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What did Sergei Bobunets witness?

- A a meteor strike
- B a plane crash
- C the bombing of Hiroshima
- D the sun falling

2. How does the author describe the meteor strike at Chelyabinsk?

- A The meteor strike had very few witnesses and was not well documented.
- B It was the most destructive meteor strike in documented history.
- C The meteor strike created a bright flash of light, a heat wave, and a shock wave.
- D The meteor strike was in a thinly populated area and did not hurt anyone.

3. The Chelyabinsk meteor was a little longer than a normal city bus and moved at 50 times the speed of sound. A bus on the street that loses control could slam into a building and kill a few people. A bus flying through space at 50 times the speed of sound could wipe out an entire city.

Which conclusion does this information best support?

- A Objects release energy.
- B The faster an object is moving, the more energy it has.
- C Bus-sized objects can be dangerous.
- D The size of an object determines how fast it can move.

4. When did the Chelyabinsk meteor most likely contain the most energy?

- A after it exploded
- B when it exploded
- C as it encountered Earth's atmosphere
- D before it encountered Earth's atmosphere

5. What is this passage mostly about?

- A Sergei Bobunets
- B atomic bombs
- C meteor strikes
- D astrophysics

6. Read the following sentence: "As the world fills with electronic cameras and sensors, we may be able to learn more about smaller meteors such as the one at Chelyabinsk before once more facing the destructive power of a **mammoth** meteor like the one at Tunguska."

What does "**mammoth**" mean in this context?

- A very, very large
- B a hairy animal from the Ice Age
- C something frightening
- D lacking in force

7. Choose the answer that best completes the sentence below.

When a meteor explodes in the sky, it radiates its energy in various forms, \_\_\_\_\_ light, sound, and heat.

- A consequently
- B above all
- C currently
- D including

8. What object visible to humans travels the fastest and carries the most energy?

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9. What were the differences between the meteor strikes at Chelyabinsk and Tunguska?

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10. Explain why it is important to study meteors. Support your answer with details from the passage.

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# Halau Hula

## By ReadWorks



As the bright sun began to stream through her window, Maya lazily rubbed her eyes and wondered what day it was. She had been in a deep, deep sleep, dreaming about swimming in a vast pool of chocolate ice cream. She licked her lips, remembering what bliss it had been to have a constant supply of her favorite dessert. All of a sudden, she realized it was Monday, and she was late for dance practice. She whipped out of bed, hastily pulled on a long, white dress, and rushed out the door.

Five minutes later, she found the rest of her class sitting underneath a cluster of palm trees in the backyard of her *halau hula*, a school that teaches hula dance, the traditional dance form of Hawaii. Her *kumu hula*, or hula teacher, stood impatiently in front of the sitting students who were all fanning themselves in the humid, Hawaiian heat. The *kumu hula* was a huge proponent of punctuality. It was just one of her many rules, all of which formed the *kapu*—a set of regulations that all her students must obey. Traditionally, in *halau hulas*, the obedience of such rules would mean that dancers would receive blessings from the gods that could increase their talent in performing the hula. Maya's *kumu hula* also had high standards of personal cleanliness and restricted the eating of most sugar, including sugarcane, a popular snack in Hawaii. This was the hardest rule for Maya to follow. She thought back to her dream of ice cream while she quietly sat amongst the other students, hoping that *kumu hula* wouldn't punish her for being late.

"All right, well now that we're all here..." the *kumu hula* started, while giving Maya a knowing look. "Tomorrow we start our preparations for the graduation ceremony."

The girls and boys looked at one another in excitement—they had been training for months in order to graduate and become professional hula dancers. They would start off as *olapa*, meaning agile ones. They are given many dancing roles. When they had danced long enough

and gained enough experience, they would become a part of the *ho'oppa*, meaning steadfast ones. The *ho'oppa* typically sit on the ground and play heavier instruments while the *olapa* dance.

“That means that you all must stay in the *halau* unless you have a very good reason to leave. We'll only practice once a day in order to give your bodies rest,” the *kumu hula* told her students.

Maya and her friends all let out a sigh of relief. They had been practicing more than usual in order to prepare for their big graduation performance. After the *kumu hula* finished explaining the schedule for the next week, the girls and boys got up to eat breakfast. They walked to the kitchen where fresh fruits were already scattered across the table. Maya picked up a mango and a knife and began to cut.

As she passed around dripping mango slices to her friends, they shared their excitement for graduation.

“I can't wait to see my family!” a boy named Keanu said. Everyone nodded their heads in agreement. It had been a month since everyone had seen their family and friends. Even though they loved living in the *halau*, it was sort of like a boarding school in the sense that they could not leave whenever they wanted to. They couldn't wait to share the celebration with their friends.

A week passed, and it was finally the night before graduation. They spent the evening in dress rehearsal in order to make sure the performance would go smoothly. Both the girls and boys wore *lei* around their heads they had each made for themselves out of native plants found near their *halau*. They strapped *kupe'e* around their ankles and wrists—bracelets made of whale teeth and bone that made a light percussion sound as they moved. Both girls and boys wore skirts, or *pa'u*, made out of stripped bark from a hibiscus tree, but the girls' skirts were painted with beautiful designs.

After they finished rehearsal, the entire group walked to the beach nearby and into the water as a ceremonial bathing ritual. “The water is meant to purify you before your performance tomorrow,” the *kumu hula* told them as she walked into the white waves, too. When they returned to the *halau*, the *kumu hula* sprinkled each of their faces with holy water. Their *kumu hula* took pride in maintaining the traditional rituals her mother and grandmother had passed on to her—she wanted to preserve the art of hula through the passing generations. She hoped that her own daughter, who was graduating with Maya, would continue the traditions when she reached a certain age.

The students rested a bit before sitting down to eat with family and friends. After everyone hugged and kissed each other, rejoicing in their reunion, the *kumu hula* explained the purpose of the feast.

“Now, we partake in the *‘ailolo* feast that marks the end of my students’ training. After this meal, they will officially be hula dancers,” she said as a pig was brought to the large table which is a traditional part of the feast. Maya looked around the table at all her friends’ smiling faces. She was so relieved she had made it so far in her training, but was nervous to start her career as a professional dancer as well.

Once they finished the meal, the students went to prepare for the performance and donned their traditional hula costumes. They lined up, ready to perform for an audience for the first time ever. Maya looked out into the audience and could see the smiling faces of her mom, dad, and little brother. She felt the soft grass between her toes, and thanked the gods for letting them be there to see her dance. The music began, and she stepped out, finally, as a hula dancer.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What is a *halau hula*?

- A) a hula dance teacher
- B) a school that teaches hula dance
- C) a set of regulations that hula students must obey
- D) a group of young hula dancers, meaning “agile ones”

2. Where does this story take place?

- A) Hawaii
- B) California
- C) Mexico
- D) Fiji

3. Students at the *halau hula* must be disciplined. What evidence from the passage best supports this statement?

- A) “They would start off as *olapa*, meaning agile ones. They are given many dancing roles.”
- B) “Maya’s *kumu hula* also had high standards of personal cleanliness and restricted the eating of most sugar, including sugarcane, a popular snack in Hawaii.”
- C) “Her *kumu hula*, or hula teacher, stood impatiently in front of the sitting students who were all fanning themselves in the humid, Hawaiian heat.”
- D) “The *kumu hula* was a huge proponent of punctuality. It was just one of her many rules, all of which formed the *kapu*—a set of regulations that all her students must obey.”

4. There are multiple traditional rituals before the *halau hula* graduation ceremony, including bathing in the ocean and the sprinkling of holy water.

Based on this information, what conclusion can best be made about the experience of graduating from the *halau hula*?

- A) It is a challenging experience.
- B) It is a boring experience.
- C) It is a spiritual experience.
- D) It is a long experience.

5. What is this story mostly about?

- A) Maya graduates from *halau hula* as a professional dancer.
- B) Maya misses her friends and family while at the *halau hula*.
- C) Hula is the traditional dance form of Hawaii.
- D) Maya's *kumu hula* has high standards of personal cleanliness.

6. Read the following sentences: "Their *kumu hula* took pride in maintaining the traditional rituals her mother and grandmother had passed on to her—she wanted to **preserve** the art of hula through the passing generations. She hoped that her own daughter, who was graduating with Maya, would continue the traditions when she reached a certain age."

As used in this sentence, what does the word "**preserve**" most nearly mean?

- A) bottle up
- B) neglect
- C) destroy
- D) keep alive

7. Choose the answer that best completes the sentence below.

\_\_\_\_\_ the graduation performance, students at the *halau hula* take part in a ceremonial bathing ritual in the ocean.

- A) Finally
- B) Before
- C) However
- D) For example

8. What is the *kapu*?

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9. Why do students at the *halau hula* traditionally have to follow certain rules?

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**10.** “Tradition and ritual play important roles in the *halau hula* graduation ceremony.” Explain whether this statement is accurate or not. Support your answer using information from the passage.

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# How to Make a Better Robot

By ReadWorks



Many people think that robots are an inevitable part of the future. It would be pretty cool to have a droid friend around to save the day, or even just to keep you company when you got bored. While it may seem like something out of science fiction, researchers are already imagining a world in which robots become a more integrated part of our lives. We already have robots among us: some are designed to work in factories, creating uniform products continuously. You may even have one in your home, in the form of a little vacuum cleaner that self-drives itself around the floor.

But for robots to make it to the next level, scientists think they'll need to be a bit more versatile. The robots scientists are imagining look nothing like the stiff creatures you might be thinking of. No need for an awkward robot with stiff legs that attempts to walk and act like we walk and act—researchers are hoping to cook up something entirely different from what we're used to seeing.

## How to Design a Robot

A group of researchers at Cornell University thinks the future of robots will actually be full of softbots. A softbot is simply a robot made out of soft tissue, so it can move more flexibly than a hard-bodied robot. And with the rise of 3D printers, building softbots is easier now than ever

before. The question that remains is: what will these robots look like? How will they move? How will they carry things, or navigate small quarters?

These are precisely the questions these scientists are trying to answer. It's easy enough to build a robot that mimics a human. We already know what we look like and how we move. But how do we know this is the best way for robots to move? To put it simply, we don't.

The researchers are trying to figure out all the different ways robots could move. They're basically in the middle of a very long brainstorming session. Once they realize what the options are, they can figure out which motions are best suited to which actions, and create a final model that will perform the best in all scenarios.

In order to do this, they've built a computer program that simulates the growth and movement of several kinds of softbots. They can use animated tissue, muscle, and bone to build a large number of different kinds of softbots. Then the computer program runs the robots through tests, checking out things like balance, coordination, or noisiness. In one example, they're looking for speed, so the fastest robots get to stick around, while the slowest robots get cut.

### **The Possibilities**

We're going to take a look at all of the different options for how a robot can move from one point to another—this is the speed test. Scientists run a computer program several times, and each time, the robots are a little bit different. Sometimes, they focus on giving the robots legs—either two legs like humans have, or four, like many animals have. And sometimes they see if they can make a mover without legs.

The fastest robot they created has legs and runs in a bounding motion—the front legs move together and the back legs bound forward, similar to how a cheetah moves. Another robot was made to have long legs that were mostly made of bone. These legs became long and skinny, so it wasn't surprising when the robot started to gallop like a horse.

Other times, they try to make robots that can move in non-traditional ways. In one instance, they created a funny sort of robot that doesn't have very much structure, just a big blob of muscle. This robot moves by inching its body forward, pulling its body in tight, and then releasing it to go long, much like an inch worm. It's not a very fast robot, but it does have an advantage, the researchers realized. If they picked this robot up and dropped it randomly somewhere else, the robot would just keep on moving as if nothing had happened. The researchers realized this trade-

off—the bot may not be very fast, but it certainly is durable.

They even make some robots that seem almost silly from the outset. For example, some of their creations are designed to have no legs at all, but they still had to figure out a way to move them forward. One of the designs that resulted from this is a big robot that, instead of legs, has two large wings, and it flaps them back and forth to move. The design is almost like a gorilla relying primarily on its arms to move, but it's a bit bulkier. Another robot that came out of this is a little guy who looks like an open jack-in-the-box. The bottom of the body is box-shaped, but at the top, out pops two little arms. This robot moves by flailing its arms back and forth, which make the little guy slowly progress forward. It may seem silly, but an advantage this robot has is that it could easily hold things in its hands, or its empty lower-box while still moving forward.

### **Putting Ideas into Action**

Now that the researchers have a number of ideas in mind, they can start performing other tests to see which robots perform better at tasks besides moving themselves along. Maybe they'll have to measure how much energy the robot requires to function for a long period of time, or how much space it takes up. All three of these aspects will play into the future success of the robot, so it's important to consider them all separately. Even if something ends up looking silly in a trial, the underlying reason behind its success may still warrant a characteristic to be considered for the final design.

For example, perhaps one of the softbot's tasks will be to take out the garbage (wouldn't that be nice?). For that, you'd want a robot that could carry things and one not likely to fall. You'd also want a robot that was pretty quick, but you'd have to balance your desire for speed with steadiness. If the bot drops its load half the time, on average, it won't be so fast. Therefore, you have to incorporate a number of skills.

When making the robot, the researchers will have to look through all of the ideas they've created in their computer program, and pick and choose which characteristics will work best together to create a robot that can easily take out the garbage. They'll have to balance their desire for speed with a steady hand, and the ability to carry heavy loads with a desire to make the robot light enough for a human to move around if the robot's turned off.

A good way to think about it may be through imagining yourself picking out your favorite clothes to wear. One day you may be torn between wearing the T-shirt that's extra soft, so it's

really comfortable to wear, and another shirt that's your favorite color. Having to pick between these options will probably convince you to eventually find a new shirt that is both the fabric that you like and the color that you like. Now this new shirt will probably be your favorite, since it has all of the positive qualities you love.

### **The Final Product**

Going back to designing our robot that will help take out the trash, it might be nice for the robot to be fast, but is that really the most important thing? It might be better to have a slower robot take out the trash. That way, there's less of a chance the robot will fall and drop the trash (making it necessary for you to clean it up). In that case, let's go back to the robot that moves sort of like an inchworm. That robot had a lot of body mass on the ground, so it was tough to tip over—think about tipping over a butter dish versus a candlestick.

Maybe when the robot has taken the trash out, you will want it to be fast. The best thing to do then is allow it to separate its front section into two legs, and its back section into two legs. Then it can move in that cheetah-like style, going faster. Perhaps the design of incorporating both ideas into one will result in a final product that isn't completely an inch-wormer, and isn't completely a cheetah either. The robot's body is a little too sleek to be a worm and a little too lumpy to be a cheetah. But the beauty of the final design is that the robot is more versatile, and can do everything you need it to do.

Hopefully, these types of robots will enter our lives soon. The Cornell researchers will just have to keep brainstorming different types of robot bodies, so we can always have the best selection of traits to pick from.

**Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_

1. What are scientists at Cornell University trying to figure out?

- A) how to build a computer program that simulates the movement of softbots
- B) all the different tasks robots could perform
- C) all the different materials robots could be made of
- D) all the different ways robots could move

2. Why does the author describe the different robots scientists are creating with a computer program?

- A) to show that scientists are unsure about what type of robot to build
- B) to show how complex these computer programs can be
- C) to show that the scientists' brainstorm session will take a long time
- D) to show a variety of ways that robots could move

3. Scientists must consider a variety of factors when designing a robot. What evidence from the text supports this conclusion?

- A) Researchers are already imagining a world in which robots become a more integrated part of our lives.
- B) Scientists at Cornell University have built a computer program that allows them to simulate the movement of a robot before they develop a final design of the robot.
- C) If a softbot is being designed to take out the trash, the softbot's ability to be steady must be balanced with its ability to be quick.
- D) The fastest robot created by scientists runs in a bounding motion, similar to how a cheetah moves.

4. What can be concluded about the purpose many robots will have in the future?

- A) Robots will be created to allow scientists to use computer programs.
- B) Robots will be created to move in non-traditional ways.
- C) Robots will be created to make life easier for humans.
- D) Robots will be created to help scientists brainstorm.

5. What is this passage mainly about?

- A) scientists who work at Cornell University
- B) the process scientists are using to design robots
- C) computer programs scientists are using to design robots
- D) robots that can move like humans

6. Read the following sentences: "But maybe when the robot has taken the trash out, you will want it to be fast. The best thing to do then is allow it to separate its front section into two legs, and its back section into two legs. Then it can move in that cheetah-like style, going faster. Perhaps the design of **incorporating** both ideas into one will result in a final product isn't completely an inch-wormer, and isn't completely a cheetah either."

What does the word "**incorporating**" mean above?

- A) crushing
- B) eliminating
- C) combining
- D) explaining

7. Choose the answer that best completes the sentence below.

Scientists have built a computer program that simulates several kinds of softbots, \_\_\_\_\_ they can figure out which model works best.

- A) however
- B) so
- C) although
- D) after

8. After scientists have a number of ideas about robot movement in mind, what types of tests do they then perform?

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**9.** According to the passage, what would be a good design for a softbot that would take out the trash?

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**10.** Scientists need to test different abilities of the robots. While scientists perform these tests, they measure how much energy the robots require to function for a long period of time and how much space they take up.

Why do the scientists run these tests and track these measurements to create a final model?

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# The Orchid's Secret

By Josh Adler



Deep in the jungles of Colombia there is a kind of flower that attracts bees with its unique perfume. The male bees store as much scent as possible from this particular flower on their hind legs. The male bees that collect the most scent attract the female bees to mate with them. In Venezuela there is a flower people collect for its large white or yellow petals. Few people ever find it, though, since it only blooms for a few days. There is a small pink and yellow flower that only grows in a very specific part of the state of Florida. It also only grows on trees, and wind or birds may spread its seeds. These flowers are some of the most rare and delicate species in all of nature. They are all types of orchids.

For hundreds of years orchids have been prized discoveries of collectors and adventurers hoping to find new and exotic breeds of the flower. In her book *The Orchid Thief*, author Susan Orlean tells how in the 1800s orchids became popular in Europe, which made them very valuable. Many “orchid hunters” set out to find and bring back new types of orchids to sell. However, many of the men who went looking for the mysterious orchids met with tragedy instead. Orlean relates that “dozens of hunters were killed by fever or accidents or malaria or foul play. Others became trophies for headhunters or prey for horrible creatures such as flying yellow lizards and diamondback snakes and jaguars.” Sometimes orchid hunters even were injured or killed by other people.

On one trip to find orchids in 1901, eight hunters ventured to the Philippines, which is a group of islands in the Pacific Ocean. A tiger ate one hunter, another was badly burned, and five more completely disappeared. The trip’s only survivor brought back 47,000 orchids. Even modern-day orchid hunters, like Tom Hart Dyke, still face incredible dangers to collect the flowers. He and his partner, Paul Winder, were held as prisoners for over nine months after they were captured on an orchid hunt in Central America.

While the plants have long been valued for their beauty, they may be even more important to science and our understanding of co-evolution. Unlike plants that can self-pollinate, orchids need very specific insects or birds to spread their pollen. The process by which insects, the wind, or birds spread the pollen of different flowers is called pollination. Pollen is a powder produced by plants that contains their genetic material. In order for the plants to reproduce, the pollen must be physically moved to the flower's stigma, which contains an egg. Now the fertilized egg can become a seed. Birds and insects can pollinate plants by touching many different flowers and spreading the pollen around.

Orchids evolved to attract insects and birds. Because there are many different species of orchid, there are also many different ways the orchids attract their pollinators. Orlean explains that "many species look so much like their favorite insects that the insect mistakes them for kin [other insects], and when it lands on the flower to visit, pollen sticks to its body.... Another orchid imitates the shape of something that a pollinating insect likes to kill.... Other species look like the mate of their pollinator, so the bug tries to mate with one orchid and then another... and spreads pollen from flower to flower each hopeless time."

Other orchids don't use their shape at all, but rather produce specialized scents to attract specific insects, such as bees, beetles or flies. Some orchids smell like cake, some like chocolate, and some like rotting meat. All these smells may seem weird or gross, but they exist to lure creatures to their pollen and help the orchids survive. The strategies to attract insects and spread their flowers' pollen go on and on. Each family of orchids has a unique kind of insect or bird that visits their flowers, as well as its own way of attracting them. It has worked, too. According to NOVA, a science television series on PBS, "orchid species number more than 25,000 worldwide." That is more kinds of species than any other flower on the planet, and new ones are still being found.

Orchids and the insects that pollinate them are one of the most amazing examples of evolution. Though their degree of co-dependence varies, as it is apparent that at least some orchids are more reliant on their pollinators than the pollinators are on the orchids, the degree of evolutionary specialization is still very impressive. Research by Harvard scientists suggests that certain species of orchid evolved specifically to attract orchid bees, which collect a wide variety of scents from various plants in preparation for mating. In another case, an orchid mimics a female's smell and appearance—and the male pollinator gets nothing out of the bargain whatsoever. By tricking the insects that collect its pollen, the orchid has survived since the time of the dinosaurs. Shh! It's a secret.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What is an orchid?

- A) an insect that spreads pollen
- B) a scent from a flower that attracts insects
- C) a hunter in the Philippines
- D) a rare and valuable flower

2. What does this passage describe?

- A) This passage describes the Europeans who collected orchids in the 1800s.
- B) This passage describes what being a prisoner in Central America is like.
- C) This passage describes the life of Susan Orlean.
- D) This passage describes orchids and orchid hunting.

3. Read the following sentence: "Unlike plants that can self-pollinate, orchids need very specific insects or birds to spread their pollen."

What evidence from the passage supports this statement?

- A) In Venezuela there is a flower people collect for its large white or yellow petals.
- B) There are more than 25,000 species of orchids worldwide.
- C) Many orchids use their scent to lure insects to their pollen.
- D) Many people who went looking for orchids met with tragedy instead.

4. Why might orchid hunters be willing to face dangerous challenges in order to get orchids?

- A) Orchids are worth a lot of money.
- B) Some orchids use their scent to attract insects.
- C) Some orchids look like insects.
- D) The orchid has survived since the time of the dinosaurs.

5. What is this passage mainly about?

- A) the Philippines and the dangers of hunting orchids there
- B) orchids, orchid hunting, and orchid pollination
- C) an orchid hunt that Tom Hart Dyke and Paul Winder went on
- D) a species of orchids that lives deep in the jungles of Colombia

6. Read the following sentence: "Other orchids don't use their shape at all, but rather **produce** specialized scents to attract specific insects, such as bees, beetles or flies. Some orchids smell like cake, some like chocolate, and some like rotting meat."

What does the word **produce** mean in the sentence above?

- A) remove
- B) deliver
- C) change
- D) make

7. Choose the answer that best completes the sentence below.

Many orchids attract insects with smells, \_\_\_\_\_ cake, chocolate, and rotting meat.

- A) such as
- B) although
- C) meanwhile
- D) but

8. What is pollination?

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9. What are three ways orchids attract insects to spread their flowers' pollen?

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10. The title of the passage is "The Orchid's Secret." Based on the information in the passage, what secret may the title be referring to? Use information from the passage to support your answer.

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## Seeing the Invisible: Mutualism and Plant Reproduction



Imagine for a moment that you are in a field of waving grass. At the edge of the field there are trees of all kinds, including maples and crabapples, and in their branches, birds are chirping. Flowers nod in the breeze. Daisies are dotted throughout the field, and blackberries are growing along a small hillside. Everywhere there are birds. It's a tranquil and beautiful spring day. Can you describe how the different plants and animals relate to each other? Do you know how they ensure there will be a new generation of plants and animals beyond themselves? While it may seem invisible at first, what's happening in the field is a complex set of interactions between organisms to ensure the reproduction of the plants that make up the food web.

Our Earth is alive with organisms carrying through their life cycle of birth, reproduction and death. All plants, animals and other living things reproduce, resulting in new offspring or organisms. Sometimes this reproduction is unassisted, such as within bacteria, and sometimes it requires the assistance of others.

Sexual reproduction results in genetically new offspring from the fusion of male and female sex cells. Humans reproduce sexually and their offspring are genetically a combination of their parents' features and DNA. Asexual reproduction produces organisms identical to the parent, which simply

splits in two. Many plants, like onions, potatoes and carrots, reproduce asexually. Some, like blackberries, can reproduce in either way—asexually, by sending shoots into the ground to form new bushes, or sexually, through their flowers. Which way a plant or organism reproduces is the result of the organism's interaction with other organisms, climate and even weather over a long period. Each organism has mastered its individual survival and that of its species, which is why reproduction is an important part of the life cycle for any organism. When reproduction is disrupted, such as through the loss of bees or habitat, a species may struggle to survive, sometimes even becoming extinct.

### ***How It Works***

In angiosperms (the scientific name for flowering plants), the flower is the reproductive organ. All flowering plants are able to reproduce sexually. Hermaphrodite flowers—called perfect flowers—contain both male and female sexual organs. Imperfect flowers contain only male or female sexual organs. Similarly, some plants have both male and female flowers while others have only one. Each plant is a result of unique conditions, remember, so they can be different from each other.

Many flowers smell good and have bright colors to attract the birds, insects, and other animals that will help with pollination. Pollination occurs when pollen (male sex cells) fertilize the ovules (female sex cells) deep inside the flower. While some flowers or even plants can self-pollinate, most need help from weather or animals to do it. Each plant has evolved to maximize efficiency and effectiveness of reproduction.

Nectar is a sugar produced inside flowers that attracts bees and insects—in fact, bees use it to make honey back in their hives. (Beekeepers sometimes grow only one kind of flower so that all the honey the bees make is flavored like that one flower.) When a bee dives deep into the flower it gets covered in pollen, which it will then deposit—hopefully—on the female reproductive organs of the next plant it visits while collecting nectar.

Flowers that rely on the wind for pollination are less likely to be bright colored, or produce nectar or a heavy scent, since they don't need to attract pollinators. For most of these plants, their anther—where the male sex cells are located—hangs outside their flowers. Remember the waving grass in the field? Pollen is easily blown in the breeze from the anther of these plants, which include wheat, corn and maple trees. Have you ever known someone allergic to pollen? In the springtime such allergies can be very cumbersome because there is literally pollen in the air we breathe.

### ***Seeds and Fruit***

When an ovule is fertilized, it divides into different cells, and each fertilized cell becomes a seed. You may have noticed most seeds have a tough outer layer. This is called the seed coat and protects the seed. Inside each seed is an embryo and endosperm—a developing plant and its food source—so that a seed can be planted and immediately have the necessary ingredients to begin growing. The plant uses this food source until it grows leaves for photosynthesis and can produce food on its own.

An ovary of a plant can contain many seeds. A melon, for example, is an ovary with many seeds at its core. As the seeds mature, the walls of ovaries may change in taste and appearance to become attractive to animals. This is important because the animal will free the seeds as it consumes the fruit. Birds regularly eat berries, including the seeds in their protective seed coats. The seeds then pass through the bird's digestive tract and are released in the bird's droppings, often far from the original plant where they were consumed originally. Birds are very important for helping to spread seeds to new places. Similarly, in our example, the field deer may consume the crabapples and deposit crabapple seeds far from where they were consumed.

Did you notice that in the above examples all the organisms benefit from the interactions? Birds get food, for example, and the plant gets to find new ground for growing. Bees get nectar for their honey, and in return, the flowers get fertilized. The system is mutualistic, which means all organisms participating benefit from it.

***Reproduction In Context***

Many scientists study the reproductive habits of plants to better understand how we can improve our food sources. In 2013, scientists found that chemicals like insecticides, used to prevent bug infestation, can actually harm the health of bees. When bees are unwell they do less pollinating, which results in fewer seeds and fruits, actually diminishing our food supply. Once designed to increase a crop yield by protecting the crop from insects, insecticides are now killing the very insects needed to pollinate the crops. Scientists are still studying the process, but the decline of bees worldwide is a global concern.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. How can plant reproduction be described?

- A Plants reproduce in only one way.
- B Plants reproduce in a variety of ways.
- C Plant reproduction has no effect on animals.
- D Plant reproduction always involves pollen.

2. What does this passage explain?

- A This passage explains the life cycle of a deer and what happens when that cycle is disrupted.
- B This passage explains sexual reproduction in human beings.
- C This passage explains plant reproduction and its importance.
- D This passage explains what the differences between apples and crabapples are.

3. Some plants need help to reproduce.

What evidence from the passage supports this statement?

- A Some plants rely on bees to spread pollen from one flower to another.
- B Some plants reproduce asexually by sending shoots into the ground to form new bushes.
- C Insecticides are used to prevent bug infestation.
- D Humans reproduce sexually, and their offspring receive traits from both parents.

4. What is the purpose of plant reproduction?

- A to prevent bug infestation
- B to produce nectar
- C to seem invisible at first
- D to create new plants

5. What is this passage mainly about?

- A the similarities between the reproduction of bacteria and the reproduction of blackberries
- B the similarities between birds that eat seeds and bees that gather nectar by flying from one flower to another
- C the different ways plants reproduce and the impact of plant reproduction on other living things
- D the different kinds of trees that are found in fields, including maples and crabapples

6. Read the following sentences: "Our Earth is alive with **organisms** carrying through their life cycle of birth, reproduction and death."

What does the word **organisms** mean?

- A harmful chemicals
- B living things
- C asexual reproduction
- D bright colors

7. Choose the answer that best completes the sentence below.

Plant reproduction is important to animals; \_\_\_\_\_, it is important to plants as well.

- A such as
- B in contrast
- C as an illustration
- D obviously

8. How do birds help spread the seeds of berries?

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9. How do birds benefit from spreading the seeds of berries?

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10. Explain how plant reproduction can affect other living things. Support your answer with an example from the passage.

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# Unearthing Pterosaurs

*This article is provided courtesy of the American Museum of Natural History.*

There is a place called the Araripe Basin in a remote, sparsely populated region of northeastern Brazil. Arid but beautiful, it can be a difficult place for farmers to grow crops. But the earth provides another bounty: fossils. And among the bevy of bones are some rare finds — including 23 species of extinct flying reptiles called pterosaurs.

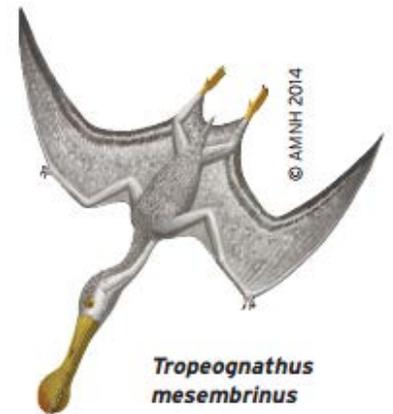
More than three decades ago, a local there found some large pterosaur bones. He delivered them to the Museu Nacional in Rio de Janeiro, where they were tucked away in a drawer. As it happens, many natural history museums have a trove of unexamined fossils awaiting study in their collections — there are just too many to go through. But a few years ago, paleontologist Alexander Kellner, a research associate at the American Museum of Natural History who as a doctoral student trained with Curators John Maisey and Malcolm McKenna, found the time to examine the 30-plus-year-old fossil finds at the Rio museum, where he is now a curator.



One especially rich layer, the Romualdo Formation, produced distinctive round nodules. Here, calcium collected around dead plants and animals that sank into the soupy mud. Sometimes, a hard shell, or calcereous nodule, formed around them. These rocky coverings preserved fish, plants, even entire pterosaurs, in three dimensions.

Before studying the bones, Kellner had to dissolve the calcereous “nodules” of rock in which the bones were entombed by sinking the fossils into buckets of formic acid. Using a pneumatic hammer, specialists at the museum gradually freed a partial skeleton of the animal from its stony home.

It included part of the animal's skull, complete with a bony crest at the tip of its nose, vertebrae, pelvis — and, perhaps most dramatically, arm and wing-bones. The wingspan of this pterosaur was, the research team concluded, nearly 27 feet — the largest pterosaur discovered so far in the Southern Hemisphere. A model of this recently described giant specimen, from the species *Tropeognathus mesembrinus*, flies overhead at the entrance to the special exhibition *Pterosaurs: Flight in the Age of Dinosaurs*, overseen by Curator Mark Norell with Kellner as co-curator.



### Not a Bird, Not a Dinosaur

What is a pterosaur? It sounds like such a simple question. But the answer was by no means obvious when the first pterosaur skeleton was discovered in the mid-1700s, in the Solnhofen limestone quarry in Germany. Perhaps, early observers theorized, that specimen's long skinny arm-and-finger bones were for swimming? Or was it some kind of toothed, clawed, winged bird? Or even a mammal?

Debates raged, even after 1801, when the great French anatomist Georges Cuvier analyzed drawings of the skeleton and determined the animal to be something new to science: a flying reptile that Cuvier later named pterodactyle (wing finger in Greek), whose wings were composed of a shortened upper arm bone, along with a dramatically elongated fourth finger that likely supported a wing membrane.

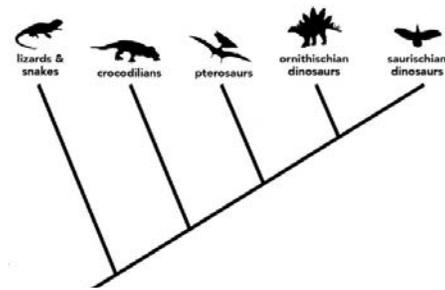
Since Cuvier's time, the fossil record has revealed much more about these extinct reptiles, which lived from about 220 million years ago to the end of the late Cretaceous period 66 million years ago, disappearing at the same time as large dinosaurs in a mass extinction event.

Still, although pterosaurs may often be grouped with dinosaurs in children's picture books, they are not dinosaurs.



This fossil animal's long forelimbs perplexed early naturalists. In 1809, it was finally identified as a flying reptile and named pterodactyle, meaning "wing finger."

“Dinosaurs are characterized by a set of anatomical features pterosaurs don’t have,” explains Norell, including a hole in the hip socket. Today’s scientific consensus is that pterosaurs are nonetheless more closely related to dinosaurs, whose living descendants are birds, than to any other group, including the next-closest, crocodiles.



This simplified cladogram shows that pterosaurs were more closely related to dinosaurs (including birds) than to crocodiles, and even more distantly to other reptiles such as lizards and snakes.

What is also clear is that pterosaurs were the first vertebrates to fly — an amazing feat. Tiny, invertebrate insects had long since taken to the air, but nothing as large as a four-legged vertebrate had attempted such a thing.

“They are the most fabulous creatures that ever existed! I am not exaggerating,” says Kellner. “They made the first attempts among vertebrates to conquer the air — they were the first to

develop powered flight,” that is, the type of sustained flight that evolved, later and independently, in birds and bats.

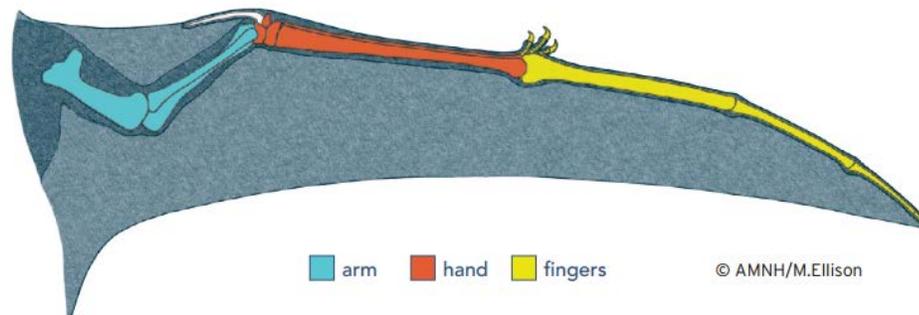
Still, many mysteries remain. What type of material covered their skin? Was it hair, or feathers, or something in between? What did they eat, and how did they hunt? Many pterosaurs had flesh-and-bone crests atop their skulls — dramatic anatomical characteristics whose purpose is still debated by paleontologists.

Unlike dinosaurs, whose living descendants are modern birds, pterosaurs left no heirs when they disappeared from Earth. That means paleontologists have no living analogs to draw from as they make inferences about pterosaur behavior. Nonetheless, in the past decade or two, there has been a resurgence of pterosaur research and synthesis, as new methods of examining fossils, such as computed tomography (CT) scanning and UV lighting to discern heretofore invisible details, have become commonplace; as researchers share data digitally; and as researchers begin to find new fossils in previously unexplored locales, including China and Brazil.

### Fossils Reveal Diversity

Pterosaur bones have been found on every continent including Antarctica. Although all pterosaurs share the wing anatomy in which the upper-arm bone (humerus) and elongated fourth digit form the truss of the wing membrane, the wing shapes are quite diverse: from long, thin soaring wings like those of an albatross to short, stubby wings that might have allowed for more frequent flapping flight, like that of a cardinal. Some early pterosaurs had

peg-like teeth seen in living reptiles, while many others were toothless. Early pterosaurs often had long tails that they might have used as airborne rudders, while later species have a short tail or no tail at all.



A number of adaptations made flight possible: a greatly elongated fourth finger of the hand that evolved to support a wing; flexible, hollow bones; and membranes between different parts of the body.

## Crazy Crests

The incredible diversity of pterosaurs is perhaps best expressed in one of the prehistoric flying reptile's most intriguing and mysterious features: the head crest.

Akin to a rooster's comb, peacock's crown, or the frill on some lizards' necks, pterosaur crests were prominent anatomical features found across many species. But rather than flesh or feathers, these reptiles' crests were made at least in part of bone — a boon to paleontologists, as hard bone tends to be preserved as a fossil. Recent research also indicates that other horn-like material comprised part or even most of some pterosaur crests, with the thin, underlying bony structure supporting sometimes expansive membranes. Pterosaurs crests are thought to have been fairly ubiquitous, appearing in many groups of pterosaurs from the Triassic (252–201 million years ago) through the Jurassic (201–145 million years ago) and Cretaceous (145–66 million years ago) periods. In terms of size and dramatic effect, crests peaked in the Late Cretaceous, when the biggest pterosaurs also evolved.

Among pterosaur species known to have had crests, there is an amazing range of shapes and sizes. *Pteranodon sternbergi*, for example, had a high upright crest on its skull; *Pteranodon longiceps*, dagger-shaped blades at the back of its head; and *Nyctosaurus*, a fan-like structure at the rear of its head. *Dsungaripterus weii* had two: a long, low crest on its snout and a short crest rising above the back of the head. The *Anhanguera* species had rounded disk shapes on both upper and lower jaws, while *Gnathosaurus* pterosaurs had long, low ridges running down

the middle of their heads. *Tupandactylus imperator* had huge sail-like extensions that dwarfed the rest of its head.

*Dsungaripterus weii*



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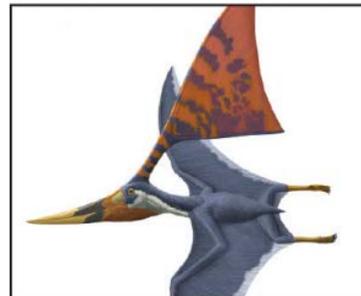


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*Nyctosaurus gracilis*



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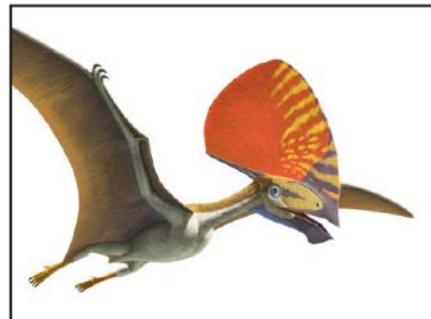


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*Tupandactylus imperator*



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Could something so flashy be all form and no function? The heavier crests cost the reptiles a lot in energy to grow and carry around. Reason suggests if they weren't useful, they would have disappeared over millions of years of evolution. But just what that use was is a question that puzzles pterosaurologists to this day.

There are competing theories, chief among them that crests serve as a form of species identification. Other possibilities include a role in sexual selection, heat regulation, as a rudder

in flight, or as a keel in the water, stabilizing the reptile as it dove or skimmed for food. The discovery in Brazil of wildly different crests among closely related species lends credibility to the theory of species identification: like a Mesozoic mohawk, a distinct crest would allow ready recognition of one's own kind and, equally important, rule out others.

Were the crests as brightly colored as shown in artists' renderings? While scientists cannot know for certain, light and dark bands of color on the rare preserved tissue of a *Pterorhynchus wellnhoferi* crest found in China led to speculation that crests might indeed have been highly colored, especially if they served to communicate identity or attract mates.

Still, without living descendants for comparison and the relative scarcity of fossils, definitive proof has been elusive — so far.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What are pterosaurs?

- A) extinct dinosaurs
- B) extinct flying reptiles
- C) living descendants of dinosaurs
- D) flying reptiles alive today

2. The author compares the wings, tails, and crests of different pterosaurs. Why does the author make these comparisons?

- A) to show that pterosaurs probably only lived in one part of the world
- B) to show that pterosaurs did not really differ
- C) to show how helpful fossils can be in the study of pterosaurs
- D) to show how diverse pterosaurs were

3. Read this sentence from the article.

“The incredible diversity of pterosaurs is perhaps best expressed in one of the prehistoric flying reptile’s most intriguing and mysterious features: the head crest.”

What evidence from the text supports the idea that the diversity of pterosaurs is best expressed in their head crests?

- A) “Many pterosaurs had flesh-and-bone crests atop their skulls — dramatic anatomical characteristics whose purpose is still debated by paleontologists.”
- B) “Akin to a rooster’s comb, peacock’s crown, or the frill on some lizards’ necks, pterosaur crests were prominent anatomical features found across many species.”
- C) “Pterosaurs crests are thought to have been fairly ubiquitous, appearing in many groups of pterosaurs from the Triassic (252–201 million years ago) through the Jurassic (201–145 million years ago) and Cretaceous (145–66 million years ago) periods.”
- D) “Among pterosaur species known to have had crests, there is an amazing range of shapes and sizes.”

4. Debates about pterosaurs continued even after George Cuvier identified pterosaurs as flying reptiles in the early 1800s. Why might debates about pterosaurs in the 1800s have continued after pterosaurs had been identified?

- A) Much about pterosaurs remained unknown.
- B) People lost interest in pterosaurs.
- C) The questions people had about pterosaurs seemed impossible to answer.
- D) Pterosaurs had wings made up of a short upper-arm bone and a long fourth finger.

5. What is this article mainly about?

- A) the relatives and descendants of dinosaurs and pterosaurs
- B) the anatomical features of dinosaurs, dinosaur extinction, and the descendants of dinosaurs
- C) what pterosaurs are, how pterosaurs were diverse, and the crests of pterosaurs
- D) pterosaur teeth, pterosaur wingspan, and pterosaur membranes

6. Read this sentence from the article.

“Still, without living descendants for comparison and the relative scarcity of fossils, definitive proof has been elusive -- **so far.**”

Why might the writer have ended this sentence with the words “**so far**”?

- A) to suggest that definitive proof may be discovered in the future
- B) to express surprise that definitive proof has not yet been discovered
- C) to persuade readers that definitive proof will be discovered in the next few years
- D) to explain why definitive proof has not yet been discovered

7. Select the word that best completes the sentence.

Pterosaurs were not dinosaurs \_\_\_\_\_ they were more closely related to dinosaurs than to any other reptiles.

- A) consequently
- B) otherwise
- C) although
- D) such as

**8.** What were pterosaur crests made out of?

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**9.** What is one thing that scientists still do NOT know about pterosaurs? Support your answer with information from the article.

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**10.** Are scientists likely to learn more about pterosaurs in the future? Support your answer with evidence from the text.

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## Are the Everglades Forever?



“Snakes,” Indiana Jones hisses through his teeth as he looks into a giant underground cavern. The floor of the pit is moving—thousands of snakes wriggling and writhing over one another. “Why did it have to be snakes?”

It’s a famous scene from the movie “Raiders of the Lost Ark,” in which the main character is confronted by his worst fear. It’s just a movie, but the nightmarish slithering mass is becoming something of a reality in the Florida Everglades. The Everglades, a famous region in Southern Florida, are a wetland ecosystem home to tropical and marshland plant and animal species. The Everglades are a protected national park, but that doesn’t mean that they’re immune to harm. And guess what is one of the most recent and dangerous threats to the ecosystem? Indiana Jones, beware—it is snakes, and they’re big ones.

Reports from just over a year ago say that thousands of pythons have been making their homes in the Everglades at the expense of the native (natural to the area) species. Pythons and anacondas aren’t normal inhabitants of the Florida ecosystem; the ones that have taken over the Everglades are ex-pets and their offspring. While it may seem cool that an exotic pet can survive on its own in an unfamiliar environment, these animals are unwelcome visitors.

They've managed to upset the natural food chain so drastically that the Everglades are starting to seem a little bit like Indiana Jones's dreaded snake pit. Besides being creepy, an ecosystem overrun by pythons is unhealthy.

There's a lot to consider when talking about the health of an ecosystem and to better understand how scientists measure that, it's helpful to know what some of the buzzwords are. For starters, an ecosystem is defined as a community, characterized by the types of things (plants and animals) that live there; the type of environment around them; and the ways in which they all interact. There are ocean ecosystems, mountain ecosystems, rainforest ecosystems, desert ecosystems and even city ecosystems.

Within those systems, one of the main ways in which animals interact is in the constant search for food. The common term is "food chain," and it's a simple way to see how different species rely on one another. An example of a food chain is this: a rabbit eats grass, a snake comes along and eats the rabbit, and a hawk dives down to eat the snake. Food chains can get much longer and more complicated, though, resembling webs more than linear chains. The word commonly used to describe the relative number of different species in an ecosystem is "biodiversity," and the more biodiversity within the ecosystem, the more complex the food web.

Biodiversity is a good thing. Having many different kinds of plants and animals means that species have different choices for survival. If the simple food chain mentioned above was the only possible choice for the animals involved—if, for instance, snakes could only eat rabbits, and hawks could only eat snakes—then both snakes and hawks would die out, should the rabbit population drop because of an outside factor, like disease. Biodiversity strengthens an ecosystem by ensuring lots of options for hungry animals, from hawks on down to rabbits.

A healthy ecosystem is one in which its plants and animals work in harmony. There are no drastic spikes in the populations of any one species, or drops in another. A large number of different species (a great biodiversity) is one indicator of an ecosystem's health. Remarkably, biodiversity is not necessarily dependent upon the size of the ecosystem; some of the richest ecosystems in the world exist within narrow boundaries (sections of the Amazon rainforest, for example, and the Galapagos Islands). These ecosystems might be relatively small, but besides threat from destructive human behavior, they're strong because of their biodiversity; each species is connected to the other in some way.

If a healthy ecosystem is one that is home to many different species, mostly native to the area and all interdependent upon one another, what's an example of an unhealthy ecosystem? Flashback to Florida; let's take a closer look at the Everglades. The invasive (not original to a specific environment) pythons and anacondas mentioned earlier are a huge problem—literally. These reptiles can reach lengths of up to 20 feet, which is longer than three adult men lying head-to-toe. At such a size, they have few natural predators, so their numbers grow with little to keep them under control. The snakes compete with alligators for food, even making a meal of a gator once in a while. They've crippled the Everglades' populations of opossums, rabbits, bobcats and foxes, thus dominating the food web to such a degree that there's not much of a web anymore.

Invasive pythons aren't the only non-native species that threaten the Everglades ecosystem. There are invasive plants too, hurting the balance of the Everglades, not only choking out native species (some vine-like plants actually grow over original trees and plants), but growing so thick that they block water flow and movement of animals.

Why should humans worry about the Everglades? The loss of the area's biodiversity doesn't just hurt the plants and animals that originally made their homes there. Humans have benefited from the Everglades in many ways, from the creation of park and tourism jobs to the water supply that keeps the cities and agriculture of Southern Florida running. If the wetlands suffer, so do humans.

A damaged ecosystem is not hopeless, however. Living things, both as individuals and as systems, have resilience (the ability to recover from harm), and can bounce back from damaging situations, especially if they have some help cleaning up the mess. In the case of the Everglades, people are already beginning to work on stopping and reversing the problems that threaten the life of the ecosystem with hopes for a healthier future. For example, people are spreading the word against disposing unwanted pets, such as pythons, in the wild. They warn others about the consequences of releasing these animals in the wild. These consequences include the threat posed to the survival of native species in the Everglades.

Additionally, scientists and members of the government have initiated a plan to restore the Everglades to a healthier state of being, called the Comprehensive Everglades Restoration Plan (CERP). Every year, the Everglades lose some of their water to the coast simply by draining from the wetlands to the sea. The water loss is more than the ecosystem can keep up with; urban and agricultural systems suffer from water shortages, too. The CERP will restore a

lot of the water by opening up unused dams and filling in old canals to help redirect water flow back to the wetlands.

So, between focused efforts by scientists and the public alike to help stop invasive species from taking over and efforts like the CERP to improve the Everglades' landscape, improvement is possible. As the Everglades become a more livable environment, it will be easier for species to recover along with the land. And, as the ecosystem finds a balance, humans will be able to keep using the land's resources, both for work and play.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What are the Everglades?

- A a wetland ecosystem
- B a coniferous forest
- C a mountain range
- D a tropical jungle

2. One of the problems explained in the passage is that the Everglades lose some of their water to the coast due to draining. What is one solution to this problem?

- A releasing more pythons in the Everglades
- B initiating the Comprehensive Everglades Restoration Plan
- C creating more park and tourism jobs for humans
- D introducing invasive plant species in the ecosystem of the Everglades

3. In the passage, the author explains that biodiversity allows species to have different choices for survival and strengthens an ecosystem by ensuring lots of options for hungry animals. Based on this evidence, what conclusion can be made?

- A Biodiversity is a buzzword.
- B Biodiversity is a good thing.
- C Biodiversity can only happen in large ecosystems.
- D Biodiversity is another term for "simple food chain."

4. Read the following excerpt from the passage: "Humans have benefited from the Everglades in many ways, from the creation of park and tourism jobs to the water supply that keeps the cities and agriculture of Southern Florida running. If the wetlands suffer, so do humans."

Based on the evidence in this excerpt, how might humans suffer when wetlands suffer?

- A They may stop creating national parks in Florida to protect the wetlands.
- B They may be disappointed when they can no longer see pythons in the wild.
- C They may lose access to good jobs and safe water supplies for drinking and farming.
- D They may lose access to alligators and other animals as food supplies.

5. What is this passage mostly about?

- A the proper care and feeding of snakes
- B the tourism industry of Southern Florida
- C the problems of the Everglades and how they are being addressed
- D the ideas scientists have for fixing the Everglades

6. Read the following sentences: "The word commonly used to describe the relative number of different species in an ecosystem is '**biodiversity**,'" and the more **biodiversity** within the ecosystem, the more complex the food web.

As used in the passage, what does the word "**biodiversity**" mean?

- A a community of connected animals and plants
- B the variety of life within an ecosystem
- C a chain of animals and plants dependent on each other for food
- D consisting of many different and connected parts

7. Choose the answer that best completes the sentence below.

Living things can bounce back from damaging situations, \_\_\_\_\_ if they have some help cleaning up the mess.

- A even
- B alternatively
- C especially
- D finally

8. Describe how invasive animal and plant species have damaged the Everglades' biodiversity.

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9. What two solutions mentioned in the passage are making improvement possible in the Everglades?

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10. Why are humans interested in improving the Everglades? Use evidence from the text to support your answer.

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