Why Do Cave Fish Lose Their Eyes?

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

How evolution can lead to losing abilities as well as gaining them

Deep underground there are caves where the sun never shines. The only light that enters these subterranean spaces is from

the headlamps of occasional cave explorers. If you found yourself in one of these caverns and turned off your headlamp, you would see nothing at all; no shadows, no shapes, just total blackness.

Carlsbad Caverns National Park

In some of these underground caves, there are fishes, crustaceans, salamanders and other organisms that have evolved to live without light. For example, more than one hundred species of cave fishes live their lives in perpetual darkness. They depend on senses other than sight to hunt, eat and reproduce.

Many of these species of fishes are blind or nearly blind-some don't even have eyes. Yet they all evolved from fishes that could see. Somehow, over millions of years, these fishes not only acquired the ability to live without sight-they lost the ability to see altogether.

How did that happen? How can evolution cause a species to lose a trait? It's a mystery that evolutionary scientists have been struggling to unravel, and the search for an answer gives us a fascinating look at how evolution works.

Regressive Evolution

We usually think of evolution in a positive sense, that is, as a process in which species acquire new traits. But in cave fishes we have an example of regressive evolution, a process in which species lose a trait -in this case, the ability to see.

Blind cave fish, Mammoth Cave National Park, Kentucky

A common assumption is that the ancestors of cave fishes went blind in their evolution because they didn't use their eyes. Though at first this idea might seem to make sense, it actually has no basis in science. Genes determine the inheritance of traits. For example, the fact that you have five fingers on each hand is because of the genes you inherited from your parents.

However, if you have an accident and lose a finger, your children will still be born with five fingers on each hand. If you lift weights and become a body builder, it doesn't mean your children will be born with bulging biceps. In each case, your genes haven't changed-even though your body has.

Darwin Is Stumped

The fact that cave fishes' ancestors didn't use their eyes had absolutely no effect on the DNA in their chromosomes. Yet clearly, at some point in the past something happened to their genes that stopped the development of their eyes. This new condition passed on from parent to offspring. How can this sort of regressive evolution be explained?

Charles Darwin himself, the scientist who first established a modern understanding of evolution, had trouble answering

this question. Darwin lived in the 19th century when DNA hadn't been discovered and so he didn't know about genes or their role in heredity. But he understood that traits were inherited and that differences within a species give some individuals an advantage over others. Animals with traits that make them more successful at having offspring will pass on those traits to succeeding generations. He called this process evolution by natural selection.

Lamarck's Mistake
Jean-Baptiste Lamarck was a French naturalist who lived from 1744 to 1829. He was a pioneer developing theories of evolution at a time when the very idea of evolution was not accepted. Lamarck tried to explain how species evolved but came to an incorrect conclusion—that traits acquired during an organism's lifetime could be passed down to its offspring. For example, he suggested that giraffes stretched their necks to reach higher leaves, and as a result their offspring were born with longer necks. The idea that cave fishes lost their eyesight because generations of fish didn't use their eyes is a Lamarckian mistake.

However, Darwin had trouble applying his theory of natural selection to the problem of why some cave fishes are blind. He could not explain how being blind gave those cave fishes an advantage. And if being blind is not an advantage, then how did natural selection lead to a species of blind cave fish? Surprisingly, Darwin was convinced that the loss of eyes could be explained entirely to disuse, which is in fact a Lamarckian explanation. Today, scientists know that this explanation is unfounded.

Two Hypotheses

Most of what we know now is based on the study of the blind Mexican tetra (*Astyanax mexicanus*). Scientists have two competing explanations for blindness in the Mexican tetra, which likely apply in other cave fishes as well.

The first hypothesis assumes that blindness gives the fish some sort of evolutionary advantage. For example, it's possible

Mexican tetra (Astyanax mexicanus).

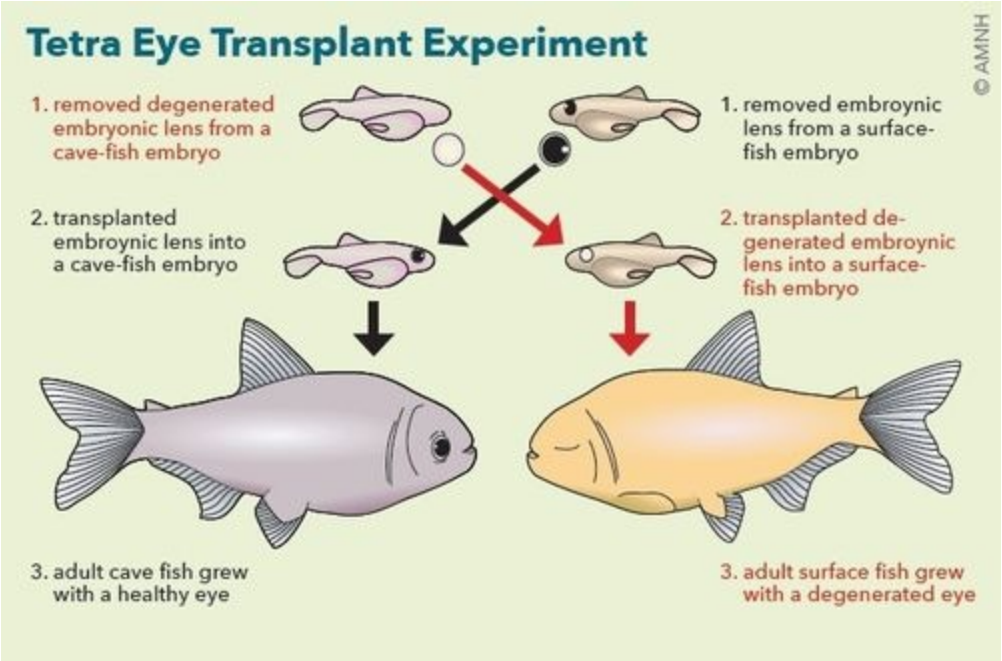
that changes in the gene or genes that cause blindness are also responsible for some other seemingly unrelated change in the fish that is beneficial. Scientists call this pleiotropy- when multiple effects are caused by the same mutation in one gene. To support this hypothesis, scientists would have to look for some advantage to the cave fish that is linked to the same mutation that causes blindness.

The second hypothesis that could explain blindness in the cave fish is based on the fact that natural selection does not just reward success, it also weeds out failures. In a lake, where there is sunlight, a fish born blind would have trouble competing with other fish that can see. It probably would not survive to have offspring. But a fish born blind in a dark cave would not be at a disadvantage, since in the darkness eyes are useless. In those conditions, natural selection will not work to weed out the mutation for blindness. Over one to two million years, many more mutations disrupting the development of the eyes will accumulate and eventually the entire population of fish will be blind. This is called the neutral mutation hypothesis, based on the idea that the mutations for causing blindness have no effect (or have a neutral effect) on the survival of the fish living in a dark cave.

An Eye-Opening Experiment

A group of scientists at the University of Maryland set out to investigate the developmental causes of blindness in the cave fish. They carried out an experiment with two varieties of the same species of Mexican tetras. One variety lives in bodies of water near the surface where there is sunlight and can see. The other variety of tetras lives in dark caves and is blind.

The scientists transplanted a lens from the eye of a surface tetra embryo into the eye of a cave tetra embryo. The result was striking-the surface tetra lens transplanted into the cave tetra caused all of the surrounding tissues to develop into a healthy eye. This experiment demonstrated that despite the degeneration of the eye in the tetra, the genes involved in eye development were still totally functional. This would seem to rule out the neutral mutation theory because, if blindness were caused by an accumulation of many neutral mutations over time, the transplant would not have resulted in the development of a healthy eye. The scientists knew that there are many genes responsible for the development of each part of an eye (for example, the retina, iris, cornea and lens), which develops independently. However, the results of the experiment showed that blindness in the Mexican tetra was not due to mutations in all those genes. Instead, it suggested a small number of mutations in genetic "master switches." These master switches are genes that control the function of many other genes, including, in this case, those responsible for eye development. These "master switches" have the ability to disable the eye genes so that these remain intact, but inactive. Putting a healthy lens into the cave tetra embryo seems to trigger master switches to send a signal to the inactive eye genes, allowing cave tetras to develop eyes.



If scientists could find the genetic "master switches" that made cave tetras blind, they could discover if the same switches had effects on other traits of the fish that do give it an evolutionary advantage for surviving in caves.

The researchers did indeed find one of those genes. It is nicknamed Hedgehog or the Hh gene. They discovered that the Hedgehog gene does more than cause blindness in cave tetras-when the fish develops without eyes, the skull bones move into the empty eye socket, which at the same time enlarges the nose. Unlike other vertebrates, fishes use their nose only for smelling. It could be that the same control gene (Hh) that stops eye development in the fish also is responsible for enhancing its sense of smell. An enhanced sense of smell would be a definite advantage for a fish that lives in darkness.

As a result of these and other experiments, it now seems highly likely that blindness in cave tetras is in part the result of pleiotropy-one mutation that causes blindness in the fish and at the same time, gives them an enhanced sense of smell.

Evolution Works

Scientists are still studying cave fishes, and new discoveries are sure to be found. But one thing is already clear-the answer lies in the basic processes of evolution that are already well understood. With new tools that give scientists the ability to map genes, find specific mutations, and understand the development of embryos, we are increasing our understanding of how evolution works.

Name: _____ **Date:** _____

1. What ability have many cave fishes lost?

A. the ability to swim

B. the ability to smell

C. the ability to see

D. the ability to hear

2. To organize this text, the author divides it into sections with subheadings. What is described in the section with the subheading "Darwin Is Stumped"?

A. Darwin's understanding of evolution and his explanation of blindness in cave fishes

B. Darwin's daily life in the 19th century and the places where he studied blindness in cave fishes

C. the animals Darwin studied as a young man that led him to develop his theory of evolution

D. the objections that have been raised to the theory of evolution developed by Darwin

3. An organism's genes determine which traits it inherits.

What evidence in the article supports this statement?

A. "In some of these underground caves, there are fishes, crustaceans, salamanders and other organisms that have evolved to live without light. For example, more than one hundred species of cave fishes live their lives in perpetual darkness. They depend on senses other than sight to hunt, eat and reproduce."

B. "We usually think of evolution in a positive sense, that is, as a process in which species acquire new traits. But in cave fishes we have an example of regressive evolution, a process in which species lose a trait-in this case, the ability to see."

C. "...if you have an accident and lose a finger, your children will still be born with five fingers on each hand. If you lift weights and become a body builder, it doesn't mean your children will be born with bulging biceps. In each case, your genes haven't changed-even though your body has."

D. "Jean-Baptiste Lamarck... suggested that giraffes stretched their necks to reach higher leaves, and as a result their offspring were born with longer necks. The idea that cave fishes lost their eyesight because generations of fish didn't use their eyes is a Lamarckian mistake."

4. Based on the information about evolution in this text, what effect does the trait of blindness have on a fish living in a dark cave?

A. The trait of blindness has a positive effect; it gives the fish an evolutionary advantage.

B. The trait of blindness has a negative effect; it puts the fish at an evolutionary disadvantage.

C. The trait of blindness has a neutral effect; it is neither an advantage nor a disadvantage.

D. The trait of blindness has a mixed effect; it is an advantage for the fish at certain times and a disadvantage at other times.

5. What is the main idea of this text?

A. There are caves deep underground where the sun never shines, and in some of these underground caves, there are fishes, crustaceans, salamanders, and other organisms that have evolved over many years to live without light.

B. Charles Darwin was a scientist living in the 19th century who was convinced that cave fishes lost their eyesight because they did not use their eyes.

C. The neutral mutation hypothesis about the blindness of cave fishes is based on the idea that the mutations that cause blindness have no effect (or a neutral effect) on the survival of a fish living in a dark cave.

D. Many cave fishes are blind, and an experiment carried out by scientists suggests that blindness in these fishes is the result of a mutation that also improves their sense of smell.

6. The title of this text is "Why Do Cave Fish Lose Their Eyes?" Why might the author have written the title as a question?

A. to encourage readers to answer the question on their own before they read the article

B. to prepare readers for a discussion of possible answers to this question in the article

C. to criticize scientists for not having reached a definite answer about why cave fishes lose their eyes

D. to praise scientists for the effort they have put into understanding the cause of blindness in cave fishes

7. Choose the answer that best completes the sentence.

Many species of cave fishes are blind or nearly blind. _____, they all evolved from fishes that could see.

A. Consequently
B. Primarily
C. However
D. For instance

8. Describe the first hypothesis that scientists have about blindness in the Mexican tetra. Be sure to discuss pleiotropy in your answer.

9. One effect of the Hedgehog gene is to make cave tetras go blind. What is another effect it might have?

10. As a result of the experiment scientists did with Mexican tetras, it seems likely that their first hypothesis about blindness in the tetras is right. Explain how the result of the experiment supports their first hypothesis.

Support your answer with evidence from the text.

Using Cellphones and Computers to Transmit Information

by Alissa Fleck

Modern technology can do some pretty incredible things. It's possible, with current technological capabilities, to transmit digital information over long distances using coding and decoding processes without losing the contents of the original information. The best part is we don't have to do anything besides send the message and wait for it to be received.

Consider, for instance, the cellular phone. It wasn't until the early 1980s that this mobile variation on the standard telephone was even available for people to use. Now, it seems like everyone has a cellphone, sending and receiving information in speedy ways invisible to the human eye.

There's so much going on below the surface of what we can see when we use our cellphones. One difference between a mobile phone and a traditional landline telephone is you can move the cellphone just about anywhere geographically and still use it to talk to other phone users. No matter

how far away you are from someone you call, you can usually still understand each other's voices over the phone, thanks to radio waves and something called a cellular network.

It took many evolutions in phone technology to get where we are today, but the current cellphone wirelessly transmits information by connecting to a cellular network. Mobile phone operators provide these cellular networks, which function with the help of cellphone towers, and then calls are made over what is known as a radio link. Through this process, information-in this case, voice input-is broken down and reassembled over the radio link, so the person on the other end instantaneously hears what is said.

In other words, as you speak into the phone, your voice is converted into an electrical signal, transmitted in the form of a radio wave by these towers, and then converted back into the sound of your voice by the phone on the receiving end. All this happens in the blink of an eye while you chat over the phone without any distortion.

The process of transmitting digital information is not exclusive to telephones. Computers are another instrument that can receive, decode and convert information, though typically this information is not a person's voice, but written content.

We may take for granted the ease with which we can pass along information with computers and the Internet, but many forces are hard at work processing information to make computers easier for us to use and communication more reliable.

The first computer showed up around 1941, but it was much more limited in its capabilities than computers now. In fact, computers are everywhere-sometimes they are so small we do not think of them as computers at all, though they serve the same function as the computers we have at home, the office or school.

Much like cellular telephones, computers were actually first used to transmit sensitive information across geographical spaces by the military at a point when government officials worried it would be possible to knock out a country's entire telephone grid.

Computer engineers began finding ways to link their computers together in order to share information among them. This linking began with just a couple of computers and grew to the millions which connect regularly today. Ultimately, that's how what we know as the Internet was developed.

Wireless computer networking is also similar to cellular phone use in that computers use the same networks our mobile phones use.

While you speak into the telephone using your voice, you typically insert data into your computer by typing on the keyboard. You may decide to share information through an email or access information on a website by typing in or visiting what is known as a hyperlink.

When you use the Internet to share and access information, you connect to the relevant network. You can send a message from your computer to another computer anywhere in the world and it will arrive almost immediately, going through many different networks in the process.

Still, the information you send does not travel in a single piece as it might through the standard mail service; instead, it is broken down into smaller digital information. As with a cellphone, the information you send is fragmented into tiny pieces and then reconstructed once it's reached its destination.

Along with your message comes other information, for instance about ordering, or how the message should be restructured to make sense to the reader. Your message will also include more basic data about where it came from and where it is supposed to go.

Computers and the Internet require many high-tech and complicated pieces to run properly, but something known as a router is a key instrument that keeps information being sent from one computer to another going along the correct pathway. The Internet also relies on telephone wires and satellite links for wireless information sharing.

It's important to note that for the Internet to work as it does, many companies have to agree to work with one another. The Internet is really a collection of networks working together toward a common goal of allowing information to be shared.

Name: _____ **Date:** _____

1. What are two examples of technology that send information over long distances?

A. the human eye and computers

B. government officials and computers

C. cellphones and the human eye

D. cellphones and computers

2. What does the author compare to cellphones in this passage?

A. The author compares companies to cellphones.

B. The author compares engineers to cellphones.

C. The author compares computers to cellphones.

D. The author compares cellular networks to cellphones.

3. A cellphone sends and receives information in a speedy way invisible to the human eye.

What evidence from the passage supports this statement?

A. When a person speaks into a cellphone, his or her voice is broken down and reassembled over a radio link, so the person on the other end instantaneously hears what is said.

B. When computers first showed up around 1941, they were used to transmit sensitive information across geographical spaces by the military because of worries government officials had.

C. Although people may take for granted the ease with which they can pass along information through computers, many forces are at work to make computer communication more reliable.

D. Like cellphones, computers can receive, decode, and convert information, though typically this information is written content rather than someone's voice.

4. What is one way that computer use has changed over time?

A. Computers were first used in homes, schools, and offices to send different kinds of information, but now they are used only by the military to send sensitive information.

B. Computers were first used by the military to send sensitive information, but now they are used in homes, schools, and offices to send different kinds of information.

C. Computers used to send a person's voice from one place to another, but now they send only written content.

D. Computers used to send a person's voice from one place to another, but they have been gradually replaced by landline telephones.

5. What is this passage mostly about?

A. computers, the Internet, and how the military uses technology to protect people

B. cellphones, landline telephones, and the reasons people have trouble hearing each other over the phone

C. mobile phone operators, government officials, and companies that work with one another

D. cellphones, computers, and how they send information from one place to another

6. Read the following sentence: "It's possible, with current technological capabilities, to **transmit**digital information over long distances using coding and decoding processes without losing the contents of the original information."

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

A. harm

B. fold

C. hear

D. send

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

Information is transmitted by different kinds of modern technology, _____ cellphones and computers.

A. in conclusion

B. instead

C. especially

D. never

8. According to the passage, what are cellphones used for?

_____

_____

_____

9. How does a cellphone transmit information using cellular networks?

_____

_____

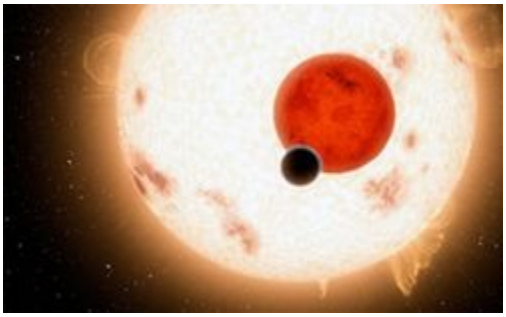
_____

10. At the end of the passage, the author writes, "The Internet is really a collection of networks working together toward a common goal of allowing information to be shared." Could cellphones be described in the same way? Explain your answer using evidence from the passage.

In Our Galaxy, Far, Far Away

NASA Announces the Discovery of a Planet That Orbits Two Stars, But There May Be More ...

In the film *Star Wars: Episode IV -A New Hope* , a future Jedi named Luke Skywalker watched as two suns set on his home planet, Tatooine. When that film was made some 30 years ago, the existence of a planet with two stars was pure science fiction. Now, astronomers say, it's a scientific fact.



NASA/JPL

On September 15, 2011, NASA, the U.S. space agency, announced the discovery of Kepler-16b, a circumbinary planet, or a planet in the orbit of two stars. Scientists had previously discovered a few other objects orbiting two stars, but Kepler-16b is the first confirmed planet.

"It's the best example we have of a Tatooine-like world from *Star Wars*," says Nick Gautier, a scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif. "Now we don't expect Luke Skywalker or anything else to be living on Kepler-16b, but if you could visit there, you would see a sky with two suns just like Luke did."

Star Power

The discovery was made by the Kepler space telescope, which is on a mission to find Earthlike exoplanets-planets in orbit around stars other than the sun. Kepler-16b is the 21st confirmed planet that Kepler has detected since its launch in March 2009.

Lucas Film/20th Century Fox/The Kobol Collection

Luke Skywalker watches a double sunset on his home planet of Tatooine.

Kepler-16b's star system is located between the constellations Cygnus and Lyra, about 200 light-years from Earth. A light-year equals the distance light travels through space in a single year, or about 5.9 trillion miles. The planet is about the size of Saturn, but, because it's gaseous, scientists don't believe it to be habitable.

Although it has two stars, Kepler-16b is probably much colder than Earth because neither star is as powerful as Earth's sun. One star is 69 percent of the mass of the sun. The other is only 20 percent of the mass of the sun. The two stars-together called a binary star-orbit around a common center. They cross paths every 41 days. The planet orbits around both stars every 229 days.

"We have two stars dancing around each other, and in our line of sight, they eclipse each other," says Laurance Doyle, principal investigator for the SETI (Search for Extraterrestrial Intelligence) Institute in Mountain View, Calif. "Then we have this exquisite little pirouette of the planet going around both of them."

The Light Stuff

Scientists are doing much more than admiring the fancy footwork of this dance in space.

EADS Astrium/Corbis

This artist's rendering shows the Kepler space telescope. Kepler has the largest camera ever launched into space.

"One way to find exoplanets is to find stars whose planets orbit so they cross in front of the star visible from Earth," says Gautier. The Kepler telescope monitors the brightness of stars, he explains.

When a planet crosses in front of a star during an eclipse, it dims some of the star's light for a few hours. By analyzing the changes in light, scientists can accurately determine the size and mass of the planet.

Astronomers hope that further study of binary star systems will help shed light on how planets are formed. "There are as many binary stars as single stars and over 2,000 eclipsing binary stars within Kepler's line of view," says Gautier. "So this could be very common."

Looking For Life

Kepler's main mission, however, is to find Earth-sized planets that are the right distance from a star to have a livable temperature. In February,2011, NASA announced the discovery of 1,235 possible exoplanets. Now the challenge is to find one that could potentially support life.

To date, Kepler has detected large gaseous planets like Jupiter that, because of their distance from their respective stars, would be as hot as Mercury. The telescope also has spied gas planets scope similar in size to Neptune in close orbit around stars. Kepler has even found rogue planets, planet-sized objects that appear to have broken free from the gravitational force of their stars so that they are no longer in orbit.

NASA/JPL

An artist's rendering shows Kepler-16b, the first known circumbinary planet.

The discovery of Kepler-16b opens up a whole new world of possibilities.

"This is an example of another planetary system. A completely different type that we've never seen before," says Doyle. "Nobody's ever seen a place like this before-with one exception. I seem to remember seeing a place like this before about 30 years ago [when *Star Wars* premiered] in a galaxy far, far away."

Name: _____ **Date:** _____

1. What fictional planet does the writer compare Kepler-16b to?

A. Pluto
B. Lyra
C. Tatooine
D. Cygnus

2. How does the author describe Kepler-16b?

A. as a rocky planet that orbits two stars
B. as a moon that crosses the path of several stars
C. as a planet probably much warmer than Earth
D. as a gaseous planet about the size of Saturn

3. Which of the following conclusions about the Kepler space telescope is supported by the passage?

A. NASA will stop searching for planets with the telescope.
B. The telescope will soon find that Kepler-16b supports life.
C. Kepler-16b is the last planet the telescope will discover.
D. The telescope will most likely discover more planets.

4. Read this sentence from the passage:

"The planet is about the size of Saturn, but, because it's gaseous, scientists don't believe it to be habitable."

In this sentence, the word **habitable** means

A. growing in size
B. carefully observed
C. suitable to live on
D. covered with holes

5. Which statement best describes the main idea of the passage?

A. The Kepler space telescope is on a mission to find Earthlike exoplanets.

B. Scientist Nick Gautier is studying exoplanets to learn how planets form.

C. Kepler-16b's star system is located about 200 light-years from Earth.

D. NASA recently announced the discovery of a circumbinary planet.

6. What is a light-year?

7. How might Laurance Doyle, principal investigator for the SETI Institute, have felt when he learned of the discovery of Kepler-16b? How do you know?

8. The question below is an incomplete sentence. Choose the word that best completes the sentence.

Rogue planets are no longer in orbit _____ they have broken free from the gravitational force of their stars.

A. before

B. however

C. because

D. although

Ancient Infant's DNA Provides Key to Native American Ancestry

This article is provided courtesy of History.com

Between 13,000 and 12,600 years ago, members of the Clovis culture appeared in North America, where they made and used distinctive stone-tipped spears to hunt mammoth, bison and mastodon. Until recently, all that archeologists knew about the Clovis people came from studying their tools, which have been unearthed at wide-ranging sites across the country. Now, DNA analysis of a single human skeleton--that of a one-year-old boy buried in a rocky field in modern-day Montana--has allowed scientists to link the Clovis culture to Native Americans throughout the Western Hemisphere.

Construction crews first discovered the ancient remains of an infant in 1968 on private property owned by the Anzick family in western Montana. Dubbed Anzick-1, the one-year-old boy is the only human skeleton that has been identified as a member of the widespread, sophisticated Ice-Age culture known as Clovis. Now, a team of scientists has succeeded in mapping the infant's DNA, in the oldest genome sequence of an American individual ever performed. According to their findings, published in the journal Nature in February 2014, the Clovis people are direct ancestors of many Native Americans now living in North America, and can be linked to many native peoples in Central and South America as well.

Up to this point, all scientists studying the Clovis culture had to go on were the stone and bone tools

that have been found at sites ranging from Washington State to Florida, along with many states in between. By sequencing the genome of the infant recovered at the Anzick site, the international team of researchers gained the most vivid insight yet about who these people might actually have been. They compared the DNA of the Clovis infant to several different genomes, including a 24,000-year-old sample from a young man buried on the banks of Lake Baikal in Siberia, a 7,000-year-old sample from Spain and a 4,000-year-old sample from Greenland. The Clovis DNA showed the most similarity with that of the Siberian youth, whom scientists genetically linked with today's Native Americans in 2013.

The new study adds to existing archeological evidence that Native Americans descended from humans who migrated to North America from Asia through Siberia around 15,000 years ago. They are believed to have made the voyage across the Bering land bridge, which connected Asia with North America during the last Ice Age. According to archeologist Michael Waters of Texas A&M University, a member of the team who conducted the new study, the genetic evidence "strongly suggests that there was a single migration of people into the Americas....[T]hese people were probably the people who eventually gave rise to Clovis."

Such evidence casts doubt on other theories arguing that Clovis' ancestors came from Europe, rather than Asia. Such hypotheses rely partially on the fact that the "Clovis points" found on their tools and weapons are so similar to the flint tools used by the Solutrean culture, which flourished in Spain and France during the Ice Age.

While Anzick-1 showed the most genetic similarities with Native Americans in North America, the study also revealed ties with the indigenous peoples of Central and South America. The team's data indicates that sometime between 13,000 and 24,000 years ago, the same ancient people that arrived from Asia split into two lineages: One gave rise to Clovis and today's Native Americans of North America, and the other became the ancestors of Central and South American tribes.

The scientists studying Anzick-1 have worked closely with Native American tribes in Montana, sharing the results of the study with them and ensuring that the remains were treated appropriately. The infant will be reburied later this year, on the same property from which he was unearthed. For their part, the tribes have shown little surprise at the scientists' conclusions. Shane Doyle, a professor of Native American History at Montana State University and co-author on the study, is also a member of the Crow tribe. As he told NBC News, after conversations with more than 100 tribe members, the main reaction was "We have no reason to doubt that we've been here for this long."

Name: _____ **Date:** _____

1. What was Clovis?

A. a widespread, sophisticated Ice-Age culture in North America

B. a culture that existed in Greenland about 4,000 years ago

C. a culture that flourished in Spain and France during the Ice Age

D. a culture that gave rise to Central and South American tribes

2. The text describes a possible sequence of human descent. At the end of the sequence are Native Americans. What people are at the beginning of the sequence?

A. people who migrated from Asia to North America about 15,000 years ago

B. tribes living in Central and South America today

C. people who were living in Greenland about 4,000 years ago

D. people who were living in Spain about 7,000 years ago

3. The Clovis people descended from humans who migrated to North America from Asia through Siberia around 15,000 years ago.

What evidence supports this theory?

A. the similarity between the DNA of a Clovis infant and the DNA of a member of the Crow tribe

B. the similarity between the DNA of a Clovis infant and the DNA of a person from Iceland who lived 4,000 years ago

C. the similarity between the DNA of a Clovis infant and the DNA of a person from Spain who lived 7,000 years ago

D. the similarity between the DNA of a Clovis infant and the DNA of a Siberian youth who lived 24,000 years ago

4. The Clovis people descended from humans living in Europe.

What evidence supports this theory?

A. the similarity between the tools of the Clovis people and the tools of people in Siberia

B. the similarity between the tools of the Clovis people and the tools of people in Montana

C. the similarity between the tools of the Clovis people and the tools of people in France and Spain

D. the similarity between the tools of the Clovis people and the tools of people in Greenland

5. What is the main idea of this text?

A. Construction crews discovered the ancient remains of an infant in 1968 in western Montana.

B. Similarities exist between the tools of the Clovis people and the tools used by members of the Solutrean culture.

C. DNA analysis of an ancient infant's remains has allowed scientists to link the Clovis culture to Native Americans.

D. Scientists studying the remains of an ancient infant worked closely with Native American tribes in Montana to ensure that the remains were treated appropriately.

6. Read this sentence from the text.

"According to their findings, published this week in the journal Nature, the Clovis people are direct ancestors of many Native Americans now living in North America, and can be linked to many native peoples in Central and South America as well."

What does the author mean by writing that the Clovis can be linked to many native peoples in Central and South America?

A. The author means that many native peoples in Central and South America could communicate with the Clovis people.

B. The author means that many native peoples in Central and South America are related to the Clovis people.

C. The author means that the Clovis people used the same technology as many native peoples in Central and South America.

D. The author means that the Clovis people got along well with many native peoples in Central and South America.

7. Read these sentences from the text.

"While Anzick-1 showed the most genetic similarities with Native Americans in North America, the study also revealed ties with the indigenous peoples of Central and South America. The team's data indicates that sometime between 13,000 and 24,000 years ago, the same ancient people that arrived from Asia split into two lineages: One gave rise to Clovis and today's Native Americans of North America, and the other became the ancestors of Central and South American tribes."

What word could best replace "While" in the first sentence?

A. Currently

B. Although

C. Consequently

D. Finally

8. Who is Anzick-1? Be sure to mention the Clovis people in your answer.

9. Scientists discovered a link between the DNA of Anzick-1 and the DNA of a Siberian youth. Who else has been genetically linked with the Siberian youth?

10. How likely is it that the ancestors of today's Native Americans came from Asia?

Support your answer with evidence from the text.

Changes in Biodiversity

by ReadWorks

Hundreds of years ago, before North America was split up according to states and countries, native populations lived in the many varied areas of the continent. There were jungles, forests, riverlands, dry prairies, wetlands, and many other types of geographies where people lived. There were no cities as we know them today: humans lived in tune with nature, relying on their surroundings to build shelters, hunt and gather food, and create forms of exchange (for example, shells found on beaches could be traded for animal skins).

Each Native American tribe was attuned to the specific land on which they lived, and had certain customs that utilized their land to the utmost. Native Americans living in what is now known as the Midwest relied on hunting large animals like bison for their meat and their skins. Their meat provided an important source of nourishment for many tribes, and their skins were a valuable material that was used in the production of clothes and teepees, a type of shelter. Other tribes who lived on the eastern coast of North America made extensive use of the forests there, trapping small animals and game (like deer) that lived among the trees, and farming hearty foods that could handle the changes in weather, like corn. Still other tribes, who lived in the deserts of what is now Arizona, built homes in the rocky cliffs and hills for protection.

The variety of plant and animal life in these specific environments is called biodiversity. The tribes who lived in what is now known as Seattle fished salmon, while the tribes who lived in what is now known as Maine caught crabs and lobsters. As you can see, even though each group relied on seafood, the type of fish they ate was dependent on the type of fish that was available to them. At the

time we are thinking about, if you lived in Seattle, there were no restaurants you could go to and order lobster!

Now think for a moment about what this means. Let's say one year, a pod of whales was unable to go to their usual feeding area in Alaska because a school of sharks was inhabiting those waters during the whales' feeding time. So, looking for other sources of food, the whales swam down towards Seattle and noticed a large population of salmon. They ate all the salmon and, full and content, swam away to their next destination. The next week, the human tribes living in Seattle go to where the salmon usually are in order to get the first big catch of the season, and they find that no salmon are there. Instead of catching salmon, a staple of their diet, the humans must find another food source: their habitat has changed, and now the humans, like the whales before them, must adapt to their new situation.

This brings us to the very important idea of the ecosystem. An ecosystem is a very complex and delicate arrangement of plants and animals that provide nourishment for each other in a variety of ways. If one part of the ecosystem changes or is disrupted, it can affect the entire workings of an environment.

Humans have made changes to their ecosystems to serve a specific need. And in certain cases, the goal is to disrupt the population of another species within the ecosystem. However, there can be unintended consequences. One example is the use of pesticides. When American farmers began using pesticides (chemical insect-repellants) to get rid of bugs that decimated entire harvests of crops, they had no idea what the consequences would be-or whether there would be any consequences. As scientists began to study how people used certain types of chemicals for certain types of crops, they learned that there are some pesticides that are not just harmful for insects-they are harmful for humans too, and were making many people sick after they had eaten the crops that had been sprayed with those pesticides. With this knowledge, scientists were able to develop other pesticides that were less harmful for humans but were still useful in getting rid of the bugs that liked to eat humans' important crops. As you can see, the changes that humans made in the ecosystem-the biodiversity that the humans cut down on by making sure the insects left the plants alone-needed to be studied carefully so that the changes made were sure to be beneficial.

Name: _____ **Date:** _____

1. What does biodiversity refer to?

A. chemical replants that are used to get rid of bugs

B. the scientific study of an ecosystem

C. the variety of plant and animal life in an environment

D. the large population of salmon that live near Seattle

2. What does the author explain in the passage?

A. the author explains the terms "biodiversity" and "ecosystem," giving examples of each

B. the author explains the terms "tribe" and "Native American" without giving any examples

C. the author explains the terms "pod," "school," and "wetlands," giving two examples of each

D. the author explains the terms "nourishment" and "chemical" without giving any examples

3. Changing one part of an ecosystem can affect other parts of the environment where the change is made.

What evidence from the passage supports this statement?

A. Native Americans who lived in what is now known as the Midwest hunted large animals like bison.

B. Tribes who lived in the deserts of what is now Arizona built homes in the rocky cliffs and hills.

C. When American farmers began using pesticide to harm bugs, they harmed humans as well.

D. Tribes on the West Coast of North America fished salmon, while tribes on the East Coast caught crabs and lobsters.

4. Based on the information in the passage, what can the reader conclude about biodiversity?

A. There was very little biodiversity in North America before it was split up into states and countries.

B. There was a lot of biodiversity in North America before it was split up into states and countries.

C. Biodiversity cannot be affected by human activity.

D. Biodiversity cannot be affected by changes to the ecosystem.

5. What is this passage mainly about?

A. different Native American tribes and the ways in which they obtained food

B. natural environments and the way changes can affect those environments

C. pesticides used by farmers and the harmful effects of those pesticides on humans

D. a pod of whales that cannot go to its usual feeding area in Alaska because of sharks

6. Read the following sentences: "An ecosystem is a very complex and delicate arrangement of plants and animals that provide nourishment for each other in a variety of ways. If one part of the ecosystem changes or is disrupted, it can affect the entire workings of an **environment**."

What does the word **environment** mean?

A. a species of plant or animal

B. a group of Native Americans living in the same place

C. the damage that humans can do to their surroundings

D. an area where things live

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

Native Americans living in what is now known as the Midwest hunted large animals; _____, Native Americans living on the eastern coast caught small animals.

A. on the other hand

B. as a result

C. as an illustration

D. most importantly

8. What happened when American farmers started using pesticides to get rid of bugs?

9. According to the passage, how could a pod of whales being unable to go to their usual feeding area affect humans? Be sure to describe the full chain of events in your answer.

10. Suppose that people living by a lake decided to put a chemical in the water to get rid of a certain type of fish in the lake. Would that action be likely to affect other living things in that environment? Use evidence from the passage to explain why or why not.