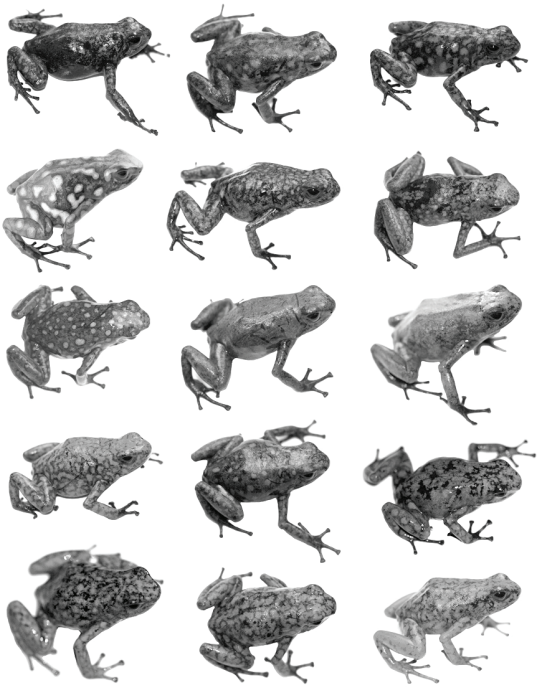
Name: Wednesday Date: _____

Warm-Up

Observing a Population

Below is an image of a rain forest in Ecuador. The frogs (also pictured below) live there and are all the same species, a type of dart frog. Observe the frogs closely and describe them below. (Note: Your teacher will project a color version of these images.)



Describe the group of frogs in the image.

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Name: _____ Date: _____

Homework: Reading "The Rough-Skinned Newt"

Read and annotate the article "The Rough-Skinned Newt." Answer the reflection questions below.

1. What are some of the traits present in the newt population described in the article?

_____

_____

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2. How might these traits change from individual to individual? *(Hint: Do you think the newts are all exactly the same color or size?)*

_____

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Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

The Rough-Skinned Newt

Rough-skinned newts may not appear dangerous: they are no longer than 20 centimeters (8 inches), with stubby legs and teeth that look like tiny bumps. However, some of these newts are the most poisonous animals in the Pacific Northwest. One rough-skinned newt can have enough poison in its body to kill dozens of humans!

Rough-skinned newts have brown, bumpy skin on their backs, with bright orange skin on their bellies. When threatened by predators, newts curl their bodies to show the orange undersides of their necks and tails. The orange color warns predators to stay away, and most predators do. The only predators that regularly eat rough-skinned newts are common garter snakes.

Newts hatch in the water, but they spend most of their lives on land, often hiding under fallen leaves or bark. At night, they hunt for insects, tiny fish, and other small prey. When they are ready to mate, rough-skinned newts return to the water, where males and females swim together in pairs. The females lay poisonous eggs and attach them to underwater plants.

Rough-skinned newts have brown, bumpy skin on their backs and orange skin on their bellies.

Rough-skinned newts spend most of their time on land, but return to the water when it's time to mate.

Name: Thursday Date: _____

Warm-Up

Describing the Rough-Skinned Newt Population

Consider the poison-level traits in the rough-skinned newt population. Then, reread the first paragraph from the "The Rough-Skinned Newt" article and answer the question below.

Think about what you have learned so far about populations in general and the rough-skinned newt population in the park. What prediction would you make about the poison-level traits in this population? (check one)

- ☐ All of the newts have the same poison-level trait because they are from the same population.
- ☐ This population has different poison-level traits: some have low poison level, some have medium poison level, and some have high poison level.
- ☐ None of the newts in the population have the same poison-level trait because they are all individuals.

Name: _____ Date: _____

Homework: Reading "Meet a Scientist Who Studies Natural Selection"

Read and annotate the article "Meet a Scientist Who Studies Natural Selection." Answer the reflection questions below.

1. Why are yeast good organisms for studying natural selection?

_____

_____

_____

_____

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2. What is one interesting thing you learned about Dr. Yuan?

_____

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Active Reading Guidelines

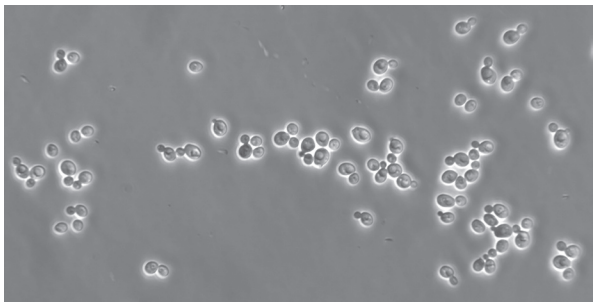
1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Meet a Scientist Who Studies Natural Selection

Dave Yuan spends his days surrounded by millions of yeast, the one-celled organisms used to make bread rise. However, Yuan isn't a baker—he's a geneticist who studies natural selection. Yeast are good organisms for studying natural selection, because they reproduce very quickly. Scientists can control the yeast organisms' environment and watch what happens to many generations of yeast in a short period of time as they pass genes down. "We use a special tool to bar code different lineages (family lines) of yeast—there are about half a million unique lineages," says Yuan. "We can watch natural selection under all kinds of conditions. For example, we can grow yeast until there's no more food or space for them, then transfer them to a fresh environment and see what happens." Yuan and his team do this type of experiment 50 to 100 times over a few months, then see how certain traits are distributed in the population of yeast. Lineages that developed adaptive traits should be more common in the population because they have lived long enough to pass on their genes, while lineages that developed non-adaptive traits should be less common in the population.

It's no surprise to Yuan that he grew up to be a scientist. He's always been interested in science, especially in understanding how there came to be so many different types of organisms on Earth. He majored in biology in college, then worked as a lab assistant for a few

Dr. Dave Yuan studies natural selection using yeast. Since yeast reproduce very quickly, he can change the yeast organisms' environment and watch how their traits are passed down over many generations.



These are tiny living yeast cells seen through a microscope.

years—he wanted to try out scientific research as a job to see whether he liked it. After a few years, he decided to go to graduate school, and today he works as a researcher studying natural selection at the molecular level.

For Yuan, studying natural selection is exciting because he sometimes learns things that nobody has ever known before. "I like that whatever I work on, I'm working toward discovery of some kind," he says. "You're in the lab all day, but at a higher level, what you're doing is on the cutting edge of what we're learning. We're actually discovering things."

On the other hand, he says things don't always go as planned. "Failure is something that every lab scientist is very familiar with, but I think that's not well known outside of research," he says. Since he and his team are working with new information and technologies, they sometimes run into problems that nobody expected—and they have to solve them. "These are experimental systems," he says. "We make things up as we go and troubleshoot, look at what we have and try to deal with very complicated machines. A lot of times, things just don't work, and it can be frustrating."

When Yuan thinks about his path to working as a scientist, he wishes he could tell his younger self a few things—like the importance of learning as much math as he could. "I was pretty good at math in junior high and high school, but I didn't like it. I thought, 'you just have to get through this and then never use it again,' but that's not really true." Yuan says he uses math and statistics every day in his research. A background in computer coding would be helpful, too. Computer coding is "a very useful tool" for scientific research, according to Yuan.

Yuan plans to continue studying natural selection—but he hopes someday to do his work outside of the lab. Some biologists study natural selection in the field, taking trips to different environments to observe and gather information, and Yuan hopes to be one of them: "I've always wanted to do something where I get to go out into nature," he says. "It's rare, but there are people who do it!"

Name: Friday _____ Date: _____

Reflection

Based on today's lesson, how would you describe the traits of this population? (check one)

- ☐ All of the horses have the same traits because they are in the same population.
- ☐ This population has different traits for color: some are brown, some are black, some are gray, and some are white.
- ☐ None of the horses in this population have similar traits because they are all individuals.
- ☐ The horses in this population are all the same because they all have a coat, a mane, and a tail.
- ☐ These horses must not be a population because they have different traits.

Name: _____ Date: _____

Homework: Reading *Wildlife in the Woods*

1. First, read and annotate the "Common Garter Snake" article.
2. Next, choose two other articles to read and annotate.
3. Then, answer the reflection questions that go with the three articles you read.

"Common Garter Snake"

1. What part of the environment might make an individual more or less likely to survive?

_____

_____

2. Which traits does the common garter snake have that might be adaptive for the environment where it lives?

_____

_____

Article 2

Which organism did you read about? _____

1. What part of the environment might make an individual more or less likely to survive?

_____

_____

2. Which traits might be adaptive for that environment?

_____

_____

Chapter 3: Common Garter Snake

Common garter snakes are colorful snakes with long stripes that may be green, blue, red, orange, yellow, or brown. They can grow up to 1.2 meters (4 feet) long, but they are slender and harmless to humans.

Often living along the edges of lakes and ponds, common garter snakes hunt small prey both on land and in the water. Their excellent sense of smell helps them to find and catch young fish, frogs, newts, worms, insects, and other small animals. Like most snakes, they swallow prey whole.

Garter snakes' stripes make it harder for predators to see them when they are hiding in grass or reeds. Predators that eat garter snakes include larger snakes, birds, fish, and dogs. If caught, garter snakes produce a foul odor to try to drive their predators away. Unlike many other snakes, common garter snakes do not lay eggs. Instead, they give birth to live young—as many as 40 little snakes at once!

The stripes of common garter snakes make them harder to see when they're hiding in grass or reeds.

Chapter 4: Western Screech-Owl

The gray-and-white feathers of the western screech-owl blend in perfectly against tree bark, helping it to hide during the day. This small owl has large yellow eyes and two feathery tufts on its head. Western screech-owls often live in tall Douglas fir trees, usually at the edges of ponds or grassy areas.

At night, western screech-owls use their excellent senses of sight and hearing to watch and listen for small prey. They swoop silently down from trees to grab mice, small birds, and large insects with their powerful feet. However, due to their small size, screech-owls have to be on the lookout for larger night predators that might eat them, such as great horned owls, raccoons, and skunks. Western screech-owls use camouflage to stay safe from predators: they stretch to be as tall as possible, hold their feathers flat against their bodies, and close their eyes so they look like part of the branch they're sitting on.

Western screech-owls lay their eggs in holes in trees without adding any sticks or other nesting material. Males and females work together to guard their nests and bring food for the young birds once they hatch. These owls guard their nests boldly, and may even attack humans who come too close.

A western screech-owl's markings act as camouflage when it sits in a tree

Name: Monday _____ Date: _____

Homework: Reading *Wildlife in the Woods* (continued)

Article 3

Which organism did you read about? _____

1. What part of the environment might make an individual more or less likely to survive?

_____

_____

2. Which traits might be adaptive for that environment?

_____

_____

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
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4. After you read, discuss what you have read with others to help you better understand the text.

Chapter 2: Western Harvest Mouse

Western harvest mice are tiny, even for mice: an adult only grows to about 7.6 centimeters (3 inches) long, plus a tail of about the same length. These mice have large, hairless ears, pale bellies, and dark stripes down their backs. Like all mice, they have large front teeth that are good for gnawing hard food.

Western harvest mice got their name because they harvest (pick and eat) the seeds of plants in grassy areas. They hide extra food underground using holes left behind by other small animals. Western harvest mice weave grass into soft nests about the size and shape of a baseball, where they hide all day. These tiny mice mostly come out at night and are especially active on dark, moonless nights when it is harder for predators to see them.

Predators that eat western harvest mice include snakes, owls, hawks, and foxes. To avoid being eaten, the mice spend a lot of time hiding in covered places: they build their nests deep in grass, underground, or under fallen trees.

These tiny mice usually live less than a year, but they reproduce a lot: about once a month, each female may give birth to up to nine babies.

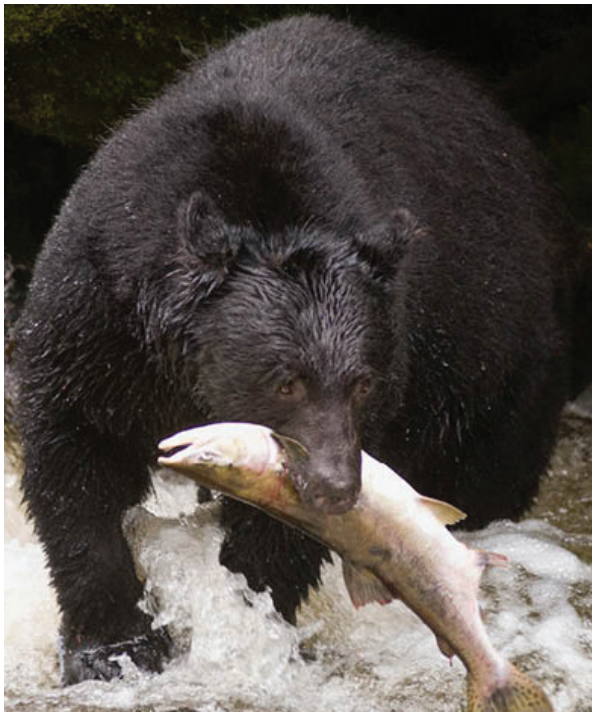
The adult western harvest mouse is only about 7.6 cm (3 in) long.

Chapter 5: American Black Bear

American black bears are not always black: their fur may be brown, reddish, or even white! Large males often grow to weigh about 250 kilograms (550 pounds). Black bears' powerful legs are tipped with long, sharp claws excellent for fighting, climbing trees, and clawing beehives open.

Hungry black bears will eat almost anything. Most of their food comes from plants, including nuts, berries, tree bark, and soft young leaves. They also eat honey, as well as bees, ants, and other insects. Many black bears hunt for salmon in rivers. Black bears don't usually hunt for land animals, but they will eat dead animals when they find them. Black bears are smart and curious, exploring their environment for anything they might be able to eat.

Adult black bears are so big that they are rarely attacked by predators. Instead, the most dangerous part of black bears' environment is people. Many bears are killed by hunters or hit by cars, and the more bears come into contact with humans, the more likely they are to be killed. Black bears also sometimes die because they can't find enough food—it takes a lot of fish, nuts, berries, honey, and insects for such a large animal to stay alive. Bears that must compete with many other bears for their food, or that live in places where food is scarce, may not survive for long.



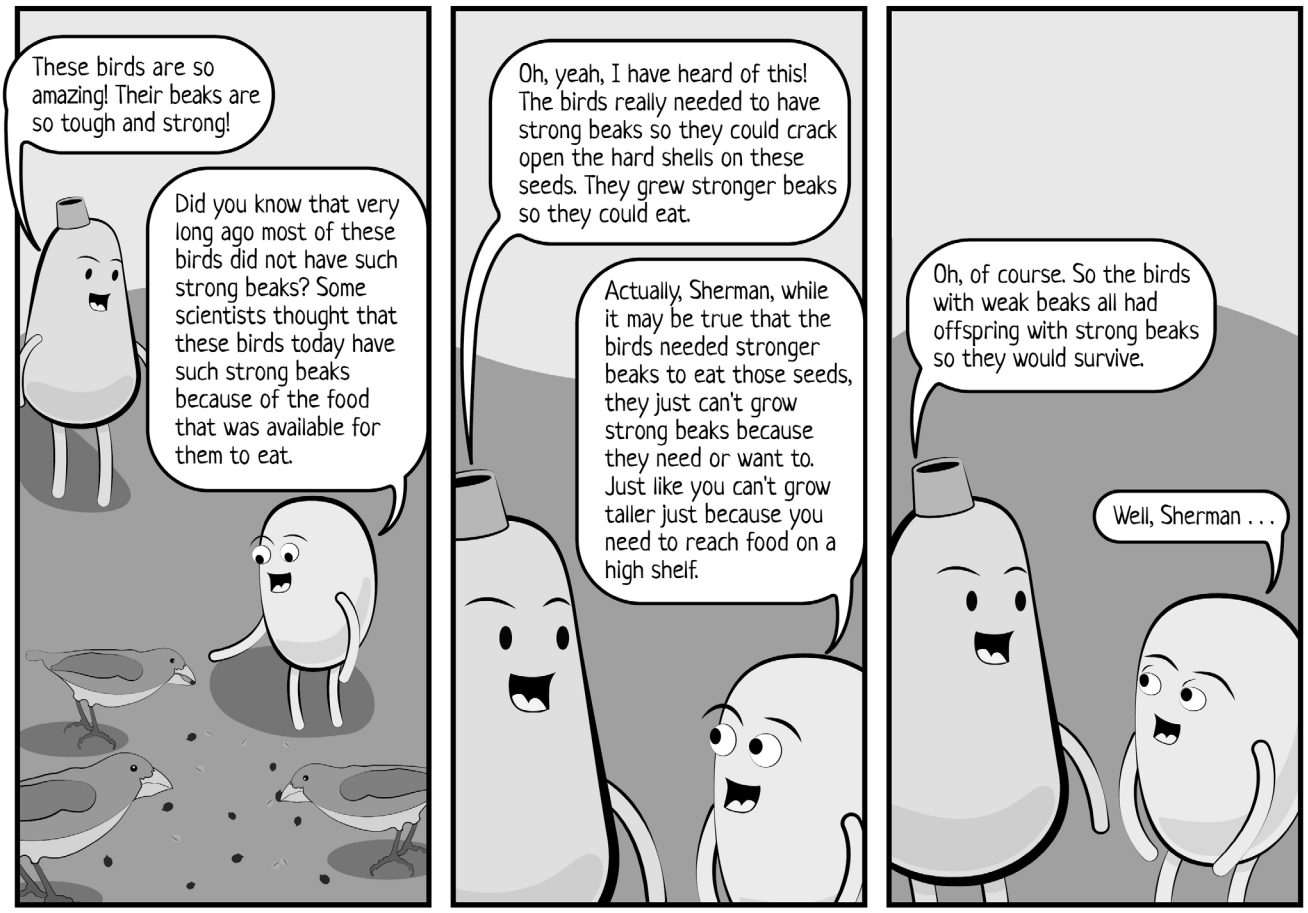
Black bears eat almost anything, including salmon they hunt in rivers.

Name: _____ Date: _____

Warm-Up

Read the story and then answer the questions below and on the next page.

Sherman's Stories #2: Bird Beaks



1. In this environment, which trait is adaptive for the birds?

_____

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_____

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Name: _____ Date: _____

Warm-Up (continued)

2. Did the birds choose to have the adaptive trait? (check one)

   ☐ yes ☐ no

3. Sherman suggests that reproduction always creates individuals with adaptive traits. Does this seem correct? Why or why not?

_____

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Name: _____ Date: _____

Reflection

How do individuals in a population get their traits?

Use what you learned in this lesson to answer the Investigation Question.

1. Where do the genes that determine an individual's traits come from? (check one)
   - ☐ An individual can be born with any genes, since genes are random.
   - ☐ Individuals grow genes specific to their environment.
   - ☐ Parents pass their genes down to their offspring.
   - ☐ Parents choose which genes their offspring have when each individual is born.

2. How do genes determine an individual's traits? (check one)
   - ☐ Genes directly cause traits.
   - ☐ Genes are random and don't lead to traits.
   - ☐ Genes give organisms the ability to change their traits.
   - ☐ Genes are instructions for making protein molecules and protein molecules determine traits.

3. How can an individual be born with an adaptive trait? (check one)
   - ☐ The individual can choose to change to the adaptive trait when they want to.
   - ☐ The parents had genes for the adaptive trait, which they passed down to the individual.
   - ☐ The individual can choose to have the adaptive trait at birth.
   - ☐ The parents can choose for the offspring to have genes for the adaptive trait.

Tuesday - read and annotate every paragraph (summarize, ask questions, connect ideas)

Glowing Jellies

Imagine splashing in a calm ocean cove at night. As you splash, you notice green flashes in the water: glowing jellies! These are called crystal jellies. They can't sting humans, so you can swim and watch them glow green as you bump into them.

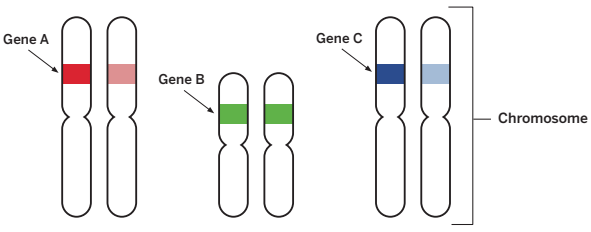
Where does this trait of being able to glow come from? In 1992, some scientists decided to find out. They examined the cells of crystal jellies and discovered that the glow comes from a protein. They gave the protein the name Green Fluorescent Protein, or GFP for short. To find out how these jellies make GFP, scientists investigated the jellies' genes. A gene is instructions for an organism's cells to make a particular protein. Scientists were able to find the gene that gave the jellies' cells instructions to make the GFP protein.

If a jelly has the GFP gene, its cells can make green fluorescent protein. If its cells make green fluorescent protein, the jelly can glow. The gene leads to the protein, which leads to the trait.

How does a jelly get the gene for glowing? When a pair of adult jellies reproduce, each one passes down genes to the offspring. Genes are found on chromosomes and chromosomes come in pairs. An organism has two copies of any given gene because there is one copy on each chromosome in a pair. However, the two copies of any particular gene can be the same version or different versions. These different versions of a gene are called alleles. When jellies reproduce sexually, each parent passes down one of each of their chromosomes (with all their genes on it) to the offspring. If at least one of the adult jellies has the version of the gene that is instructions for GFP, then that gene could be passed down to the offspring. Offspring with that gene will have cells that produce GFP, so they will glow, also.

Scientists think that jellies glow as a defense against predators. The bright glow might startle or confuse predators, or it might attract bigger predators that could scare away or eat the jelly's attacker! Glowing is an adaptive trait for jellies because it helps them survive in their environment.

A protein molecule called Green Fluorescent Protein (GFP) causes some jellies to glow in the dark!



This diagram shows three pairs of chromosomes. Chromosomes have many genes, but in this diagram only shows one for each chromosome. There are two copies of each gene, one on each chromosome of the pair. When an organism reproduces sexually, it gives the offspring one of each of its chromosomes and therefore one copy of each gene.

Name: Wednesday Date: _____

Reading "The Deadly Dare"

1. Read and annotate the article "The Deadly Dare."
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

What is something about the text that you discussed with your partner?

_____

_____

_____

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Active Reading Guidelines

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3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

The Deadly Dare

Rough-Skinned Newt Defenses

In 1979, friends dared a 29-year-old man in Oregon to swallow a living rough-skinned newt. The man didn't realize how poisonous rough-skinned newts are. A lethal, fast-acting poison called tetrodotoxin (TTX) oozes from their skin. The man swallowed the newt whole and started feeling weak a few minutes later. He described a numb feeling all over his body. His friends tried to take him to a hospital, but he refused. Just 20 minutes later, the man was dead.

Of course, the newt the man swallowed died, too. In that particular case, being poisonous didn't help that individual newt survive. If newts have to be eaten in order to defend themselves, being poisonous doesn't sound like a very good defense! How is being poisonous—having a high level of TTX poison—an adaptive trait for a rough-skinned newt?

Why Poison Is Adaptive

One reason TTX is adaptive is that it acts quickly. A predator that tries to eat a poisonous newt may become sick before it's able to kill the newt, allowing the newt to escape. In fact, TTX acts so quickly that sometimes predators die before finishing their meals. Scientists have observed rough-skinned newts crawling out of dead or paralyzed predators.

Rough-skinned newts may look harmless, but they are extremely poisonous.

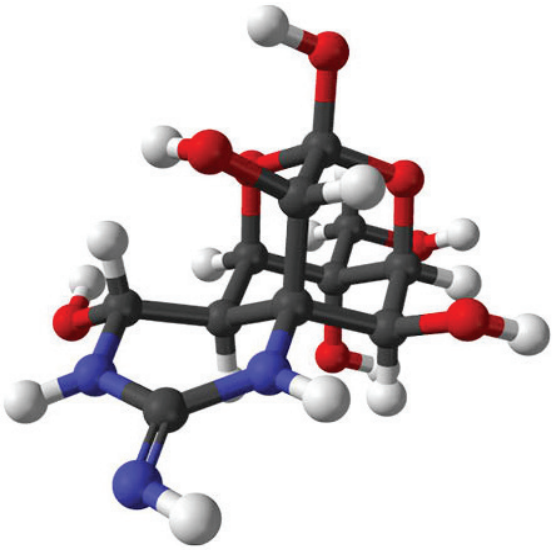
Even more important, predators can smell and taste TTX poison. The main predator of rough-skinned newts is the garter snake. Scientists have found evidence that garter snakes use their senses of smell and taste to tell whether a rough-skinned newt is too poisonous to eat. They have even observed garter snakes doing quick "taste tests"—licking rough-skinned newts before deciding whether to eat them.

Scientists have studied whether garter snakes are able to detect TTX poison in newts. Biologists have placed one newt and one garter snake together in a cage to see whether the snake would eat the newt. They have tried this test over and over again, using different snakes and different newts. Even though the newts are placed directly in front of the snakes, not every newt gets eaten! Biologists are able to consider the cause-and-effect relationship between high poison levels and survival in newts by examining a population of newts with high variation. The newts in the test range from having no poison to having very high levels of TTX in their bodies. In these tests, the snakes consistently eat the newts with the lowest levels of TTX, and do not eat the newts with high levels of TTX. These results are evidence that garter snakes can detect TTX and that they prefer to eat rough-skinned newts with lower levels of TTX. The more poisonous a rough-skinned newt is, the less likely it is to be eaten by a garter snake. That means high levels of TTX are an adaptive trait in rough-skinned newts that live near garter snakes.

The common garter snake is one predator that eats rough-skinned newts.

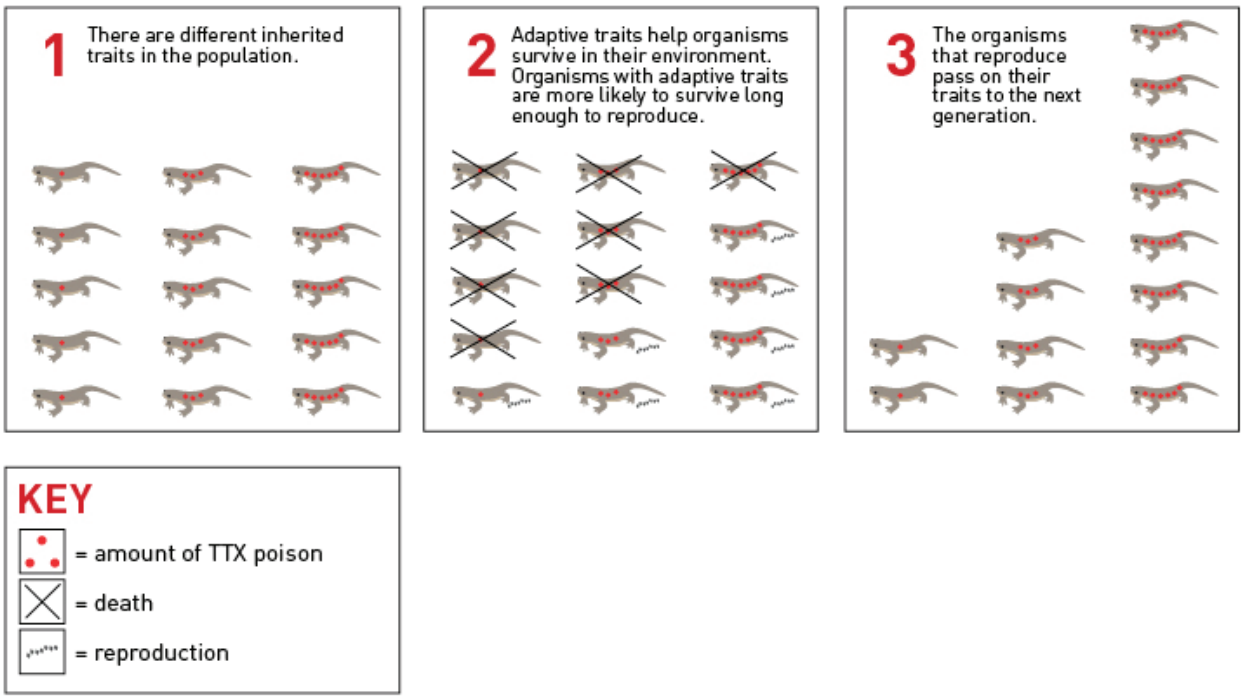
How Adaptive Traits Spread

If snakes are in its environment, a poisonous newt is less likely to die from being eaten than a newt that isn't poisonous. The newts that don't get eaten have a better chance of living longer, and that's important because it means more chances to reproduce. Organisms have to reproduce in order to pass on their genes, which are the instructions for making the protein molecules that determine traits: if they don't reproduce, their traits die with them. In the newt population, more poisonous newts are more likely to survive long enough to reproduce and pass down their genes, and therefore the trait of being poisonous, to the next generation. As a result, there will be more and more highly poisonous rough-skinned newts in each generation. This will cause the distribution of traits in the population to change over many generations. Scientists call this process natural selection. This process does not only happen in rough-skinned newts. It has been observed in populations of different species all over the world.



A rough-skinned newt's poison is a type called tetrodotoxin, or TTX for short. This is a model of a molecule of TTX.

How Natural Selection Works



Other Poisonous Organisms

Being poisonous is an adaptive trait for many different organisms, not just rough-skinned newts. There are many poisonous plants, such as deadly nightshade, hemlock, and mint. You might be surprised to see mint on this list, since you've probably eaten mint yourself! The poisons in mint are harmless to humans, but deadly to some plant-eating insects. These poisons are what give mint its minty taste and smell—they are warning signals telling insects to stay away.

Like rough-skinned newts, poisonous plants are poisonous as a defense against being eaten. Plants can't run away from animals that want to eat them, so they have to defend themselves in other ways—with adaptive traits like tough bark, sharp thorns, and being poisonous.

Deadly nightshade (left) is an extremely poisonous plant; eating just a few berries can kill a human. Mint (right) is harmless to humans, but deadly to some insects.

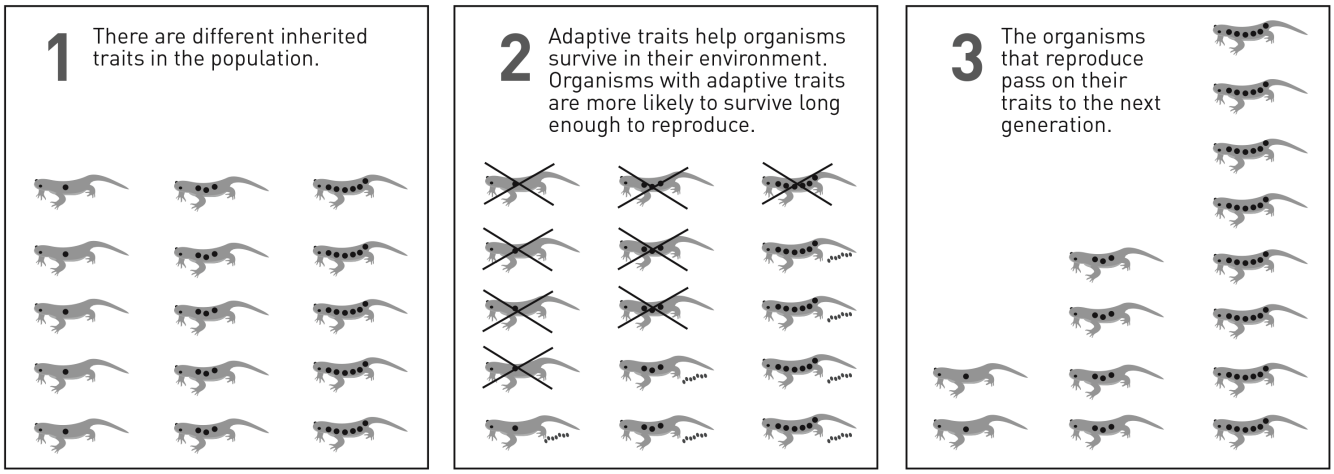
Besides poison, plant defenses include sharp thorns and thick bark.

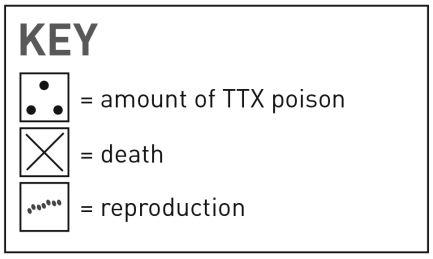
Name: Thursday Date: _____

Warm-Up

Examine the visual representation. Then answer the questions below. (Note: Your teacher will project a color version of this image.)

How Natural Selection Works





1. Look at Diagram 1. How could you describe this newt population? (check one)

   ☐ There are fifteen poison levels shown, and each individual has a different amount of poison.

   ☐ There is one poison level shown, and all newts have the same amount of poison.

   ☐ There are three poison levels shown, and no poison-level trait is more common than the others.

   ☐ There are three poison levels shown, and one poison-level trait is the most common.

2. Look at Diagrams 2 and 3. Did newts from all poison levels reproduce? (check one)

   ☐ yes ☐ no

Name: _____ Date: _____

Warm-Up (continued)

3. Look at Diagram 2. Did newts from all poison levels die? (check one)

   ☐ yes ☐ no

4. Look at Diagram 3. How could you describe this newt population? (check one)

   ☐ There are fifteen poison levels shown, and each individual has a different amount of poison.

   ☐ There is one poison level shown, and all newts have the same amount of poison.

   ☐ There are three poison levels shown, and no poison-level trait is more common than the others.

   ☐ There are three poison levels shown, and one poison-level trait is the most common.

5. What other questions or connections do you have about this visual representation?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

Rereading "The Deadly Dare"

Part 1: Understanding How Adaptive Traits Become More Common by Reproduction

Reread the section "How Adaptive Traits Spread" in the "The Deadly Dare" article, and then work with a partner to answer the questions. Remember to pay close attention to the diagram.

1. Which individuals are most likely to die before reproducing, those with adaptive traits or non-adaptive traits? Why? *(Hint: You may use the newt population as an example in your explanation.)*

_____

_____

_____

2. When many individuals with the same trait die before reproducing, what happens to the distribution of that trait in the population? Why?

_____

_____

_____

3. Why are there more newts with a high-poison level in the population in Diagram 3 than in the population in Diagram 1?

_____

_____

_____

4. Are the newts with high poison in Diagram 3 simply the oldest newts? How do you know?

_____

_____

_____

Name: _____ Date: _____

Rereading "The Deadly Dare" (continued)

Part 2: Considering What the Claim Additions Mean

Work with your partner to complete the statement and to answer the question below.

Some people think the **cause** of the change in the newt population is that the more poisonous newts lived longer than other newts. Other people think the **cause** of the change in the newt population is that the more poisonous newts reproduced more than other newts. The **effect** is that more newts now have the trait for high-poison level.

Add more detail to this statement to make it more accurate: "The less poisonous newts died and the more poisonous ones lived." (Hint: Start with *"The less poisonous newts . . . and the more poisonous ones . . . ")*

_____

_____

_____

The newt population became more poisonous because the snakes in this environment caused poison to be an adaptive trait. Which claim addition provides the most accurate explanation for this change? (check one)

- ☐ **Claim 1:** Poison Level 10 is the most common because the newts with this trait were able to live longer than other newts.
- ☐ **Claim 2:** Poison Level 10 is the most common because the newts with this trait reproduce more than other newts.
- ☐ Neither claim addition is accurate on its own.
- ☐ Both claim additions are accurate.

Name: Friday Date: _____

Reasoning About the Rough-Skinned Newts

Use the Reasoning Tool to connect each piece of evidence to the combined claim. Use the histogram on page 71 as a visual support if needed.

Claim: The newt population became more poisonous because the snakes in this environment caused poison to be an adaptive trait.

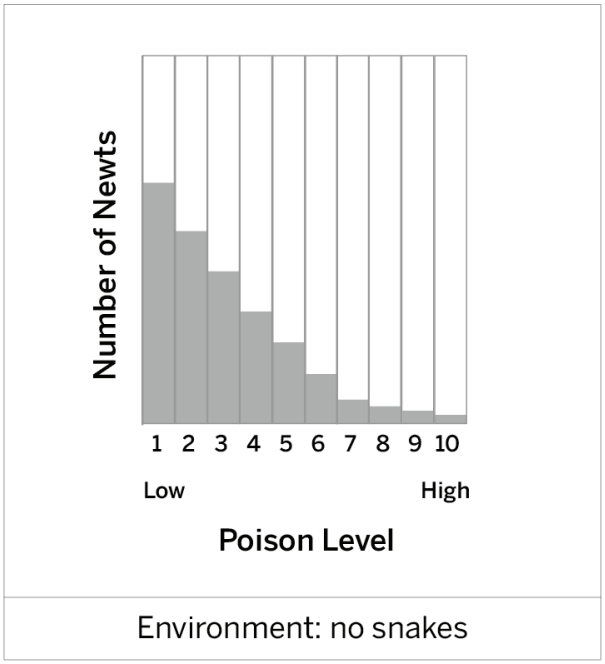
Revised Claim Addition: Poison Level 10 is the most common because the newts with this trait were able to live longer and reproduce more than other newts.

Evidence	This matters because . . .	Therefore, . . .
Sometime between 50 generations ago and today, snakes became part of this newt population's environment.		
50 generations ago, most newts had the trait for Poison Level 1. Today, most newts have the trait for Poison Level 10.		
50 generations ago, some newts had each of the poison-level traits. Today, no newts have the trait for Poison Level 1.		
From "The Deadly Dare": "Even more important, predators can smell and taste TTX poison. The main predator of rough-skinned newts is the garter snake. Scientists have found evidence that garter snakes use their senses of smell and taste to tell whether a rough-skinned newt is too poisonous to eat."		

Name: _____ Date: _____

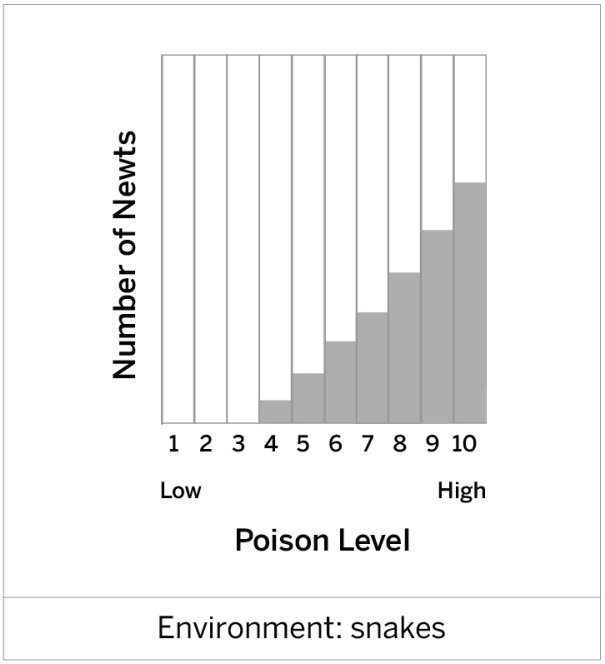
Reasoning About the Rough-Skinned Newts (continued)

Population 50 Generations Ago

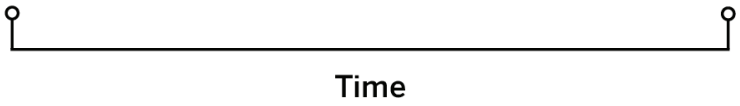


Environment: no snakes

Population Today



Environment: snakes



Name: _____ Date: _____

Homework: Writing About the Rough-Skinned Newts

Now that you have a better understanding of natural selection, write Alex Young an argument for the claim you think is best supported about the mystery of the rough-skinned newts.

Be sure to use some of the vocabulary words you have learned so far.

Word Bank

adaptive trait	distribution	environment	gene
generation	natural selection	non-adaptive trait	population
protein molecule	trait	variation	

Name: _____ Date: _____

Homework: Writing About the Rough-Skinned Newts (continued)