Saving the Mountain Lion - Student Materials

Unit 4	Biology

Student Materials Table of Contents

Unit Opening

Unit 4 Saving the Mountain Lion	Biology

Student Name:

The Connecticut Cat

Directions:

1. Silently read the text provided to you.
2. Circle or highlight three details that are most important to the phenomenon being described.
3. Share with your group. Each person should identify the details that they circled or highlighted.
4. Discuss as a group, and determine the overall story. What is the phenomenon?

Mountain Lion

In the spring of 2011 there were several reports of a mountain lion around Greenwich Connecticut. These reports were a surprise because mountain lions were eliminated by hunters several decades ago in the northeast United States. Historically, they covered much of North America and all of South America, but as human populations expanded, mountain lions' ranges shrank.

In early June, the sightings were confirmed by paw prints, animal droppings, and photographs. And then, on June 11, an SUV struck and killed a male mountain lion on the Wilbur Cross Parkway close to Milford Connecticut, just 71 miles from Manhattan.

The mountain lion was found to be a young, solitary male. While it is normal for young males to leave their home to roam individually, it is unusual for them to appear in regions without any established mountain lion population.

Mountain Lion Range in the Americas

What is the overall story?

Important details our group surfaced (provide at least 5):

1. _____
2. _____
3. _____
4. _____
5. _____

Overall Story (based on group discussion):

At first,

_____

_____

_____

Then,

_____

_____

_____

Finally,

_____

_____

_____

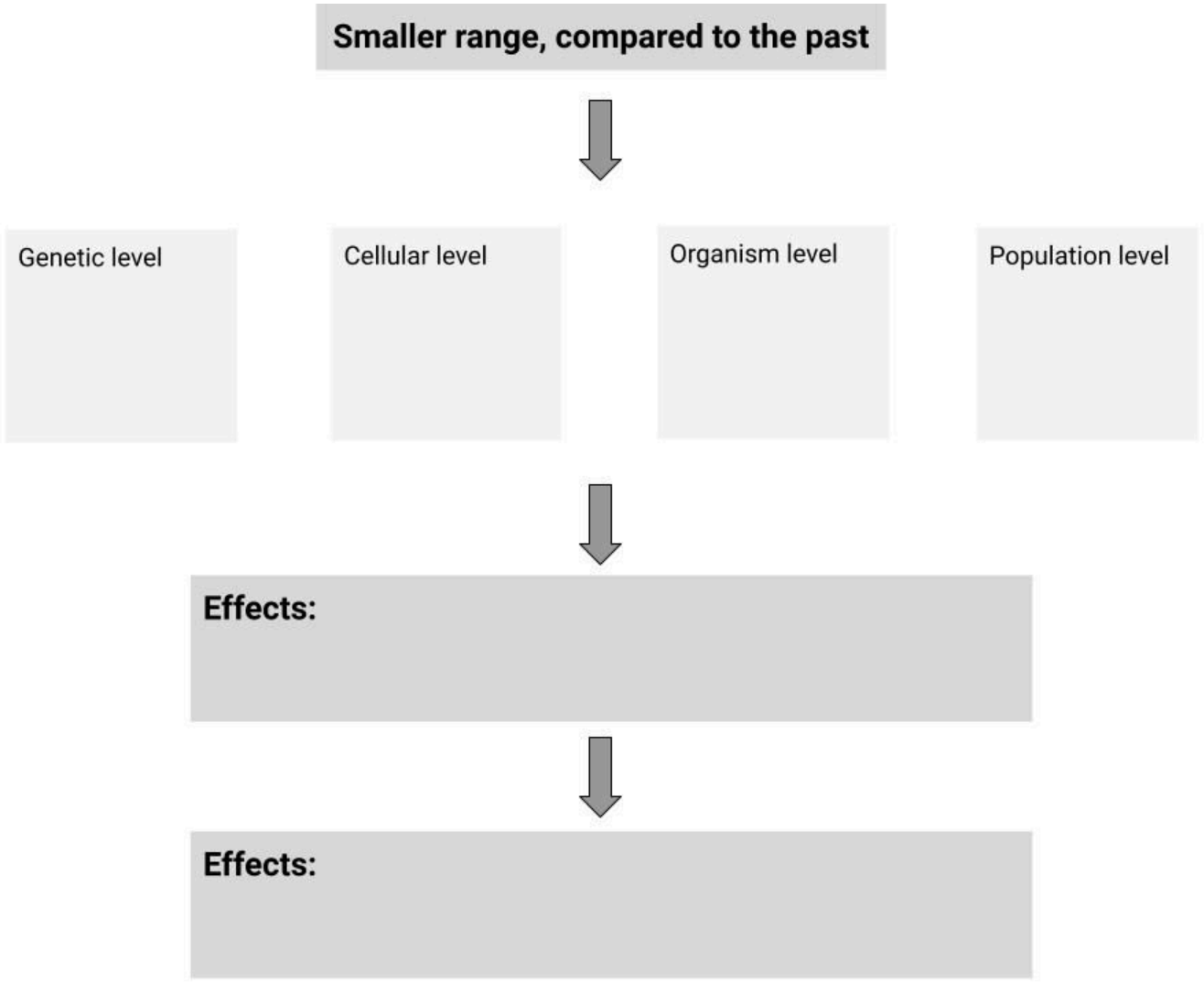
Performance Task Organizer

Unit 4 Saving the Mountain Lion	Biology
Student Name:	

Mountain Lion Populations

Directions: Complete the cause-effect model, based on evidence, to show what is happening at different scales to represent why the Connecticut cat may have migrated so far from his ancestral population. Draw additional arrows between the genetic, organism, and population level to show connections.

Cause and Effect Model



Reflection:

1. Use your model to explain how patterns at different scales helped you identify causality and to explain what happened to the Connecticut cat.

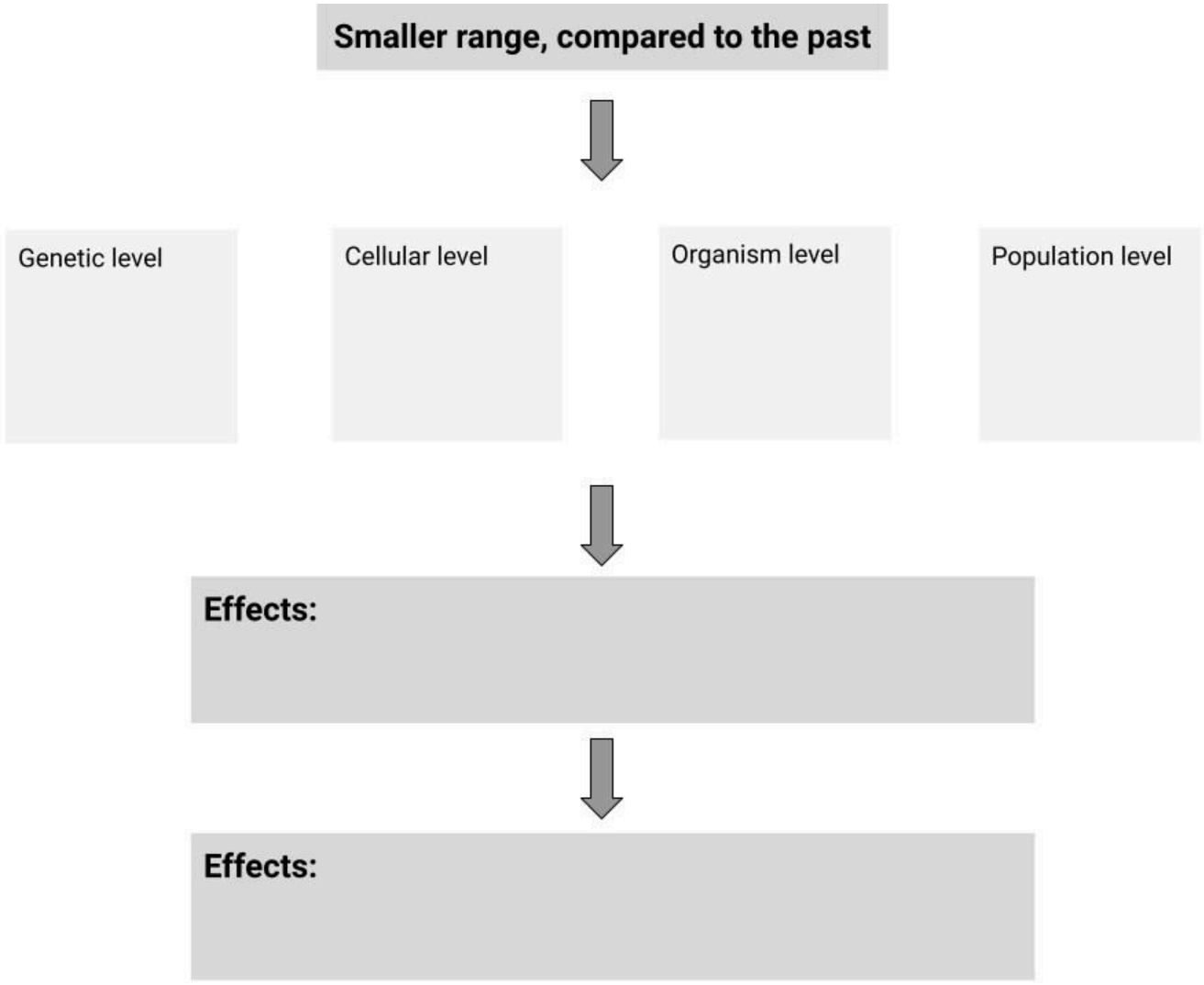
2. Describe the evidence you used to develop your model.

3. Describe the scientific reasoning you used to develop your model

Genetic Variation

Directions: Complete the cause-effect model to show what is happening at different scales to lead to mountain lions having disadvantageous traits. Draw additional arrows between the genetic, organism, and population level to show connections.

Causes of Disadvantageous Traits in Mountain Lions



Reflection:

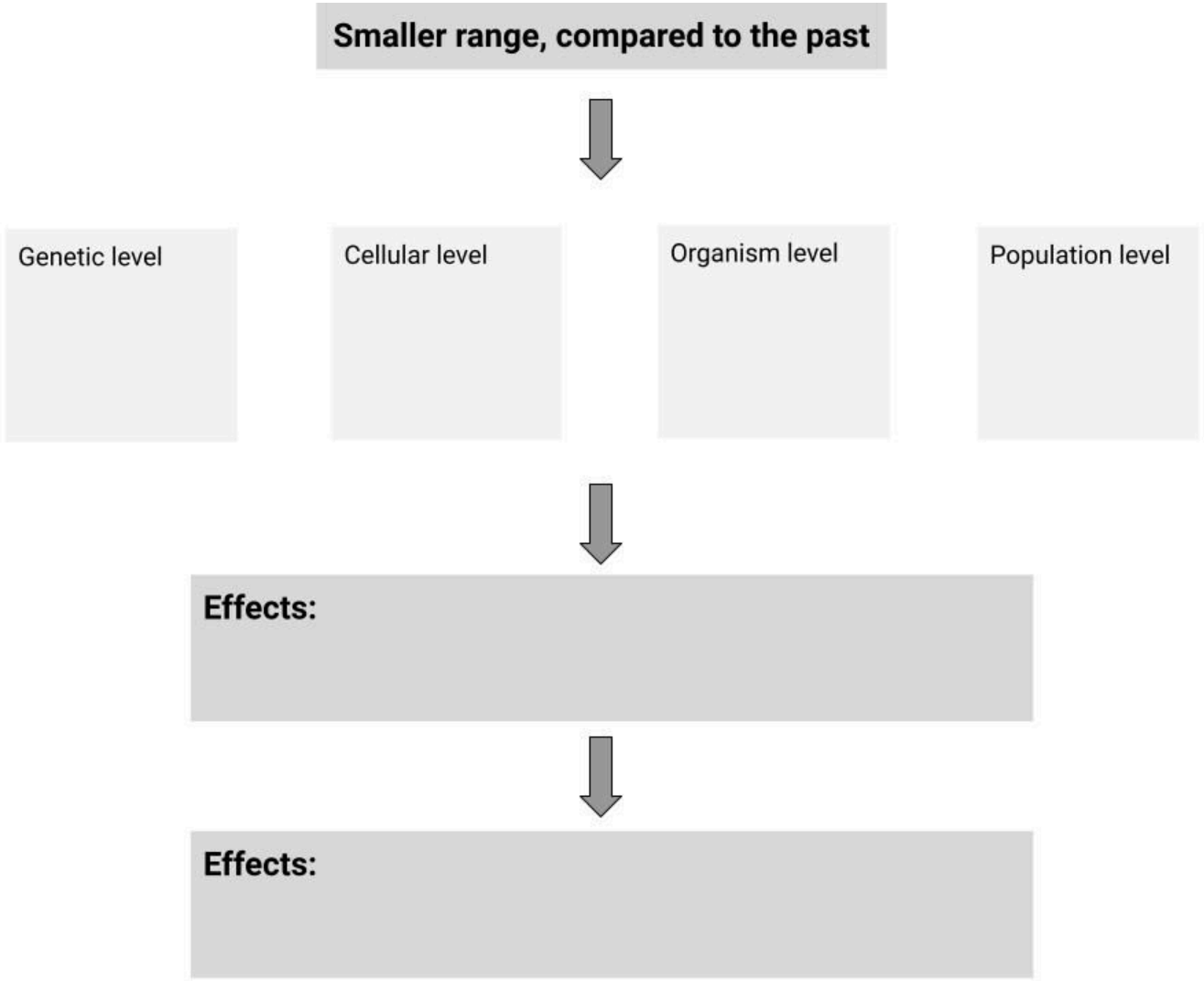
1. Use your model to explain how changes at the population level can result in changes to the traits in an individual organism.

2. Use the space below to clarify anything in your model, add in additional scientific reasoning, or ideas.

Engineering Gene Flow

Directions: Complete the cause-effect model to show what is happening at different scales to lead to greater gene flow in mountain lions. Draw additional arrows between the genetic, organism, and population level to show connections.

Engineering Gene Flow in Mountain Lions



Reflection:

1. Use your model to explain how changes at the genetic level can change a population overall.

2. Use the space below to clarify your model or add additional information.

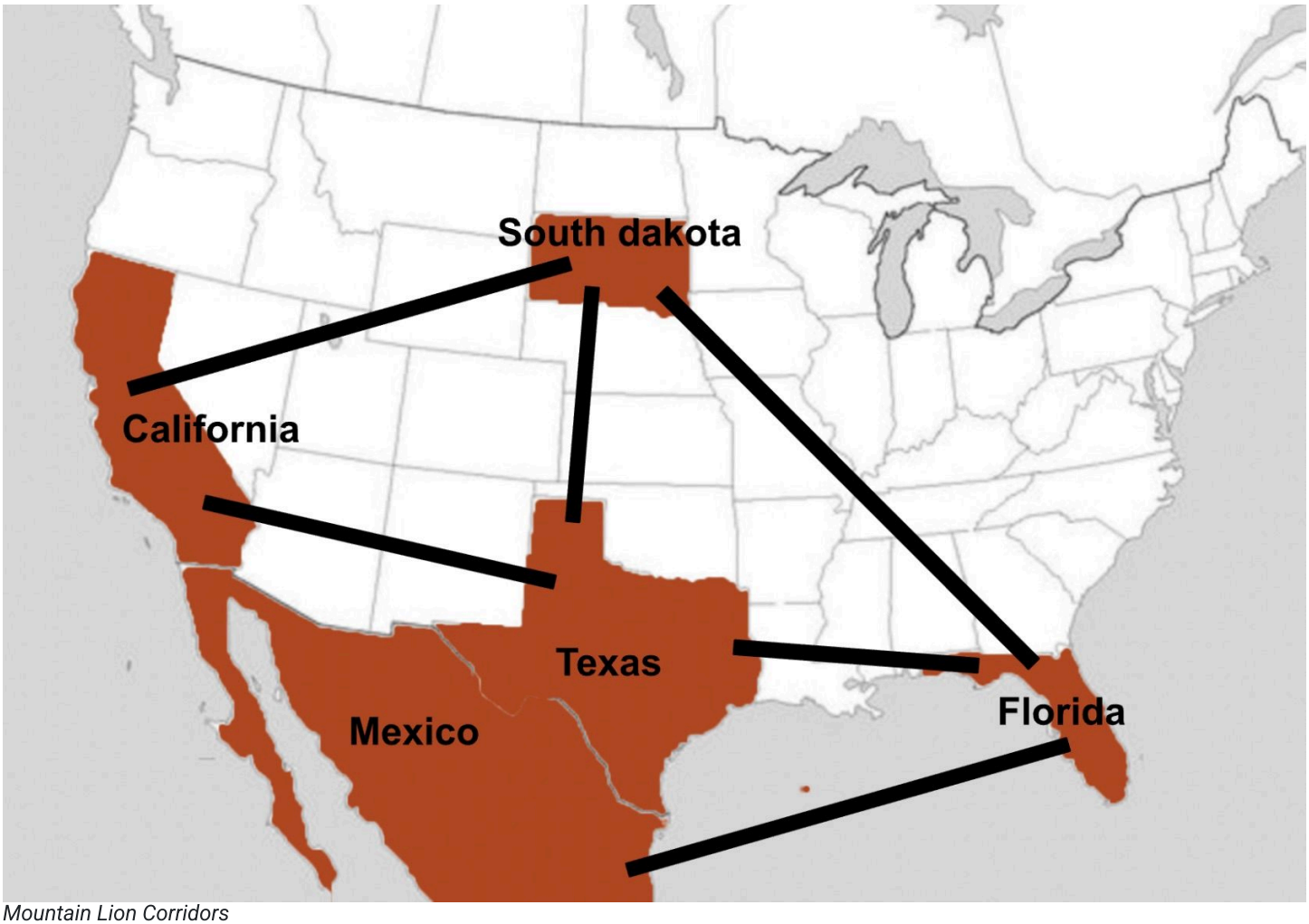
Mountain Lion Final Task

Introduction

For this task, you will learn about a suggested solution to support healthy Mountain Lion populations. You will analyze data and create a model in order to make and defend a claim about its success.

Analyzing the Impact of Wildlife Corridors

A solution that has been proposed for preventing inbreeding in mountain lions is something called wildlife corridors. In this proposal, mountain lion habitats would be connected with areas of protected habitat, allowing them to migrate safely between populations, as shown in the map below.



Mountain Lion Corridors

However, it is not practical to construct wildlife corridors between every population of every species in need of support. In this activity, you will make and defend a claim based on evidence in support of one wildlife corridor which would be the most impactful for mountain lion conservation.

1. How could corridors be used to increase **inheritable** genetic variation within a population?

2. If you had to prioritize a corridor, what characteristics of the populations would you consider?

Shared Alleles

3. Using the Table of Unique Alleles, compare the alleles shared (the ones they have in common) by the populations (the intersection of the sets). In the table below, list all the alleles present in both populations stated in the left column.

	PcoA106	PcoA312	PcoB207	PcoB316
California and Mexico				
California and South Dakota				
California and Florida				
California and Texas				

Mexico and South Dakota				
Mexico and Florida				
Mexico and Texas				
South Dakota and Florida				
South Dakota and Texas				
Florida and Texas				

4. Based on the shared alleles, which two populations would benefit most from a wildlife corridor connecting them?

5. Make and defend a claim using multiple lines of evidence in support of the creation of the wildlife corridor you identified above. In your response. In your claim, be sure to include:
    - Which corridor you are advocating for
    - Why you selected that corridor
    - How the existence of that corridor would support healthy mountain lion populations
    - A discussion of the role of sexual reproduction in this process
    - How changing the ability of populations to interbreed would likely affect levels of genetic diversity in these populations
    - Why levels of genetic diversity are important to long term survival of populations

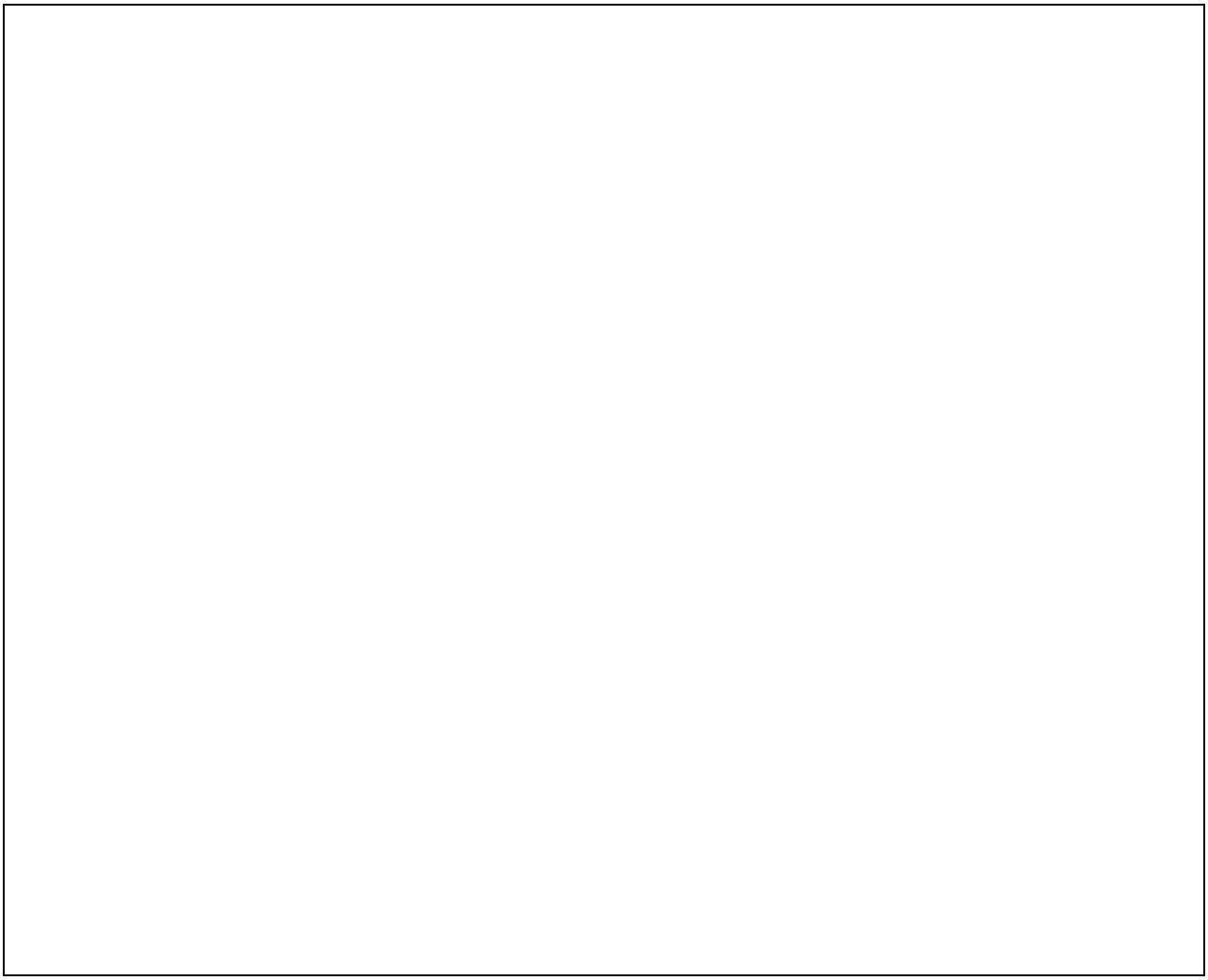


Table of Unique Alleles

	PcoA106	PcoA312	PcoB207	PcoB316
California	248 250 252 254	272 274 276 280	304 310 318 324 330	266 268
Mexico	248 250 254	266 272 274	322 326 328	260 262 264
South Dakota	246 250 252 254 258	266 270 272 274	302 304 306 308 316	324	258 262 272
Florida	244 246	270 276 280	308 314 324	262 266 274
Texas	244 246 254	270 272 276 278 280	308 314 324	258 262 266 274

Performance Task Rubric

Component	Not Evident	Level 1: Beginning	Level 2: Developing	Level 3: Advancing	Level 4: Proficient
Developing a Claim	Does not make a claim	A claim is provided, but does not related to the efficacy of the conservation solution	A claim(s) are provided that is related to the efficacy of the conservation solution	Claim includes an idea related to the efficacy of the conservation solution in addressing low population #s or increasing genetic diversity; but is inappropriate, or incomplete.	Claim includes an appropriate idea related to the efficacy of the conservation solution in addressing low population #s or increasing genetic diversity.
Identifying Scientific Evidence	Does not provide evidence	Identifies evidence that is not appropriate or does not support the claim	Identifies and describes some evidence to support the claim; with extensive errors and/or missing analysis of genetic data tables	Identifies and describes evidence to support the claim; may include some minor errors or missing minor analysis of genetic data tables	Identifies and describes appropriate and sufficient evidence to support the claim referencing the accurate analysis of genetic data tables
Evaluating & Critiquing Evidence	Does not evaluate or critique the evidence	Identifies a strength and a weakness of the evidence used to support the claim	Identifies strengths and weaknesses of the evidence used to support the claim; but is missing a discussion of **either** the validity and reliability of the evidence based on statistical analysis **or** the sufficiency of the evidence in identifying causal relationships	Identifies strengths and weaknesses of the evidence used to support the claim including the validity and reliability of the evidence based on statistical analysis and discusses the sufficiency of the evidence in identifying causal relationships with a few inconsistencies or minor errors	Identifies appropriate strengths and weaknesses of the evidence used to support the claim including the validity and reliability of the evidence based on statistical analysis and discusses the sufficiency of the evidence in identifying causal relationships

Note: It is ideal but not required that students do additional statistical analysis on the mountain lion genetic data – they can critique the data provided based on earlier work done on statistical analysis on small sample sizes from the mountain lion data

Scientific Reasoning: Algebraic Thinking and Statistical Analysis	Does not include a pairwise statistical analysis as evidence	Conducts statistical analysis but does not apply it to how a change in one variable would impact another	Applies statistical analysis as evidence to demonstrate how a change in one variable would impact another with minor errors	Applies statistical analysis as evidence to demonstrate how a change in one variable would impact another with a few minor errors	Effectively and accurately applies statistical analysis as evidence to demonstrate how a change in one variable would impact another without errors
Reasoning & Synthesis	Does not include scientific reasoning or a counterclaim	Does not include relevant explanation of science concepts/ reasoning and/or a counterclaim	Includes an explanation of science concepts that link the evidence to the claim with major errors or omissions and/or a counterclaim is not provided	Includes an explanation of science concepts that link the evidence to the claim with some minor errors or omissions. A counterclaim is provided	Includes relevant and an accurate explanation of science concepts that link the evidence to the claim. A counterclaim is provided
Note: Students should provide scientific reasoning related to connecting isolated/fragmented/reduced populations and the resulting increase in genetic diversity (lower heterozygosity and/or higher inbreeding) and the resulting evolutionary fitness of these populations					

Self Reflection

Directions:

Use all of your resources from the unit (Performance Task Organizer, class notes, handouts) to respond to the following reflection prompts.

Part 1: Using Models to Understanding Cause-Effect at Different Scales

How did modeling at different scales support your explanation?

What was most surprising or new to you about considering problems at different scales?

Mountain Lion Populations 5E

Unit 4 Saving the Mountain Lion	Biology

Student Name:

Investigating Genetic Data

We are trying to figure out where the Connecticut Cat came from.

What are some possible explanations for its origin that we have ruled out?
Name at least two possible explanations and why they are ruled out.

Why are we going to look at genetic data?

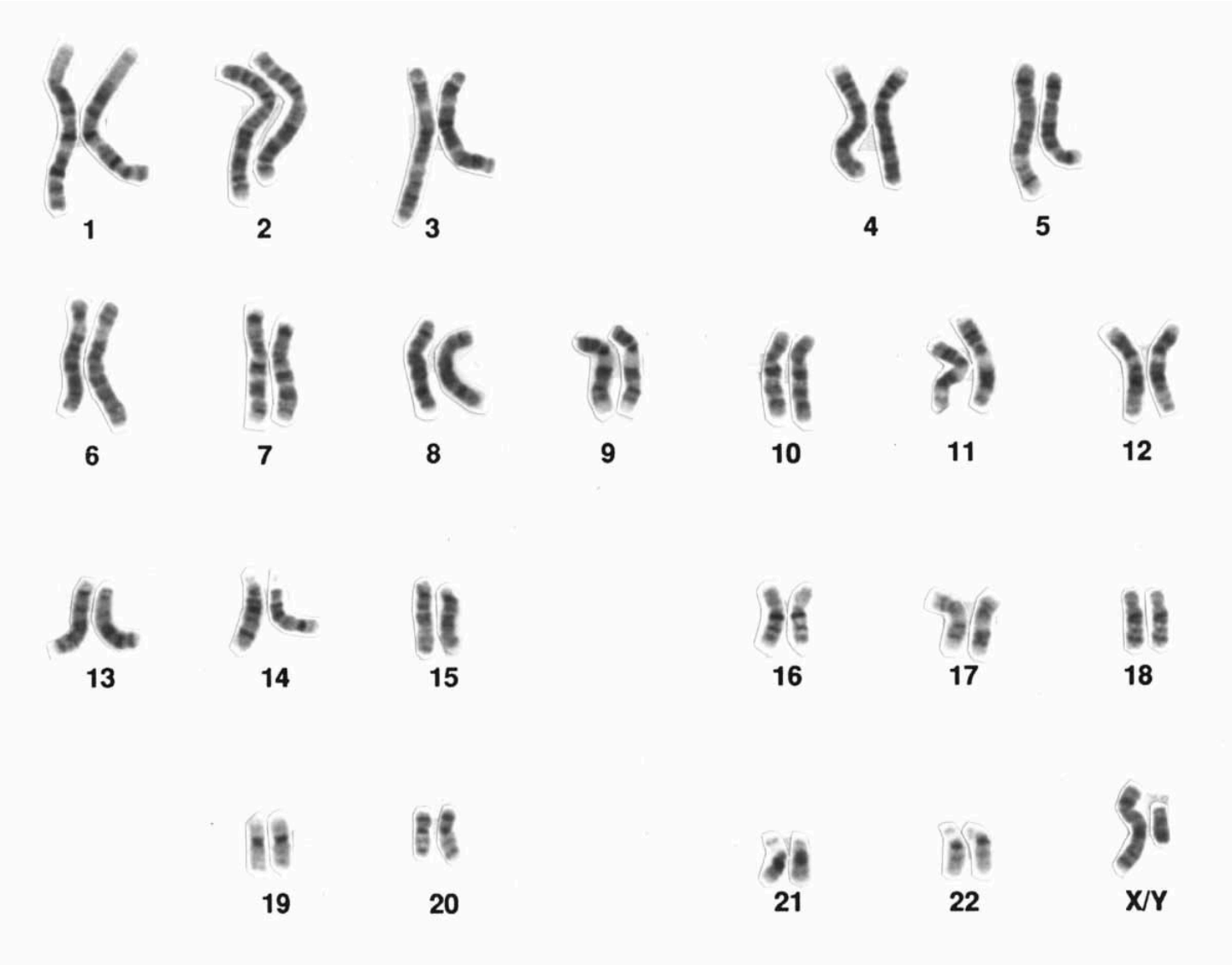
What do you and your partner think we should do in order to investigate genetic data?

Visualizing Karyotypes

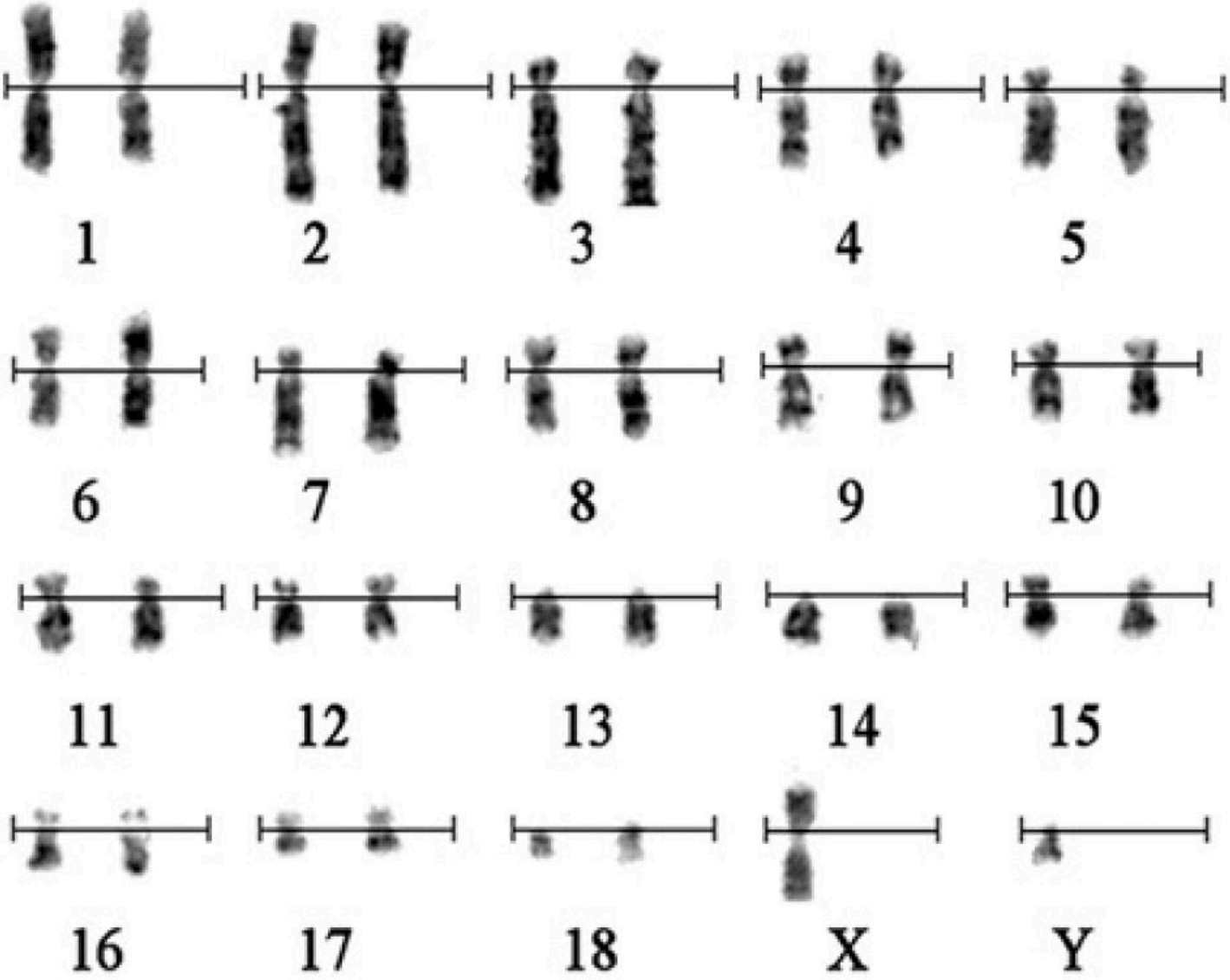
Directions:

1. Review the human and feline karyotypes.
2. Note similarities, differences, and questions you have.

Similarities	Differences	Questions
Both humans and mountain lion karyotypes . . .	Only human karyotypes. . .	
	Only mountain lion karyotypes. . .	



Human Male Karyotype



Feline Male Karyotype

Interpreting Microsatellite Data

In every organism's DNA there are repeating sequences of bases that occur in different lengths and can be used to identify individuals. These regions are called microsatellites and they occur in regions of DNA that usually do not code for proteins. To analyze them they are cut out of the DNA, isolated, and copied using PCR (Polymerase Chain Reaction) which tags the fragments with a fluorescent marker. They are fed through tiny glass capillary tubes in a machine that reads the tags. The microsatellites show up in sequencing software as little peaks that indicate the length of the repeated segment.

Since chromosomes come in pairs, it is possible for one individual to have two different microsatellites (alleles) or two of the same. If there are two of the same alleles that location is homozygous. If the allele is different then it is heterozygous.

Directions:

1. Use the data from the microsatellite sample on the next page to fill out the table below with your analysis of the individual mountain lions in the sample.

2. Then answer the questions below.

Microsatellite Analysis

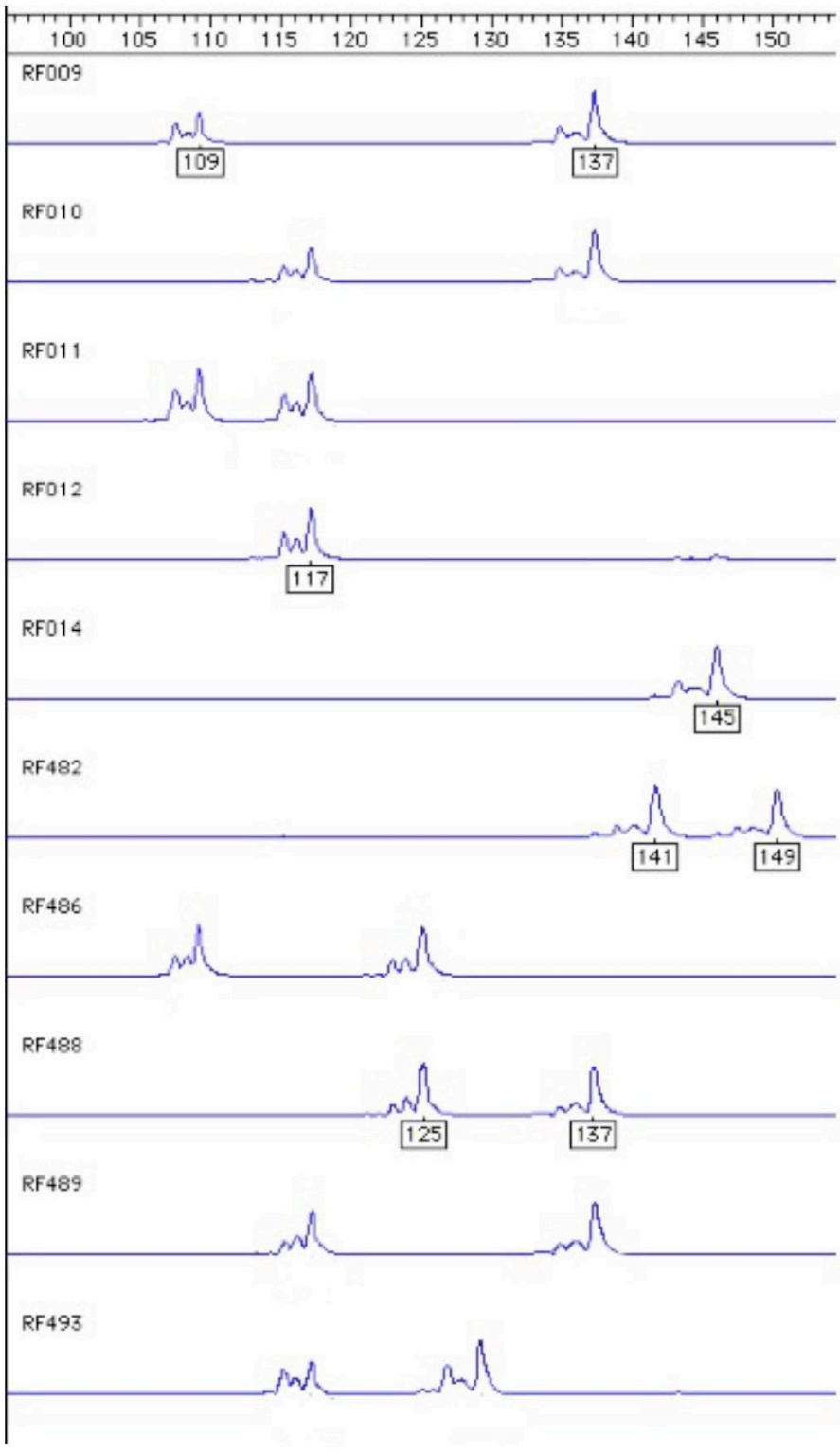
Individual Mountain Lion	Allele from Parent 1	Allele from Parent 2	Homozygous or Heterozygous?
RF009	109	137	Heterozygous
RF010			
RF011			
RF012	117	117	Homozygous
RF014			
RF482			
RF486			
RF488			
RF489			
RF493			

Why might scientists collect microsatellite data?

What do you notice about the animals in the sample you looked at?

What do you wonder about the animals in the sample you looked at?

Microsatellite Sample



Microsatellite Analaysis of Ten Mountain Lions

Mountain Lion Genotype Data

Individual	Population	Pco A106	Pco A106	Pco A312	Pco A312	Pco B207	Pco B207	Pco B316	Pco B316
CA_01	California	254	254	276	280	324	330	266	266
CA_02	California	250	254	272	276	310	318	266	266
CA_03	California	250	252	276	280	310	310	266	268
CA_04	California	248	250	276	280	324	330	266	266
CA_05	California	250	254	274	280	304	330	268	268
MX_01	Mexico	250	254	266	266	322	326	262	264
MX_02	Mexico	248	254	272	272	322	326	260	264
MX_03	Mexico	250	250	272	274	326	326	262	262
MX_04	Mexico	248	254	266	272	322	328	264	264
MX_05	Mexico	250	254	266	272	322	322	262	264
SD_01	South Dakota	254	258	272	274	302	324	262	272
SD_02	South Dakota	246	250	266	270	316	324	262	262
SD_03	South Dakota	250	254	270	274	324	324	262	262
SD_04	South Dakota	250	250	270	274	304	324	258	258
SD_05	South Dakota	246	252	266	266	306	308	258	262
FL_01	Florida	244	244	270	270	314	314	266	266
FL_02	Florida	244	246	280	280	308	324	262	266
FL_03	Florida	244	246	276	280	324	324	262	266
FL_04	Florida	244	244	280	280	308	308	274	274
FL_05	Florida	246	246	280	280	314	314	262	274
TX_01	Texas	246	254	278	280	308	314	258	258
TX_02	Texas	246	254	270	270	308	308	266	274
TX_03	Texas	244	246	278	280	314	314	262	266
TX_04	Texas	246	246	276	280	308	324	266	274
TX_05	Texas	246	254	272	272	308	324	266	274

Mountain Lion Genotype Data Investigation

Analyze the Mountain Lion Genotype Data

1. Using *Mountain Lion Genotype Data*, list the alleles that occur in each population in Data Table 1. Only list each number once. These are called **unique** alleles.

Data Table 1. Unique and Private Alleles

	PcoA106	PcoA312	PcoB207	PcoB316
California				
Mexico				
South Dakota				
Florida				
Texas				

2. Examine your list of alleles and circle the numbers that only appear in one population. These are called **private** alleles.

Compare Mountain Lion Genotype Data to the Connecticut Cat

The row of data below is from the mountain lion that was hit by a car in Connecticut. Compare his alleles to the unique alleles from the California, Mexico, South Dakota, Florida, and Texas populations. What do you notice?

Individual	PcoA 106	PcoA 106	PcoA 312	PcoA 312	PcoB 207	PcoB 207	PcoB 316	PcoB 316
Connecticut Cat	246	258	266	274	302	324	262	272

See-Think-Wonder

Use the graphic organizer below to record your ideas from the investigation.

See Things I see in the data collected	**Think** Ideas that this data makes me think about	**Wonder** Questions and wonderings I have about the data

Analysis Questions

Where do you think the Connecticut Cat came from? Explain the patterns in the evidence you used to make that conclusion.

What level of evidence (e.g. individual cats, population ranges, genetic information, populations) that you studied so far, was the most helpful in figuring out where the Connecticut cat came from?

How do you think this mountain lion got to Connecticut?

Based on what you know so far, why do you think that some populations had many private alleles, while others did not?

Determining Confidence in Sample Sizes

Determining Confidence in Sample Sizes

When studying populations, it is important to collect samples that accurately represent the larger population. Use the Confidence Calculator to calculate the confidence intervals and standard errors for each population, using the data table below. The lower the calculated confidence interval and standard error, the higher the chance that the data accurately represents the larger population.

Region	Approximate Population Size	Sample Size (5 individuals x 4 loci)	Calculated Confidence Interval	Calculated Standard Error
California	5,000	20		
Mexico	20,000	20		
South Dakota	250	20		
Florida	150	20		
Texas	5,000	20		

Based on these calculations, how confident do you feel that the alleles from each sample are representative of the populations as a whole?

Mountain Lion Genotype Data Investigation Rubric

Student Rubric - Mountain Lion Genotype Data Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and / or respond to the analysis questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - Mountain Lion Genotype Data Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Genotype Data Read-Generate-Sort-Solve

Guiding Prompt: Using the patterns found in the genetic data, and scientific concepts discussed in the articles: Develop and defend a claim on why the Connecticut Cat roamed so far from its original location.

Directions for Read-Generate-Sort-Solve:

1. Read: Read the text about the Connecticut Cat from the From South Dakota to Milford, Connecticut, One Mountain Lion or A Cougar's Thousand-Mile Quest to Find a Mate .
2. Generate: On your group's chart paper, generate ideas about concepts that are connected to the reading.
3. Sort: Have everyone in the group star one idea that they think is most relevant to the question.
4. Solve: As a group, discuss the ideas you deemed most important, and come up with a response to the question.

Where did the Connecticut Cat originally come from? Why did he travel to Connecticut?
Generate Ideas.

Name:	**Name:**
Name:	**Name:**

Where did the Connecticut Cat originally come from? Why did he travel to Connecticut?
Record your group's answer.

Summary Task

How did the class consensus discussion go?

1. One thing that went well in the discussion:

2. One thing we can improve the next time we have a discussion:

3. One person who helped me learn today: _____

What did you learn from this person?

4. One idea that I contributed to my group or my class:

Explain what you know about the following questions, based on what we discussed today.

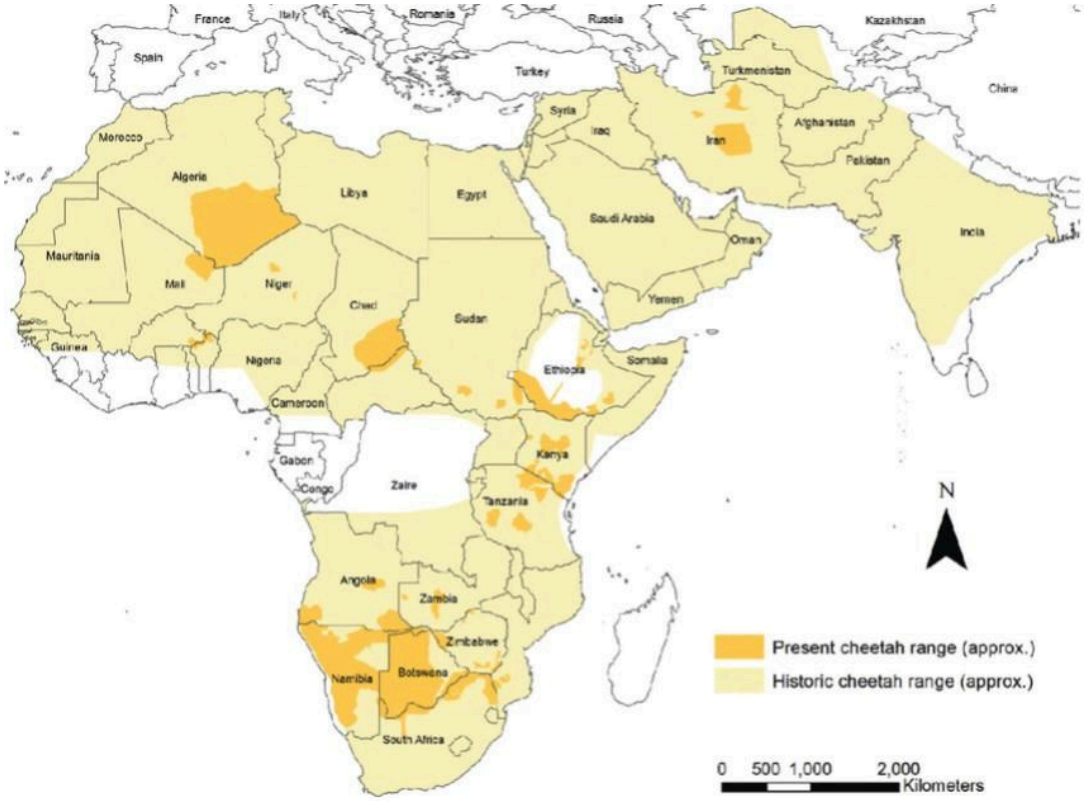
5. Evaluate the evidence and reasoning behind the following claim: The Connecticut cat was originally from a population in South Dakota. It traveled to Connecticut, based on the behavioral trait of male dispersal. This trait could be beneficial because it would allow the cat to seek out a genetically different mate for sexual reproduction (a mate that was not closely related to him). In your response, be sure to include:

- Strength of the evidence
- Weaknesses of the evidence – what additional evidence would you want to collect or analyze to better establish specific cause and effect relationships?
- Strength/weaknesses of the scientific reasoning – is there appropriate scientific reasoning that can link the evidence to the claim? What additional scientific reasoning would strengthen this claim?
- What counterclaims or additional critiques can you discuss?

Are Cheetahs Like Mountain Lions?

Directions:
Using the data below and information from the video and article, explain what causes low genetic diversity in cheetah populations and discuss how mountain lions and cheetahs are similar and different. Finally, what claim can you make about the genetic variability of cheetah populations, and their ability to adapt and survive as a species?

Cheetah Range - Current and Historic



Historical and Present Distribution of Cheetahs in Africa

Cheetah Genetic Diversity Sample

Individual	Population	FCA008	FCA008	FCA005	FCA005	FCA006	FCA006	FCA007	FCA007
Aju_070	**East Africa**	160	160	152	154	184	184	164	164
Aju_134	**East Africa**	158	160	146	156	182	184	164	164
Aju_135	**East Africa**	158	168	154	154	182	184	164	164
Aju_137	**East Africa**	158	158	154	156	182	184	164	164
Aju_138	**East Africa**	158	158	146	150	184	184	164	168

National Geographic Video Key Points

1. _____

2. _____

3. _____

National Geographic Article Key Points

1. _____

2. _____

3. _____

What are the causes of low genetic diversity in populations? Construct a model demonstrating how the causes of low genetic diversity are similar and different in mountain lions and cheetahs.

What claim can you make about the genetic variability of cheetah populations, and their ability to adapt and survive as a species? Be sure to:

- identify and evaluate the evidence and scientific reasoning for your claim
- Discuss additional evidence to support your claim that would help you in determining cause and effect relationships

Mountain Lion Populations Mini Rubric

Component	Developing	Proficient
Evidence	Effectively and clearly identifies evidence that informed the model: includes **some** of the elements below: • At least 2 examples of evidence are provided • Provided evidence is **data** from an investigation or resource in the learning cycle • Evidence supports the model	Effectively and clearly identifies evidence that informed the model: includes **all** of the elements below: • At least 2 examples of evidence are provided • Provided evidence is **data** from an investigation or resource in the learning cycle • Evidence supports the model
Scientific Reasoning & Logic	Effectively and clearly demonstrates scientific reasoning that includes **some** of the elements below: • Genetic information (two variants of each chromosome pair) is inherited from parents to offspring • Genes determine traits • Sexual reproduction plays a role in the genetic variation in individuals and populations • Trait variation may lead to differences in performance, ability to reproduce, and survive • Variation in genetic information (and trait variation) is an essential component of natural selection • Clear use of annotations, arrows, etc to convey scientific reasoning	Effectively and clearly demonstrates scientific reasoning that includes **all** of the elements below: • Genetic information (two variants of each chromosome pair) is inherited from parents to offspring • Sexual reproduction plays a role in the genetic variation in individuals and populations • Trait variation may lead to differences in performance, ability to reproduce, and survive • Variation in genetic information (and trait variation) is an essential component of natural selection • Clear use of annotations, arrows, etc to convey scientific reasoning
Model	A model that accurately represents cause and effect relationships with **some** of the following components: • Demonstrates interactions within and between different parts of the system, including cause and effect relationships at different scales. • Used proper symbols/notations to demonstrate phenomenon components, relationships, and mechanisms.	A model that accurately represents cause and effect relationships with **all** of the following components: • Demonstrates interactions within and between different parts of the system, including cause and effect relationships at different scales. • Used proper symbols/notations to demonstrate phenomenon components, relationships, and mechanisms.
Student Self-Evaluation Circle one		**Teacher/Peer Evaluation** Circle one

Evidence	Developing	Proficient	**Evidence**	Developing	Proficient
Reasoning	Developing	Proficient	**Reasoning**	Developing	Proficient
Model	Developing	Proficient	**Model**	Developing	Proficient
Glow			**Glow**		
Grow			**Grow**		

Sexual Reproduction 3E (optional)

Unit 4 Saving the Mountain Lion	Biology
Student Name:	

Florida Mountain Lions

In the 1990's wildlife researchers started noticing some strange traits in a small population of mountain lions that were located in Florida. This population was called the Florida panthers. The population only consisted of about 20-25 individuals at that time. Researchers noticed that many of the mountain lions had kinked tails.

An image and an X-ray of the kinked tails of Florida mountain lions

Upon closer inspection, the researchers found that the mountain lions had even more troubling issues. They documented holes in their hearts, higher than normal parasites and infectious diseases, and in males a set of reproductive problems including low testosterone, low sperm count, and undescended testes.

Sexual Reproduction Models Investigation

Guiding Prompt: How does closely examining the structures of the reproductive system help us understand the functions of those structures, and how parts of the systems interact at different scales to produce offspring inside of the female's body?

Introduction: Both humans and all other mammals (like mountain lions) reproduce sexually and have both internal fertilization (the joining of the sex cells) and internal development (the baby develops inside of the mother). In this investigation, you will use models to closely examine the structures and the components of structures in the reproductive system to reveal their functions and how the reproductive system as a whole works.

Procedure:

1. Look over each model that represents a part of the human reproductive system.
2. In pairs, choose **one** structure from each model that you would like to investigate further
3. Describe the structure, paying close attention to its shape, size, location, and connections to other parts of the reproductive system
4. Describe how the structure reveals or supports its' function in the reproductive system, including how it interacts with other parts to support internal fertilization and/or internal development of the baby

Helpful Sentence Starters:

• The shape (or size) of the structure …. • This part of the structure …. • The location of the structure …. • The structure is connected to …..	• The shape helps ….. • The part of the structure does … • The location helps …. • The structure works together with …. • The scale of this structure ….

Model 1: Male Reproductive System

Model 2: Male Sex Cell

Model 3: Female Reproductive System

Model 4: Female Sex Cell

Model 5: Developing Fetus in The Female

Return to the guiding prompt: How does closely examining the structures of the reproductive system help us understand the functions of those structures, and how parts of the systems interact at different scales to produce offspring?

Discuss the guiding prompt with your table group. Record your ideas below.

Making Sense of Sexual Reproduction Models Investigation

See-Think-Wonder

Use the graphic organizer below to record your ideas from the Making Sense of the Sexual Reproduction Models Investigation.

See Things I see in the data collected	**Think** Ideas that this data makes me think about	**Wonder** Questions and wonderings I have about the data
		What evidence do you think was used to develop the models of the reproductive system?

Sexual Reproduction Models Investigation Rubric

Student Rubric - Sexual Reproduction Models Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and / or respond to the analysis questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - Sexual Reproduction Models Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Florida Mountain Lion Reproduction TTOE

Think-Talk-Open Exchange + Buzzwords

Step 1:

Think - Respond to the prompt individually, in the space below. Use as many of the buzzwords as possible.

Using the models and your understanding of the structures and interactions of the male and female reproductive systems, discuss why the abnormalities found in the Florida population may be disadvantageous for them.

Buzzwords: offspring, structure, interaction, hormone, internal fertilization

Step 2:

Talk - Share with your group one at a time. Write a tally mark (✔✔✔✔) each time you hear a specific buzzword during the share.

	offspring	structure	interaction	hormone	Internal fertilization
Person 1					
Person 2					

Step 3:

Open Exchange- As a group, discuss the following questions- be sure to use the buzzwords!

- Describe patterns or commonalities between what each group member shared.
- Which buzzwords did you hear the most? Least?
- Are there buzzwords that your group doesn't understand?
- Are there other words you heard a lot? If so, which words?

Step 4:

Reflection - Individually respond to the prompt below.

What are some new ideas you heard during your discussion with your group?

Summary Task

Today we completed a think-talk-open exchange discussion! How did it go?

1. One thing that went well in the discussion:

2. One thing we can improve the next time we have a discussion:

3. One person who helped me learn today:

4. What did you learn from this person?

5. One idea that I contributed to my group or my class:

6. Scientists observed a high frequency of abnormal traits (kinked tails, low sperm count, undescended testes, etc.) in a small population of Florida mountain lions. How might those abnormalities be a disadvantage to the continued survival of that population?

7. Choose one structure of the female reproductive system. Discuss how the structure interacts with another structure of the female reproductive system at another scale, and how it interacts with the male reproductive system to transmit information between systems. .

Genetic Variation 5E

Unit 4 Saving the Mountain Lion	Biology

Student Name:

Florida Mountain Lions

In the 1990's wildlife researchers started noticing some strange traits in a small population of mountain lions that were located in Florida. This population was called the Florida panthers. The population only consisted of about 20-25 individuals at that time. Researchers noticed that many of the mountain lions had kinked tails.

An image and an X-ray of the kinked tails of Florida mountain lions

Upon closer inspection, the researchers found that the mountain lions had even more troubling issues. They documented holes in their hearts, higher than normal parasites and infectious diseases, and in males a set of reproductive problems including low testosterone, low sperm count, and undescended testes.

Mountain Lion Genetic Diversity Investigation

Introduction:
In this investigation you will use allele data to investigate genetic differences between different populations of mountain lions. Additionally, you will calculate the **inbreeding coefficient** for each population.

This number will help you compare each population in terms of the amount of inbreeding. Inbreeding is defined as the probability of two alleles in an individual being identical by descent (from the parents), and is normally the result of mating related individuals. Follow each procedure step described below and enter the data in each data table.

Analyzing Mountain Lion Genetic Data

1. Using *Mountain Lion Genotype Data*, list the alleles that occur in each population in Data Table 1. Only list each number once. These are called **unique** alleles.

Note: You should have already listed unique alleles for each population in Data Table 1 during the *Mountain Lion Genotype Data Investigation*. You can refer to this data table or copy the unique alleles into the data table below.

Data Table 1. Unique Alleles

	PcoA106	PcoA312	PcoB207	PcoB316
California				
Mexico				
South Dakota				
Florida				
Texas				

2. Using *Mountain Lion Genotype Data*, for each locus, count the number of heterozygous and homozygous mountain lions in each population. Recording your data in Data Table 2. Then calculate

the observed frequency of heterozygous mountain lions by dividing the number of heterozygotes by 5 (the number of individuals sampled in each population). Record your results in Data Table 2.

Data Table 2. Mountain Lion Heterozygosity at Specific Locations

	PcoA106	PcoA312	PcoB207	PcoB316
California	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:
Mexico	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:
South Dakota	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:
Florida	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:
Texas	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:

3. Using the Mountain Lion Genetic Diversity Calculator , enter the frequency of heterozygotes in the Ho (observed heterozygosity) row for each population.

The inbreeding coefficient calculated by the Mountain Lion Genetic Diversity Calculator is a comparison of the observed heterozygosity in a population to the expected heterozygosity which is based on probability. Comparing the observed heterozygosity to what we would expect based on probability is a good indication of the degree of inbreeding in a population.

Record each population's Inbreeding Coefficient for each allele in Data Table 3.

Data Table 3. Inbreeding Coefficient

	PcoA106	PcoA312	PcoB207	PcoB316	Average
California					
Mexico					
South Dakota					
Florida					
Texas					

Making Sense of the Mountain Lion Genetic Diversity Investigation

Use the See-Think-Wonder graphic organizer to help make sense of the genetic diversity data.

See	Think	Wonder
	What do you think a negative inbreeding coefficient means? Hint: You might want to look back at the numbers in your genetic diversity calculator. Is this coefficient positive or negative when the observed heterozygosity is greater than the expected heterozygosity? How did looking at patterns at different scales help establish causality?	

Mountain Lion Genetic Diversity Investigation Rubric

Student Rubric - Mountain Lion Genetic Diversity Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and / or respond to the analysis questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - Mountain Lion Genetic Diversity Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Abnormal Traits Note-taker

Process Resources Jigsaw

1. Resource 1 (reading and video): Mutations
2. Resource 2 (reading): Differentiation
3. Resource 3 (video): Mitosis

Directions:

1. Use the note-taker below to record your ideas for your assigned biological process.
2. As a group, share your ideas, and then generate an individual response to the guiding prompt based on the group discussion.
3. As a group, use your conclusions to determine why the Connecticut Cat roamed far from his home territory.

Guiding Prompt:

Make and defend a claim, based on evidence and scientific reasoning, that explains the cause behind the abnormalities found in the Florida population.

Note taker

My assigned process:

Patterns I am noticing in my process	Ideas on how this process relates to the cause behind the abnormalities in the Fl mountain lions	Questions I have about my process or how it connects to the Fl mountain lions

Individual Response:

Make and defend a claim, based on your group discussion of the evidence and scientific reasoning, that explains the cause behind the abnormalities found in the Florida population.

Group Response:

Make and defend a claim, based on evidence and scientific reasoning, that explains why it is advantageous for young mountain lion males to leave their home territories.

Inbreeding Text

The Florida population of mountain lions was isolated geographically and had a small population size. In the 1990's there were only about 20-25 individuals. This meant that the mountain lions had very few individuals to mate with, and over a period of time, they had only matted with closely related individuals. This situation leads to inbreeding.

Mutations can be neutral, beneficial, or negative. Many of the abnormal traits in the Florida mountain lions were traced to negative mutations. Mutations can be caused by environmental factors – sunlight and toxins in the environment are some examples. Scientists were unable to find an environmental reason for the mutations; therefore these mutations were the result of random replication errors during the replication of chromosomes. Mutations in body cells are not viable and cannot be passed onto offspring.

If an individual possesses a mutation in a sex cell (like the one that causes a kinked tail), when they mate, they could pass that mutation on to their offspring. Then when that individual mates with a close relative (also likely to possess the mutation) the mutation could be passed on again, increasing the frequency of that mutation in the population over time as a consequence of inbreeding.

Without individuals with different genetic variations (including healthy tails) to mate with, mutations can build up in a population over time. This may lead to many disadvantageous traits, such as low sperm count or the inability to fight infections being very common in a population.

Summary Task

Today we completed a class consensus discussion! How did it go?

1. One thing that went well in the discussion:

2. One thing we can improve the next time we have a discussion:

3. One person who helped me learn today:

4. What did you learn from this person?

5. One idea that I contributed to my group or my class:

6. Discuss how a mutation, that occurs at the level of DNA within a cell, is related to a process at the cellular level (mitosis) and can impact the individual, the population, and an entire species.

7. Construct a model demonstrating how the behavior of young male mountain lions is a heritable adaptation.

Chernobyl Dogs

The Dogs of Chernobyl

After the nuclear disaster at Chernobyl in 1986, dogs that had been abandoned as pets and local wild animal populations began to take over the deserted region. In 2023, it was estimated that more than 800 dogs lived in the Chernobyl exclusion zone, an area with a 19 mile radius around the former power plant.

Scientists have been studying these dogs, wondering what traits they share that allow them to thrive in conditions deemed too hazardous for life. This area has high levels of radiation and environmental pollution like heavy metals. A 2023 study analyzed the DNA of 302 Chernobyl dogs and found that there were two genetically distinct populations in this area, both of which were genetically distinct from purebred dogs and free-breeding (wild) dogs.

Scientists have been left to continue studying the causes of these distinct populations. Hypotheses include rapid accumulations of mutations through exposure to radiation and heavy metal poisoning, strong selective pressure acting on these populations subjected to such harsh conditions, or inbreeding as a result of the small population size of the groups remaining in this inhospitable environment.

Read-Generate-Sort-Solve Graphic Organizer

Guiding Prompt: Defend the claim that the unique genetic populations found in the Chernobyl dogs were caused by chemicals or toxins in the environment.

Directions for Read-Generate-Sort-Solve:

1. Read: Read *The Dogs of Chernobyl* and your assigned text.
2. Generate: On your group's chart paper, generate ideas about concepts that are connected to the reading and prompt.
3. Sort: Have everyone in the group star one idea that they think is most relevant to the question.
4. Solve: As a group, discuss the ideas you deemed most important, and then individually come up with a response to the guiding prompt.

Generate Ideas.

Name:	**Name:**
Name:	**Name:**

Individually respond to the prompt using your group's discussion.

In defending this claim, what evidence was available in the text(s)? What additional evidence would you want to collect or analyze in order to provide evidence for causality?

Genetic Variation Mini Rubric

Component	Developing	Proficient
Evidence	Effectively and clearly identifies evidence that informed the model: includes **some** of the elements below: • At least 2 examples of evidence are provided • Provided evidence is **data** from an investigation or resource in the learning cycle • Evidence supports the model	Effectively and clearly identifies evidence that informed the model: includes **all** of the elements below: • At least 2 examples of evidence are provided • Provided evidence is **data** from an investigation or resource in the learning cycle • Evidence supports the model
Scientific Reasoning & Logic	Effectively and clearly demonstrates scientific reasoning that includes **some** of the elements below: • Organisms start as a single cell and divides to create a multicellular organism through mitosis • Mitosis produces identical daughter cells; differentiation allows for a complex organism • Genetic variation allows for natural selection that can lead to differential reproduction and survival • Mutations are a source of genetic variation; they may be neutral, beneficial, or negative • Mutations can be random during cell division or caused by environmental factors • Includes a logic statement that links the evidence to the claims of the model (including words such as because and therefore)	Effectively and clearly demonstrates scientific reasoning that includes **all** of the elements below: • Organisms start as a single cell and divides to create a multicellular organism through mitosis • Mitosis produces identical daughter cells; differentiation allows for a complex organism • Genetic variation allows for natural selection that can lead to differential reproduction and survival • Mutations are a source of genetic variation; they may be neutral, beneficial, or negative • Mutations can be random during cell division or caused by environmental factors • Includes a logic statement that links the evidence to the claims of the model (including words such as because and therefore)
Model	A model that accurately represents cause and effect relationships with **some** of the following components: • Demonstrates interactions within and between different parts of the system, including cause and effect relationships at different scales. • Used proper symbols/notations to demonstrate phenomenon components, relationships, and mechanisms.	A model that accurately represents cause and effect relationships with **all** of the following components: • Demonstrates interactions within and between different parts of the system, including cause and effect relationships at different scales. • Used proper symbols/notations to demonstrate phenomenon components, relationships, and mechanisms.

Student Self-Evaluation Circle one	**Teacher/Peer Evaluation** Circle one

Evidence	Developing	Proficient	**Evidence**	Developing	Proficient
Reasoning	Developing	Proficient	**Reasoning**	Developing	Proficient
Model	Developing	Proficient	**Model**	Developing	Proficient
Glow			**Glow**		
Grow			**Grow**		

Engineering Gene Flow 5E

Unit 4 Saving the Mountain Lion	Biology

Student Name:

Increasing Genetic Variation Investigation Part 2

Research Question: Why did introducing 8 females to the Florida population increase the genetic variation of the entire population?

Introduction:
In this activity we will model one process that is occurring at the genetic level in sexual reproduction. We will explore the results of starting with different levels of genetic variation in individual parents to see how this will affect the offspring population.

Procedure:
Each group will use two paper bags. One labeled male and another labeled female (these are the parents). Before each trial, set up each bag with the appropriate number of colored marbles. In this simulation, the marbles represent alleles that are passed on to the offspring, and the number of marbles indicates population size. Draw one marble from each bag. Enter the code for each colored pair of marbles in the space below. After ten trials calculate the observed heterozygosity for the "offspring" you have created. Use the See-Think-Wonder graphic organizer below to record your observations, ideas, and questions.

Use the following codes to record your results:
R = red
B = blue
Y = yellow
G = green

Trial 1:
Start each bag with 10 red and 10 blue marbles

Observed Heterozygosity: _____

Trial 2:
Start each bag with 7 red, 7 blue, and 7 yellow marbles

Observed Heterozygosity: _____

Trial 3:
Start each bag with 5 red, 5 blue, 5 yellow, and 5 green marbles

Observed Heterozygosity: _____

Trial 4:
Design your own starting bags

_____ red _____ blue _____ yellow _____ green

Observed Heterozygosity: _____

Trial 5:
Design your own starting bags

_____ red _____ blue _____ yellow _____ green

Observed Heterozygosity: _____

Trial 6:
Design your own starting bags

_____ red _____ blue _____ yellow _____ green

Observed Heterozygosity: _____

See	Think	Wonder

Increasing Genetic Variation Investigation Rubric

Student Rubric - Increasing Genetic Variation Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and / or respond to the analysis questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - Increasing Genetic Variation Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Increasing Genetic Variation Investigation Part 1

Research Question: What happened to the genetic variation of the Florida mountain lion population after females from Texas were introduced in 1995?

Introduction: In order to investigate the impact of bringing in additional females to the Florida population in 1995, you will analyze data from post 1995 to compare heterozygosity to the pre-introduction (or pre-1995) population in Florida.

Procedure:

1. For each allele count the number of heterozygous and homozygous mountain lions in each population. Then calculate the observed frequency of heterozygous mountain lions by dividing the number of heterozygotes by 5 (the number of individuals sampled in each population). Record your results in **Data Table 1. Observed Heterozygosity**.

Pre-1995 Florida Panther Genotype Data

Individual	Population	PcoA106	PcoA106	PcoA312	PcoA312	PcoB207	PcoB207	PcoB316	PcoB316
FL_01	Florida	244	244	270	270	314	314	266	266
FL_02	Florida	244	246	280	280	308	324	262	266
FL_03	Florida	244	246	276	280	324	324	262	266
FL_04	Florida	244	244	280	280	308	308	274	274
FL_05	Florida	246	246	280	280	314	314	262	274

Post-1995 Florida Panther Genotype Data

Individual	Population	PcoA106	PcoA106	PcoA312	PcoA312	PcoB207	PcoB207	PcoB316	PcoB316
FL_A_01	Florida	244	256	270	276	308	314	262	274
FL_A_02	Florida	244	246	280	280	314	324	266	266
FL_A_03	Florida	246	256	280	282	308	310	266	274
FL_A_04	Florida	246	246	272	276	324	324	262	262
FL_A_05	Florida	244	248	270	270	310	324	258	266

Data Table 1. Observed Heterozygosity

	PcoA106	PcoA312	PcoB207	PcoB316
Florida pre-1995	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:
Florida post-1995	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: Frequency of Heterozygotes:	Hetero: Homo: 1 Frequency of Heterozygotes:	Hetero: 3 Homo: 2 Frequency of Heterozygotes:

2. Using the Mountain Lion Genetic Diversity Calculator enter the number of unique alleles in the Na (number of alleles) row and then enter the frequency of heterozygotes in the Ho (observed heterozygosity) row for each population.

Recall that the inbreeding coefficient calculated by the Mountain Lion Genetic Diversity Calculator is a comparison of the observed heterozygosity in a population to the expected heterozygosity which is based on probability. Comparing the observed heterozygosity to what we would expect based on probability is a good indication of the degree of inbreeding in a population.

Record each population's Inbreeding Coefficient for each allele in **Data Table 2. Inbreeding Coefficient**.

Data Table 2. Inbreeding Coefficient

	PcoA106	PcoA312	PcoB207	PcoB316	Average
Florida pre-1995					
Florida post-1995					

3. After completing your analysis, use the See-Think-Wonder organizer below to record your observations, ideas, and questions.

See	Think	Wonder
What do you notice about the number of unique alleles in the post 1995 Florida panther population compared to the pre-1995 Florida panther population and other populations?	What do you think the number of unique alleles tells us about the degree of isolation for each population?	
What do you notice about the frequency of heterozygotes in the post 1995 Florida panther population compared to the pre-1995 Florida panther population and other populations?	What do you think the frequency of heterozygotes tells us about the degree of inbreeding in each population?	
What do you notice about the inbreeding coefficient in the post 1995 Florida panther population compared to the pre-1995 Florida panther population and other populations?		

Making Sense of Increasing Genetic Variation Investigation

Summary Questions

1. Based on your background knowledge, where do you think the cellular process you simulated is actually happening in an organism?

2. Discuss the evidence that supports the claim that introducing the female Texas mountain lions increased the genetic diversity of the Florida population. What additional evidence would be helpful to support this claim?

3. Why do you think we saw a change in the genetic variation of the Florida mountain lion population after the Texas mountain lions were introduced?

4. Describe how you used the inbreeding coefficient, a type of statistical calculation, to examine how changing the genetic variation of the females would impact the genetic diversity of the overall population.

Florida Mountain Lion Solution

Directions: Make and defend a claim about a solution for the Florida mountain population that enhances their long term survival. Explain why implementing the change in this solution would lead to the predicted positive outcome. Be sure to include a critique of the evidence, for example, is there more evidence needed for the claim? As you watch the video, Meiosis add in additional scientific information from the video, and the text, *Solution for the Florida Mountain Lions Text*.

Claim:

Evidence:

Scientific Reasoning:

Solution for the Florida Mountain Lions Text

Meiosis and Genetic Variation

Earlier in this unit, you learned about how mutations serve as new sources of genetic variation. Mutations that occur in sex cells (gametes) can be passed onto offspring. Crossing over in meiosis also is a source of genetic variation. Meiosis, the division of sex cells, also called gametogenesis (because it is how gametes are created) reshuffles genetic information, resulting in unique combinations of alleles in offspring. Meiosis is very good at providing different gamete combinations!

You can calculate the number of gamete combinations using the formula: 2^n where n = the haploid number. Remember that haploid is the single set of chromosomes, and diploid is the two sets of chromosomes (one from each parent). From looking at the karyotypes early on in the unit, you can see that in mountain lions, the diploid number is 38. Calculate the possible number of gamete combinations for mountain lions

---

However, we saw that heterozygosity in the Florida population is low, so sexual reproduction (i.e. meiosis) does not have a lot of variation to recombine, as all of the alleles are the same.

Genetic Variation for Natural Selection

Natural selection, the change of a species over time, can only occur if genetic variation that is expressed as trait differences between individuals in a population exists. If those trait variations confer a difference in performance, differential reproduction and survival results. Thus, meiosis and mutations play a crucial role in organisms being able to adapt and survive, especially in changing environments.

The Florida mountain lions, or any isolated small population with a high level of inbreeding, are at risk for extinction over the long term. Without the genetic variation to draw upon, there are fewer variations in traits that can be selected for (or against) based on the environment.

The Connecticut Cat

Male dispersal, to seek mates, is a behavioral trait acted upon by natural selection. Generally, genetic variation in a population is a positive factor that allows for a healthy and diverse gene pool. However, as we have observed, isolated populations can have increased inbreeding and reduced genetic variation. Therefore, male cats leaving their material territory and finding females that are not closely related to them may increase or maintain genetic variation, because historical mutations and meiosis in each population may have resulted in different alleles. The outcome of this dispersal is gene flow, when genes move from one population into another.

Cats that express this trait to find new populations to mate in (behavior) may be well suited to survive and reproduce in their environment. In turn, they can then pass this trait on to their offspring, which is expressed in their male descendants as well. Thus, male dispersal of mountain lions can be considered an adaptation – leading to the increase of the frequency of this trait in the population, and supporting the flow of genes to encourage genetic diversity across populations.

Summary Task

Today we completed a class consensus discussion. How did it go?

1. One thing that went well in the discussion:

2. One thing we can improve the next time we have a discussion:

3. One person who helped me learn today:

4. What did you learn from this person?

5. One idea that I contributed to my group or my class:

Explain what you know about the following questions, based on what we discussed today.

1. Discuss the solution of bringing in outside individuals into the Florida population. Should scientists continue to use this solution to maintain long term health? Explain your response in terms of examining the data you have, what do you predict would be the effect of bringing in individuals from different populations of mountain lions on the Florida population?

2. In order to make and defend a claim about whether the introduction of Texas mountain lions was effective, you looked for patterns in genetic data. What patterns on a different scale did you look for to make and defend your claim?

3. The expected heterozygosity at specific gene locations is based on probability. How was using the expected heterozygosity useful when you were evaluating the genetic variation in the pre and post - 1995 Florida Panther populations?

4. Using your understanding of natural selection, return to the phenomena of the Connecticut cat and explain why he may have migrated from South Dakota to Connecticut.

Environmental Factors and Gene Expression R-G-S-S

Guiding Prompt: Develop and defend a claim for how environmental factors affect if a turtle is born male or female. In defending your claim, be sure to evaluate the evidence you are using to support the claim, including additional evidence needed to support the claim.

Directions for Read-Generate-Sort-Solve:

1. Read: Read the text, What causes a sea turtle to be born male or female? silently.
2. Generate: On your group's chart paper, generate ideas about concepts that are connected to the reading.
3. Sort: Have everyone in the group star one idea that they think is most relevant to the question.
4. Solve: As a group, discuss the ideas you deemed most important, and then individually come up with a response to the question based on that discussion.

Generate Ideas.

Name:	**Name:**
Name:	**Name:**

Record your individual answer.

Engineering Gene Flow Mini Rubric

Component	Developing	Proficient
Evidence	Effectively and clearly identifies evidence that informed the model: includes **some** of the elements below: • At least 2 examples of evidence are provided • Provided evidence is **data** from an investigation or resource in the learning cycle • Evidence supports the model	Effectively and clearly identifies evidence that informed the model: includes **all** of the elements below: • At least 2 examples of evidence are provided • Provided evidence is **data** from an investigation or resource in the learning cycle • Evidence supports the model
Scientific Reasoning & Logic	Effectively and clearly demonstrates scientific reasoning that includes **some** of the elements below: • Genetic variation (and the variation in the expression of traits) allows for natural selection that can lead to differential reproduction and survival • Advantageous traits for an environment are more likely to be reproduced and increase in the population • Sexual reproduction, meiosis, and mutations in sex cells all generate genetic variation in a population • Environmental factors can also affect the expression of traits • Clear use of annotations, arrows, etc to convey scientific reasoning	Effectively and clearly demonstrates scientific reasoning that includes **all** of the elements below: • Genetic variation (and the variation in the expression of traits) allows for natural selection that can lead to differential reproduction and survival • Advantageous traits for an environment are more likely to be reproduced and increase in the population • Sexual reproduction, meiosis, and mutations in sex cells all generate genetic variation in a population • Environmental factors can also affect the expression of traits • Clear use of annotations, arrows, etc to convey scientific reasoning
Model	A model that accurately represents cause and effect relationships with **some** of the following components: • Demonstrates interactions within and between different parts of the system, including cause and effect relationships at different scales. • Used proper symbols/notations to demonstrate phenomenon components, relationships, and mechanisms.	A model that accurately represents cause and effect relationships with **all** of the following components: • Demonstrates interactions within and between different parts of the system, including cause and effect relationships at different scales. • Used proper symbols/notations to demonstrate phenomenon components, relationships, and mechanisms.

Student Self-Evaluation Circle one	**Teacher/Peer Evaluation** Circle one

Evidence	Developing	Proficient	**Evidence**	Developing	Proficient
Reasoning	Developing	Proficient	**Reasoning**	Developing	Proficient
Model	Developing	Proficient	**Model**	Developing	Proficient
Glow			**Glow**		
Grow			**Grow**		