LEARNING THROUGH PERFORMANCE

Variation and Heredity

GRADE 6

How do the environment and genetics affect who we are and how we are similar or different?

Generously funded by the Lucas Education Research Foundation

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Task 2: Traits Leading to Successful Reproduction

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Variation and Heredity

Unit Performance Expectations

- Use an argument based on evidence and reasoning to explain how animal behaviors and plant structures affect reproduction success.
- Construct a scientific explanation for how environmental and genetic factors influence growth of an organism.
- Develop models to show why asexual reproduction results in identical offspring and sexual reproduction results in variation.

How do the environment and genetics affect who we are and how we are similar or different?

Evaluation and Feedback

To evaluate your work, you will

- Use the "Constructing Explanations and Designing Solutions" row of the Science and Engineering Practices Rubric.
- Use the "Developing and Using Models" row of the Science and Engineering Practices Rubric.
- Use the "Engaging in Arguments from Evidence" row of the Science and Engineering Practices Rubric.

Group Culminating Project

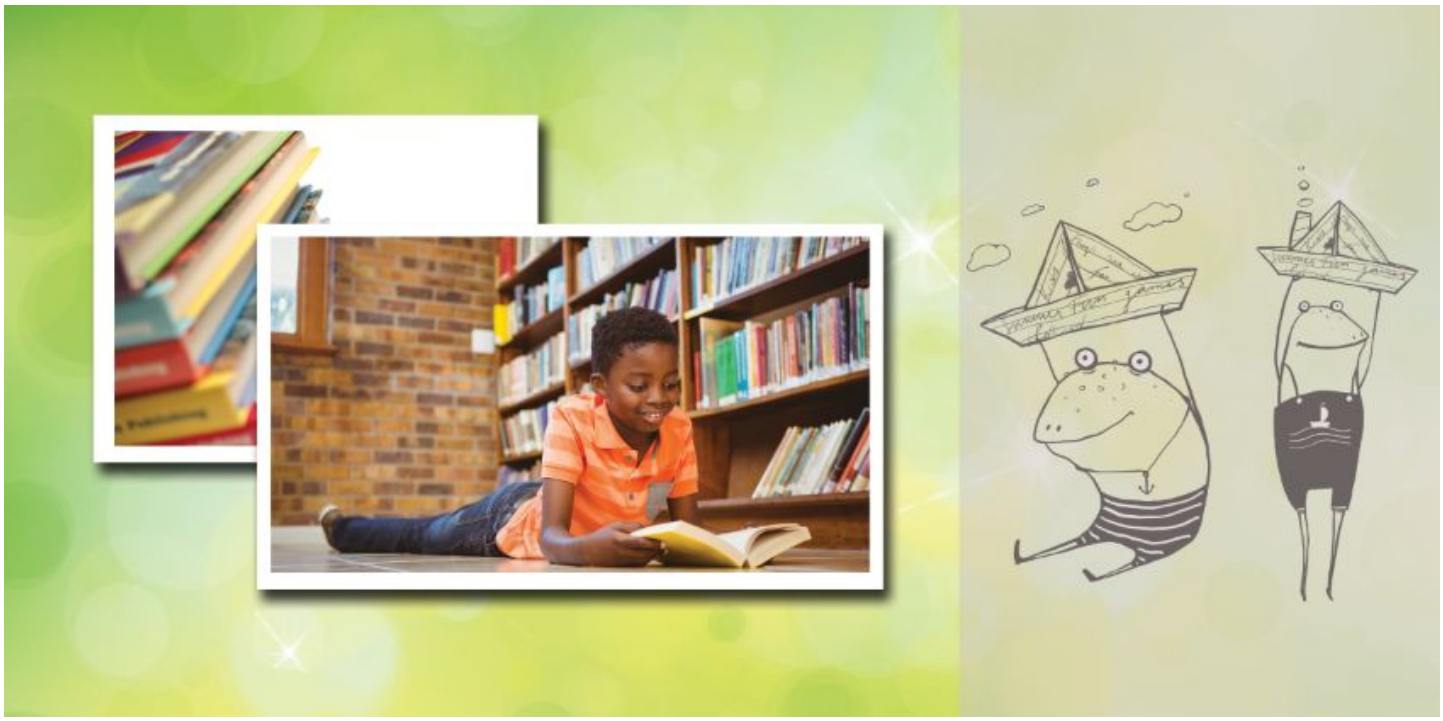
As a group:

- Create a story that teaches the reader about heredity and the interaction between traits and the environment.
  - Create a character.
  - Design an environment for your character.
  - Invent a mate for your character.
  - Create offspring for your character and mate.
  - Write your story about your character, it's mate, and their offspring.
  - Illustrate your story.

Individual Culminating Project

- Conduct simulation about pigeon genetics.
- Design your own pigeon breed.
- Draw a model showing the genetics of your new pigeons.
- Explain the genetics of your new pigeons.

Group Culminating Project: Create a Children's Book



"The Life of _____"

(fill in the blank)

In this book, you will be creating a main character and then describing the character's adventures as it goes through life, overcomes a problem, has offspring, and is influenced by its environment.

You should think about the following things as you write your book. Who is your audience? Are you writing to someone younger? What does the setting look like? Is your character an animal or plant? Does it live on earth or some other alien planet? What does your character and its offspring look like?

Your children's book should be colorful, well written, fun, and capture the reader's imagination. By sharing the story of your character, its mate, and their offspring, you should also be teaching your readers about heredity and interactions between traits and the environment.

Due Dates

Create storyboard
[Date]
Insert detail here, if any

Get/give peer feedback
[Date]
Insert detail here, if any

Write story
[Date]
Insert detail here, if any

Get/give peer feedback
[Date]
Insert detail here, if any

Revise and Submit
[Date]
Insert detail here, if any

Your children's book should contain the following parts.

- ❑ **Exposition: Set up the story**
  - Description of the main character(s), including identification of at least four traits
  - Description of the environment that the character(s) live in (setting)
- ❑ **Scene 1: Traits and environment**
  - Characters are drawn within an environment
  - Story and pictures show how human traits are affected by the environment
  - Story explains why the environment affects your character's human traits
- ❑ **Scene 2: Attract a mate**
  - Story and pictures show two specific traits that your character uses to help attract a mate
  - Story and pictures depict a mate for your main character
  - Story and pictures depict traits in at least one of the characters that will help their offspring survive
  - Story explains how traits and/or behaviors increase the probability that your characters have surviving offspring
- ❑ **Scene 3: Make offspring**
  - Main character is drawn with at least five specific traits
  - Allele key and alleles for both parents are provided for one trait
  - Offspring is drawn with the five traits that correspond with the main character parent
  - Alleles for the corresponding trait above are drawn for the offspring
  - Story explains how the offspring inherited traits from its parents
  - Story explains why the offspring alleles are the same or different from those of the parents
- ❑ **Other Scenes: Genetics and environment**
  - Additional scenes depict the theme that both genetics and the environment affect who we are, how we are different, and how we reproduce successfully
  - Additional scenes flow well with the rest of the story

Your final children's book should be:

- ❑ Easy to understand
- ❑ Legible (easy to read)
- ❑ Illustrated and visually pleasing
- ❑ Organized into a logical story line
- ❑ Interesting to the reader

Individual Culminating Project: Heredity and Variation—Introduction

You meet a local pigeon breeder who tells you all about his pigeon farm. The pigeon breeder raises four main types of pigeons: the ornamental show pigeon, the racer pigeon, the messenger pigeon, and the performing tumbler pigeon.

In this task you will

- Learn about pigeon traits and pigeon breeding.
- Pick two parent pigeons with different traits to make your own pigeon breed.

Ornamental Show

Racer

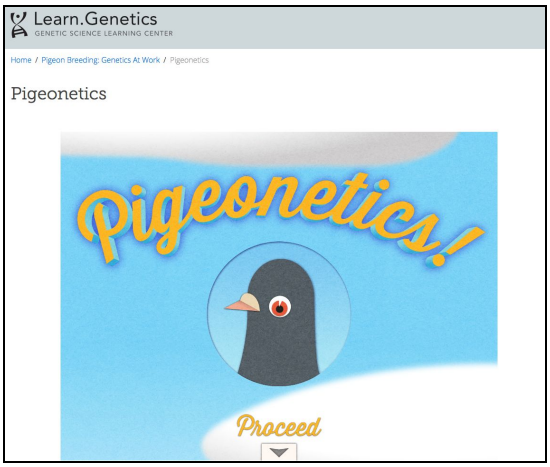
Messenger

Performing Tumbler

Individual Culminating Project: Heredity and Variation—DAY 1

Getting Started

1. Open Pigeonetics: http://learn.genetics.utah.edu/content/pigeons/pigeonetics/



2. Try out each of the Pigeonetics game controls.

Action	Click on
Move screen to next page.	
Pick the pigeon you want to mate.	
Pick the allele you want.	Click on one allele Z or W 
Check your answer.	
Find games 1–26.	
Get an explanation or more information.	
 means your answer is correct.	

Part I • Pigeon Gender

Credit: Dori/Wikipedia/Creative Commons Attribution

Alleles	Male	Female
Allele = Z Allele = W	ZZ  	ZW 

Game 1 Pigeonetics

1. Make a **Female** offspring (baby).

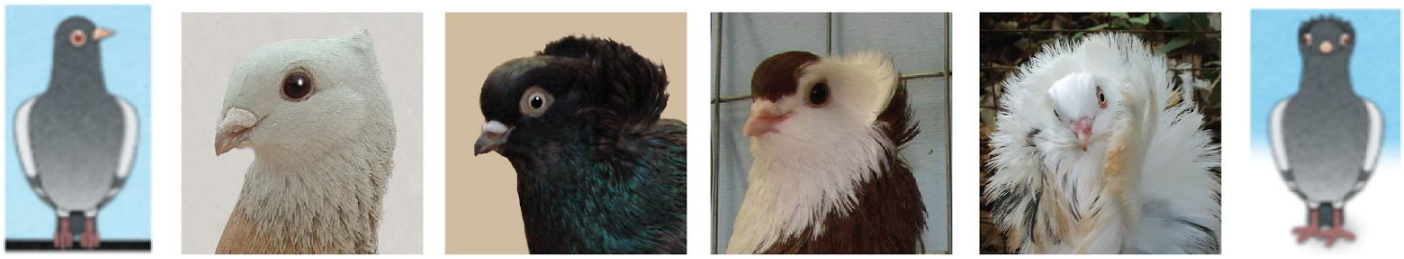
2. Draw a model (diagram/picture) to show the process for creating the offspring. Include labels in your model.

Game 2 Pigeonetics

1. Make a **Male** offspring.
   - ❏ Check this box when you get the breeding correct.

Part II • Crest Gene

No Crest Crest



Credit: Wikipedia/Creative Commons Attribution (left to right): Jackie Brooks and Jim Gifford, Leestababee, Gyyr, Captaincid

Gene	Dominant	Recessive
Crest	No crest Allele = N 	Crest Allele = n 

Game 3 Pigeonetics

1. Make a **Male with No Crest** offspring.

2. Draw a model (diagram/picture) to show the process for creating the offspring. Include labels in your model.

Game 4 Pigeonetics

1. Make a **Male with a Crest** offspring.
   - ❏ Check this box when you get the breeding correct. 

Game 5 Pigeonetics

Hint: You will need two generations to have success.

1. Make a **Female with a Crest** offspring.

2. Draw a model (diagram/picture) to show the process for creating the offspring. Include labels in your model.

Part III • Slippers Gene



Credit: Wikipedia/Creative Commons Attribution (left to right): Graham Manning, Jim Gifford

The slippers gene acts differently from what you have studied so far. When a pigeon has both a slippers and a no slippers allele, the pigeon has small slippers. Look at the pigeon's feet in the simulation to see the difference.

	Dominant	In-Between Look	Recessive
Slippers (foot feathers—feathers on legs and a few feathers on feet)	Slippers Allele = L 	Small slippers Alleles = LN 	No slippers Allele = N 

Game 6 Pigeonetic

Hint: You will need more than one generation for successful breeding.

1. Make a **Male with No Slippers** offspring.
   - ❏ Check this box when you get the breeding correct.

Game 7 Pigeonetics

Hint: You will need more than one generation for successful breeding.

1. Make a **Female with Slippers and a Crest** offspring.

2. Draw a model (diagram/picture) to show the process for creating the offspring. Include labels in your model.

Individual Culminating Project: Heredity and Variation—DAY 2

Now that you know a little about pigeon breeding, you can create your own pigeon with the traits you want.

1. Decide on the **type of pigeon** you want to create.

Types of Pigeons	Description
Racer Pigeons	Bred to race against other pigeons; races are up to 1,000 miles
Tumbler Pigeons	Bred to do acrobatics in the air to entertain people
Ornamental Show Pigeons	Bred to be fancy and showy and be fun to look at
Messenger Pigeons	Bred to bring messages to others around the world and then return home

2. Refer to the Pigeon Reference Card: Possible Parent Pigeon Breeds. Select the parents you want to breed to get the baby you want. Look closely at the allele combinations.

3. Refer to the Pigeon Reference Card: Pigeon Alleles. Decide on the traits you want in your type of pigeon.

4. Draw a model to show how the pigeon parents you selected would produce the baby pigeon you want. Include labels in your model.

Pigeon Reference Card: Possible Parent Pigeon Breeds

Red Capuchin Fancy  nn ff tt bb PP LL	**Frill Back**  nn Ff tt bb SP HH	**Silesian Wing**  Nn ff tt bb SS HH
German Long Faced Tumbler  Nn ff Tt bb PP LL	**Dragoon Messenger**  Nn ff Tt BB PP LL	**Rasduver**  Nn ff Tt bb SP LH
Australian Performing Tumbler  Nn ff tt bb PP HH	**Messenger Racing**  Nn ff tt Bb SP LL	**Blue Magic Racer**  Nn ff tt bb PP HH

Credit: Wikipedia/Creative Commons Attribution (left to right): Row 1—Jim Gifford, Jim Gifford, Unknown; Row 2—Jim Gifford, Graham Manning, Jim Gifford; Row 3—Graham Manning, Jim Gifford

Pigeon Reference Card: Pigeon Alleles

Gene	Dominant Allele		Recessive Allele		In-Between Trait	
Crest	N	No crest	n	Crest	X	
Frill back	F	No Frill back	f	Frill back	X	
Body	T	Trim	t	Thick and muscular	X	
Beak	B	Bumpy	b	Regular	X	
Slippers	S	Slippers	P*	No slippers	SP	Small Slippers
Neck	L	Long neck	H*	Short	LH	Long Bubble

*Not actually recessive. When this allele is mixed with the opposing allele, a medium trait is expressed.

Outside of a Pigeon House

Inside of a Pigeon House

5. Your best friend wants to know what you were doing at the pigeon farmer's place. You excitedly tell your friend that you created your own special type of pigeon with traits that you chose. Explain to your friend what type of pigeon you created (its traits) and how you were able to choose and breed parent pigeons to create a pigeon with the desired traits.

   Your explanation should include:

   - ❑ A **claim** about the type of pigeon you wanted to make (the traits you wanted in your offspring)
   - ❑ **Evidence** to back up your claim
     - ❑ Describe why you selected the traits for your type of pigeon.
     - ❑ Describe how traits get passed down from parents to offspring.
   - ❑ A scientific concept and your **reasoning** that shows how the evidence supports your claim

6. Your best friend still has some good questions, listed below. As a future pigeon breeder, you think it's a good idea to create a FAQ (Frequently Asked Questions) Sheet that answers these questions. Design a FAQ Sheet you can provide your friend and other people interested in pigeon breeding.

   - Why isn't your baby pigeon exactly like its parents?

   - What are some environmental conditions that you need to think about while raising your new type of pigeons to help them be the best that they can be?

   - I want to make sure there are more pigeons in the world. What traits in pigeons do you think best help them survive and reproduce?

Draw your baby pigeon:

Additional Gene Combinations Found in Pigeonetics

Dominant and Recessive

One allele is dominant over another allele.

Game #	Gene	Dominant	Recessive
8, 20	Grouse Feathers on the legs	Grouse Allele = (G) 	No Grouse Allele = (g) 

Multiple Alleles:

More than one allele available for 2 spots

Game #	Gene	Dominant	Less Dominant	Even Less Dominant	Recessive
9, 10, 11, 12, 14, 15, 16, 17, 18	Wing Pattern	T-Check Allele = (B)  	Check Allele =  	Bar Allele =  	Barless Allele = (t)  

Sex Linked

The allele is only found on the X chromosome. Females (XW) have only one allele for color and males (XX) have two alleles for color.

Game #	Gene	Dominant	Less Dominant	Recessive
13, 14, 15, 16, 17, 18	Color	Ash red Allele = 	Blue Allele = 	Brown Allele = (t) 

Epistasis

The trait masks or hides another trait. For example, spread is a solid color and hides any wing pattern.

Game #	Gene	Dominant	Recessive
13, 14, 15, 16, 17, 18	Wing color (dominant over wing pattern)	Spread Allele = 	No spread Allele = 

	Dominant	In-Between	Recessive
Muff Lots of feathers on the legs and feet	Big muff Grouse + Slippers 4 dominant alleles	Medium muff Grouse + Slippers 3 dominant alleles	Small muff Grouse + Slippers 2 dominant alleles

Individual Project Organizer

Unit Essential Question: *How do the environment and genetics affect who we are and how we are similar or different?*

For the Culminating Project, your job is to write a children's book. The **theme** of your book is to help a reader understand how genetics and the environment affect who we are, how we are different, and how we increase the probability that we reproduce to produce offspring.

When you write a book, you must first brainstorm ideas. Keep in mind that your first ideas may change during the development of your story over the unit. There is nothing wrong with change over time.

The following Individual Project Organizer will help you brainstorm ideas and organize what you learn throughout the tasks; you will use the information in it to write your children's book at the end of the unit. There is one page for each task in this unit. Complete the page after you complete the task. For each activity, be sure to include answers to the **all** the questions provided.

Individual Project Organizer—Lift-Off Task

Lift-Off Task: A Storied Life and Human Traits

Character Traits
Begin by brainstorming ideas about your main character.
1. Start brainstorming some possible main characters for your book. Draw the character and label at least four of their distinguishing traits.
2. Describe your character. Make sure to include their human traits, their personality, and their interests in your description.

Individual Project Organizer—Task 1

Task 1: Effects of the Environment on Plant Growth

Your Character and the Environment
Now that you have seen a real-life example of the environment's effect on plant growth, think of a significant way in which your main character can be affected by the environment.
1. Draw a scene that shows where your main character lives. 2. Draw your character in the environment. Show how the character's human traits have been affected by the environment.
3. **Cause and Effect:** Write a short narrative that explains how and why the environment affects your character's human traits.

Individual Project Organizer—Task 2

Task 2: Traits Leading to Successful Reproduction

Your Character and Their Family	
As you saw in this task, organisms have a variety of different characteristics and behaviors that help them successfully reproduce. It is now time for your main character to find a mate.	
1. Decide on two specific traits that your main character has that the character can use to help attract a mate. Redraw your main character with these two specific traits.	2. Draw a mate for your main character.
3. Are there any behaviors your parent or offspring might have to help the offspring survive?	
4. **Cause and Effect:** Write a short narrative describing how traits and/or behaviors increase the probability that your character mates and has surviving offspring.	

Individual Project Organizer—Task 3

Task 3: Make a Dog and a Bacteria Family

Your Character and Their Genes	
Consider the large amount of variation you saw in the puppies in the activity. Choose one trait of your character and assign letters to the alleles for that trait. Show the allele pairs for your parents and your offspring.	
1. Draw your main character. ● Identify in your illustration at least five specific traits.	2. Pick one trait: _____ ● Make a key for the alleles for that trait. ● Show the allele pairs for both your mom and dad characters. **Mom's Alleles** **Dad's Alleles**
3. Using what you learned in the activity about heredity: ● Create and draw the offspring of your main character and their mate. ● Label the five traits in your offspring that correspond to the five traits in question 1. ● Add under your drawing the alleles the offspring has for the trait mentioned in question 2.	4. Are the alleles in your offspring the same or different from that of the parents? Why or why not?

Individual Project Organizer—Task 4

Task 4: Variation in Elephant

The Plot		
In this task, you learned that growth is affected by both genetics and the environment. Remember that the theme of your story is to help the reader understand how both genetics and the environment affect who we are, how we are different, and how we reproduce successfully. Start brainstorming a plot using your characters and setting. Begin creating your storyboard by drawing pictures and writing short narratives to **show your character's adventures as it goes through life, attracts a mate, has offspring, and is influenced by the environment. Remember that your story might still change over time.**		
What happens first …	What happens next …	What happens next …
What happens next …	What happens next …	How the story ends …

Science Content Rubric

Assess Using Individual Culminating Project Script

SCIENCE CONTENT RUBRIC				
THE STUDENT DEMONSTRATES THEIR SCIENTIFIC KNOWLEDGE OF THE FOLLOWING CONTENT STANDARD	EMERGING	DEVELOPING	PROFICIENT	ADVANCED
In sexually reproducing organisms, each parent contributes (at random) half of the genes acquired by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (LS3.B)	The concept of how one allele moves from each parent to the pigeon offspring is modeled and/or explained **inappropriately and/or incorrectly**.	The concept of how one allele moves from each parent to the pigeon offspring is modeled and/or explained **correctly but incompletely**.	The concept of how one allele moves from each parent to the pigeon offspring is modeled and/or explained **correctly and completely**.	The concept of how one allele moves from each parent to the pigeon offspring is modeled and/or explained **in detail**, **correctly and completely**.
Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (LS3.A)	The concept that variation between the parent and pigeon offspring is a result of different genes on chromosomes is modeled and/or explained **inappropriately and/or incorrectly**.	The concept that variation between the parent and pigeon offspring is a result of different genes on chromosomes is modeled and/or explained **correctly but incompletely**.	The concept that variation between the parent and pigeon offspring is a result of different genes on chromosomes is modeled and/or explained **correctly and completely**.	The concept that variation between the parent and pigeon offspring is a result of different genes on chromosomes is modeled and/or explained **in detail**, **correctly and completely**.
Genetic factors as well as local conditions affect the growth of an adult organism. (LS1.B) *DCI has been expanded from plant to organism to align with PE	The concept that the environment as well as genetics affects the growth of pigeons is explained **inappropriately and/or incorrectly.**	The concept that the environment as well as genetics affects the growth of pigeons is explained **correctly but incompletely**.	The concept that the environment as well as genetics affects the growth of pigeons isexplained **correctly and completely**.	The concept that the environment as well as genetics affects the growth of pigeons is explained **in detail**, **correctly and completely**.

Science and Engineering Practices Rubric

The Variation and Heredity Unit will be assessed using the highlighted rows.

SCIENCE AND ENGINEERING PRACTICES RUBRIC				
SCORING DOMAIN	**EMERGING**	**DEVELOPING**	**PROFICIENT**	**ADVANCED**
ASKING QUESTIONS AND DEFINING PROBLEMS ❑ No Evidence*	Asks general questions that cannot be investigated. Writes a problem or design statement but it does not match the intent of the problem or the need of the client.	Asks specific questions that can be investigated but do not require empirical evidence. Writes a problem or design statement that matches the intent of the problem or the need of the client with minor errors.	Asks questions that require empirical evidence to answer. Writes a problem or design statement that accurately matches the intent of the problem or the needs of the client.	Asks questions that require empirical evidence to answer and evaluates the testability of the questions. Writes a problem or design statement that accurately and completely matches the intent of the problem or the need of the client.
DEVELOPING AND USING MODELS ❑ No Evidence*	Makes models (drawings, diagrams, or other) with major errors. Explains the limitations of the model with major errors.	Makes models (drawings, diagrams, or other) to represent the process or system to be investigated with minor errors. Explains the limitations of the model with minor errors.	Makes accurate and labeled models (drawings, diagrams, or other) to represent the process or system to be investigated. Explains the limitations of the model as a representation of the system or process.	Makes accurate and labeled models (drawings, diagrams, or other) to represent the process or system to be investigated and explains the model. Explains the limitations of the model as a representation of the system or process and discusses how the model might be improved.
PLANNING INVESTIGATIONS ❑ No Evidence*	Plans an investigation that will not produce relevant data to answer the empirical question(s). Plans a design that does not match the criteria, constraints, and intent of the problem.	Plans an investigation that will produce some relevant data to answer the empirical question(s). Plans a design and writes an explanation that partially matches the criteria, constraints, and intent of the problem.	Plans an investigation that will produce relevant data to answer the empirical question(s) and identifies the dependent and independent variables when applicable. Plans a design and writes an explanation that accurately and adequately matches the criteria, constraints, and intent of the problem.	Plans an investigation that will completely produce relevant and adequate amounts of data to answer the empirical question(s) and identifies the dependent and independent variables when applicable. Plans a design and writes a detailed explanation that accurately and completely matches the criteria, constraints, and intent of the problem.
CARRYING OUT INVESTIGATIONS ❑ No Evidence*	Writes procedures that lack detail so the procedures cannot be duplicated by another person.	Writes procedures with enough detail that another person can duplicate (replicable) but does not conduct a sufficient number of trials.	Writes detailed replicable procedures with descriptions of the measurements, tools, or instruments and conducts adequate number of trials.	Writes detailed replicable procedures with descriptions of the measurements, tools, or instruments and conducts adequate number of trials with an explanation for the proposed data collection.

* If there is no student response then check the “No Evidence” box.

The Variation and Heredity Unit will be assessed using the highlighted rows.

SCIENCE AND ENGINEERING PRACTICES RUBRIC				
SCORING DOMAIN	**EMERGING**	**DEVELOPING**	**PROFICIENT**	**ADVANCED**
ANALYZING AND INTERPRETING DATA *"Accurately labeled" means inclusion of title, column titles, description of units, proper intervals.* ❑ No Evidence*	Makes spreadsheets, data tables, charts, or graphs that are not accurately labeled or do not display all the data. Uses inappropriate methods or makes major errors analyzing the data.	Makes accurate and labeled spreadsheets, data tables, charts, or graphs to summarize and display data but does not arrange the data to examine the relationships between variables. Uses appropriate methods but makes minor errors analyzing the data.	Makes accurate and labeled spreadsheets, data tables, charts, and/or graphs to summarize and display data and arranges the data to examine relationships between variables. Uses appropriate methods to accurately and carefully identify patterns **or** explains possible error or limitations of analyzing the data.	Makes accurate and labeled spreadsheets, data tables, charts, and/or graphs and uses more than one of these methods to summarize and display data; arranges the data to examine relationships between variables. Uses appropriate methods to accurately and carefully identify patterns **and** explains possible error or limitations of analyzing the data.
CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS ❑ No Evidence*	Constructs an explanation that includes an inappropriate claim, inaccurate evidence, and/or unclear reasoning. Uses no data to evaluate how well the design answers the problem and the redesign of the original model or prototype is inappropriate or incomplete.	Constructs or evaluates an explanation consisting of minimal claim(s), limited sources of accurate evidence, and/or minimal reasoning. Uses minimal data to evaluate how well the design answers the problem and describes an appropriate redesign of the original model or prototype with minor errors.	Constructs or evaluates an explanation that includes a claim, multiple sources of accurate evidence, and reasoning using accurate and adequate scientific ideas or principles. Uses adequate data to evaluate how well the design answers the problem and accurately explains an appropriate redesign of the original model or prototype.	Constructs, evaluates, or revises an explanation that includes a claim, multiple sources of accurate evidence, and reasoning using accurate and adequate scientific ideas or principles. Uses adequate data to evaluate how well the design answers the problem and accurately provides a detailed rationale for the appropriate redesign of the original model or prototype.
ENGAGING IN ARGUMENTS FROM EVIDENCE ❑ No Evidence*	Constructs an argument that includes an inappropriate claim, inaccurate evidence, and/or unclear reasoning.	Constructs or evaluates an argument consisting of minimal claim(s), limited sources of evidence, **or** minimal reasoning.	Constructs and/or evaluates an argument consisting of appropriate claim(s), multiple sources of evidence, and reasoning using accurate and adequate scientific ideas or principles.	Constructs, evaluates, or revises an argument consisting of appropriate claim(s), multiple sources of evidence, and reasoning using accurate and adequate scientific ideas or principles.
OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION ❑ No Evidence*	Communicates information that is inaccurate and/or inconsistent with the evidence.	Communicates accurate but minimal information consistent with the evidence but does not explain the implications **or** limitations of the investigation or design.	Communicates accurate, clear, and adequate information consistent with the evidence and explains the implications and/or limitations of the investigation or design.	Communicates accurate, clear, and complete information consistent with the evidence and provides a rationale for the implications and limitations of the investigation or design.

* If there is no student response then check the "No Evidence" box.

Peer Feedback for Children's Book

Children's Book Owners' Names	Children's Book Reviewers' Names

Review the following sections of the children's book.

❑ Exposition: Set up the story
- Description of the main character(s), including identification of at least four traits
- Description of the environment that the character(s) are in

Positive comment:

Constructive comment:

❑ Scene 1: Traits and environment
- Characters are drawn within an environment
- Story and pictures show how human traits are affected by the environment
- Story explains why the environment affects the character's human traits

Positive comment:

Constructive comment:

- ❑ Scene 2: Attract a mate
  - Story and pictures show two specific traits that the character uses to help attract a mate
  - Story and pictures depict a mate for the main character
  - Story and pictures depict traits in at least one of the characters that will help their offspring survive
  - Story explains how traits and/or behaviors increase the probability that the characters have surviving offspring

  Positive comment:

  Constructive comment:

- ❑ Scene 3: Make offspring
  - Main character is drawn with at least five specific traits
  - Allele key and alleles for both parents are provided for one trait
  - Offspring is drawn with the five traits that correspond with the main character parent
  - Alleles for the corresponding trait above are drawn for the offspring
  - Story explains how the offspring inherited traits from its parents
  - Story explains why the offspring alleles are the same or different from those of the parents

  Positive comment:

  Constructive comment:

- ❏ Other Scenes: Genetics and environment
  - Additional scenes depict the theme that both genetics and the environment affect who we are, how we are different, and how we reproduce successfully
  - Additional scenes flow well with the rest of the story

  Positive comment:

  Constructive comment:

The final children's book should be:

- ❏ Easy to understand
- ❏ Legible (easy to read)
- ❏ Illustrated and aesthetically pleasing
- ❏ Organized into a logical storyline
- ❏ Interesting to the reader

Positive comment:

Constructive comment:

Lift-Off

Variation and Heredity

Objectives

You will be able to

- Identify human traits.
- Identify the influence of genetic and environmental factors on human traits.
- Make an argument from evidence about whether humans are more similar to each other or more different from each other.
- Collaborate with your teammates to identify human traits.
- Identify the plot, theme, setting, characters, and engaging characteristics of a children's book.

How do the environment and genetics affect who we are and how we are similar or different?

Evaluation and Feedback

To evaluate your work, you will

- Use the "Engaging in Arguments from Evidence" row of the Science and Engineering Practices Rubric.
- Use other criteria determined by your teacher.

Lift-Off Task: A Storied Life and Human Traits

As a group:

- Listen to and analyze a children's story.
- Identify your own human traits.
- Compare your own traits to those of the rest of the class.
- Decide how genetics and the environment contribute to your traits.

Vocabulary

- characteristic
- dominant
- environment
- gene
- heredity
- inheritance, inherited
- plot
- recessive
- theme
- trait
- variation

Connect to the Culminating Project

Plan and organize your children's book in your Individual Project Organizer:

- Create your main character.
- Describe your main character's traits, personality, and interests.

Introduction

Over the course of this unit, you will be designing and writing a children's book with the theme of variation and heredity. You will create your own characters, setting, and plot. It will be your job to teach readers about a character who goes through life, struggles to survive, has offspring, and is influenced by their environment. In order to do this, you first need to think about what makes a good story and what heredity is.

Part I • Example of an Engaging Story with a Message

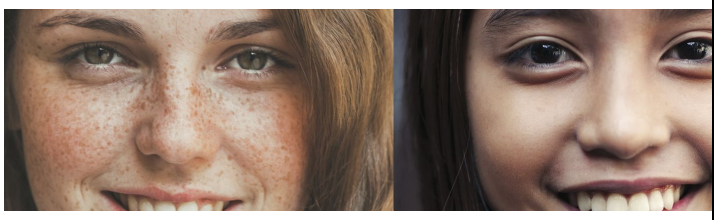
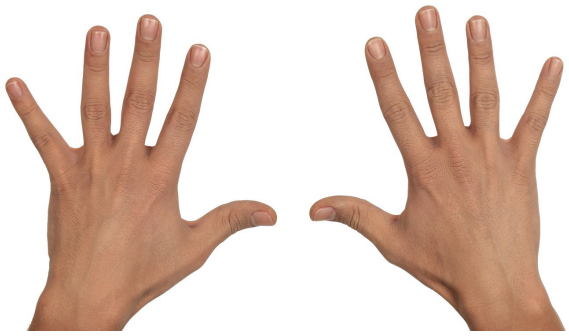
1. Listen to a children's story and then discuss the following questions with your group.
    - What big ideas, themes, or messages do you think the author wants you to understand?
    - What are the different parts of the story: setting, characters, and plot?
    - What are some examples of **cause and effect** in the story?
    - What is on a typical page of the book that makes the story fun and interesting?

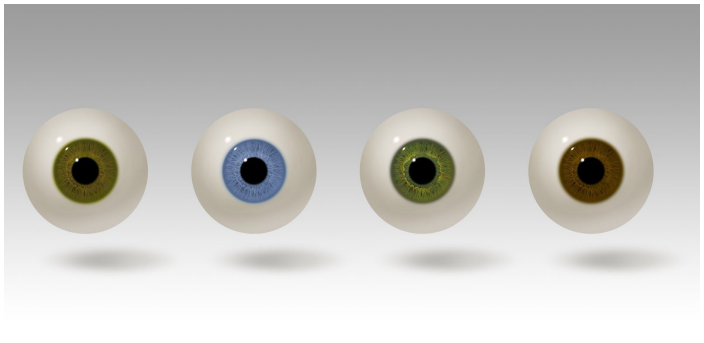
Part II • Identify Human Traits

1. Identify your traits by circling the appropriate trait on the Your Traits and Your Classmates' Traits chart.
2. Gather data about your classmates' traits and fill in the last two columns of the chart.

Your Traits and Your Classmates' Traits

Trait	Circle Your Trait	Number of Students in Your Class with Each Trait	
Earlobes		Detached	Attached
Tongue Rolling		Tongue Roll	No Tongue Roll
Widow's Peak		Widow's Peak	Straight Hairline
Mid-Digit Hair		Mid-Digit Hair	No Mid-Digit Hair
Hitchhiker's Thumb		Hitchhiker's Thumb	Straight Thumb

Trait	Circle Your Trait	Number of Students in Your Class With Each Trait	
Dimples		No Dimples	Dimples
Hand Clasping		Right Over Left	Left Over Right
Cleft Chin		Cleft Chin	No Cleft Chin
Face Freckles		Freckles	No Freckles
Handedness		Left Dominant	Right Dominant

Trait	Circle Your Trait	Number of Students in Your Class With Each Trait	
Eye Color		Brown	Green
		Blue	Hazel
Hair Color		Black	Red
		Brown	Blond

3. Discuss the following three questions and write your answers in your science notebook.

- All the traits you identified are inherited. What does *inherited* mean to you?
- Which traits on the chart can you change over your lifetime? How?
- Give two examples of traits (not found on the chart) that can change over your lifetime due to environmental influences.

4. Fill in the following chart to answer this question: Are humans more similar to each other or more different from each other?

Claim, Evidence, and Reasoning

Are humans more similar to each other or more different from each other?
Claim
Evidence (data from the Your Traits and Your Classmates' Traits chart)
Reasoning (Use a science concept to justify that your evidence supports your claim.)

REFLECT

How has your idea of what a trait is changed over the course of this task? In particular, do you still have the same ideas about where traits come from?

Part III • Connect to the Culminating Project and Assessment

Complete the Individual Project Organizer for this task.

1 Variation and Heredity

Objectives

You will be able to

- Determine how different environmental conditions affect plant growth rate.
- Plan and conduct an experiment about environmental effects on plant growth.
- Use data to construct an explanation about how the environment and genetics influence plant growth.
- Discuss and plan procedures.
- Write a lab report.

How do the environment and genetics affect who we are and how we are similar or different?

Evaluation and Feedback

To evaluate your work, you will

- Use the "Carrying Out Investigations" row of the Science and Engineering Practices Rubric.
- Use the "Analyzing and Interpreting Data" row of the Science and Engineering Practices Rubric.
- Use the "Constructing Explanations and Designing Solutions" row of the Science and Engineering Practices Rubric.
- Use other criteria determined by your teacher.

Task 1: Effects of the Environment on Plant Growth

As a group:

- Observe the variation of traits in beans.
- Design an experiment to see the environmental effects on plant growth.
- Conduct the plant growth experiment.
- Record data and make a graph of your data.
- Observe and analyze patterns in the results of your experiment.
- Explain what effects the environment had on your plants.

Vocabulary

- control group
- environmental conditions
- experiment
- experimental group
- organism
- prediction
- standard factor (fair test)
- variable

Connect to the Culminating Project

Plan and organize your children's book in your Individual Project Organizer:

- Draw a scene that shows how the environment affects the main character.
- Write a short narrative that explains how the environment affects the main character.

TASK 1 Effects of the Environment on Plant Growth

Introduction

In the last task, you identified different traits and thought about the ways human beings are similar and different. Now it's time to think about why. Why are we similar? Why are we different? Is it because of genetics or environment? Today you will design an experiment that tests whether the environment affects traits of living organisms.

- Think about what you already know. Based on your prior knowledge of how plants and animals grow, do you think the environment can have an effect on organisms' similarities and differences? How?

Part I • Variation of Beans

1. Pick four beans out of the bowl. Make observations about each bean.

Characteristic	Bean 1	Bean 2	Bean 3	Bean 4
Length (mm)				

2. Put your beans back in the bowl. Mix the beans up. Pour the beans out on the table.
   See if you can find the beans you described!

3. Use evidence and reasoning to support the claim provided.

Claim Beans have many different traits.
Evidence Use evidence from your observations to support the claim.
Reasoning Use a scientific concept to explain why your evidence supports the claim.

Part II • Design an Experiment to Analyze How the Environment Affects Physical Traits of a Plant

A. Experimental Question

The question you will answer in your experiment: **How does the environment affect a plant's growth rate?**

B. Brainstorm Your Experimental Design

1. Think about what you already know about what plants need to grow. Then brainstorm and list different **environmental conditions** that might be responsible for variations in plant growth.

2. Decide on one **environmental condition** (**variable**) your group will test to see the effect it has on plant growth.

   Teacher initials: _____

3. Decide **how many seeds** your group will use in your experimental group and the control group.

4. **Measurements:** Together as a class decide on what and how you will will measure:
   a. Look at the Bean Anatomy reference sheet at the end of this task and decide what you will measure.

   b. How will you measure?

   c. What units will you use?

   d. How often will you measure?

5. Draw your experimental and control setups.

Draw and **label** your **experimental setup.** Include amounts of materials. Teacher initials: _____	**Draw** and **label** your **control setup.** Include amounts of materials. Teacher initials: _____

6. **Standard Factors (Fair Test)**
   What conditions will you keep the same for both your experimental setup and your control setup?

7. **Prediction**
   Cause and Effect: What do you think will happen in your experiment? Why?

C. Record Your Experimental Design

8. Write a formal description of your experiment in your science notebook, as shown below.

Section	Details Included in Each Section
Experimental Question	• Write the question you want to answer.
Procedure	• Write step by step procedures. • Include amounts of materials. • Include times to do steps. • Describe both your experimental setup and your control setup. • Include details about measuring or gathering data.
Materials	• Make a list of the materials.
Prediction of the Results	• Predict and give reasons for the predicted results in the experiment.
Data Table	• Make a data table. • Give your data table a title. • Label all your columns. • Identify units of measurement.

D. Conduct Your Experiment

9. Conduct your experiment.

10. Fill in your data table each day to record your results.

E. Graph Your Data

11. After collecting all your data, **graph** the data on the graph paper provided by your teacher.

F. Analyze Your Data and Make Conclusions

12. Discuss the following:
    - Examine your seed growth data and identify patterns you see.
    - Compare your results with your prediction. Were you correct in your prediction? Why or why not?

13. **Cause and Effect**

Use your evidence and the patterns you noticed in the data to explain what effect, if any, the environmental factor had on the growth of your seeds.

a. Write a **claim** about what affect the environmental factor had on the growth of your seeds.
b. Use **evidence** from your experiment to support the claim.
c. Use a scientific concept to **justify** that your evidence supports your claim.

Claim
Evidence
Reasoning

G. Communicate Your Findings

14. Share your data, analysis, and conclusion with the class.

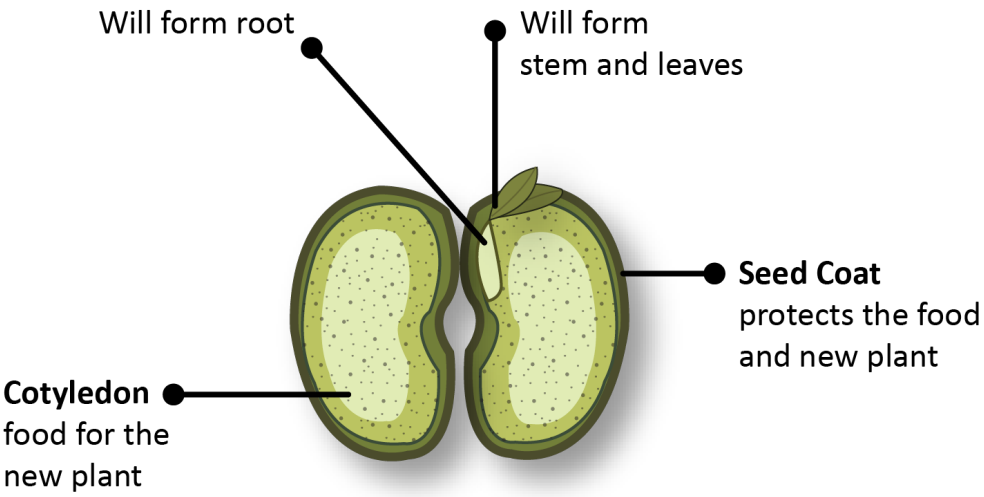
REFLECT

At the beginning of this task, you were asked if you thought environment could have an effect on organisms' similarities and differences. Look back at your response. Do you still agree with what you initially thought? How could you add to or change your answer after what you have learned from this task?

Part III • Connect to the Culminating Project and Assessment

Complete the Individual Project Organizer for this task.

Bean Anatomy



Bean Cut in Half

2 Variation and Heredity

Objectives

You will be able to

- Identify animal behaviors and plant structures that are associated with reproduction.
- Construct an argument identifying the correct explanation for how an animal behavior results in successful reproduction.
- Summarize key points in video clips.
- Debate competing ideas with peers.
- Listen to others' ideas.
- Construct an argument based on evidence.

How do the environment and genetics affect who we are and how we are similar or different?

Evaluation and Feedback

To evaluate your work, you will

- Use the "Engaging in Arguments from Evidence" row of the Science and Engineering Practices Rubric.
- Use other criteria determined by your teacher.

Task 2: Traits Leading to Successful Reproduction

As a group:

- Watch video clips to determine different animal behaviors that help animals successfully reproduce.
- Watch video clips to determine how specialized plant structures help plants successfully reproduce.
- Analyze guppy mating data and make an argument about why female guppies prefer certain male traits when predators are absent and when they are present.

Vocabulary

- attract
- life cycle
- mate
- mating
- offspring
- ovaries
- plant structure
- pollen
- pollination
- predator
- seed dispersal
- successful reproduction

Connect to the Culminating Project

Plan and organize your children's book in your Individual Project Organizer:

- Decide on two traits your main character has that will help attract a mate.
- Identify behaviors of the parents or offspring that help the offspring survive.

TASK 2 Traits Leading to Successful Reproduction

Introduction

In the previous task, you conducted an experiment that illustrated how certain traits, like plant growth, can be influenced by the environment. Traits can also be influenced by genetics, which are passed on from parent to child. One of the most important characteristics of life is this passing on of traits from parent to child, otherwise known as *reproduction*. Organisms have certain traits that help them reproduce more successfully, and that is what you will be exploring today.

- Attracting a mate in order to create offspring is an important part of every organism's life cycle. Can you think of any traits (physical or behavioral) of plants and animals you have seen that may help them attract a mate?

Part I • Explore How Animal Behavior Helps Animals Successfully Reproduce

Watch these four video clips. Then answer the two questions that follow for **each** video clip.

Video clips:

Pronghorn bucks battle for dominance: https://youtu.be/qJ9s6WF68LQ

Peacock mating dance display: https://youtu.be/jTBHiZtnCsA

Matriarch Elephants Protect Baby Elephant from Crocodile Attack: https://youtu.be/BGY0BHmjEtg

Amazing Animal Babies: Emperor Penguin Chicks: https://youtu.be/lf26jtJfL30

1. What animal behaviors are the animals displaying in the video?

2. **Cause and Effect:** How does the behavior attract a mate or help the babies survive?

Part II • Explore How Specialized Plant Structures Help Plants Successfully Reproduce

A. Introduction to Plant Reproduction

Watch these two video clips to introduce you to the process of plant reproduction.

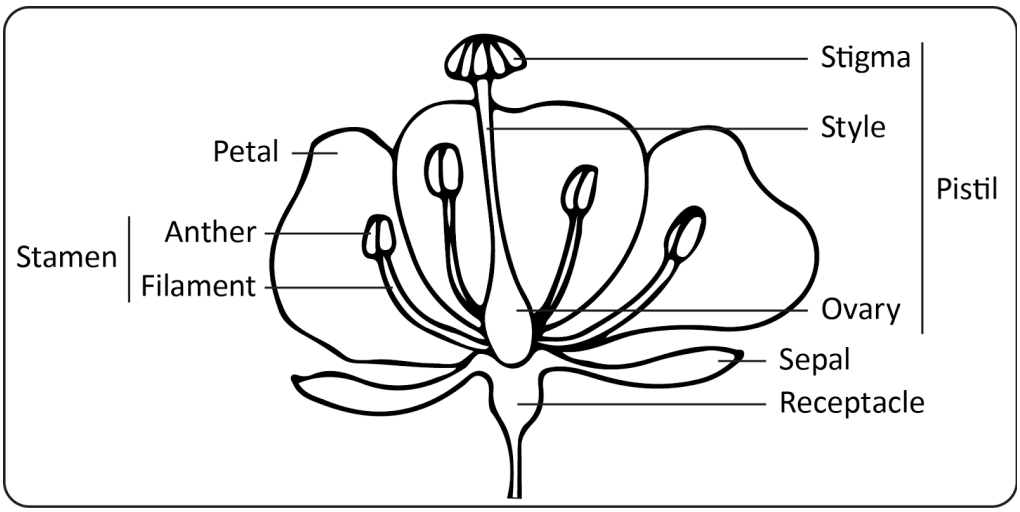
Video clips:

Flower Reproduction: https://youtu.be/YqM6rgB_l_o

Pollination Rock: https://youtu.be/V5yya4elRLw

Analysis:

1. On the diagram of a flower below, use red to color in the area where the pollen (flower sperm) is made.
2. On the diagram below, use green to color in the area where the ovaries (eggs) are found.



3. Write a brief description of pollination and its role in plant reproduction.

B. Successful Reproduction

Watch the following four video clips. Then answer the two questions that follow for **each** video clip.

Video clips:

Seed Dispersal: https://youtu.be/j1hRxuy1ezQ

Biggest Flower in the world: https://youtu.be/FHaWu2rcP94

Butterfly pollination: https://youtu.be/gLJIcKpzH5E

Pine pollen blown by the wind: https://youtu.be/V_9palHvAIc

Analysis:

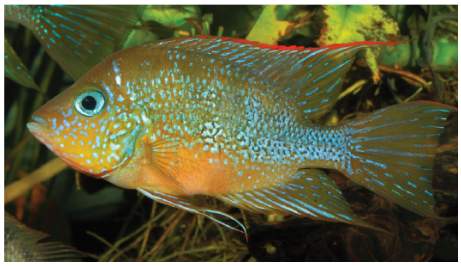
1. What did you observe in the video about the plant or about the animals around the plant?

2. **Cause and Effect:** How does the **plant structure** or **animal behavior around the plant** help the plant successfully reproduce?

Part III • Analyze Guppy Mating Data

1. Female guppies always choose their male guppy mate. Watch the video clip, which shows a male guppy doing a mating dance for a female guppy. Video clip: https://youtu.be/1tKOIc0qReQ

2. Two scientists studied guppy mating habits while predators were around (PRESENT) and when predators were not around (ABSENT). A **predator** is a fish that wants to eat a guppy. A guppy predator is a **cichlid**.

Female Guppy	Male Colorful Guppy	Male with Orange Spots
		
Guppy Predator: A Cichlid 		

The data below shows the traits female guppies prefer in male guppies when predators are **absent** and when they are **present**.

Type of Male	Percent of Time Female Chooses a Male When Predators Are	
	Absent	Present
Colorful	55	24
Drab (dull or not colorful)	12	44
Lots of Orange Spots (physically fit)	33	32

3. These scientists then compared each other's data and came up with two different arguments to explain what is happening with guppy mating. Read the arguments below and discuss which you think is better and why.

   - Scientist 1: Female guppies choose to mate with the most brightly colored males simply because they are easier to spot and imply good genes, no matter whether predators are present or not. The only reason females would not choose these colorful males is if they were all eaten by predators. This choice of mates makes their offspring more likely to have bright colors, attract mates, and reproduce in the future.

   - Scientist 2: Female guppies prefer orange-spotted males for the physically-fit genes they will pass on to their offspring. They prefer colorful males because their offspring would then be flashier and more likely to reproduce; this is especially true when predators are absent. When predators are present, females choose colorful males less often because they know that they are more easily seen and thus eaten more often by predators; by choosing a drab male, females help their offspring's chance of survival.

4. Using the scientific ideas you learned in Part I and Part II of this task, as well as the data above:
   - **Cause and Effect:** Choose the better argument and use the evidence provided to write your own scientific argument to explain **why female guppies prefer certain male traits when predators are absent or present**.
   - Use the claim, evidence, reasoning format.

REFLECT

At the beginning of this task, you were asked whether you could think of any traits (physical or behavioral) of plants and animals you have seen that may help them attract a mate. Look back at your response. Is there anything you can add to your answer based on what you have learned through this task? What types of examples had you never thought about before this task?

Part IV • Connect to the Culminating Project and Assessment

Complete the Individual Project Organizer for this task.

3 Variation and Heredity

Objectives

You will be able to

- Distinguish between sexual and asexual reproduction.
- Develop a model to show how sexual reproduction results in variation of traits and asexual reproduction results in identical traits.
- Collaborate to identify patterns.
- Use language to describe diagrams

How do the environment and genetics affect who we are and how we are similar or different?

Evaluation and Feedback

To evaluate your work, you will

- Use the "Developing and Using Models" row of the Science and Engineering Practices Rubric.
- Use other criteria determined by your teacher.

Task 3: Make a Dog Family and Bacteria Family

As a group:

- Identify variation of traits in dogs.
- Identify the traits and alleles in parent dogs.
- Create two puppies from the parent dogs.
- Create a model to describe variations in puppies.
- Identify the traits and alleles in bacteria.
- Create bacteria offspring.
- Create a model to describe the lack of variation in bacteria offspring.

Vocabulary

- allele
- asexual reproduction
- bacteria
- chromosome
- dominant
- gene
- recessive
- sexual reproduction
- trait
- variation

Connect to the Culminating Project

Plan and organize your children's book in your Individual Project Organizer:

- Design and draw your main character as a baby and its parents.
- Make allele pairs for six character traits.
- Show how alleles are passed from parent to offspring.

TASK 3 Make a Dog Family and Bacteria Family

Introduction

In Task 2, you discovered different structures and behaviors that make it more likely for a plant or animal to reproduce successfully. Now it's time to think about the results of reproduction. You started out the unit thinking about your own human traits, but how did you get them? You know that your parents reproduced to make you, but how did you end up with the collection of traits you have?

- Do you look identical to or different from your parents? Make a prediction: Why do you think this is the case?

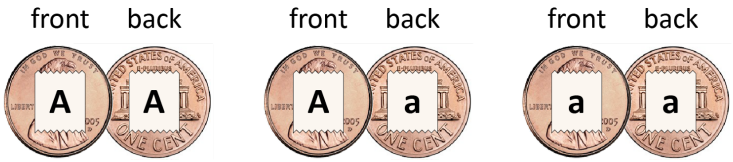
Part I • Dog Traits

1. You will find these resource cards on your table:
   - Domestic Dog Pictures Resource Card
   - Animal and Plant Reproduction Resource Card
2. Analyze the Domestic Dog Pictures Resource Card and answer these questions:
   - Describe three variations, or differences, you see among the dogs.
   - **Cause and Effect:** Why does variation in dogs exist?
3. Analyze the Animal and Plant Reproduction Resource Card.
   - Describe the process of sexual reproduction.

Part II • Make a Dog Family

1. Place the following handouts that your teacher gives you in front of you:
   - Domestic Dog Pictures Resource Card (one per group)
   - Dog Traits and Alleles Resource Card (one per group)
   - Dog Family Picture Frame (one per student)
2. Pick a mom dog and a dad dog from the Domestic Dog Pictures.
3. Draw your mom and dad dogs in your Dog Family Picture Frame.
4. Identify your mom and dad dogs' **traits** in the Dog Traits and Alleles Resource Card. Record the traits in the Dog Data Table.
5. Identify your mom and dad dogs' **alleles** in the Dog Traits and Alleles Resource Card. Record the traits in the Dog Data Table.
6. Follow your teacher's instructions to make a puppy with your penny alleles. Record its traits and alleles in the Dog Data Table.

Make a Dog Family and Bacteria Family



2 dominant alleles | 1 dominant allele, 1 recessive allele | 2 recessive alleles

United States coin images from the United States Mint

7. Repeat step 7 for a second puppy. Record its traits and alleles in the Dog Data Table.
8. Draw your two puppies in the Dog Family Picture Frame.
9. Name the four dogs in your dog family.

Dog Data Table

	Mom Dog		Dad Dog		Puppy 1		Puppy 2	
	Use Dog Traits and Alleles Resource Card.				Flip Mom and Dad pennies.			
Trait	**Trait**	**Alleles**	**Trait**	**Alleles**	**Trait**	**Alleles**	**Trait**	**Alleles**
Example: Tail Shape	Curved	Tt	Curved	Tt	Curved	Tt	Straight	tt
Tail Shape								
Tail Fluffiness								
Tail Length								
Height								
Coat Color								
Coat Length								
Ear Stance								
Ear Length								
Your Choice								
Sex: M or F								

Part III • Dog Family Analysis

1. Using the process you modeled in making your dog family, develop and draw a model to show how sexual reproduction results in variation of traits in the offspring. Make sure to label the parts of your model. Draw your model in your science notebook.

2. **Cause and Effect:** Describe why sexual reproduction results in variations of traits in the offspring. Record your answer in your science notebook.

3. Apply the model above and show how two brown-haired parents can have a blond-haired child. Record your answer in your science notebook.

   B = Brown allele b = blond allele

Part IV • Bacteria Traits

1. You will find these resource cards on your table:
   - Bacteria Resource Card
2. Analyze the Bacteria Resource Card and discuss the following with your group:
   - Brainstorm three variations, or differences, you see among the bacteria.
   - **Cause** and **Effect:** Why does variation in bacteria exist?
3. Analyze the Bacteria Reproduction part of the Bacteria Resource Card and discuss with your group:
   - Describe the process of asexual reproduction.

Part V • Bacteria Family

1. In addition to the resource cards in Part IV, you will find the Bacteria Traits Resource Card on your table.
2. Place the following handout that your teacher gives you in front of you:
   - Bacteria Family Picture Frame
3. Select your parent bacteria from the Bacteria Resource Card (you only need to choose one parent).
4. Draw your parent bacteria on your Bacteria Family Picture Frame.

5. Identify the parent bacteria's **traits** using the Bacteria Traits Resource Card. Record these traits in the Bacteria Data Table.

6. Identify the parent bacteria's **alleles** using the Bacteria Traits Resource Card. Record these alleles in the Bacteria Data Table.

7. Make two bacteria babies.

   HINT

   Design a way to identify the alleles that will be passed from parent to offspring in bacteria.

8. Record the **traits** and **alleles** of your baby bacteria in your Bacteria Data Table.

9. Draw your baby bacteria on your Bacteria Family Picture Frame.

Bacteria Data Table

	Parent Bacteria		Baby Bacteria 1		Baby Bacteria 2	
Trait	Trait	Allele	Trait	Allele	Trait	Allele
Cell Shape						
Growth Pattern						
Flagellum						
Outer Coat (Capsule)						
End (Spore)						

Part VI • Bacteria Family Analysis

1. Using the process you modeled in making your bacteria family, develop and draw a model to show that asexual reproduction **does not** result in variation of traits in the offspring. Make sure to label the parts of your model.

   Draw your model in your science notebook.

2. **Cause and Effect:** Use your model to describe why asexual reproduction **does not** result in variations of traits in the offspring. Record your answer in your science notebook.

3. Make a Venn diagram to show the differences and similarities between asexual reproduction and sexual reproduction. Draw your diagram in your science notebook.

REFLECT

At the beginning of this task, you tried to explain why you look identical or different from your parents. Look back at your response. After what you have learned about sexual and asexual reproduction, how could you change or add to your ideas?

Part VII • Connect to the Culminating Project and Assessment

Complete the Individual Project Organizer for this task.

4 Variation and Heredity

Objectives

You will be able to

- Determine whether variations of living organisms are due to genetics or the environment.
- Construct a scientific explanation about how environmental and genetic factors influence the growth of organisms.
- Share observations with your group.
- Communicate your ideas and listen actively.

How do the environment and genetics affect who we are and how we are similar or different?

Evaluation and Feedback

To evaluate your work, you will

- Use the "Constructing Explanations and Designing Solutions" row of the Science and Engineering Practices Rubric.
- Use other criteria determined by your teacher.

Task 4: Variation in Elephants

As a group:

- Observe and explain variation in elephants.
- Analyze a graph of average heights of different species of elephants.
- Explain why the different species of elephants have different heights.
- Analyze a graph of two orphaned baby Asian elephants who are fed different diets.
- Explain why the orphaned baby Asian elephants have different weights after 44 weeks.

Vocabulary

- environmental differences
- genetics
- inheritance
- species
- variation

Connect to the Culminating Project

Plan and organize your children's book in your Individual Project Organizer:

- Write and illustrate a storyboard for your book.

Introduction

In the previous task, you modeled how sexual reproduction passes on a combination of genes from parents to offspring, resulting in variation in traits. You have also looked at how the environment influences traits of organisms. So which is it—genetics or environment?

- In 1979, researchers at the University of Minnesota had the same question and conducted a study looking at identical twins (genetically the same) who were raised apart (in different environments). Make a prediction: Do you think these identical twins still had identical traits after 20 years apart? Why or why not?

Part I • Variation in Elephants

1. Consider the elephant photo below. Make four observations about what might explain the variation in elephant size.

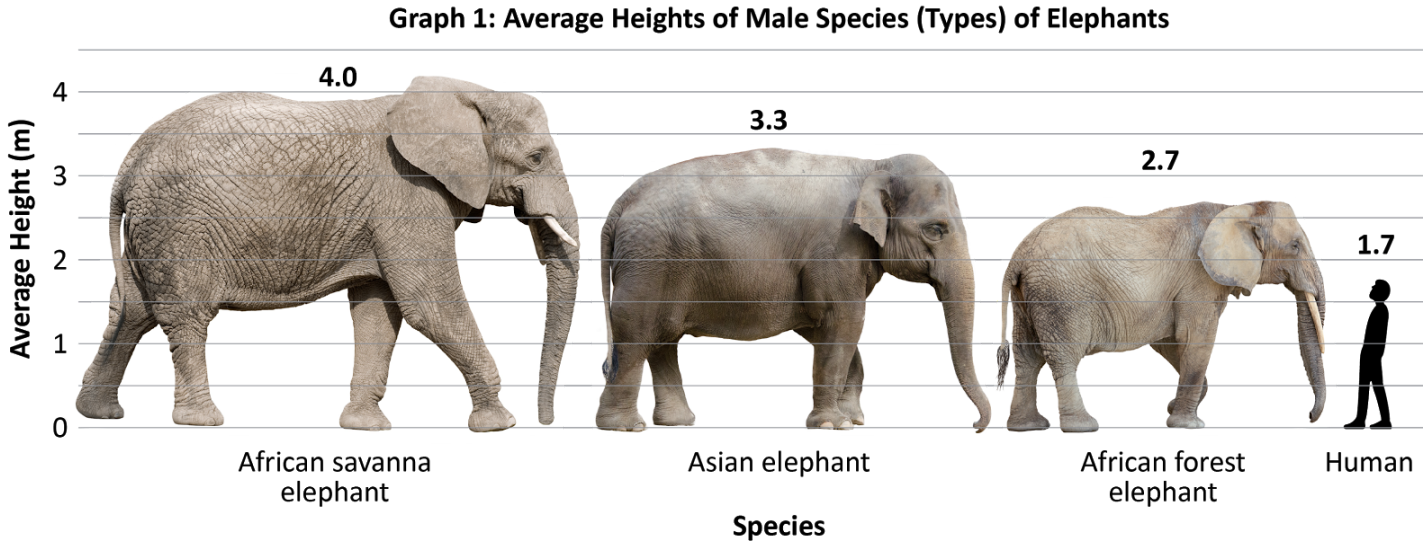
Observation 1
Observation 2
Observation 3
Observation 4

2. The elephants in the above picture belong to the same **species**.

   - What does *species* mean to you?

   - In the space below, write a sentence that has the words **cats** and **species** in it.

Part II • Genetic Variations Resulting in Different Elephant Sizes



1. Graph 1 above shows the average heights of three different species of elephants. Look over the graph and then discuss these questions with your group:

   - What does the axis that runs up and down on the left side of the graph (the *y*-axis) tell you?

   - What does the axis that runs across the bottom of the graph (the *x*-axis) tell you?

   - Write three statements that compare elephant data found in the graph.

Sample Statement: The male African savanna elephant is 0.7 m taller than the Asian elephant.
Statement 1
Statement 2

Statement 3

2. Construct an explanation.

Claim: After analyzing Graph 1, make a claim about elephant heights and elephant species.
Evidence: Use evidence from the graph to support your claim. Use numbers when stating your evidence.

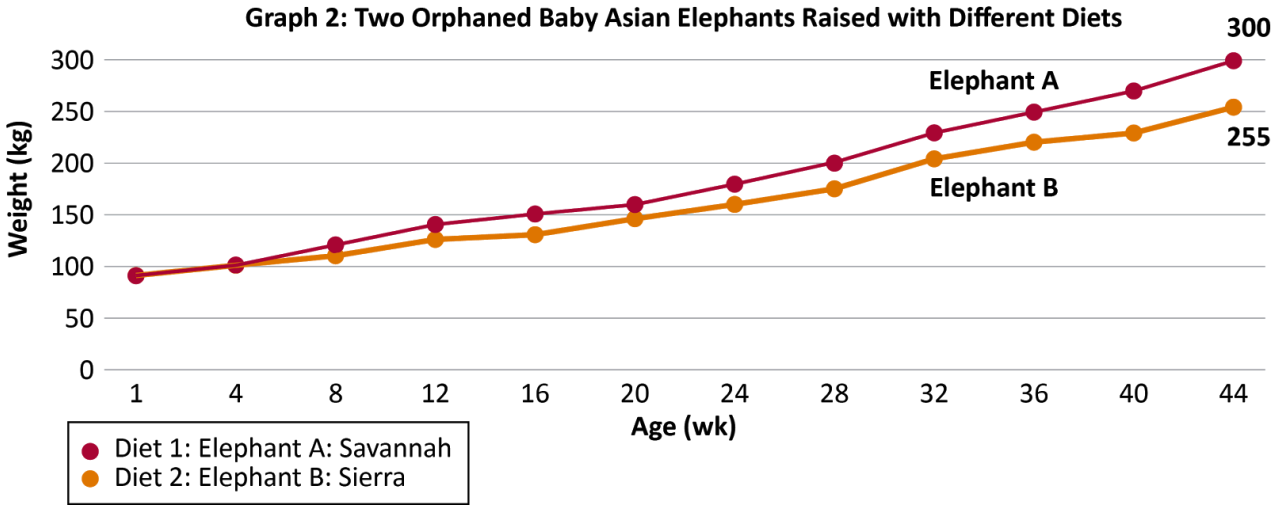
Reasoning: Use a scientific concept to connect your evidence to your claim.

Part III • Different Environmental Conditions Resulting in Variation in Elephant Sizes

1. Brainstorm with your group to describe five different **environmental differences** that might cause elephants of the **same** species to be different sizes. **Cause and effect:** Discuss **why** and **how** the different environments affect the elephants.

Difference 1

Difference 2
Difference 3
Difference 4
Difference 5



2. Graph 2 above shows the weekly weights of two orphaned elephants who were fed different diets. Look over the graph and then discuss the following questions with your group. Make notes and write your answers in your science notebook.
   - What does the axis that runs up and down on the left side of the graph (the *y*-axis) tell you?
   - What does the axis that runs across the bottom of the graph (the *x*-axis) tell you?
   - Describe three possible differences between the two different diets.

3. In your science notebook, construct a claim, evidence, reasoning explanation following the guidelines in the table below.

Claim: After analyzing Graph 2, make a claim about the weight of the orphaned Asian elephants.
Evidence: Use evidence from the graph to support your claim. Use numbers when writing your evidence.
Reasoning: Use a scientific concept to connect your evidence to your claim.

4. **Cause and effect:** Based on what you have learned about why elephants have different heights and weights, explain why humans have different heights and weights.

REFLECT

At the beginning of this task, you were asked to think about a study of identical twins raised apart and predict whether these identical twins still had identical traits after 20 years. Look back at your response. After what you have learned about genetics and environment through this task, how would you add to or change your ideas? Is there any evidence from this task that you can add?

Part IV • Connect to the Culminating Project and Assessment

Complete the Individual Project Organizer for this task.