

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)

Gene 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

Gene 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

G 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





Performing Tumbler



Individual Culminating Project: Heredity and Variation—DAY 1

Getting Started

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



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.	Hatch!		
Find games 1–26.			
Get an explanation or more information.	Explain		
means your answer is correct.			



Part I • Pigeon Gender



Credit: Dori/Wikipedia/Creative Commons Attribution

Alleles	Male	Female
Allele = Z Allele = W	ZZ	ZW female

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.



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



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	Domina	nt Allele	Recessive Allele In-Between Tra		een Trait	
Crest	N	No crest	n	Crest	2	K
Frill back	F	No Frill back	f	Frill back	2	K
Body	т	Trim	t	Thick and muscular		K
Beak	В	Bumpy	b	Regular	;	K
Slippers	S	Slippers	Р*	No slippers	SP	Small Slippers
Neck	L	Long neck	Н*	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.

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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.

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- 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	Grouse	No Grouse
	Feathers on the legs	Allele = (G)	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)
			₩	Ţ	V

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,	Color	Ash red	Blue	Brown
17, 18		Allele =	Allele =	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	Big muff	Medium muff	Small muff
the legs and feet	Grouse + Slippers 4 dominant alleles	Grouse + Slippers 3 dominant alleles	Grouse + Slippers 2 dominant alleles



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.
 Start brainstorming some possible main characters for your book. Draw the character and label at least four of their distinguishing traits.
 Describe your character. Make sure to include their human traits, their personality, and their interests in you description.



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.



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.		
 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 mi	ght have to help the offspring survive?	
4. Cause and Effect: Write a short narrative describing your character mates and has surviving offspring.	how traits and/or behaviors increase the probability that	



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.			
 Draw your main character. Identify in your illustration at least five specific traits. 	 Pick one 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?		



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
What happens next	What happens next	How the story ends
What happens next	What happens next	How the story ends
What happens next	What happens next	How the story ends
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What happens next	What happens next	How the story ends
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	Asks general questions that cannot be investigated.	Asks specific questions that can be investigated but do not require empirical evidence.	Asks questions that require empirical evidence to answer.	Asks questions that require empirical evidence to answer and evaluates the testability of the questions.
No Evidence*	Writes a problem or design statement but it does not match the intent of the problem or the need of the client.	Writes a problem or design statement that matches the intent of the problem or the need of the client with minor errors.	Writes a problem or design statement that accurately matches the intent of the problem or the needs of the client.	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	Makes models (drawings, diagrams, or other) with major errors.	Makes models (drawings, diagrams, or other) to represent the process or system to be investigated with minor errors.	Makes accurate and labeled models (drawings, diagrams, or other) to represent the process or system to be investigated.	Makes accurate and labeled models (drawings, diagrams, or other) to represent the process or system to be investigated and explains the model.
No Evidence*	Explains the limitations of the model with major errors.	Explains the limitations of the model with minor errors.	Explains the limitations of the model as a representation of the system or process.	Explains the limitations of the model as a representation of the system or process and discusses how the model might be improved.
PLANNING INVESTIGATIONS	Plans an investigation that will not produce relevant data to answer the empirical question(s).	Plans an investigation that will produce some relevant data to answer the empirical question(s).	Plans an investigation that will produce relevant data to answer the empirical question(s) and identifies the dependent and independent variables when applicable.	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.
No Evidence*	Plans a design that does not match the criteria, constraints, and intent of the problem.	Plans a design and writes an explanation that partially matches the criteria, constraints, and intent of the problem.	Plans a design and writes an explanation that accurately and adequately matches the criteria, constraints, and intent of the problem.	Plans a design and writes a detailed explanation that accurately and completely matches the criteria, constraints, and intent of the problem.
CARRYING OUT INVESTIGATIONS	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

STUDENT EDITION

Project Specifications



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	Constructs an explanation that includes an inappropriate claim, inaccurate evidence, and/or unclear reasoning.	Constructs or evaluates an explanation consisting of minimal claim(s), limited sources of accurate evidence, and/or minimal reasoning.	Constructs or evaluates an explanation that includes a claim, multiple sources of accurate evidence, and reasoning using accurate and adequate scientific ideas or principles.	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.
No Evidence*	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.	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.	Uses adequate data to evaluate how well the design answers the problem and accurately explains an appropriate redesign of the original model or prototype.	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	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 D 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.

 \ast 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:

Given 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

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• 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: