Teacher Guide: Genetics: Red-Hair Mystery Series

Gizmos Investigation

Overview

Grade Level: 6-8
Subjects: Life Science
Time: 90 min
Topic: Mendelian Genetics

Unlike everyone else in her family, Sadie has red hair. She wonders where it came from and why she's the only one. To solve the mystery of Sadie's hair, students will use laboratory mice as a model to understand how dominant and recessive traits are passed from parents to their offspring. Using experimentation, student-created models of inheritance, and Punnett squares, students will learn how traits are passed down and how some traits can be "hidden" for generations.

Student Learning Objectives

By the end of this lesson series, students will be able to:

- Understand that our genetic traits are formed by combinations of dominant and recessive alleles.
- Define and use the terms inherit, allele, dominant, recessive, genotype, and phenotype.
- Gather data on parent and offspring phenotypes to create and revise a model of how alleles are passed from parents to offspring.
- Use Punnett squares to model offspring genotypes and predict percentages of different phenotypes.
- Construct an explanation of how two brown-haired parents can have a red-haired child.

Summary

Lesson 1

Driving Question	Practices	Learning Outcomes
How did Sadie inherit red hair from her brown-haired parents?	Gathering data, building and revising models	Students create and revise their own model of how traits are passed down from parents to offspring

Connection to next lesson: In Lesson 2, students will compare two proposed models of inheritance.

Lesson 2

Driving Question	Practices	Learning Outcomes
Which model best explains how two black-fur parent mice can have white-fur offspring?	Analyzing and interpreting data, engaging in argument from evidence	Understand that traits are caused by dominant and recessive alleles

Connection to next lesson: In Lesson 3, students will use Punnett squares to predict offspring genotypes and phenotypes.

Lesson 3

Driving Question	Practices	Learning Outcomes
How do we know for sure that red hair is caused by a recessive allele?	Modeling, gathering and analyzing data, using mathematics, constructing explanations	Use a Punnett square to predict the frequency of different offspring genotypes and phenotypes, explain to Sadie how she inherited her red hair

NOTE: Need additional support implementing this Gizmos Investigation in your classroom? Check out our other resources under the “Supplemental Resources” section of this Investigation on our website!

Standards Alignment

Gizmos Investigations are designed to align with the Next Generation Science Standards. This is done in terms of the three dimensions of disciplinary core ideas (DCIs), science/engineering practices (SEPs), and cross-cutting concepts (CCCs). These correlations should also apply to other states' standards that similarly reference DCIs, SEPs, and CCCs or their equivalents (although individual states' numbering schemes will likely differ).

Please note that our alignment is specifically to the **middle grades (grades 6-8)** level learning goals for the below-listed DCIs, SEPs, and CCCs.

Disciplinary Core Ideas (DCI)	Science and Engineering Practices (SEP)	Crosscutting Concepts (CCC)
LS1.B: Growth and Development of Organisms • Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. **LS3.A: Inheritance of Traits** • Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. **LS3.B: Variation of Traits** • In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) 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.	**Planning and Carrying Out Investigations** • Collect data to produce data to serve as the basis for evidence to answer scientific questions. **Developing and Using Models** • Develop a model to predict and/or describe phenomena. • Develop a model to describe unobservable mechanisms. **Using Mathematics** • Apply mathematics to scientific questions. **Constructing Explanations** • Construct an explanation using models or representations.	**Patterns** • Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. **Cause and Effect** • Understanding mechanisms and explaining how variables interact.

The Genetics: Red-Hair Mystery Series builds toward the following NGSS Performance Expectation (PE):

- ***MS-LS3-2****: Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]*

Prior Knowledge

Include what students should know leaving the previous grade they were in. (Can be found in the framework)

By the end of grade 5.

- Offspring acquire a mix of traits from their biological parents. Different organisms vary in how they look and function because they have different inherited information.
- In each kind of organism there is variation in the traits themselves, and different kinds of organisms may have different versions of the trait.
- The environment also affects the traits that an organism develops—differences in where they grow or in the food they consume may cause organisms that are related to end up looking or behaving differently.

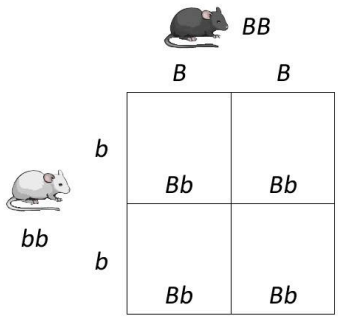
Genetics: Red-Hair Mystery - Scientific Background

In 1866, Gregor Mendel published a paper called *Experiments in Plant Hybridization*, summarizing years of careful experiments with pea plants. Although his work was ignored during his life, his discoveries form the foundation of what we know about how traits are passed down from parents to their offspring.

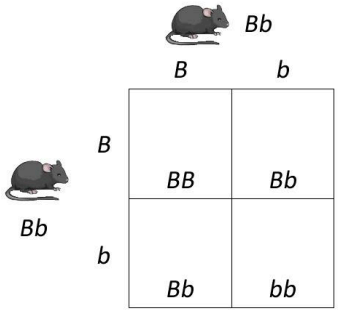
The *Genetics* Investigation Series explores Mendel's Laws of Inheritance.

- Each trait is determined by a pair of alleles. Each offspring organism inherits one allele from each parent. (Law of Segregation)
- Some alleles are dominant and some are recessive. If the dominant allele is present, the organism will display the dominant trait. If two copies of the recessive allele are present, the organism will display the recessive trait. (Law of Dominance and Uniformity)
- The inheritance of one trait does not affect the inheritance of other traits. (Law of Independent Assortment)

For a simple trait such as the black and white fur color illustrated in the *Genetics* Investigation, there are two alleles: a dominant black-fur allele (*B*) and a recessive white-fur allele (*b*). The combination of alleles (such as *Bb*) is referred to as the *genotype*, and the resulting physical trait (in this case, black fur) is the *phenotype*. If both alleles in a genotype are the same (*BB* or *bb*), the organism is *homozygous* for that trait. If the alleles are different (*Bb*) the organism is *heterozygous* for that trait.



The possible results of a genetic cross can be illustrated with a Punnett square (right), which is used by students in lesson 3. When a homozygous *BB* mouse is bred to a *bb* mouse, each offspring will have the genotype *Bb*. When two *Bb* mice are bred, this results in one *BB*, two *Bb*, and one *bb* offspring. This explains the mystery of Sadie's red hair. If both of her parents carry the recessive red-hair allele, there is a 25% chance that their child will inherit both of the recessive alleles and have red hair.



In humans, red hair is associated with some variants of the MC1R gene found on chromosome 16. These variants are known as RHC (red hair color) alleles. Individuals who possess two RHC alleles are likely to have red hair. These alleles are also associated with fair skin, lack of ability to tan, and freckles.

Genetics: Red-Hair Mystery - Key Vocabulary

To support your students, you can print this graphic organizer and have them draw pictures to support their learning of key vocabulary words from the Gizmos Investigation.

Glossary Term	Definition	Picture
Trait *(trayt)*	A **trait** is a characteristic of an organism such as eye color, hair color, allergies, or height.	
Geneticist *(juh NEH tuh sist)*	A **geneticist** studies how traits are passed from parents to offspring.	
Offspring *(OFF spring)*	**Offspring** are the children of a set of parents	
Gene *(jeen)*	A **gene** is a segment of DNA that helps to determine a trait.	
Allele *(uh LEEL)*	**Alleles** are different forms of genes. Different alleles code for different traits, such as brown eyes vs. blue eyes.	
Genotype *(JEH nuh tipe)*	The combination of alleles an organism has is called a **genotype**.	
Dominant allele *(DAH muh nunt uh LEEL)*	If an organism has one copy of a **dominant allele**, the organism will have the dominant trait.	
Recessive allele *(ruh SEH suhv uh LEEL)*	An organism will only show the recessive trait if it has two copies of the **recessive allele**.	

Phenotype *(FEE nō tipe)*	The **phenotype** is the physical appearance of the organism.	
Punnett square *(PUN et skwehr)*	A **Punnet square** is a diagram that shows which offspring could result from a parent combination.	

Genetics: Red-Hair Mystery - Usage Guide

This guide provides recommendations for using the *Genetics: Red-Hair Mystery* Investigation Series in your classroom and covers some general information about Gizmos Investigations for those who might be new to using this product.

In this Investigation, students meet Sadie, a lone red-haired child in a family of brunettes. To determine how she inherited her red hair, students will run experiments with lab mice to observe inheritance patterns. After developing their own models, students learn about dominant and recessive alleles and use Punnett squares to solve the mystery of how Sadie inherited her red hair.

Classroom Pacing Schedule (series)

This Investigation series should take approximately three class periods (about 120 minutes). Each lesson has an “End of Lesson” screen that can serve as a pause point for students.

- **Day 1**: Ask students to start the Investigation and **stop** when they reach the “End of Lesson” screen. This signifies the end of Lesson 1, in which students observe patterns and create their own models of inheritance.
    - Students will have completed up to question 14 in the heatmap.
    - *Note:* Questions are not numbered within the Investigation, and the Heatmap view is only visible to teachers. **Students should stop** when they reach this page:
        - 

- **Day 2**: Instruct students to open the Investigation, which will start them where they left off. Students should work through Lesson 2 and stop when they reach the “End of Lesson” screen.
    - Students will have completed 24 questions in the heatmap.

- **Day 3**: Instruct students to open the Investigation, which will start them where they left off. Students should work through Lesson 3.
    - Students will have completed all 40 questions in the heatmap

Series vs. Standalone Lessons

Our lesson platform offers both **series** and **standalone** lessons to support flexible use in a variety of classroom contexts. Teachers can choose to implement an entire sequence of lessons or use a single lesson independently, depending on instructional goals, student readiness, and available time.

Series Lessons

- Designed to be taught in a specific order, with each lesson building on the ideas, models, and evidence from previous lessons.
- Students revisit and revise models, refine explanations, and apply their learning to new scenarios over time.
- Encourages deeper understanding of disciplinary core ideas, crosscutting concepts, and science and engineering practices through a coherent storyline.
- Ideal for comprehensive instruction, sustained engagement, and performance-based assessments.

Standalone Lessons

- Fully self-contained and can be used independently from other lessons in the series.
- Include necessary background or recap content to ensure all students can engage meaningfully, even without completing prior lessons.
- Useful for targeted instruction, intervention, enrichment, or aligning to specific standards or pacing needs.
- Designed to deliver meaningful learning outcomes in a single class or unit without requiring prior knowledge from other lessons.

Recommendation

Use **series lessons** when you want students to explore a phenomenon over time, develop and revise models, and connect concepts across multiple lessons. Use a **standalone lesson** when you're focusing on a specific concept, skill, or standard—or when time constraints require a more flexible instructional approach.

Teacher Preview Version

We highly recommend that teachers complete a preview version of an Investigation before assigning it to their class. In the teacher version, each page functions as it would for your students, so you can preview feedback, scaffolding, and other support tools. You can use this

version to familiarize yourself with the activities that students will complete. You can also use it to review concepts with your class by presenting them via a projector or smartboard.

Heatmap

The heatmap is a tool available for all Investigations that allows teachers to observe their students' current thinking and monitor student progress in real time. It can also be used to determine what additional support a student might need in the content and practices involved, individually or as a class.

Some questions are automatically graded and instantly populate the heatmap with a score and color, while others are categorized as "teacher graded." These questions require a teacher to grade a student's response for points to be awarded. All teacher-graded questions are provided with rubrics to support grading.

Prior Knowledge

Throughout the Investigation, students are encouraged to share their current thinking and preconceptions to help relate new information they explore with their prior knowledge and experiences. These questions are shown on the heatmap with a purple lightbulb and labeled as "Conversational Questions".

Formative Assessment

Students are assessed on their learning by answering questions and receiving feedback as they progress through the Investigation. Students can check their understanding and receive targeted feedback when answering questions to discover if they have a misunderstanding. Students receive three tries on a formative question, listed to the left of the submit button.

Formative questions are color-coded within the heatmap to help teachers best support students. Detailed "scoring criteria" within the question view explains how colors were assigned for the heatmap question. The heatmap color codes are based on colors distributed across three percentage categories:

Mastered	Developing	Below Expectations
75%-100%	50-75%	0-50%

Summative Assessment

Additionally, some questions within the Investigation are labeled as summative. These questions reflect moments where students have had ample opportunity to practice their understanding of a concept or skill and are thus assigned points after a single attempt to judge their current knowledge. These questions are color-coded in the heatmap using the same percentages

described above. The only difference here is that students are only given one attempt to answer a summative question. Summative question point values are the only points included in the total on the heatmap. Teachers can use these question types to assess student's knowledge or skills to better support learning in their classroom.

While the final score they receive on the Investigation can be used for a classroom grade book, we recommend assigning points to students' responses based on their ability and expectations.

Student Support and Accessibility

Investigations include the following supports to help students further in their learning.

Vocabulary Support

- The Key Vocabulary handout provides definitions and phonetic pronunciation for all key vocabulary terms used in the Investigation. The handout also includes space for students to draw pictures to help them learn these terms.
- Teachers can preview vocabulary using the handout to help support students before starting the Investigation.

Writing Support

- Where applicable, sentence stems are provided for open-response questions to help students structure their writing.
- For some open-response questions, key vocabulary terms are automatically highlighted in green when included in student responses. This helps reinforce student vocabulary usage.
- Validation feedback is triggered for open-response questions when students submit vague answers or skip important vocabulary. This feedback guides students towards complete and meaningful responses. There is a checkbox at the bottom of this type of feedback so that students can move forward if they choose without getting stuck.