Teacher Guide: Chicken Genetics

Learning Objectives

Students will …

- Describe a codominant inheritance pattern.
- Predict the results of genetic crosses involving codominant traits.
- Use a Punnett square to calculate the probability of offspring genotypes.
- Explain the importance of performing multiple trials during an experiment.

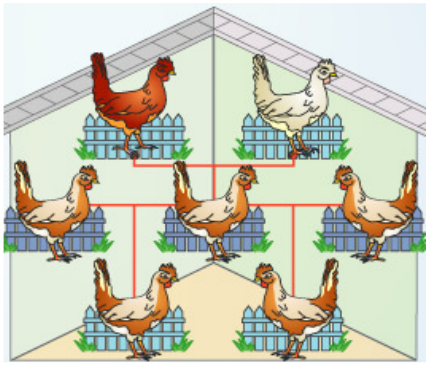
Vocabulary

allele, codominance, dominant, genotype, heterozygous, homozygous, phenotype, probability, Punnett square, recessive, trial

Lesson Overview

Using pea plants, Gregor Mendel discovered an inheritance pattern controlled by dominant and recessive alleles. However, not all alleles follow this inheritance pattern. Sometimes, alleles are not completely dominant to one another. At other times, alleles will share dominance. This type of inheritance pattern is called *codominance*.

The *Chicken Genetics* Gizmo™ allows students to conduct breeding experiments in order to explore the inheritance of a codominant trait. Offspring can be saved for future breeding experiments, and large numbers of offspring can be produced from a set of parents.



A white parent and a red parent yield mixed-colored offspring

The Student Exploration sheet contains two activities:

- Activity A – Students determine how codominant inheritance patterns differ from dominant/recessive inheritance patterns.
- Activity B – Students use a Punnett square to predict the probable outcome of a cross and then conduct multiple trials in order to test their predictions.

Suggested Lesson Sequence

1. **Pre-Gizmo activity** (45 – 60 minutes)
   To introduce students to dominant/recessive inheritance patterns, have students explore the *Mouse Genetics (One Trait)* Gizmo.

   To introduce students to probability, give each student a penny. Ask them what the chances are of the coin landing heads up if they toss the coin. [The chance is ½ or 50%.] Have students toss their coins. Determine what percentage of students got heads. Have students discuss why the result was not exactly 50%. (More probability games can be found in the **Selected Web Resources** below.)

2. **Prior to using the Gizmo** (10 – 15 minutes)
Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations. Demonstrate how to take a screenshot and paste the image into a blank document.

3. **Gizmo activities** (15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (15 – 30 minutes)
As students are working or just after they are done, discuss the following questions:

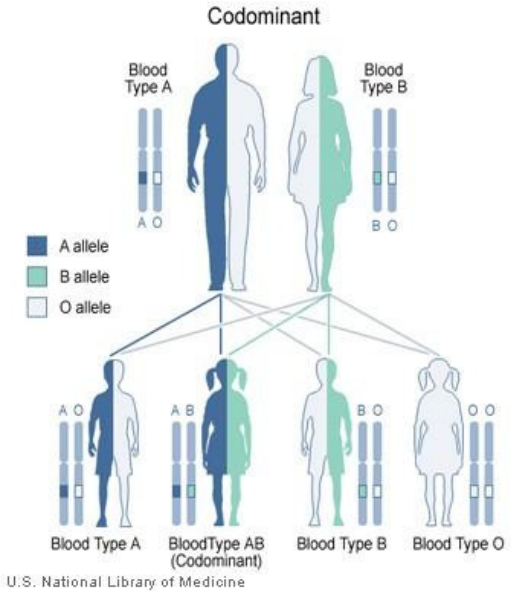
   - Which feather color is recessive: white or red? [The allele for neither of the feather colors is recessive. Both colors are controlled by dominant alleles.]
   - Why does crossing a pure white chicken and a pure red chicken only produce mixed-colored offspring?
   - Suppose two mixed-colored chickens were crossed and they produced a white feathered offspring. Could this offspring be heterozygous for red feathers?
   - Suppose you were studying the inheritance pattern for fur color in rabbits. How could you determine whether rabbit fur color was a codominant trait?
   - Do you think probability calculations predict average outcomes or exact outcomes?

5. **Follow-up activity** (15 minutes)
Tell students that blood type is determined by a mix of codominant and recessive alleles. The three possible alleles are for type A (I^A), type B (I^B), and type O (i) blood. Give students the following information:

   - The alleles for type A and type B are codominant to each other. If they are inherited together, a person will have type AB blood.
   - Type O blood is caused by a recessive allele. The alleles for type A and B are both dominant to the allele for type O.

   Ask students to use this information to identify all of the possible genotypes for people with type A, type B, type AB, and type O blood. [Type A: I^AI^A and I^Ai; Type B: I^BI^B and I^Bi; Type AB: I^AI^B; Type O: ii].

   Then ask students to use Punnett squares to predict the outcomes of various crosses. (I^Ai crossed with I^Bi is shown at right.)



Scientific Background

Different versions of the same gene are called *alleles*. Organisms inherit one copy of an allele from each parent. Thus, an organism has two alleles per gene. These two alleles make up the organisms *genotype.* The way the alleles interact with each other and the environment control how the gene is expressed. The physical expression of a gene is the organism's *phenotype.*

Gregor Mendel studied traits in pea plants that were governed by a dominant/recessive inheritance pattern. In a dominant/recessive pattern, one version of a gene is dominant over another version. If the dominant allele is present, it will always be expressed. The recessive allele will only be expressed if the dominant allele is absent.

There are many other patterns of inheritance besides the dominant/recessive pattern. The table below summarizes some of the other patterns of inheritance.

Inheritance pattern	Description
Codominance	A pattern of inheritance in which the phenotypes produced by both alleles are completely expressed
Incomplete dominance	A pattern of inheritance in which one allele is not completely dominant over another allele
Multiple alleles	A gene that is governed by more than two alleles
Polygenic traits	A trait that is controlled by two or more genes

The pattern of inheritance modeled by the *Chicken Genetics* Gizmo is codominance. The Gizmo reflects a real-world example of codominance. In several chicken breeds, feather color is determined by codominant alleles. For example, crossing a white-feathered chicken with a black-feathered chicken will produce the *hybrid* speckled chicken shown above.

Health Connection: Cholesterol

In humans, one important gene governed by codominant alleles is the gene for a protein that controls cholesterol levels in the blood. There are two different versions of the gene. One version (*H)* helps the liver effectively remove cholesterol from the blood. The other version of the gene (*L*) prevents liver cells from recognizing and removing the cholesterol. A person with an *HH* genotype will typically be able to maintain a normal blood cholesterol level. A person with an *HL* genotype is likely to struggle with a high blood cholesterol level. A person with an *LL* genotype will have potentially lethal amounts of cholesterol in his bloodstream.

Selected Web Resources

Codominant genes: http://www.cccoe.net/genetics/codominant.html
Inheritance patterns: http://ghr.nlm.nih.gov/handbook/inheritance/inheritancepatterns
Probability games: http://www.betweenwaters.com/probab/probab.html
Probability of inheritance: http://anthro.palomar.edu/mendel/mendel_2.htm
High cholesterol—a genetic disease: http://en.wikipedia.org/wiki/Familial_hypercholesterolemia

Related Gizmos
Inheritance: http://www.explorelearning.com/gizmo/id?657
Mouse Genetics (One Trait): http://www.explorelearning.com/gizmo/id?449
Mouse Genetics (Two Traits): http://www.explorelearning.com/gizmo/id?382