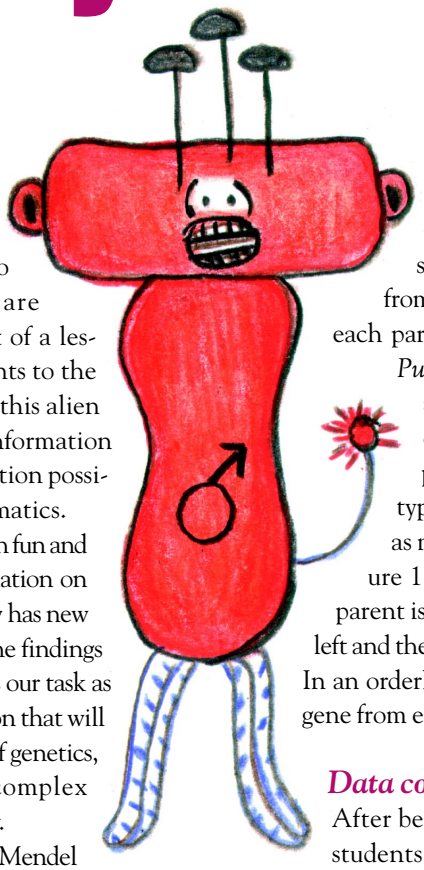
The Alien Lab: A Study in Genetics

By Nancy Cowdin



For the past several years, my seventh grade life science classes have been building a population of aliens. But no need to worry about invasion, these aliens are friendly—and educational. They are part of a lesson I've developed to introduce my students to the fundamentals of genetics. The purpose of this alien invasion is to give students some basic information about genetics. It also has fantastic integration possibilities with language arts, art, and mathematics.

Teaching genetics to seventh graders is both fun and challenging. With a plethora of new information on the human genome, the study of genetics now has new relevance. Newspapers and magazines cite the findings of researchers with increasing frequency. It is our task as educators to provide fundamental information that will allow students to understand the principles of genetics, and to be able to approach more complex genetics-related topics with increased facility.

The lesson begins with a history of Gregor Mendel and his classic study of heredity in pea plants. We go on to discuss and define vocabulary such as *dominant*, *recessive*, *gene*, *trait*, *incomplete dominance*, *purebred*, *hybrid*, *genotypes*, and *phenotypes*. Next, we identify certain dominant and recessive traits in our student population. Students enjoy the opportunity to stick out their tongues at me to display tongue-rolling ability (a dominant trait) and debating what constitutes a "free" versus "attached" earlobe in their classmates. The class takes a survey to look at the ratios within our student population of known dominant and recessive traits, and then hypothesize as to whether or not they think the ratios might hold true within the student body or community. We also discuss patterns of traits that may exist within the students' families. Students are encouraged to test family members to identify common traits.

Having already completed a thorough study of mitosis, a discussion of meiosis is necessary to provide understanding as to how sex cells (*gametes*) receive the information that is passed on during fertilization. Understanding this process also helps students understand how several phenotypic outcomes can be possible from the potential selection of genes donated by each parent. This is followed up by exercises with *Punnett squares* to examine possible genotypic and phenotypic ratios of a given set of parent traits. A Punnett square is a tool used to predict all possible combinations of genotypes and resulting phenotypes for a given trait as might be expressed in the offspring (see Figure 1).The gene pair for a particular trait of one parent is written on the outside of the square on the left and the other parent's gene pair is written at the top. In an orderly fashion, gene pairs are created using one gene from each parent until all possibilities are shown.

Data collection

After becoming comfortable with the vocabulary, students begin the data collection phase. Each student pairs with another, and each student is given a penny and a data grid. Working together, student partners flip the coins and record the results as follows: Heads=H, Tails=h. Each grid contains space to record 12 sets of data (see activity sheet on page 27), which gives the information for one alien. You may want students to fill out additional data sheets to create several aliens.

Each student in the pair flips the coin and together they record the results. For example, Joe and Sue flip their coins. Joe gets "heads" and Sue gets "tails." They each record results on the first line of their first data sheet. The students continue this process until all spaces on all grids are filled. We then have a discussion of alien characteristics and develop a list of traits necessary to build our aliens. Some examples include body and head shapes, antennae, wings, tails, scales, number of legs and arms, etc. The only limitations are their imaginations. But

Nancy Cowdin *is a science coordinator at Holy Trinity School in Washington D.C.*

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in the end the class must have the same key to the alien traits in order to build their population. A key is created that is be used to translate the data into specific traits (see Figure 2).

While the key could be determined in advance of the coin flipping, there is an advantage to doing it after as it makes the flipping process entirely random. Knowing the key to the traits in advance could cause some data manipulation by the students if they happen to like certain traits over others. Some students are disappointed when they begin construction of their aliens once they find that they have no aliens with wings, for example, but this lends well to a discussion of diversity.

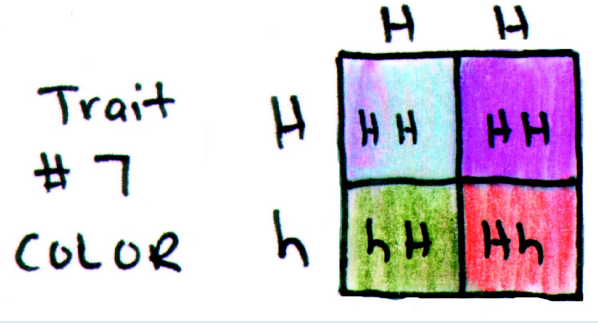
While traits are typically shown by different capital and lower case letters, such as B=brown hair, b=blond hair, we do not translate the "H" and "h" into other letters. Rather, we focus on whether the genotypes resulting from our coin flips represent the *homozygous dominant*, *heterozygous dominant*, *heterozygous with incomplete dominance*, or *homozygous recessive* conditions.

Alien construction zone

My classes use sketchbooks throughout the year to illustrate cell and anatomic structures, as well as physiologic processes. These sketchbooks are used to draw the alien population. Each grid contains the information needed to construct an alien. Next to each gene pair is a space to translate the genotypes, using the key, into their phenotypes. Students cut out and place the grids on the sketchbook page, allowing space to draw the alien next to it.

While students are guided by the information on each grid to construct their aliens, there is still room for genetic variation. If a triangle head is required, the type of triangle drawn is the student's decision. Questions such as, "Is it okay to use a different shade of blue?" or "Does the mouth have to look identical to my partner's alien mouth?" give the opportunity to discuss the variety of traits we see in our human, animal, or plant populations. It is important to relay that other factors contribute to variations in traits found in a species and to help students understand that in real-life, some traits are *multifactorial*, or affected by environmental and genetic factors. A return to the topic of meiosis will remind students that recombination and mutations contribute to the amazing genetic variability we find in our world. We create an opportunity in our alien population for certain traits to be altered by an additional factor consisting of a roll of the dice. For example, some students wanted to include spots or stripes on their aliens. To try for this outcome, each student was allowed to roll the die only once per alien. If he or she rolled a "1", they could include spots for that alien; if a "6" was rolled, that alien could have stripes.

FIGURE 1 **Sample Punnet square**



The symbol for male or female is added next to each drawing to show the results of the gender genotype on each grid. The students then name their aliens. There is an incredible amount of excitement in the room as the aliens take shape. In the days that follow, students are excited about "how cute" or "how cool" the aliens are. Even students who are not artistically inclined seem to love this exercise. Now the fun begins!

The dating game

The students are asked to pick one alien from their collection to go in search of a mate. To this end, each student creates a tasteful "personals ad" as one would find in the classified section of the newspaper. The students take turns reading them aloud and then get a chance (this is not a quiet activity!) to shop around for a suitable mate. Students are allowed to choose alien mates. Some students look for par-

FIGURE 2 **Sample trait key**

#	Trait	Homozygous dominance HH	Hetrozygous dominant or incomplete dominance Hh	Homozygous recessive hh	Other Influences
1	Body shape	peanut	peanut	hersey kiss	
2	Head shape	octagon	octagon	twinkie	
3	Legs	4 tentacles	4 tentacles	3 chicken	
4	Wings/tail	wings	wings	tails	
5	Eyes on stalks	3 on stalks	3 on stalks	3 no stalks	
6	Mouth	with fangs	with fangs	wlo fangs	
7	Color	blue	green	yellow	✓
8	Hair	afros	Dreds	Braid	
9	Suction cups	S.C.	S.C.	none	
10	Nose	small	small	slits	
11	Ears	average	average	Dumbo	
12	Gender	female ♀	male ♂	female ♀	

To create offspring, the parents share the data (copy the "spouse" genotypes) given on the grids for their respective aliens.

FIGURE 3 **Discussion questions**

1. What is a *genotype*? Explain using an example from your alien data.
2. What is a *phenotype*? Explain using an example from your alien data.
3. List the traits that showed *incomplete dominance* in your aliens.
4. Distinguish between the terms *hybrid* and *incomplete dominance*. Use examples in your alien population to explain.
5. List the traits that were either dominant or recessive only (purebred or homozygous) and explain how this is evident in our alien population.
6. List three traits that showed up often (high frequency) in your aliens?
7. Define *mutation*. Then explain how mutations can occur.
8. How could a mutation be considered good? Give an example.
9. How could a mutation be passed on to future generations?
10. List several things that you learned in doing this lab.

ticular traits in their potential mates. For example, if they are hoping to have wings in their baby alien offspring, they might look for an alien mate that has this characteristic.

To create the offspring, the parents share the data (copy the "spouse" genotypes) given on the grids for their respective aliens. Once shared, each student creates 12 Punnett squares using the information for each trait (see Figure 1 for an example). Students color code each of the four squares in order to identify the genotypes for each "baby". For example, the first "baby" would be drawn using data given in the upper left hand comer of each Punnett square. When the 12 Punnett squares are completed and the four alien babies are created, the students have a chance to share their first generation.

Mutations

Scenario: A radical ion storm of cosmic radiation has bombarded the aliens' planet. The result is a mutation affecting the gametes of one of the original parents. Create a mutation in one of the alien babies.

After our alien babies are created, we spend some time discussing how mutations can occur, both through transcription errors in the DNA or by potential mutagens. We also discuss how mutations, or changes in the information of a gene, can be neutral (have no observed effect), helpful, or harmful and give examples of each possibility. I tell the students that we are going to rewrite the script of one of their alien babies to include a mutation. I let the students determine the type of mutation and whether or not its outcome is neutral, helpful, or harmful to the offspring. Then the student creates a story about the alien family to explain what happened as a result of the mutation. Students often want to share these stories, often giving the baby "super" powers.

Back on Earth

The last part of the alien lab is a set of discussion questions used to review terms and to evaluate what was learned (see Figure 3). The exercise could stand alone as an evaluation tool as students display their understanding of dominant, recessive, and hybrid traits in the drawing of their aliens and the use of the Punnett squares.

If time allows, the class data could be used to examine predicted ratios for the given traits. Or, when given an unknown set of alien offspring, students could try to predict the traits of the parents. As students generally don't want this activity to end, the "babies" could grow up and be parents of the next generation!

References

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Alien lab activity sheet

Purpose

To learn about dominant, recessive, and hybrid traits and how they effect the traits of an organism. To distinguish between genotypes and phenotypes.

Materials

- colored pencils
- sketchbook
- pennies

Procedure

1. Flip pennies and record your results in sets of 12 on your data sheets (Heads=H, Tails=h). Each data sheet will create one alien.
2. As a class, create a key for each of the 12 genotypes (see Figure 2).
3. Label the specific trait represented by each numbered line on your data sheets (according to the key).
4. Based on the information from one data sheet, draw your alien.
5. Choose a mate for your alien(s) and create offspring using Punnet squares to gather the information.
6. Draw the offspring, accounting for mutations.

#	Trait	First coin toss	Second coin toss
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Glossary of terms

- Dominant: term given to an allele (a form of a gene) that is always expressed when present
- Recessive: an allele that is usually only expressed when a dominant gene is not present
- Gene: instructions found on the chromosome for a particular characteristic
- Trait: another name for a characteristic
- Purebred: a gene pair composed of either two dominant or two recessive genes (homozygous dominant or homozygous recessive)
- Hybrid: a gene pair composed of one dominant and one recessive gene
- Genotype: the gene pair for a given trait
- Phenotype: the physical expression of the genotype
- Incomplete dominance: a gene pair that results in a trait somewhere between the traits of the two parents
- Homozygous dominant: HH genotype
- Homozygous recessive: hh genotype
- Heterozygous dominant: Hh genotype; dominant gene is expressed