Teacher Guide: Inheritance

Learning Objectives

Students will…

- Observe that offspring resemble their parents.
- Compare the results of sexual and asexual reproduction.
- Distinguish between traits that are determined by genes and those that are acquired.
- Understand that acquired traits are not passed on to offspring.
- Observe different types of inheritance:
  - Inheritance of codominant traits.
  - Inheritance of dominant/recessive traits.

Vocabulary

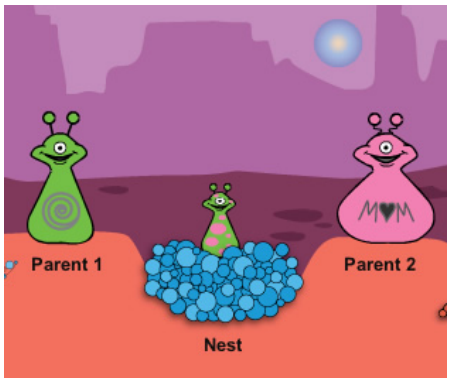
acquired trait, asexual reproduction, clone, codominant traits, dominant trait, offspring, recessive trait, sexual reproduction, trait

Lesson Overview

The *Inheritance* Gizmo™ allows students to investigate several modes of inheritance in an alien life form. Three types of traits are explored: **acquired** traits, **codominant** traits, and **dominant/recessive** traits.

The Student Exploration sheet contains three activities:

- Activity A – Students determine which traits are inherited and which traits are acquired.
- Activity B – Students investigate inheritance of a codominant trait.
- Activity C – Students investigate inheritance of a dominant/recessive trait.



Proud alien parents with offspring

Suggested Lesson Sequence

1. **Pre-Gizmo activity: Whose family is that?** (1 – 2 weeks)
   Ask each student to prepare a poster of family photographs. Ideally, each poster would include pictures of parents when they were children, grandparents, siblings, and baby pictures. Teachers are encouraged to make their own posters. (Tip: Some students may not have access to family photos. Consider having an alternative assignment for them. Also, be sensitive to any adopted children in your class.)

   To maintain anonymity, ask students to sign their names on the back of their poster and turn in the project in secret. Once all the posters are displayed on the wall, you can have a lot of fun guessing which family goes with which student. Even though mature parents may not look that much like their young children, the resemblance found in childhood photos is often uncanny. Discuss how various traits such as height and hair color are passed from parents to children.

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.

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:
   - How is asexual reproduction different from sexual reproduction?
   - Why aren't acquired traits like tattoos passed from parent to offspring?
   - Which alien trait is determined by its environment?
   - Can alien parents with straight antenna produce offspring with curly antenna?
   - Can alien parents with curly antenna produce offspring with straight antenna?
   - How can a trait "skip a generation"?

5. **Follow-up activity: Asexual Reproduction** (10 – 20 minutes)
   Asexual reproduction can be observed in several ways. Yeast is a fungus that reproduces asexually by **budding**. Add dry yeast to a solution of sugar and warm water, wait 30 minutes, and then observe the yeast cells budding under a microscope.

   Several plants can be used to illustrate asexual reproduction. New potato plants can be grown by cutting out and planting an "eye" of a potato. Geraniums can be grown from cuttings, and new spider plants can be grown from plantlets. Some plants, such as African violets, can even be grown from dropped leaves!

Scientific Background

Gregor Mendel

The laws of genetics were first published in 1865 by Gregor Mendel, an Austrian monk and science teacher. His discoveries were based on the results of seven years of experiments with pea plants. During this time, Mendel cultivated and crossbred over 29,000 plants!

Mendel discovered that for each physical feature of the pea plants (flower color, plant height, pea shape, pod shape, etc.) there were two possible traits. When plants were crossed, one trait appeared to dominate over the other. For example, when tall pea plants were crossed with short pea plants, all the offspring were tall. When these offspring were crossed with each other, however, 25% of the offspring were short. The recessive trait ("shortness") had skipped a generation.

Mendel proposed that each physical feature was determined by two **alleles**, one **dominant** and one **recessive**. An organism possesses two alleles for any given trait; offspring inherit one allele from each parent. The possible allele combinations can be shown in a **Punnett square**.

The first Punnett square at right shows a cross between a pure tall pea plant (**TT**) and a short pea plant (**tt**), just like in Mendel's first generation of offspring. All offspring inherit a **T** allele from the first parent and a **t** from the second parent, so their **genotype** is **Tt**. These **hybrid** offspring are tall because **T** is dominant. This explains why none of the pea plants in Mendel's first experiment were short.

	T	T
t	Tt	Tt
t	Tt	Tt

The second Punnett square shows a cross between two hybrid pea plants (**Tt**), just like in Mendel's second generation of offspring. About one quarter of the offspring receive a **T** from each parent. These offspring are **TT** (pure tall). About half of the offspring receive a **T** from one parent and a **t** from the other. These offspring are **Tt** (hybrid tall). The remaining offspring receive a **t** from each parent. These offspring are **tt** (short). This explains why 25% of the pea plants in Mendel's second experiment were short.

	T	t
T	TT	Tt
t	Tt	tt

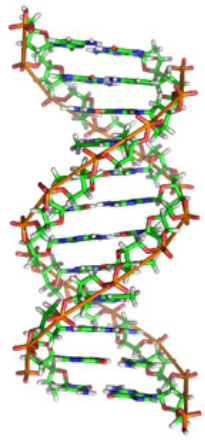
For some traits, neither allele is dominant. In this form of inheritance, called **codominance**, hybrid offspring display both traits. Alleles are denoted with superscripts. In the Gizmo, a S^GS^P alien might have green skin with pink spots. (S^G stands for green skin, S^P for pink skin.)

During **asexual reproduction**, only one parent contributes genes to offspring. Each offspring, called a **clone**, has the same genes as its parent. Asexual reproduction is used by most unicellular organisms as well as some plants and animals. **Sexual reproduction**, in which two parents contribute genes, is the most common form of reproduction for animals and plants.

Biotechnology connection: Mapping the human genome

Our genetic information is encoded by the DNA molecules contained within every cell of our body. The shape of the DNA molecule is a **double helix**, which looks a bit like a twisted ladder. The "rungs" of the ladder are a sequence of small molecules called **bases**: thymine, adenine, cytosine, and guanine. The sequence of bases forms a genetic code that ultimately determines our physical features.

In 1990 the Human Genome Project began with the bold goal of sequencing all 25,000 genes (~3 billion bases) in human DNA. Completed in 2003, the sequence has allowed scientists to identify genes associated with breast cancer, muscular dystrophy, blindness, and other disorders. Data from the project will fuel new discoveries for many years to come.



DNA

Selected Web Resources

Yeast budding: http://artsedge.kennedy-center.org/content/2290/
Asexual plants: http://educ.queensu.ca/~science/main/concept/biol/b12/B12DEMC1.htm
Genetics for kids: http://www.genetics.gsk.com/kids/index_kids.htm
Gregor Mendel exhibit: http://www.fieldmuseum.org/mendel/
Probability of Inheritance: http://anthro.palomar.edu/mendel/mendel_2.htm
The GEEE! In Genome: http://nature.ca/genome/index_e.cfm
DNA "From the Beginning": http://www.dnaftb.org/dnaftb/
Human Genome Project: http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml
See also ExploreLearning Gizmos: Mouse Genetics (One Trait) and Chicken Genetics