



Exploring Inheritance With a Genetics Simulation

Activity Overview

Grades 7-12

In this activity students explore Mendel's principles of dominance and recessiveness using a free online simulation, "Mouse Genetics," from ExploreLearning.com. Students will conduct online mice breeding experiments to collect data, as Mendel did using pea plants. Within a single class period, several generations of mice can be bred to allow the students to develop their own theories about dominance and recessiveness.

While Mouse Genetics can be used to teach a variety of lessons and concepts about genetics, the activity discussed here will use the simulation to focus on the topics of dominance, recessiveness, and phenotype.



Advantages of Technology

Computer models and simulations allow students to explore concepts of inheritance without the complications of breeding live organisms. Using live organisms introduces several issues for the classroom teacher in terms of cost, space requirements, time, care of the organisms, and disposal after the activity is completed, just to name a few. By using the online simulation featured at ExploreLearning.com, students can participate in the inquiry process as they collect and analyze data about how traits are inherited.

Educational Standards

This activity addresses the following Virginia Standards of Learning (SOLs):

Biology 1: The student will plan and conduct investigations in which:

- hypotheses are formulated based on observations;
- conclusions are formed based on recorded qualitative and quantitative data; and
- appropriate technology is used for gathering and analyzing data and communicating results.

Biology 6: The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include prediction of inheritance of traits based on the laws of heredity.

Materials

Computer with Internet connection and Shockwave, a free browser plug-in that can be downloaded from the ExploreScience website.

[Labsheet](#) for recording hypotheses and results (see appendix).

ExploreLearning Web Address: www.ExploreLearning.com

Procedure

NOTE TO TEACHERS:

These procedures are written to show you how you might use these technologies to teach science concepts. Suggested questions, approaches, and expected answers are all provided. Therefore, these activity descriptions should be used as a guide for your instructional planning, rather than as a step-by-step activity guide for students.

Getting Started

The Mouse Genetics activity can be found by selecting Life Science from the Science pulldown menu on the ExploreLearning.com home page.

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BROWSE the Collection

Mathematics (dropdown menu)

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Then elect Heredity and Genetics and the Mouse Genetics "gizmo." (Note that there are several mouse breeding gizmos with similar names, so be sure to select *Mouse Genetics* to follow the steps in this activity description.)

Once you have entered the Mouse Genetics screen, click on the Advanced MouseHouse button at the bottom of the page.

Mouse Genetics | Multimedia Activities - Microsoft Internet Explorer

Address: http://www.explorescience.com/activities/Activity_page.cfm?ActivityID=39

We begin our study of genetics by studying Mendelian (or "Classical") genetics. Before continuing, you should make sure you're familiar with the terms: **gene**, **chromosome**, **trait**, **dominant**, **recessive**, **phenotype**, **genotype**, **homozygous**, and **heterozygous**.

Hold your mouse over any of the highlighted words and the definitions will be shown below.

Genetics: Intro Material [Click to continue](#)

Intro | Stats | Simple MouseHouse | **Advanced MouseHouse**

Done | Start | Mouse Genet... | 6:30 AM

Exploring Dominance with Hybrids

What color offspring do you think will be produced if you breed a purebred white mouse with a purebred black mouse?

[Record your prediction](#) and an explanation before going on to the next step.

First, clear the pedigree and reset the counter.

This time, place two different colored mice in the top circles of the pedigree and click **Breed**.

The screenshot shows the 'The Virtual Mouse House' simulation interface. On the left, there are 'Potential Parents' represented by four empty circles, with a black mouse and a white mouse placed in the third and fourth circles respectively. Below them is 'The Cage' with seven empty circles and an 'escape door' icon. The main area is titled 'The Virtual Mouse House' and shows a pedigree chart with two parent mice at the top and their offspring in the middle. To the right, there is a 'Sound' icon with 'on' text, a table for fur and eye colors, and a 'Total' counter with a 'reset' button. Below these are 'Control' buttons: 'Breed', 'Clear Kids', and 'Reset'. At the bottom, there are 'Info', 'Counter', and 'Questions' buttons, and a navigation bar with 'Intro', 'Stats', 'Simple MouseHouse', and 'Advanced MouseHouse' buttons. The 'Advanced MouseHouse' button is highlighted in green. Arrows point to the 'reset' button and the 'Clear Kids' button, with the text 'Click here to reset' and 'not here' respectively.

fur color	eye color
0 white	black
0 black	black
0 white	red
0 black	red

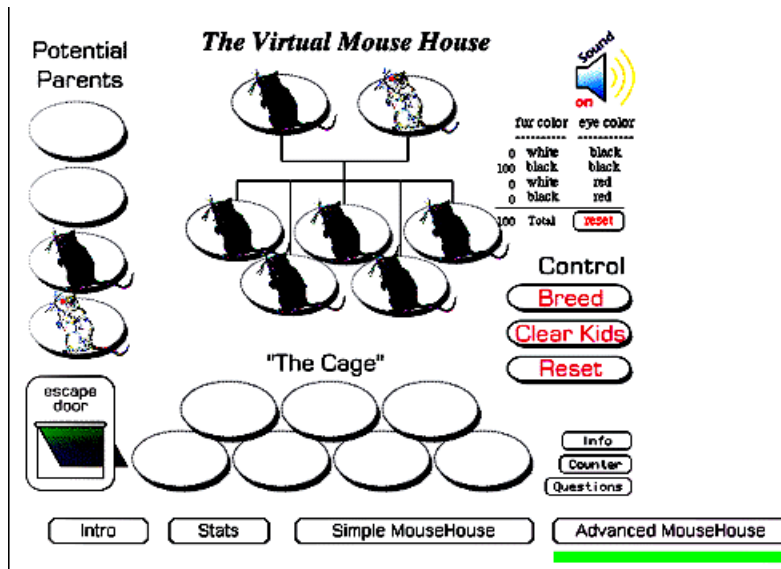
0 Total

Control

Info
Counter
Questions

Intro Stats Simple MouseHouse **Advanced MouseHouse**

Repeat this breeding 20 times to produce enough mice to clearly illustrate the inheritance pattern for this first-generation cross (also referred to as the F1 generation). Because these offspring were bred from two different varieties of mice, they are considered to be *hybrids*.



Compare your results to your predictions.

Why do you think all the offspring from the black and white parents turned out black?

To answer this question, drag and drop two of the offspring into The Cage for the next breeding trial.

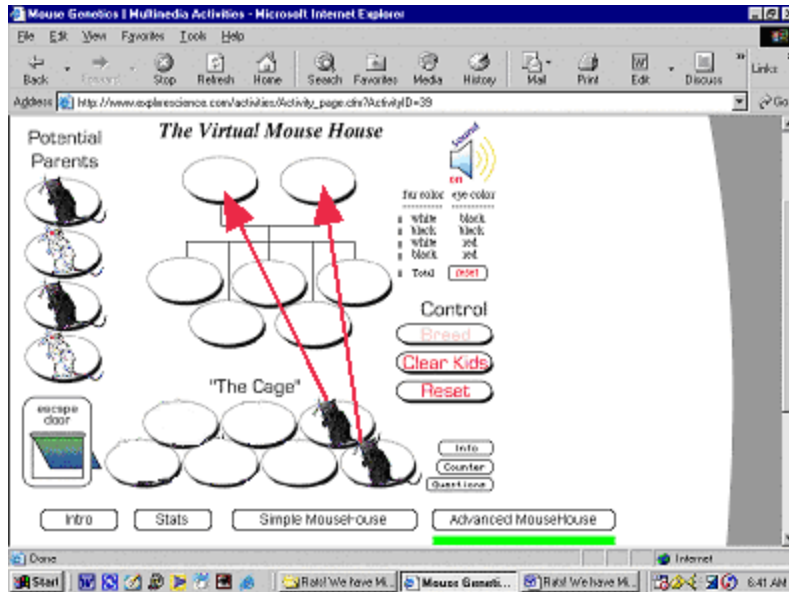
As you saw in the last trial, all the mice offspring were black and none were white, no matter how many times you bred them together. It appears that the black trait dominates the white trait.

Has the white trait disappeared altogether?

To answer this question, you need to breed together the two black F1 offspring you stored in "The Cage." This means that you will be collecting data for the next generation (F2) of mice. Remember to write down on the lab sheet what you think will happen and why.

First, clear the pedigree, click on **Clear Kids**, and reset the counter. (Do **not** click on **Reset** in the **Control** panel.)

Drag and drop the two F1 black offspring from The Cage into the top two pedigree circles.



Again perform at least 20 breedings. Add up all the black fur offspring and all the white fur offspring, regardless of eye color. Remember to share data with your classmates to obtain a larger number of trials and, therefore, more accurate results.

Are any of the mice white?

Why do you think the results turned out this way?

Geneticists call the expression of genetic traits the *phenotype* (the appearance of an organism due to its inherited traits).

Record the phenotypes of the offspring from each of the trials on a chart like the one below (see [labsheet](#)).

Cross	Phenotypes
Purebred Black Parent w/Purebred Black Parent	
Purebred White Parent w/Purebred White Parent	
Purebred White Parent w/Purebred Black Parent	
F1 Black Offspring w/F1 Black Offspring	

Possible results:

Cross	Phenotypes
Purebred Black Parent w/Purebred Black Parent	100% black offspring
Purebred White Parent w/Purebred White Parent	100% white offspring
Purebred White Parent w/Purebred Black Parent	100% black offspring
F1 Black Offspring w/F1 Black Offspring	75% black offspring 25% white offspring

Drawing Conclusions

Have your students use their recorded predictions and the combined class data to draw conclusions about what they have just experienced. With guidance from you, they should be able to develop understandings of the genetics concepts of dominance, recessiveness, and phenotype. You can then segue to instruction about genotypes and homozygous and heterozygous alleles.

Expanding the Activity

If desired, you can have your students simulate breedings of different combinations of offspring with one another to see other inheritance patterns. For example, have students predict the results of such crossings as purebred black with hybrid black, pure white with hybrid black, and hybrid white with hybrid white — then try them out.

Also, you can explore the genetics of dihybrid crosses by keeping track of the eye color as well as the fur color.

Modifications

As this activity is written, it is expected that pairs or small groups of students share a computer and go through each step of the activity. This activity can also be adapted to a whole class setting, using a projection device to allow all students to see the screen. If time is an issue, assign particular breedings to particular groups of students. In this

setting, all the breeding simulations will be performed and the combined data can still be analyzed by the whole class.

Assessment Strategies

Collect the lab sheet and assess students' understanding of traits produced by the various cross breedings.

You may also use the following ideas for assessment:

- Students could write a letter to a friend about their "discovery" in which they have to explain the experiment, describe their conclusion, and give support for their findings based on their observations.
- Give students a printed copy of a screen shot of Mouse Genetics in which a breeding trial has been performed and ask them to provide a written comment on what has happened and explain how they know. You can vary this assessment by changing the type of information left out of the shot. For example, you could have the offspring circles filled and the counter showing results but have the parents unknown. The students would then be required to identify the parents and explain data that supports their answers.

Resources

NOTE: The Mouse Genetics website includes a tutorial on basic statistics that could help students gain background information for learning about genotype combinations.

For more ideas on the topic of genetics check out the following URL's:

AT&T ENRICH: www.officeport.com/enrich/

This curriculum project by teachers in Chicago produced several lessons about Genetics. Almost all of the lessons involve technology and cooperative learning.

MendelWeb: www.mendelweb.org

This website, maintained in part by Brown University and the University of Washington-Seattle, is dedicated to providing information about classical Genetics and Gregor Mendel. Copies of Mendel's original papers can be found here.

BioLogica: biologica.concord.org/

This website, created by the Concord Consortium, with funding from the National

Science Foundation, contains several high quality biology simulations that are free for teachers and students to use. Related to genetics, BioLogica offers interactive, web-based activities introducing students to genotype and phenotype relationships. It also provides a Mendel's peas activity demonstrating principles of meiosis and pedigree.

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Appendix
**Mouse Genetics:
 Exploring Mendel's Law**

Trial 1 – Two Purebred Black Mice and Two Purebred White Mice

Will breeding two purebred mice with the same fur color always produce similar colored offspring? Record your prediction.

Explain:

Record your results in Table 1 below. Were the results what you expected? Why or why not?

Table 1. Results From All Breeding Trials

Breeding	Our Data	Data From Other Students or Groups
Purebred Black Parent w/Purebred Black Parent	# of Black:	# of Black:
	# of White:	# of White:
Purebred White Parent w/Purebred White Parent	# of Black:	# of Black:
	# of White:	# of White:
Purebred White Parent w/Purebred Black Parent	# of Black:	# of Black:
	# of White:	# of White:
F1 Black Offspring w/F1 Black Offspring	# of Black:	# of Black:
	# of White:	# of White:

(Blanks rows have been left in the table so you may continue your exploration.)

Trial 2 – Crossbreeding of a Purebred Black Mouse and a Purebred White Mouse

What color offspring do you think will be produced if you breed a purebred black mouse with a purebred white mouse? Record your prediction.

Explain:

Record your results in Table 1 on the previous page.

Were the results what you expected? Why or why not?

Trial 3 – Crossbreeding of Two Hybrid (F1) Black Mice

What color do you think the offspring will be when you breed a two hybrid black mice from the last trial? Record your prediction.

Explain:

Record your results in Table 1. Were the results what you expected? Why or why not?

Complete the Table 2 by adding the phenotypes of the offspring produced by each of the breeding trials.

Table 2. Phenotypes

Breeding	Phenotypes
Purebred Black Parent w/Purebred Black Parent	
Purebred White Parent w/Purebred White Parent	
Purebred White Parent w/Purebred Black Parent	
F1 Black Offspring w/F1 Black Offspring	