

Genetics – Horns Dilemma

Teacher's Guide

1.0 Summary

The *Horns Dilemma* is an extension of the *Genetics* Core curriculum. It may be used as an enrichment activity for students who are looking for a challenge. It can serve as reinforcement or as an assessment of their work in Rules and Meiosis.

Most students complete the *Horns Dilemma* activity in 15 minutes.

2.0 Learning Goals

Driving Question: Can two horned parents have a hornless baby?

This activity challenges the students to use the knowledge gained in the previous activities to solve a puzzle. Students work to produce a hornless dragon from two parents who each have horns.

Learning Goals

- Students will understand the terms heterozygous and homozygous.
- Students will know that an individual trait can be heterozygous, homozygous dominant or homozygous recessive.
- Students will learn that two parents can pass on a trait that they do not have because they are both heterozygous for that particular trait.
- Students will demonstrate their understanding by creating offspring with a recessive trait.

Additional Teacher Background

This activity is a quick method of reinforcing and applying the Rules of Inheritance. For quick reference, a printed copy of the Dragon Genome Chart is always helpful.

Cystic Fibrosis is a recessive hereditary disease that affects the respiratory system. Most genetic disorders are recessive; therefore, a person must inherit two defective genes, one from each parent in order to have the disease. The parents may not in fact know that they have mutated gene because they do not have the disorder; they have only one allele for the disease. Other recessive disorders are, Tay-Sach's disease, albinism, PKU, and nearsightedness.


3.0 Standards Alignment

Alignment to National Math and Science Standards (NCTM or NSES)

Objective	Standards
Students will engage in multilevel thinking.	<ul style="list-style-type: none"> Students should develop the ability to move among three domains of thought.
Students will exercise effect-to-cause and cause-to-effect reasoning.	<ul style="list-style-type: none"> Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description--providing causes for effects.
Students will demonstrate knowledge of the inheritance of recessive traits.	<ul style="list-style-type: none"> Students will know that hereditary information is contained in genes, located in the chromosomes of each cell.
Students will recognize that each offspring inherits 1/2 of its genes from each of its parents.	<ul style="list-style-type: none"> Students should recognize that the transmission of genetic information to offspring occurs through egg and sperm cells that contain only one representative from each chromosome pair. Students should understand that an egg and a sperm unite to form a new individual. Students should understand the fact that the human body is formed from cells that contain two copies of each chromosome -- and therefore, two copies of each gene -- explains many features of human heredity, such as how variations that are hidden in one generation can be expressed in the next.

4.0 Activity Sections

In this activity students use what they have learned about the rules of inheritance, specifically, how recessive traits pass to offspring from parents who display a dominant trait. A child can have the genetic illness, Cystic Fibrosis, even if his/her parents do not, because it is a recessive trait.



The Story

George and Mary just had a new baby girl named Sara. Not long after Sara was born, she was diagnosed with **cystic fibrosis**. Cystic fibrosis is a common genetic disease passed from parents to their children.

George and Mary were both saddened and surprised. Both of them are quite healthy. In fact, they have never heard of anyone in their families having the disease! Could Sara have inherited cystic fibrosis from them? Could the doctor be right?

In this activity, you will try to discover the answer by breeding dragons. You will investigate whether traits that parents don't have could show up in their children, and if traits that parents DO have could not be passed to their children.


To learn about the rules of **inheritance**, you will try to produce a baby dragon with no horns from parents who both have horns.

Click 'Next' to begin.


Introduction

4.1 Review Horns Rule

Step 1: Recall, are horns a dominant or recessive trait? (Dominant)
Step 2: Answer the question and provide an explanation.



Aleph
dragon
Male
Color: Green



Beth
dragon
Female
Color: Red

That's right! Horns are dominant, so it takes at least one capital 'H' [allele](#) to produce a dragon with horns. Dragons with two small 'h' alleles will have no horns. Here is the tricky part: there are different terms for the different combinations of alleles.

Dragons with two capital 'H' alleles (HH), are called [homozygous dominant](#). 'Homo' basically means 'the same.' And think of the capital letter alleles as dominant. Dragons with two small 'h' alleles (hh), are called homozygous [recessive](#). Both alleles are the same type, and they are both recessive (small 'h').

Dragons with one small 'h' and one capital 'H' allele (hH) or (Hh), are called [heterozygous](#). 'Hetero' means 'different.'

It works the same way in the real world. Animals and people can be homozygous dominant, homozygous recessive, or heterozygous for any number of traits.

Click on the 'Next' button to try one more question about dragon horns.

Review of heterozygous and homozygous

Aleph dragon
Male
Color: Green

Beth dragon
Female
Color: Red

4. Here is one last question about dragons and horns. The picture above shows the chromosomes for a specific dragon, in a slightly different format. Look carefully at the picture. Do you think this dragon has horns?

Yes No Not sure

5. Why do you think it has horns?
Horns are a dominant trait.

Back Next

Horns are a dominant trait.

4.2 Solve the Puzzle

Students must:

- check the parents' alleles,
- figure out that they have to change Aleph's allele for Horns to heterozygous,
- run meiosis,
- select gametes with the 'h' allele, and
- run fertilization.

Aleph

Chromosome: 1 H Horns

Chromosome: 1 h Horns

These two dragons both have horns. Your job is to give them a hornless baby. You can inspect the [genes](#) of the two parents -- and change them if you wish -- but they must have horns. (Clicking on a dragon will show its [chromosomes](#).) Remember horns are [dominant](#); it takes at least one capital 'H' [allele](#) to get a dragon with horns. And a dragon with two 'h' alleles will NOT have horns.

Back Go to Meiosis




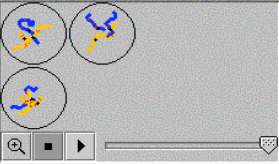
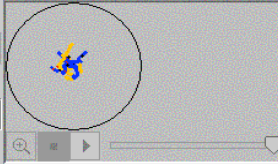
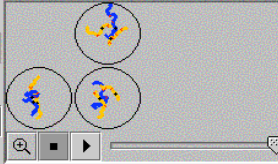
Using the pull down menus, change Aleph's Horns alleles to Hh.

Father

Create a set of [gametes](#) by running [meiosis](#) on each parent. Then select a gamete from each parent for [fertilization](#). If you want to view the [chromosomes](#), you can either use the magnifying glasses or go back to the [organisms](#) and chromosomes view. Remember that you want to create a baby dragon with no horns.

Back to Chromosomes

Select gametes with 'h' allele.

Mother	Offspring	Father
 Beth	 dragon 606	 Aleph
		


Excellent job! You changed the father to create a hornless offspring.

Next

Run fertilization to produce a "Hornless" dragon.

4.3 Real World Application

In this section, students learn how the recessive allele situation applies to real life. Also included are examples of a dominant trait in animal parents, producing a recessive trait in their offspring.



What about Sara?

You have successfully bred a hornless baby dragon from parents with horns. Now think again about George and Mary's baby, Sara. Even though George and Mary are healthy, the doctor says that Sara has cystic fibrosis.

Cystic fibrosis is a genetic disease caused by a defective gene. For Sara to get it, she must inherit two copies of the defective gene from her parents.

8. Do you think the doctor could be right? Is it possible for Sara to have cystic fibrosis even though her parents don't have it?

Yes No


9. Why do you think the baby could have cystic fibrosis?

Each of Sarah's parents have a recessive gene for Cystic Fibrosis.


Yes, this can also happen in humans.

10. In our imaginary dragons, horns are dominant over no-horns. In the real world, animals and people also have dominant and recessive traits. For example, in guinea pigs, black fur (B) is dominant over white fur (b). Based on what you learned about dragons, do you think it is possible for two black guinea pigs to have a white piglet?

Yes No



Guinea pig question (1)



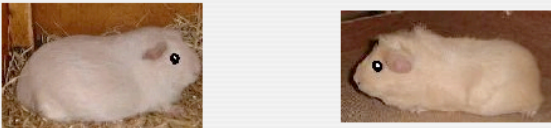
12. You are right. Two guinea pigs with black fur can have a baby with white fur. Check all responses that can apply to produce a white piglet.

Mom is homozygous dominant (BB) Mom is homozygous recessive (bb)

Mom is heterozygous (bB or Bb) Dad is homozygous dominant (BB)

Dad is homozygous recessive (bb) Dad is heterozygous (bB or Bb)

Guinea pig question (2)



13. What if both guinea pig parents have white fur? If they have 20 babies, how many do you think will be white?

None
 1/4
 1/2
 3/4
 All


That's right! Because white fur is a recessive trait, both parents must have (bb) alleles. So their babies will also all have (bb) alleles, and white fur!

You answered this question on your first try! Great!

Guinea pig question (3)



Aleph dragon
Male
Color: Green



Beth dragon
Female
Color: Red

Wrap-up

In this lesson, you learned about inheritance, or about how traits can be passed on through reproduction. You saw that dragon parents with horns can produce a baby with no horns. Horns are a **dominant** trait. That means that there must be at least one big 'H' allele for a dragon to have horns. Both the parent dragons might be **heterozygous**, meaning that they each have a big 'H' and a small 'h' allele. In that case, they could each pass on a small 'h' allele to their baby. The baby would have two 'h' alleles, and be hornless!

It works the same way in the real world. Animals and people can pass physical traits on to their children through inheritance.

You are all done! Click the 'done' button to end the lesson.

Summary

5.0 Student Reports

Your students' work with Horns Dilemma is logged and viewable on the MAC Project Web Portal at <http://mac.concord.org>. For each student, you can view a report containing questions and answers.

If students successfully create a hornless dragon without assistance from peers or teacher, it is considered evidence that they have a good model of meiosis and fertilization. Students are now well prepared for core activities *Monohybrid* and beyond.