

Genetics - Invisible Dragons

Teacher's Guide

1.0 Summary

The *Invisible Dragon* activity is designed to be completed in a class period of 45-50 minutes. This culminating activity may be used as a review of learned concepts or as an assessment itself.

2.0 Learning Goals

Driving Question: Can YOU determine the genotypes of invisible parents from the phenotypes of their offspring?

This activity presents a difficult problem for the students to solve using all the techniques they have learned throughout this series of activities. They must figure out the genetic make-up of two invisible dragons. They make crosses, look at the pedigrees, and even make backcrosses. The players start out with \$20,000 in the bank. Each procedure they use costs money as does each wrong answer. Players make money by answering questions correctly.

Learning Goals

- Students will incorporate all of the concepts and skills they have acquired through *Genetics* activities to complete *Invisible Dragon* puzzles.
- Students will demonstrate their understanding of the principles of inheritance.

3.0 Standards Alignment

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

Objective	Standards
Students will develop strategies for determining the parents' genomes.	Students should demonstrate appropriate procedures, a knowledge base, and a conceptual understanding of scientific investigations.
Students will be able to determine the parents' genotypes from the phenotypes of their offspring.	The students will focus on questions that can be answered by using observational data, the knowledge base of science, and processes of reasoning.

Additional Teacher Background

This activity could well serve as part of a final exam for the unit. *Invisible Dragons* incorporates all of the genetic concepts and the strategies involved in solving genetic questions, which the students have been learning throughout the *Genetics* model.

By this point students will have worked with pedigrees and Punnett squares for a variety of characteristics and traits. Each puzzle in *Invisible Dragons* begins with a randomly generated, but invisible, pair of parents.

Students work through each characteristic to determine the parents' alleles for that characteristic. In order to figure out the genotypes of the parents, students must make crosses that will give them useful information.

Backcrosses -- crossing an offspring with the appropriate parent -- are particularly useful. When crossing an offspring with a recessive trait and a parent yields only offspring with the recessive trait, the parent must have 2 alleles for the recessive trait.

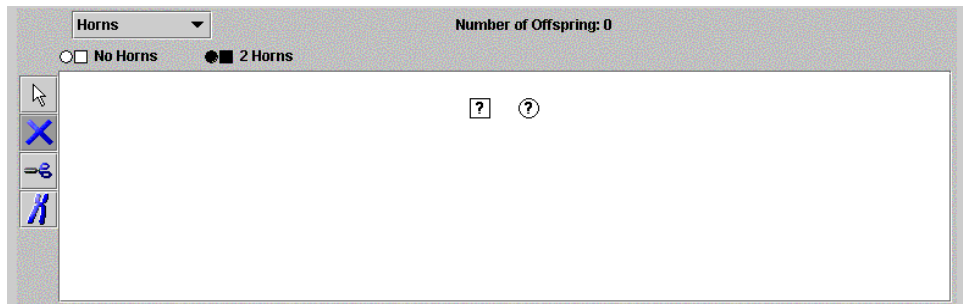
The Dragon Genome Chart is available for reference. A Punnett square pad is available so students can test their hypotheses before committing to an answer.

Students can minimize the number of crosses they have to make, and the amount of data they have to deal with, by checking the pedigree for each characteristic and figuring out as many of the parental genotypes as possible before making a second cross.

4.0 Activity Sections

In this activity, students will attempt to identify the alleles of 9 genes for each parent dragon, 18 allele pairs in total. The format for *Invisible Dragon* is that of a game. The goal of the *Invisible Dragon* game is to solve a series of puzzles, collecting as much "cash" as possible for correct answers along the way. The first screen clearly outlines all of the rules.

4.1 Rules of the Game



Welcome to the Invisible Dragon game! Here's how it works. The two question marks on the screen represent invisible dragons. The circle is a female and the square is a male, but other than that you can't tell anything about them. You don't know what color they are, whether or not they have wings, or anything else.

Your job is to figure out everything you can about these two dragons, simply by crossing them and their offspring. The offspring will be visible and you can use the chromosome tool on them, but you can't see the chromosomes of the parents. To make things a bit more interesting, we're putting a price on getting information. You'll start off with a bank account of \$20000. Each cross will cost you \$1000. Looking at the chromosomes of a dragon (which requires a lot of fancy equipment!) is more expensive -- \$5000 per examination.

There are nine genes in the dragon genome -- genes for horns, wings, legs, tail shape, scales, firebreathing, plates, and two for color. Your job is to figure out the alleles for each of these genes for the mother and the father. That's 18 allele pairs in all. You will get \$1000 for every right answer, but you lose \$2000 for every wrong answer. Answers left blank don't count for you or against you so if you're not sure about something, leave it blank!

HINT: It's often very helpful to run 'back crosses' where you cross an offspring with one of the parents. Real geneticists use this technique a lot to discover how various genes work.

4.2 Play the Game

- Step 1: Use the Cross (X) tool to cross the parents.
- Step 2: Read the questions, decide if you need another cross (it costs money).
- Step 3: Answer the questions.
- Step 4: Go to the pull-down menu, choose another trait.
- Step 5: Continue until you have determined the alleles for each trait
- Step 6: Submit your answers.***
- Step 7: View a summary of your correct/incorrect responses and check your bank account.
- Step 8: Play again.

*****NOTE:** Up to this point in the game, you can view a summary of all of your answers. If you wish to change an answer, go back to the pull down menu and make your corrections. Once you have submitted your answers, you cannot change them.

Horns Number of Offspring: 20

No Horns 2 Horns

You're looking at the horns trait.
If you want to answer the questions below about horns, here's your chance. If you're not ready, try making another cross. If you look at a different trait I'll ask you about that one.

What is the mother's genotype for horns?

HH Hh or hH hh

What is the father's genotype for horns?

HH Hh or hH hh

Punnett Square Notepad You have \$20000 in your account.

The Dragon Genome Chart, bottom left is a helpful reminder of dominant, recessive and X-linked traits.

Note: Plates are X-linked and incompletely dominant and Scales are autosomal-recessive.

Invisible Female
dragon
Female

Invisible Male
dragon
Male


Here are your answers so far:

You said the mother was hh for horns and the father was Hh or hH
The mother was ww for wings and the father was Ww or wW.
The mother was LL for legs and the father was Ll or lL.
The mother was Tt or tT for tail and the father was tt.
The mother was FF for firebreathing and the father was f-.
The mother was No answer for the color1 gene and the father was No answer.
The mother was BB for the color2 gene and the father was B-.
The mother was no answer for scales and the father was no answer.
The mother was no answer for plates and the father was no answer.


If these are your final answers, click on "Submit." Otherwise, you can go back and change them.

Punnett Square Notepad

Show me my answers so far button produces this screen.



Invisible Female dragon
Female
Color: Red




Invisible Male dragon
Male
Color: Yellow

Invisible Female Genotype

Trait	Your Answer	Actual	
Horns	hh	hh	Right
Wings	WW	WW	Right
Legs	Ll or lL	Ll or lL	Right
Tail	tt	tt	Right
Fire	Ff or fF	Ff or fF	Right
Color1	No answer	Aa or aA	N/A
Color2	BB	BB	Right
Scales	no answer	SS	N/A
Plates	no answer	Pp or pP	N/A

Invisible Male Genotype

Trait	Your Answer	Actual	
Horns	hh	hh	Right
Wings	ww	Ww or wW	Wrong
Legs	Ll or lL	Ll or lL	Right
Tail	tt	tt	Right
Fire	f-	f-	Right
Color1	No answer	a-	N/A
Color2	B-	B-	Right
Scales	no answer	Ss or sS	N/A
Plates	no answer	p-	N/A



After submitting their answers students can review their answers and start another round.

5.0 Student Reports

Your students' work with Invisible Dragons 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.