

GENIQUEST Guide Part I

Setting Ground Rules

Before you begin, decide if your students should work as partners or individually. Be sure to discuss with them how far they should proceed before stopping and your plans for assessment. Give them instructions for the paper scientist's notebook. Remind them to maximize the screen size and to label their "snapshots". Consider offering a Nobel Prize for a team or individual. Criteria might include the paper notebook, the snapshot collection, solving the scales problem within budget, etc.

Using this guide

The software is divided into three parts, which are divided further into sections. At the beginning of each section you will find a driving question, a short summary of the section, key student outcomes, and a list of possible follow up activities and questions.

Intro and Rules

Driving Question- What do dragons look like and why?

In this section students learn about dragon phenotypes and use the software to see the possible offspring of a mating pair of dragons. With the production of multiple offspring, they determine simple inheritance patterns for horns and wings. Learners are then guided through BioLogica's Chromosome Model and its representations of chromosomes, genes and alleles. As learners use pull down menus to change the alleles and traits of dragons in order to manipulate the chromosomes, the Organism Model shows them the changes in the dragons. Students experience the impact of dominant and recessive alleles on traits.

Students should make definite connections between the physical traits of each dragon (phenotype) and the genetic make-up of each dragon (genotype), and will also identify particular chromosomes, genes, and alleles.

Activities following the completion of this section:

- 1. Have students present most interesting dragons***
- 2. Use overhead to explore last screen with class***
- 3. Discuss how to organize data***

Questions to ponder after completing this section:

- 1. Besides horns and wings, what other dragon traits did you observe?***
- 2. Did you identify any other inheritance patterns besides those for horns and wings?***
- 3. Did you find any lethal combinations?***

Intro and Rules	1
<p>Today is a very exciting day on the island of Gandwar. Two dragons there are about to have a baby. Because it happens only about every 500 years, the birth of a dragon is met with great anticipation. The lucky parents are Molthwan and Lucenne, two of the island's most admired inhabitants.</p>	
<div style="display: flex; border: 1px solid black; border-bottom: none;"> <div style="width: 20%; background-color: #4CAF50; color: white; padding: 5px;"> <p>Intro</p> <ul style="list-style-type: none"> <li style="background-color: white; color: black; padding: 2px;">Intro and Rules <li style="background-color: white; color: black; padding: 2px;">Meiosis <li style="background-color: white; color: black; padding: 2px;">Pedigree and Genes <li style="background-color: white; color: black; padding: 2px;">The Plates Problem </div> <div style="width: 80%; padding: 10px;"> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>Lucenne dragonmarkers Female Color: Purple</p> </div> <div style="text-align: center;"> <p>Molthwan dragonmarkers Male Color: Yellow</p> </div> </div> <p style="font-size: small; margin-top: 10px;">Today is a very exciting day on the island of Gandwar. Two dragons there are about to have a baby. Because it happens only about every 500 years, the birth of a dragon is met with great anticipation. The lucky parents are Molthwan and Lucenne, two of the island's most admired inhabitants.</p> </div> </div>	
<div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p style="color: blue; text-align: center;">Navigate between sections</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p style="color: blue; text-align: center;">Navigate within sections</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p style="color: blue; text-align: center;">Photo album used later for student snapshots</p> </div> </div> <div style="text-align: center; margin-top: 20px;"> </div>	

Intro and Rules	2
<p>Like all eager parents, Molthwan and Lucenne are anxious to know what their baby will be like. Molthwan is especially interested in knowing whether the baby will be born with a fancy spiky or forked tail, a much-admired trait. Lucenne is hoping that the baby will have wings and be able to fly, something not many dragons on Gandwar are able to do.</p>	

Intro and Rules

3

Try breeding some dragons to see if you can figure out any rules that govern which dragons have a fancy tail. Click the "Breed Offspring" buttons as many times as you like.

Try breeding some dragons to see if you can figure out any rules that govern which dragons have a fancy tail. Click the "Breed Offspring" buttons as many times as you like.

Mother	Child	Father
 female dragonmarkers Female Color: Red	 child dragonmarkers Female Color: Red	 male dragonmarkers Male Color: Yellow
<input type="button" value="Breed offspring"/>		
 female dragonmarkers Female Color: Red	 child dragonmarkers Female Color: Purple	 male dragonmarkers Male Color: Yellow
<input type="button" value="Breed offspring"/>		

Based on these examples, what kind of a trait do you think a fancy tail is?

Dominant

Recessive

Intro and Rules

4

Now see if you can figure out any rules that govern which dragons have wings. Click the button as many times as you like to breed possible children from these pairs.

Click on from these pairs.

Mother	Child	Father
 female dragonmarkers Female Color: Red	 child dragonmarkers Male Color: Green	 male dragonmarkers Male Color: Yellow
<input type="button" value="Breed offspring"/>		

If two dragons both have wings, what can you say about their offspring?

All have wings

Mother	Child	Father
 female dragonmarkers Female Color: Red	 child dragonmarkers Female Color: Purple	 male dragonmarkers Male Color: Yellow
<input type="button" value="Breed offspring"/>		

If one parent has wings, does that guarantee that the child will have wings?

Yes

No

Do you have an idea about how wings are inherited? Try the two scenarios below to see if they confirm your suspicions.

Scenario 1: Mother (female dragonmarkers, Female, Color: Red) x Father (male dragonmarkers, Male, Color: Yellow) = Child (child dragonmarkers, Male, Color: Green)

Scenario 2: Mother (female dragonmarkers, Female, Color: Red) x Father (male dragonmarkers, Male, Color: Yellow) = Child (child dragonmarkers, Male, Color: Green)

What do these two scenarios tell you about how wings are inherited?

What kind of trait do you think wings are?

Dominant

Recessive

Below is a dragon and its chromosomes. You can control and change the dragon's genes. Try changing some of the genes and see what happens. Experiment with the genes for tails and wings to see if you were correct.

Lanthana dragonmarkers, Female, Color: Red

Which gene combinations yield a fancy tail?

TT

Tt

tt

Check Answer

Which gene combinations yield wings?

WW

Ww

ww

Check Answer

Chromosome 1: H (Horns), h (Horns)

Chromosome 2: w (Wings), l (Legs), T (Tails)

Chromosome X: f (Fire), a (Color1), B (Color2)

What other traits can you change on this dragon? Find one trait you think is particularly interesting, and use the button above to take a snapshot for your lab notebook. Use the toolbar to point to or circle the trait, and write a note in your notebook describing how you caused that trait to be expressed. (Note: You can view your notebook at any time by clicking the notebook icon at the lower right.)

Looking Deeper

You have gained some ideas about how tails and wings are inherited. In the next section, you will look deeper into the genetics of dragons to determine whether you were correct. Use the menu at left to move to the next section.

Meiosis

Driving Question- Why don't members of a family look more alike?

In this section students are introduced to gamete formation by modeling the random distribution of chromosomes. It allows students to inspect, in an enlarged window, the alleles in each gamete and to choose particular gametes for fertilization to produce a dragon with a specific trait. In learning to use the Meiosis Model, students will understand how chromosomes and alleles participate in meiosis and will be able to link the Meiosis Models' representation of gametes and chromosomes with the Chromosome Model introduced previously. The Meiosis Model simulates the process of meiosis comparable to the simple diagrams of the phases of meiosis found in textbooks. Students are then able to select gametes and determine the traits for the resulting zygote. The animation does not include crossing over. Instead, the action pauses to give students the opportunity to swap alleles at various places along the chromosome.

It is important that students understand meiosis occurs in both males and females as a process of reduction and division and that as a result of crossing over, each gamete carries only a haploid number of chromosomes, each of which is a patchwork of the original parental homologous pairs. In addition to the independent assortment of each homologous pair, the individual chromosomes of the diploid cell that results when egg and sperm unite have the potential to be different from any of those of the parents. It is important that students understand not only what happens during crossing over, but also appreciate its frequency and the resulting recombination's that occur.

Activities BEFORE the completion of this section:

- 1. "Snap-bead" manipulations. In teams of two, have students use snap beads to create two strands of 10 beads, each strand of a different color to represent two parental lines. Ask them to use these to model crossing over.***
- 2. Have students compare resulting models between groups and discuss that crossing over can occur along the entire length of the chromosome***
- 3. Have students place a single bead of a third colored "marker" about 1/3 of the way along the length of each strand. Ask students to determine how many unique combinations crossing over in these ten strands could produce.***

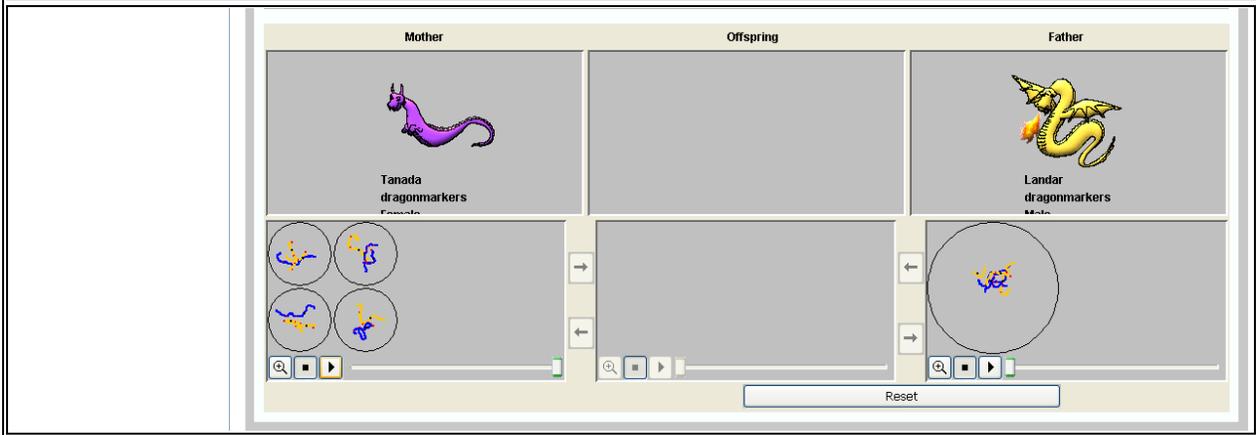
Questions for students to ponder after completing this section:

- 1. In theory, how many unique dragons can Tanada and Landar produce?***
- 2. Would you be able to see evidence of crossing over in pairs of chromosomes which carry the same allele?***

Meiosis

1

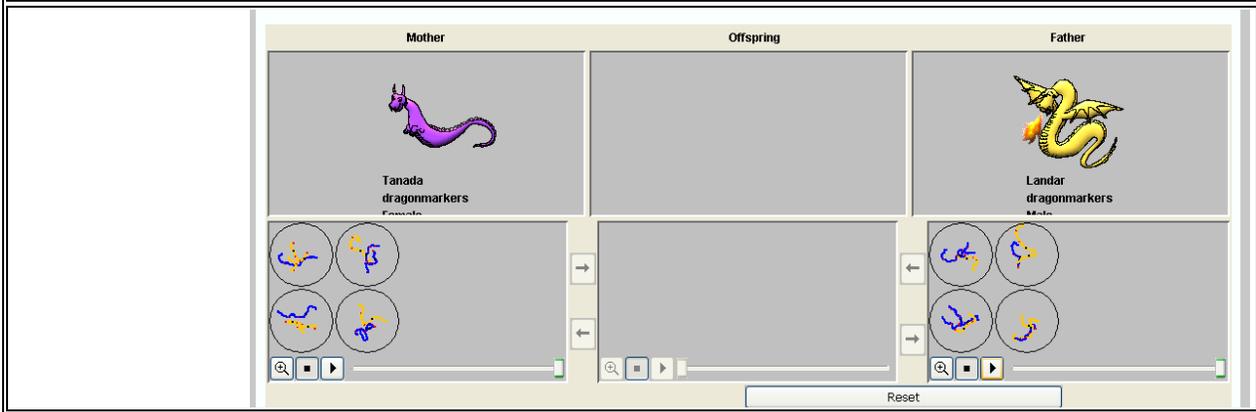
Tanada and Landar also hope to be able to have a baby soon. This is a view of their cells as they undergo the process of meiosis. Click on the play button to start the process in the mother, Tanada.



Meiosis

2

Great. Now try running meiosis for the father.



Meiosis

3

Your goal will be to create a child dragon with wings, but no legs. To inherit these traits, the child will need to have the gene combinations ww and ll.

Can the father provide his half of these combinations?

Yes
 No

Use the mouse to move the chromosomes within a cell to separate them

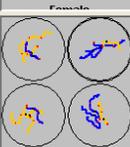
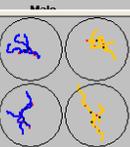
Meiosis

4

Now reset the meiosis and zoom in on our expectant mother dragon. Run meiosis a few times. (Note that you will have to return to the un-zoomed view and hit "reset" to get a fresh run).

If we want to "design" a child dragon with the gene combinations ww and ll, can the mother carry through on her part of the bargain?

Yes
 No

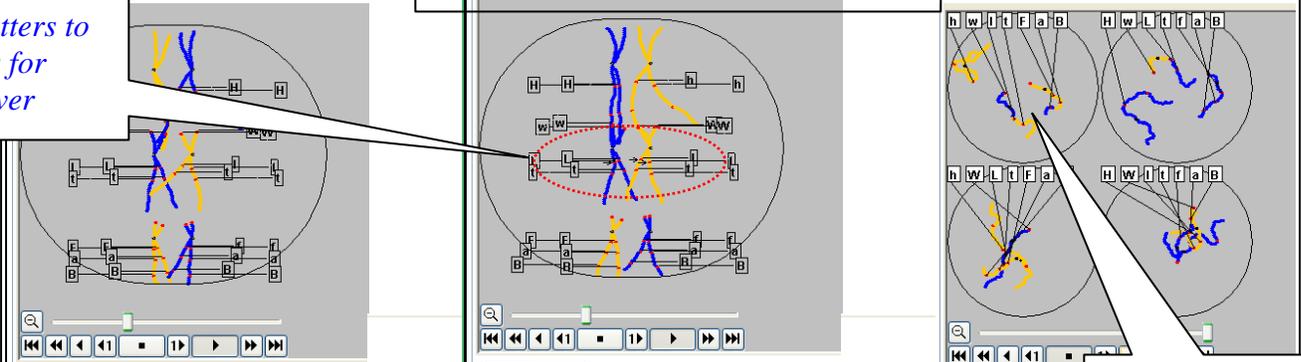
Mother	Offspring	Father
 Tanada dragonmarker Female		 Landar dragonmarker Male
		

Mother

If you looked closely, you noticed that we have a problem. The mother can only give chromosomes with the genes **Wl** or **wL**. And neither of these will help us in our quest. Fortunately, there's a catch... **Zoom** in on the mother and press the triangular "play" button again. The process will stop halfway through and wait for you. When it does, click on one chromosome with the tip of your mouse. See the flashing arrows? The arrows show places on other chromosomes you can click. Try it.

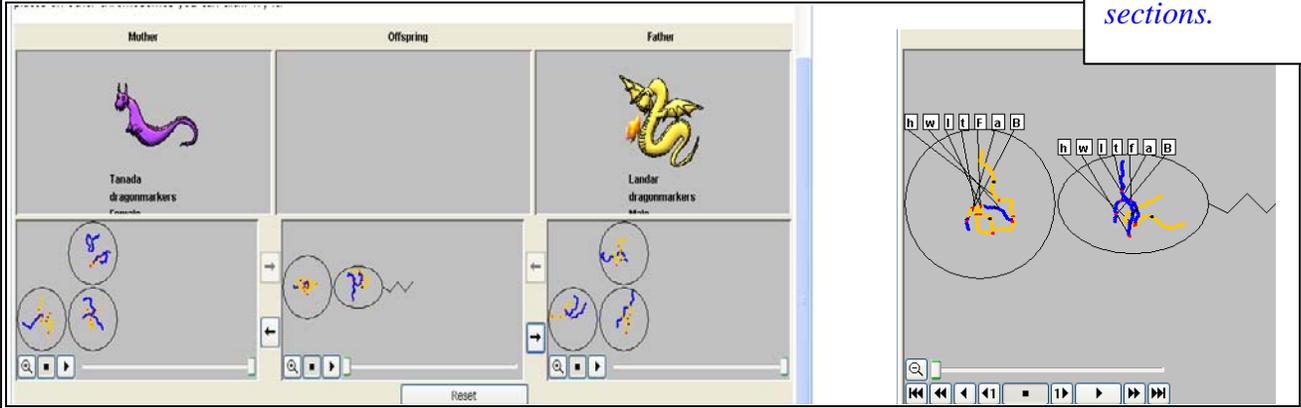
Note-There is no pause without the zoom

Click on letters to see arrows for crossing over



Congratulations, you just performed a crossover! (This is also called genetic recombination.) Zoom out to reset things, and try a few more times. Can you create our desired dragon now? Give it a shot.

These chromosomes are a patchwork of sections.



When you think you've succeeded (and before you proceed to breed the child!), zoom in on the chromosomes you crossed over and take a snapshot for your lab notebook. Write a note to go along with the snapshot describing what you did and why you think it will make the correct child dragon.

The screenshot shows a genetic simulation interface. At the top, there are three panels: 'Mother' (Tanada dragon, purple), 'Offspring' (dragon with purple and yellow), and 'Father' (Landar dragon, yellow). Below each panel are chromosome diagrams. The 'Offspring' panel is highlighted with a white arrow pointing to a callout box. The callout box contains the text: "Use these arrows to grab gametes for fertilization in the center box. Note that the process is reversible." Below the main interface is a larger 'Offspring' panel showing a detailed view of chromosomes with labels 'w', 't', 'B', 'd', 'h' and a search bar.

Pedigree and Genes

Driving Question- How do you go about creating an inbred strain and how might you measure success?

In this section, students continue to intercross successive offspring until at least the F8 generation. Regardless of which parents they select, they will find the dragons all begin to look alike. They have created an inbred strain.

It is important that students understand that in theory, an inbred strain carries identical alleles thus while crossing over occurs, no new combinations result.

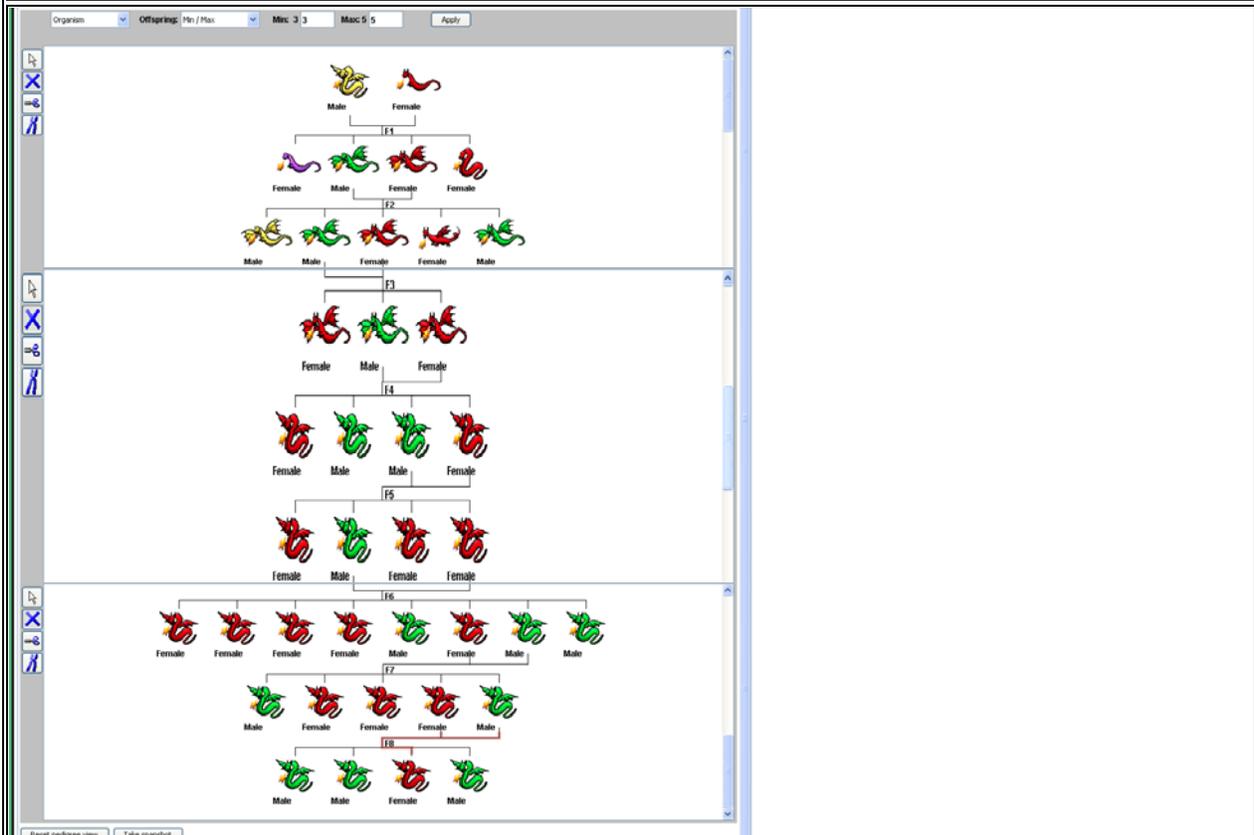
Questions for students to ponder after completing this section:

1. Why is an inbred strain helpful to researchers?
2. What did your inbred strain look like?

Now that you know how to breed dragons, let's try some selective breeding. This is the pedigree view.

Use the cross tool to breed a new generation of dragons. Then breed two of the dragons from this new (F2) generation together. Repeat this as far as you wish. What do you notice about the dragons as you continue to breed more generations this way?

Use the chromosome tool to examine the genes of the dragons more closely. Can you find any genes that are different among the members of your F8 generation? How many generations do you have to breed until all the dragons are exactly the same?



You are creating an inbred strain of dragons in the last generations of this process. When you think you have succeeded in creating a strain, use the button above to take a snapshot of your strain for your lab notebook. Along with the snapshot, write a note describing your strain, and explain what is special about all individuals in an inbred strain of organisms. Then proceed to the next section.

The Plates Problem

Driving Question- How might the identification of one gene help in finding the location of other genes?

In this section, students are introduced to a phenotype (plates) for which the gene(s) are not known. Breeding parents and subsequent generations will allow them to see traits in these dragons that tend to be inherited together.

It is important that students understand that genes that are near one another on the same chromosome tend to be inherited together and that when crossing over occurs, nearby genes “travel” together.

Questions for students to ponder after completing this section:

1. Based on the location, are there other dragon traits you would expect to see inherited together often?
2. According to independent assortment, which traits would you expect to be only randomly inherited together?

The Plates Problem		1
Some traits are less obvious than others. Here is a dragon with plates on her upper back. Try changing the chromosomes and see what happens.		
Intro Intro and Rules Meiosis Pedigree and Genes The Plates Problem	 <p>Strain 1 Female dragonmarkers Female Color: Blue</p> <p>Is it possible to tell what controls the plates on the dragon's back by just changing the alleles? <input type="radio"/> Yes <input checked="" type="radio"/> No</p>	<p>Strain 1 Female</p> <p>Chromosome: 1 h Horns</p> <p>Chromosome: 2 w Wings l Legs t Tails</p> <p>Chromosome: X f Fire a Color1 b Color2</p> <p>Chromosome: 1 h Horns</p> <p>Chromosome: 2 w Wings l Legs t Tails</p> <p>Chromosome: X f Fire a Color1 b Color2</p>

The Plates Problem- Breeding Test Area

2

Try breeding some offspring to see what crosses between these strains produce. Does the inheritance of the plates tell you anything useful?

Try breeding some offspring to see what crosses between these strains produce. useful?

Mother



female dragonmarkers
Female
Color: Purple

Child



child dragonmarkers
Male
Color: Yellow

Father



male dragonmarkers
Male
Color: Green





The Plates Problem

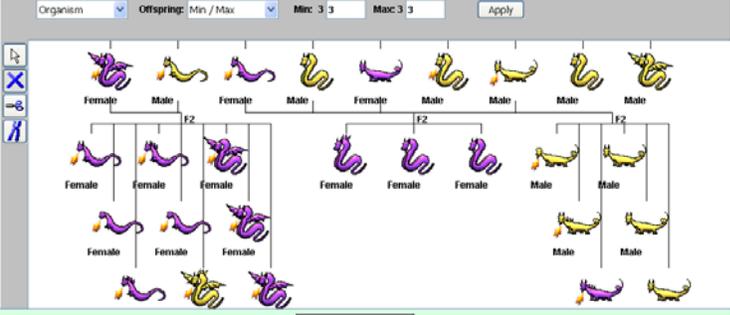
3

Try breeding some more dragons here. What pattern or patterns do you notice in dragons that have plates?

Try breeding some more dragons here. What pattern or patterns do you notice in dragons that have plates?

Dragons with plates also have horns

Organism: Offspring: Min / Max Misc: 3 3 Misc: 3 3



The Plates Problem

4

The gene for plates is still undiscovered, but your experiments may have helped you narrow down its location.

ChromosomeView



female dragonmarkers
Female
Color: Purple

<p>female</p> <p>Chromosome: 1</p>  <p>H Horns</p> <p>Chromosome: 2</p>  <p>w Wings l Legs t Tails</p> <p>Chromosome: X</p>  <p>f Fire a Color1 B Color2</p>	<p>Chromosome: 1</p>  <p>H Horns</p> <p>Chromosome: 2</p>  <p>W Wings L Legs t Tails</p> <p>Chromosome: X</p>  <p>f Fire a Color1 B Color2</p>
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Based on your breeding experiments, where do you think the gene for plates is located? (Hint: If you don't have a snapshot of the dragon chromosomes, you can use the chromosome tool to examine one of the dragons above.)

Based on your breeding experiments, where do you think the gene for plates is located? (Hint: If you don't have a snapshot of the dragon chromosomes, you can use the chromosome tool to examine one of the dragons above.)

- Chromosome 1
- Chromosome 2
- X Chromosome
- Y Chromosome

Why do you think this?

Plates seem to be related to horns. Gene for horns is on chromosome 1.

The Plates Problem- The Power of Prediction

5

Dragons that grow plates usually do so quite late in their life, so dragons that have a new baby don't know right away whether or not it will grow plates. Which of the following traits shown by a baby could help a parent dragon guess whether her baby would grow up to have plates?

Dragons that grow plates usually do so quite late in their life, so dragons that have a new baby don't know right away whether or not it will grow plates. Which of the following traits shown by a baby could help a parent dragon guess whether her baby would grow up to have plates?

- Fancy tail
- Fire breathing
- Horns
- Four legs

The Plates Problem

6

The existence of horns on a dragon can be a genetic marker for the tendency to grow plates. This means that the gene for horns is an indicator of where the gene for plates is located.

Plates are a trait that grow in and become visible after a while. Diseases may not be obvious until it's too late, however. Narrowing the gene location for a genetic disease down to a chromosome and then pinpointing its precise location can be serious business, as you will soon learn.

Continue to the next activity to find out more...