Genetics – Meiosis

Teacher's Guide

1.0 Summary

The *Meiosis* activity is the third core Genetics activity. It builds on *Introduction and Rules* and requires students to use what they learned about dragon genotypes and phenotypes to complete a series of challenges. This activity should take approximately 45-50 minutes to complete.

2.0 Learning Goals

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

Meiosis introduces students 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.

Part One: **Introduction to Meiosis** focuses on learning to use the Meiosis Model, understanding how chromosomes and alleles participate in meiosis, and linking the Meiosis Model's representations of gametes and chromosomes with the Chromosome Model introduced previously. The Meiosis Model simulates the process of meiosis comparable to the diagrams of the phases of meiosis found in textbooks.

Part Two: **Designer Dragons** challenges the students to create specific offspring by examining the chromosomes in the gametes of each parent and selecting those that will produce the desired phenotype in the offspring.

Learning Goals

- Students will develop an understanding of the process of meiosis.
- Students will manipulate the gametes in the model.
- Students will develop an understanding of meiosis as a process of reduction and division.
- Students will understand the terms *diploid* and *haploid*.
- Students will know the stages of meiosis.
- Students will understand that in males the gametes produced by meiosis are sperm.
- Students will understand that in females the gametes produced by meiosis are eggs.
- Students will understand that the successful uniting of egg and sperm creates a new organism.
- Students will describe the main results of meiosis.

Additional Teacher Background

Basic Mendelian genetics states that each organism must inherit a single copy of every gene from both its "parents." Additionally, when an organism produces its own gametes, those two sets of genes must be separated from each other so that each gamete contains only one set of genes.

A cell that contains both sets of homologous chromosomes is diploid. Diploid cells contain two sets of chromosomes and two sets of genes. However, the gametes of sexually reproducing organisms contain only a single set of chromosomes and therefore only a single set of genes and are know as haploid cells.

During meiosis, the number of chromosomes per cell is cut in half through the separation of the homologous chromosomes. The result of meiosis is a haploid gamete.

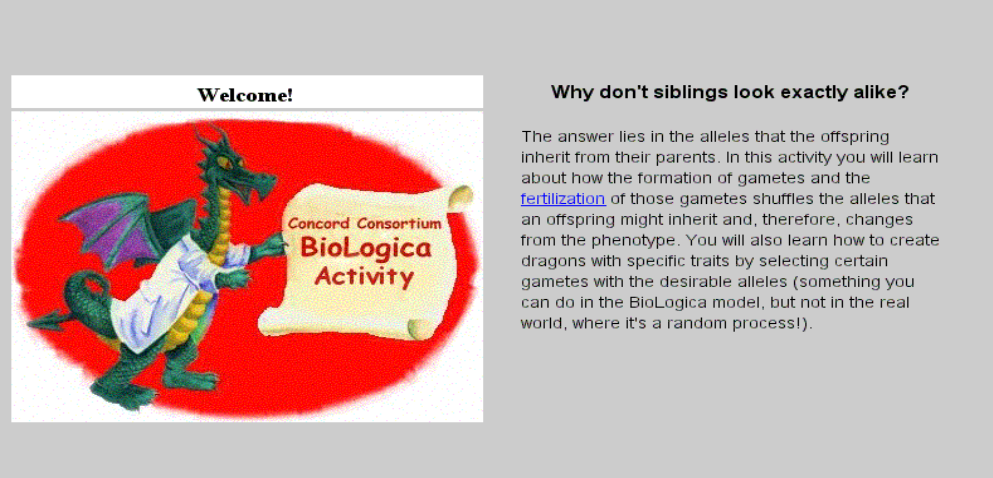
In the Meiosis model activities, students view the entire process of meiosis through animation. They are able to select gametes and determine the traits of the resulting zygote.

3.0 Standards Alignment

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

Objective	Standards
Students will be reminded that genotype determines phenotype.	Students will know that the characteristics of an organism can be described in terms of a combination of traits.
Students will learn that each parent contributes half the chromosomes, and therefore half the genes, to the zygote.	Students will understand that transmission of genetic information to offspring occurs through egg and sperm cells that contain only one representative from each chromosome pair. Students will understand that an egg and a sperm unite to form a new individual.
Students will learn that chromosomes are assorted independently during meiosis.	Students will understand basic concepts of probability.

4.0 Activity Sections



Opening Page reinforces terms from Rules.

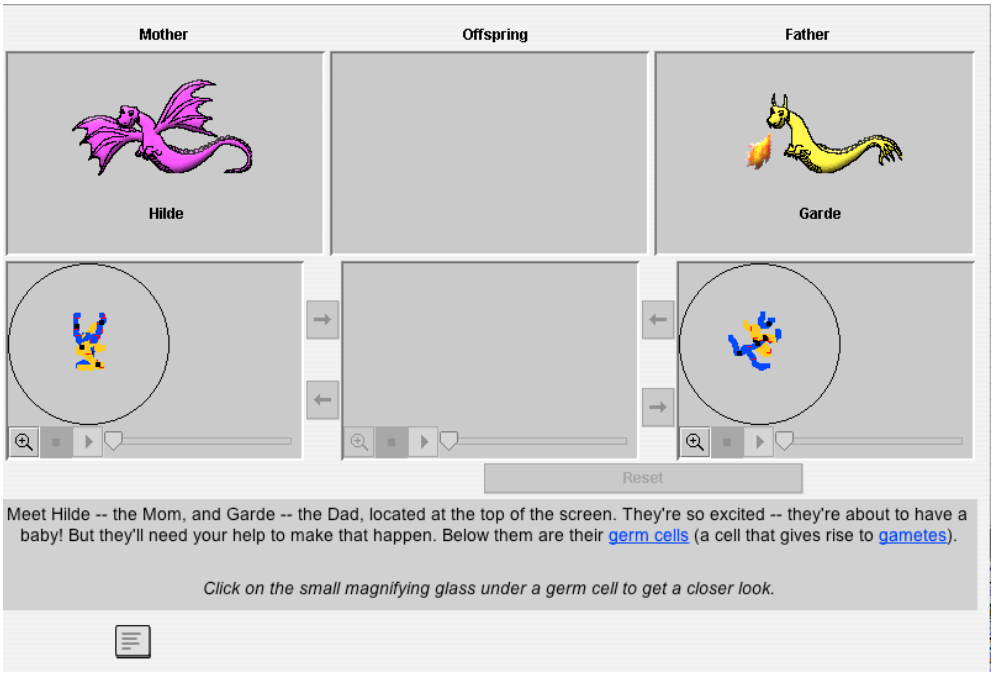
4.1 Table of Contents

This activity has two main sections, *Introduction to Meiosis* and *Designer Dragons*. They are to be done in order.

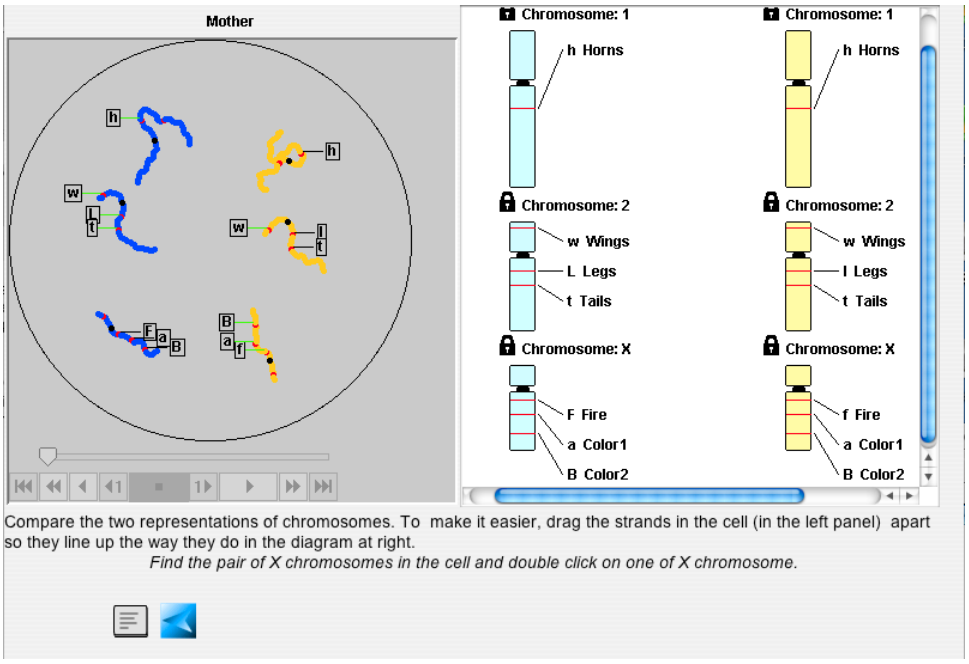
Table of contents

4.2 Introduction to Meiosis

Introduction to Meiosis is the first step in explaining why members of a family do not look more alike. Students are introduced to the meiosis and fertilization model and then connect its representations to the representations used in *Introduction and Rules* and to the terms *diploid*, *haploid*, *germ cells* and *gametes*.



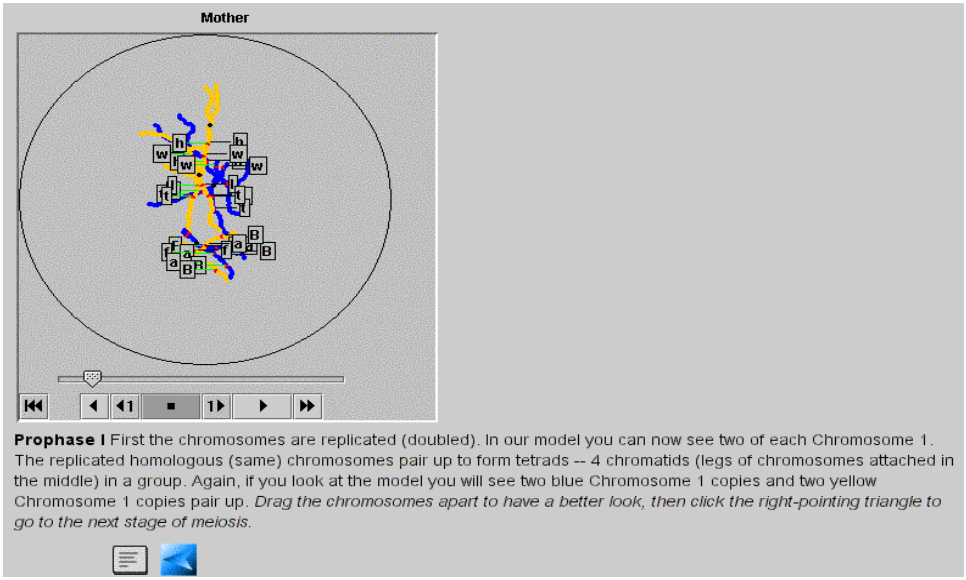
Students first delve into the meiosis model by clicking the magnifying glass  located under each dragon's germ-line cell.



Students inspect the cells and their chromosomes, drag the chromosomes apart, and compare them to the representations used in *Introduction and Rules*. Questions and instructions interspersed throughout the activity help focus students' attention on the representations. Students are asked to click on either an X or a Y chromosome. The key to finding the Y chromosome is to look for one without any alleles.

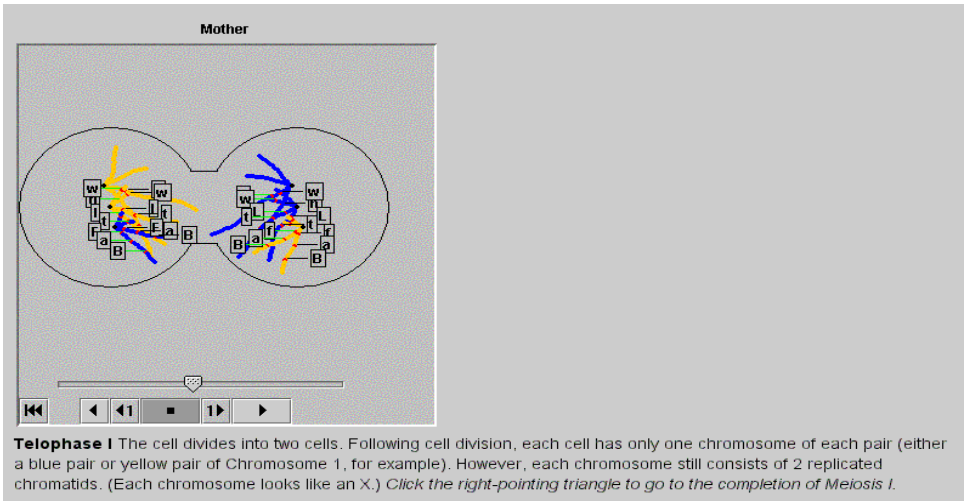
4.2.1 Stages of Meiosis

In the following screens, students use the meiosis model to study the stages of meiosis. They can drag chromosomes around to investigate more closely.

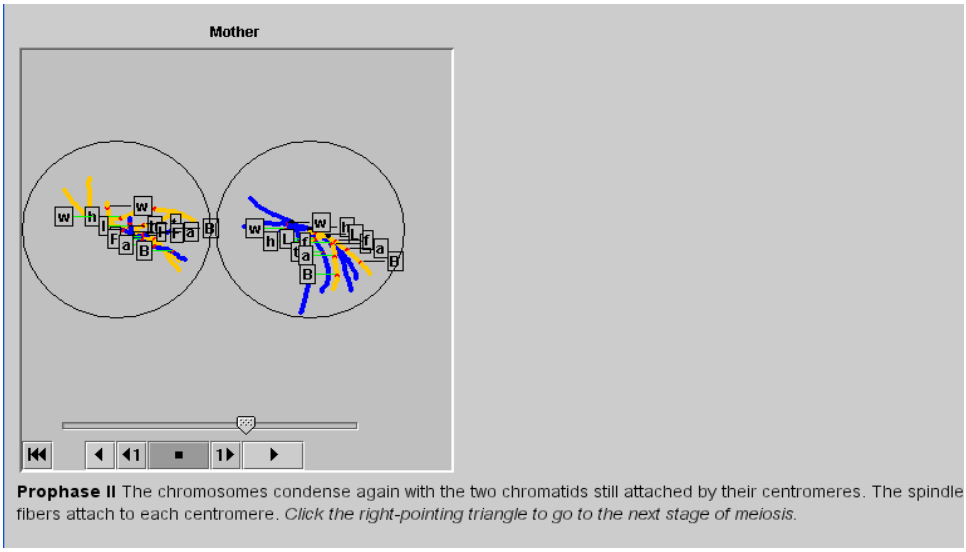


Meiosis I, Prophase I

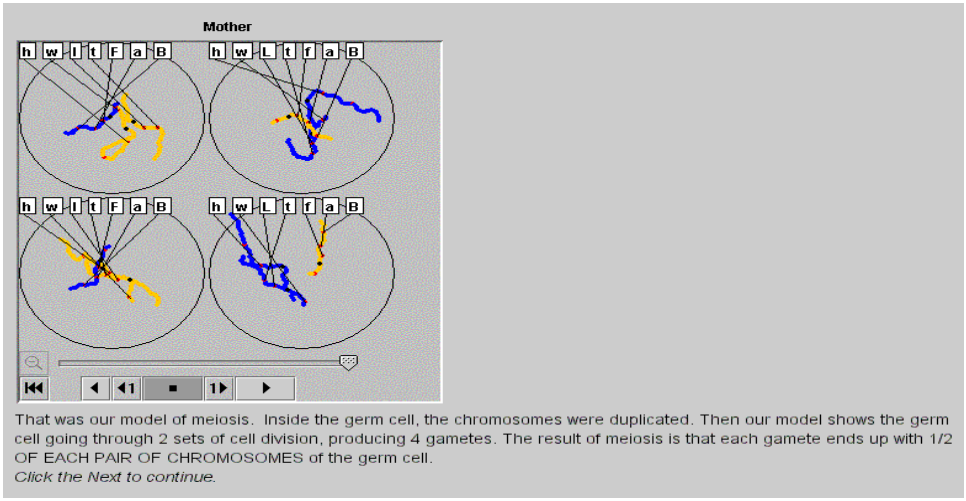
Students click on the play arrow  under the model to progress from one stage to the next.



Telophase I, Cell divides into two cells



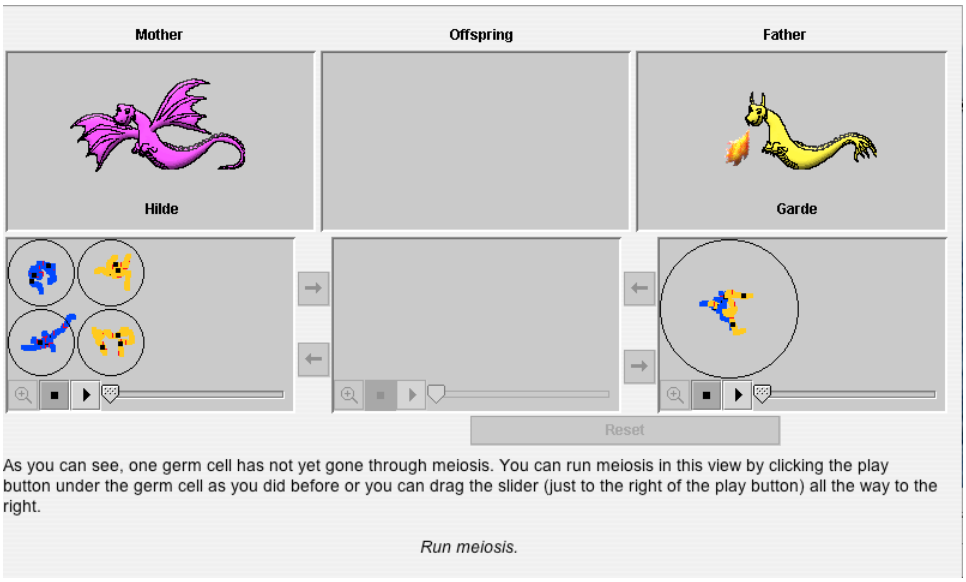
Prophase II, click play arrow to animate



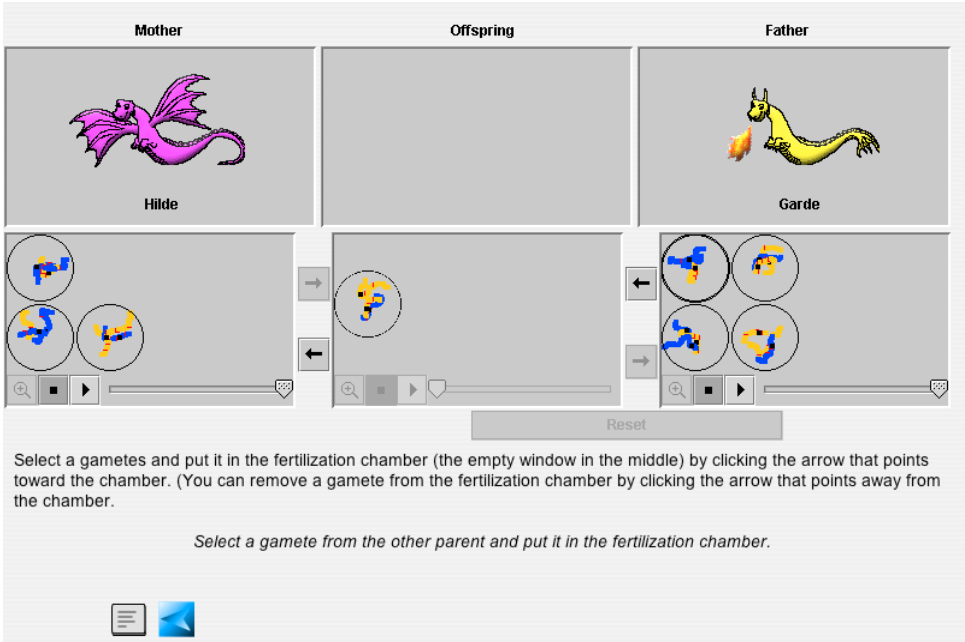
Meiosis is completed

4.2.3 Models of meiosis and fertilization: Putting it together

This section teaches the student how to run the model of meiosis and fertilization in order to produce a baby dragon. Here, interspersed questions focus attention on variation among offspring.

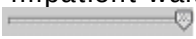


Students must run meiosis for the male by clicking the play button under the father dragon's germ cell.

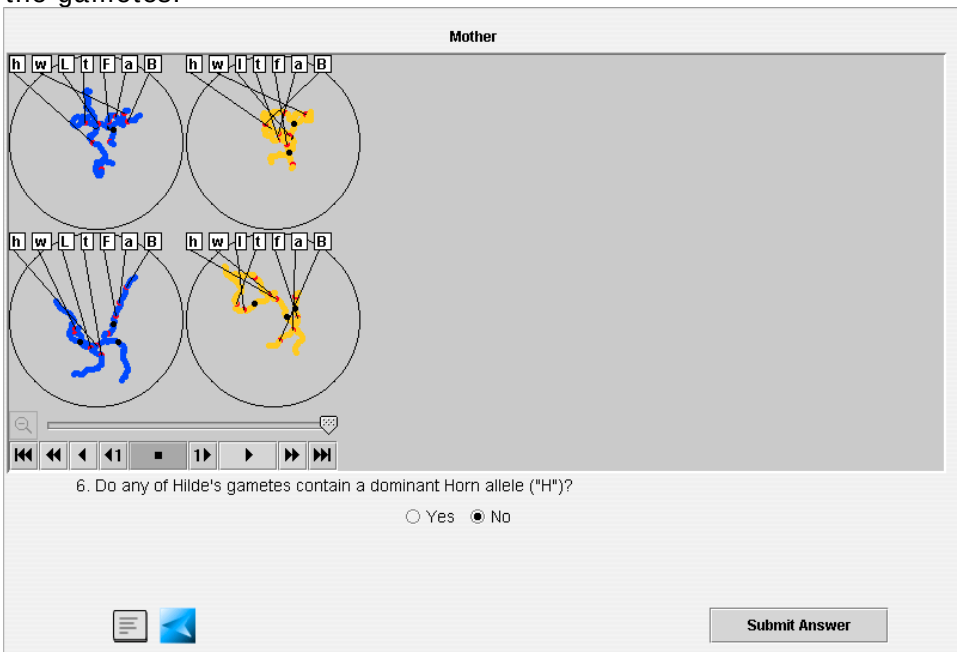


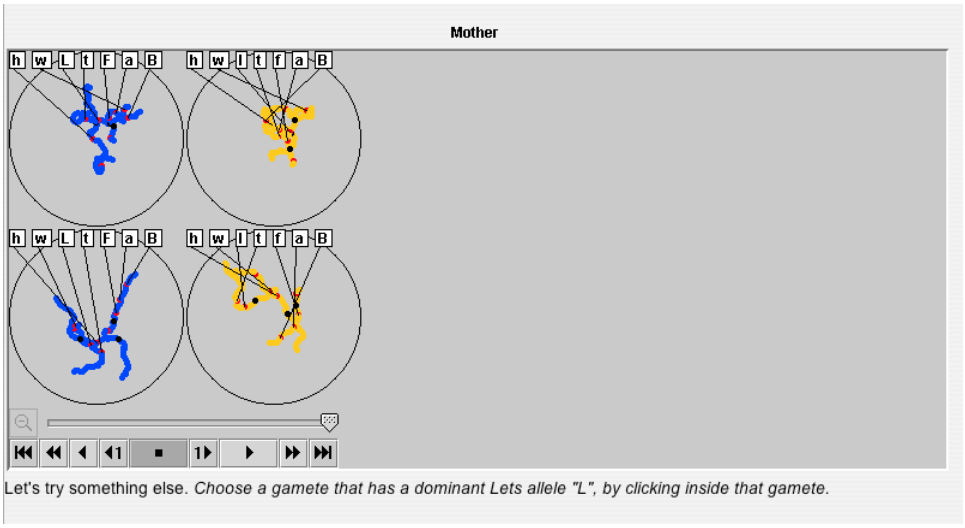
Then, they must select a gamete from each parent and move the chosen gametes into the fertilization chamber between the gametes by clicking on the arrow  .
Students then run fertilization as they have done for meiosis. After fertilization is complete, a new offspring appears between the parents.

The idea of variation among offspring is then demonstrated by asking students to create a series of offspring using the reset button, which triggers a new meiosis and shuffling of chromosomes.

When students become impatient waiting for meiosis and fertilization to run, they can use the slider  to complete the processes in less time.

A series of questions and tasks ensures that students 'see' the alleles within the gametes.





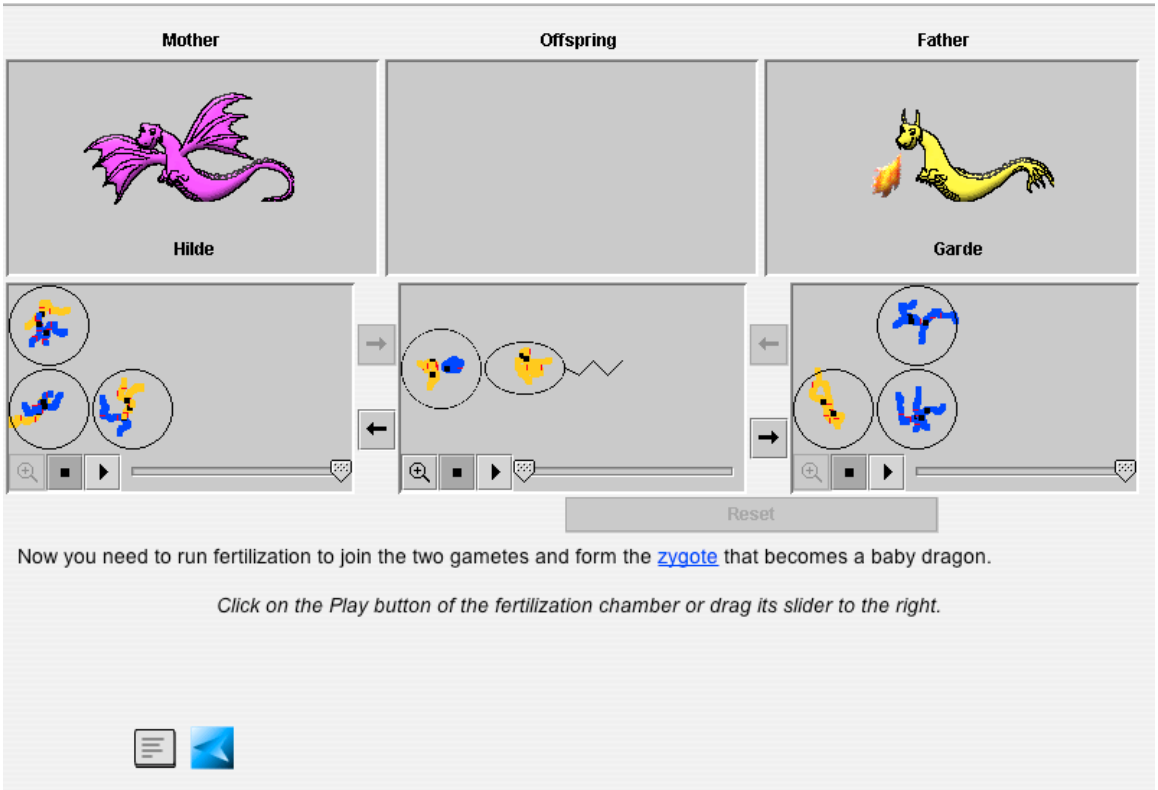
Note: when selecting a gamete in this view, don't click on the mass of chromosomes; it works better to click outside the chromosomes but inside the circle.

A series of questions followed by a summary concludes this section.

4.3 Designer Dragons

This is the second activity in the table of contents. Students use the models of meiosis and fertilization to meet increasingly difficult challenges that test their understanding of what they've learned so far. The challenges start with

any baby dragon and progress through male and female offspring with particular traits to the challenge of producing particular live offspring when the recessive lethal allele ‘b’ of the Color2 gene is in play.
Screen one show the parent cells and has students run the meiosis process for each parent. To run the meiosis of both parents simultaneously, click the right arrow of both boxes. You can also drag the sliders to speed up the processing.



Four gametes produced from each parent cell, with one from each parent added to the fertilization chamber.

The last challenge, producing a baby boy with 2 legs, may require multiple resets in order to get the necessary ‘L’ allele without the lethal ‘b’.

5.0 Student Reports

Your students’ work with Meiosis 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.

The next core activity that students should use is *Mutations*, which allows students to manipulate the DNA model to create mutations in dragons.

If you have time, students can try a short optional activity, *Horns Dilemma*, before they move onto *Mutations*. *Horns Dilemma* is a fun way to test students’ understanding of the meiosis model, genotypes, and phenotypes.