Genetics – Mutations 2

Teacher's Guide

1.0 Summary

Mutations II is an extension activity, which reviews and enhances the previous Core activities. We recommend that it follow ***Mutations*** and ***X-Linkage***. This activity should take approximately 35-45 minutes.

2.0 Learning Goals

Driving Question: How are mutations inherited? Are all mutations harmful?

Mutations II builds on **Mutations** and **Monohybrid.** In Mutations students changed the DNA bases of the dragon genome and saw the resulting alterations in their traits. In this activity, students continue their investigations of mutations, distinguishing between dominant vs. recessive and somatic vs. germline mutations and how they are inherited. **Mutations II** guides students as they explore lethal mutations and x-linked mutations and gives the students more practice in using Punnett squares to determine the probability of inheriting a mutated trait.

Learning Goals

Students will understand that

- Mutations are changes in the DNA that may produce new alleles.
- There can be more than 2 alleles per gene in a population.
- An organism can carry and pass on a mutated gene without displaying the mutated trait.
- A mutated allele has a dominance relationship with every other existing allele for that gene.
- The inheritance of two recessive mutated genes can be lethal.
- Somatic mutations can occur in body cells and may result in abnormal growths or cancer, but are not inherited.

Additional Teacher Background

In this activity, students can come to understand that mutations, when occurring in humans, can possibly have profound effects. For example, in the *Horns Dilemma*, we found that Cystic Fibrosis is an autosomal recessive disorder. This genetic illness, usually caused by the deletion of three bases in the DNA of a single gene on chromosome 7, is a serious degenerative disease.

In the course of this activity, students are reminded that mutations are changes in the DNA, which may produce new alleles. The effects of mutated alleles can range from insignificant to fatal and everything in between. For example, a mutation does not always affect a gene, an organism's, ability to survive, its phenotype or its behavior. However, other, more serious mutations cause devastating illness such as, Huntington's disease and Achondroplasia, which are dominant and Tay-Sach's and

Polycystic Kidney disease which are recessive. Mutations that create new alleles are a main source of genetic variation within a population.

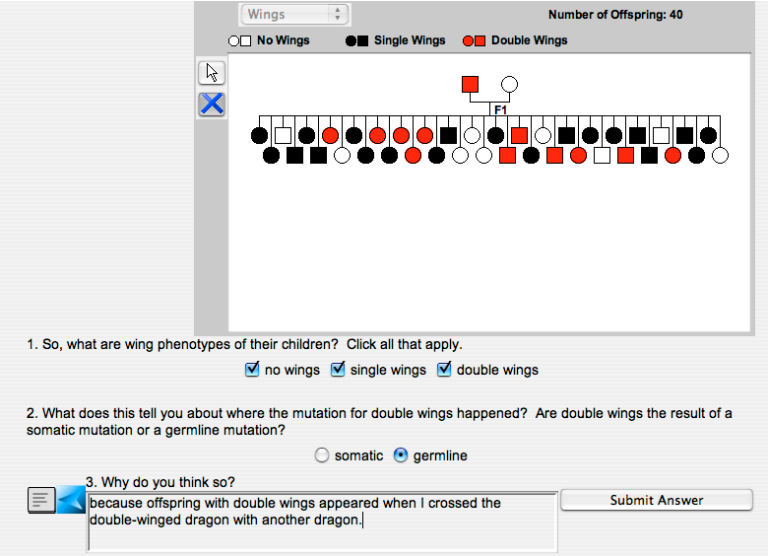
Students should be aware that mutations also are caused by environmental factors such as radiation and toxins but will be inherited only if they occur in the germline of an organism.

4.0 Activity Sections

This activity deals with four interrelated ideas:
dominant and recessive mutations, lethal alleles, the distinction between somatic and germline mutations, and the parallel between mutated dragon genes and mutated human genes.

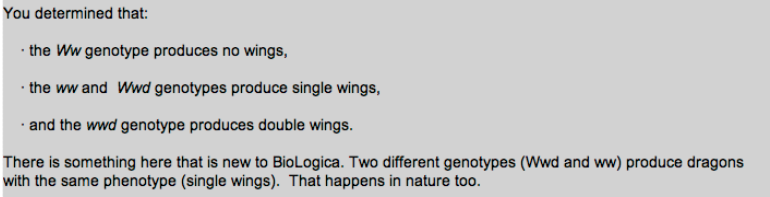
4.1 Double wings: When too much of a good thing is lethal!

Step 1: Determine if double wings result from a germline or somatic mutation.

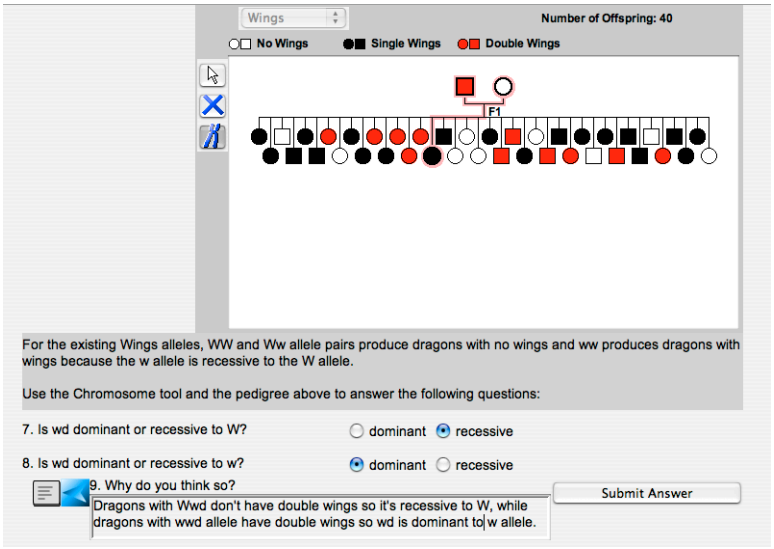


Cross double-winged dragon with wingless dragon.

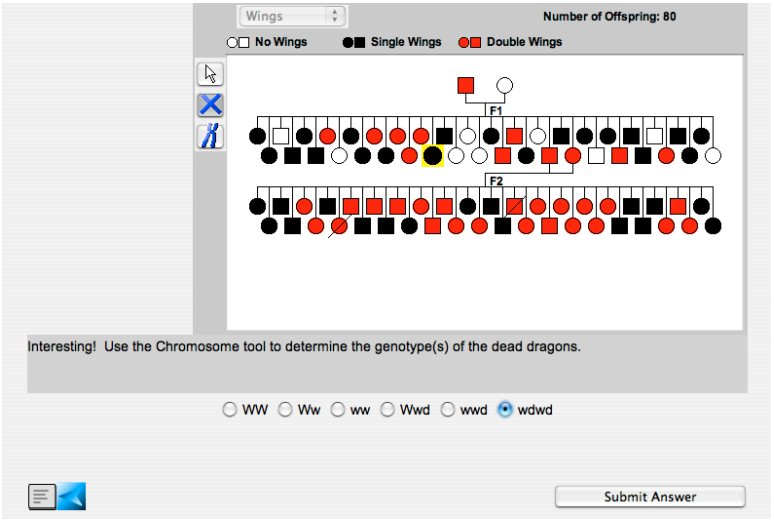
Step 2: Determine which genotypes create double-winged dragons.



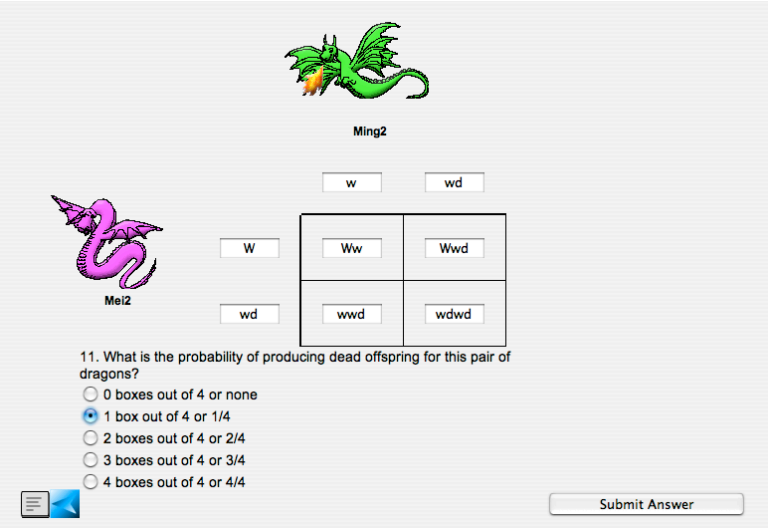
Step 3: Determine whether mutated allele is dominant or recessive when paired with existing Wings alleles.



Step 4: Examine recessive lethal pattern in pedigree.



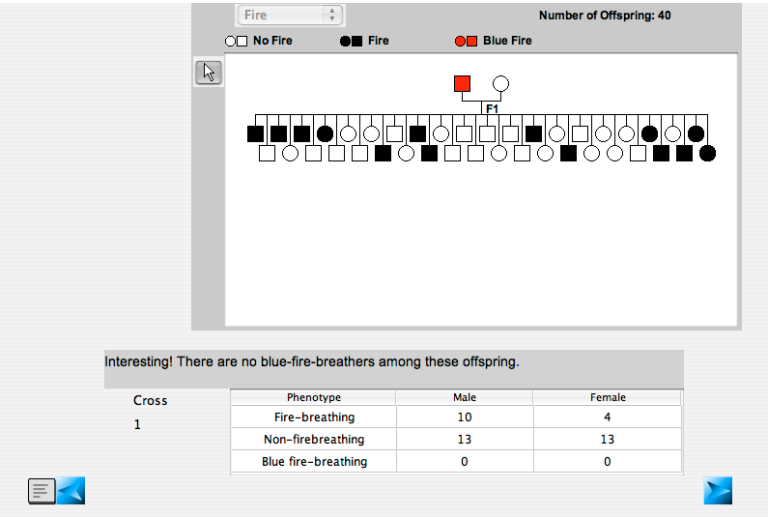
Step 5: Complete a Punnett Square to determine probability of offspring inheriting two alleles for double wings.



4.2 Tracking down X-linked mutations

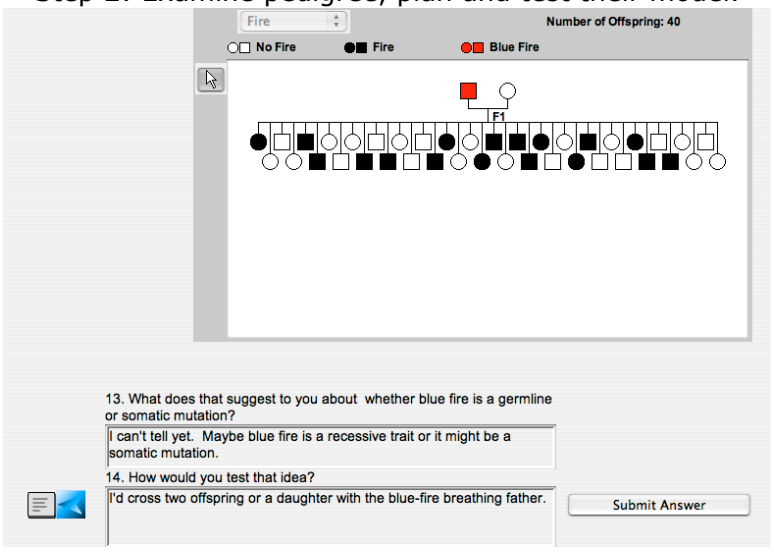
After a review of the inheritance of fire-breathing as an x-linked recessive trait, students are guided as they investigate a dragon that breathes blue fire.

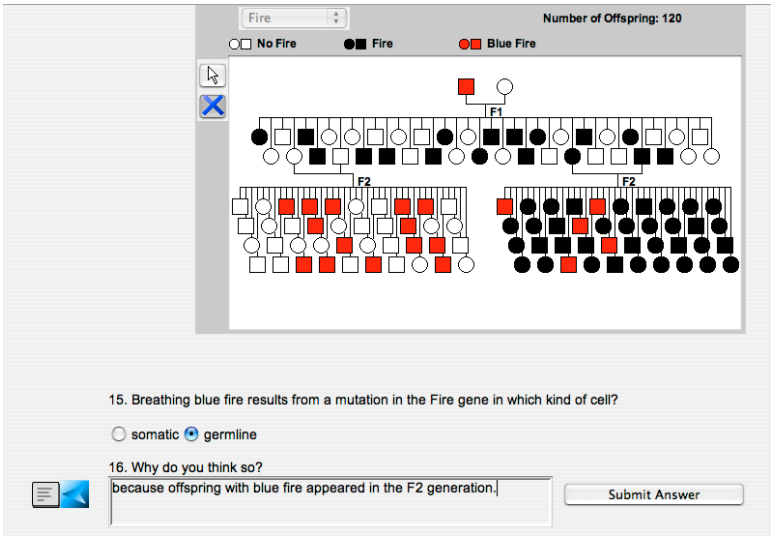
Step 1: Cross new dragon with another dragon to see if offspring breathe blue fire.

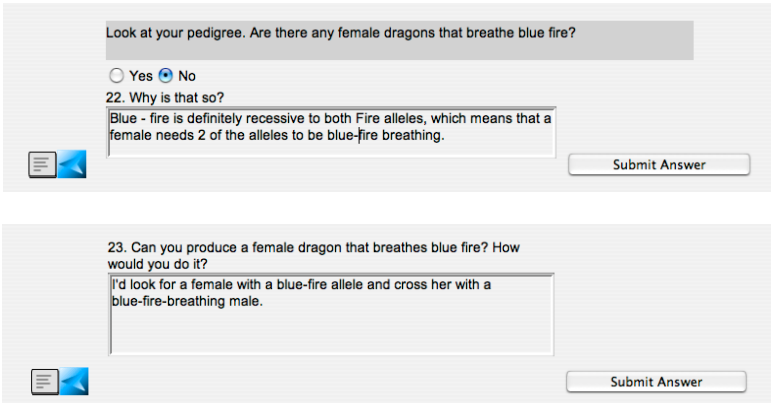


Lack of blue-fire-breathing offspring in the F1 generation keeps the question open.

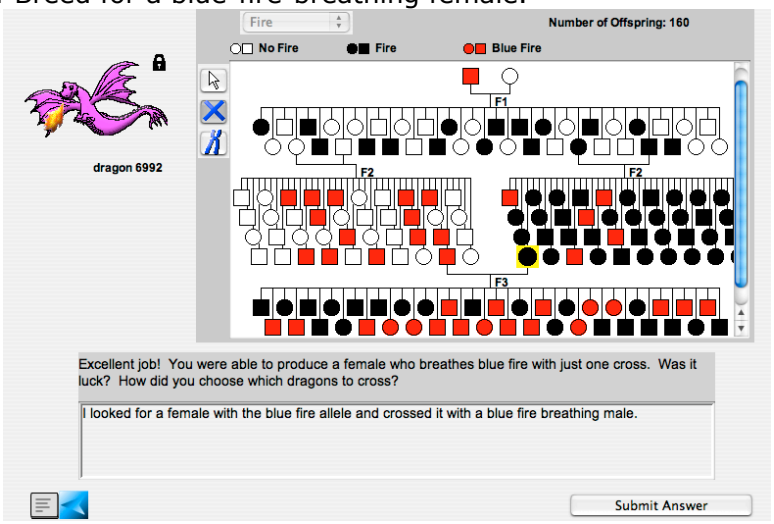
Step 2: Examine pedigree, plan and test their model.



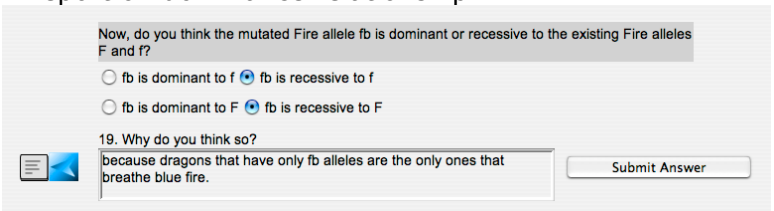




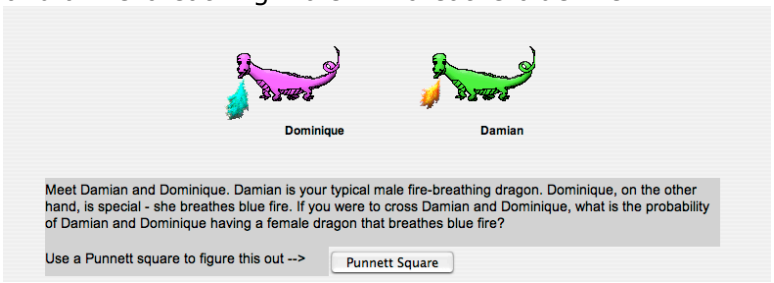
Step 3: Breed for a blue-fire-breathing female.

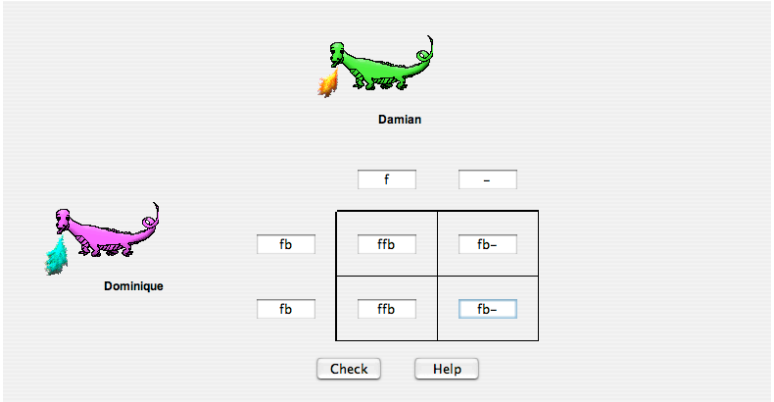


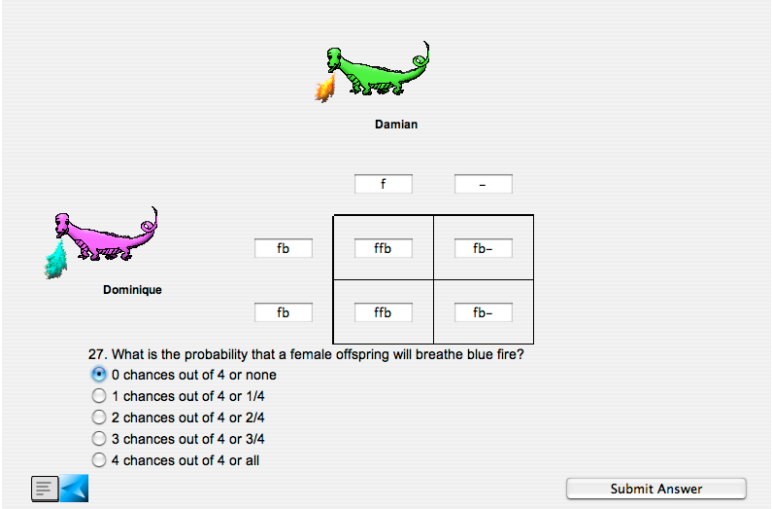
Step 4: Report on dominance relationship.



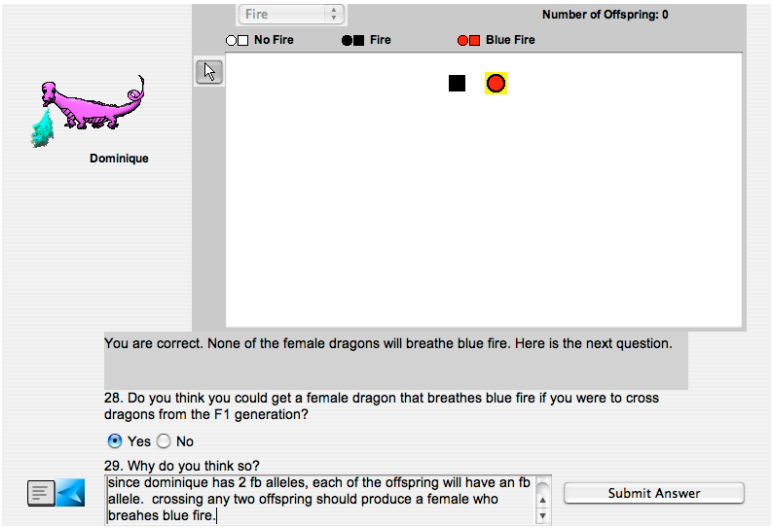
Step 5: Work through the probability that offspring of a blue-fire-breathing female and a fire-breathing male will breathe blue fire.



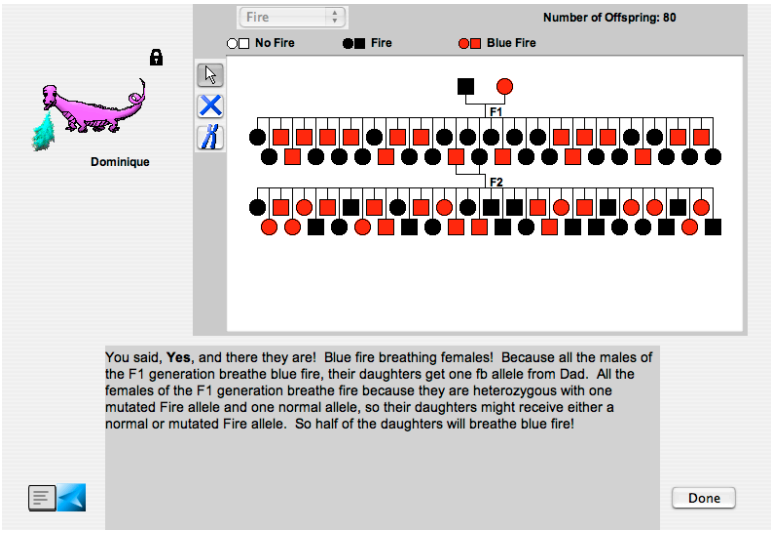




Step 6: Test prediction by crossing Dominiqué and Damian.



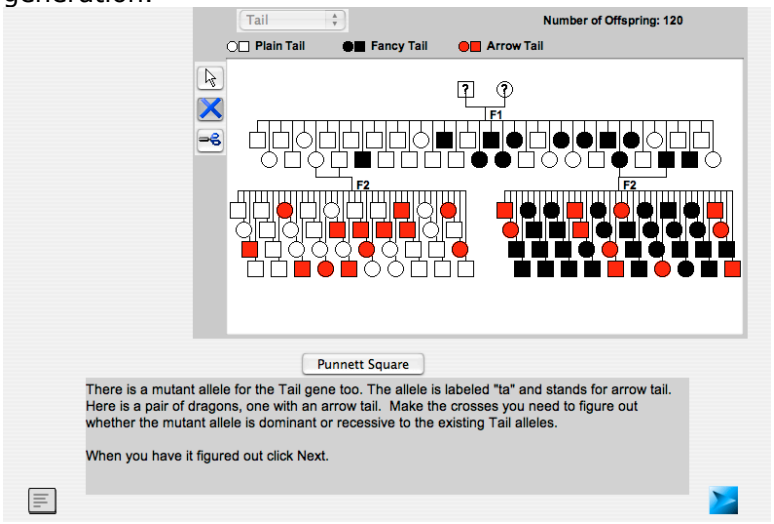
Students must make both an F1 and an F2 generation to produce females who breathe blue fire.



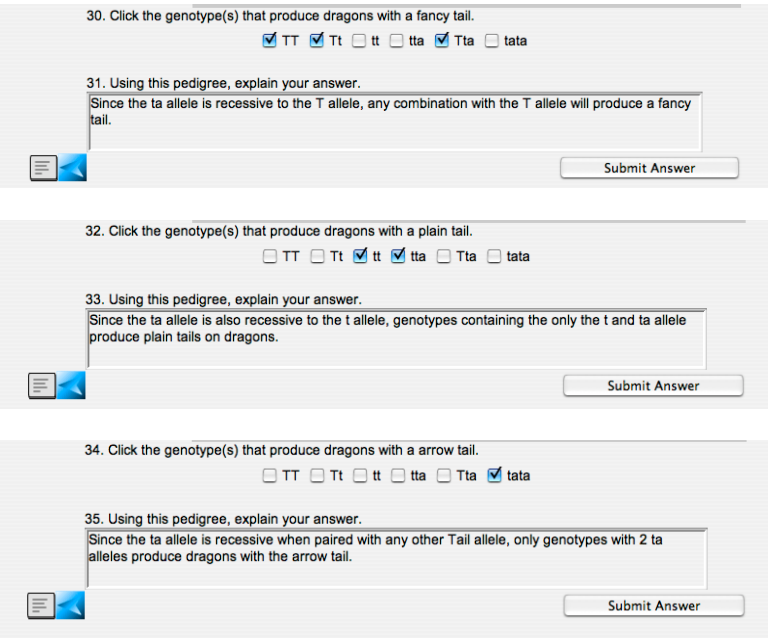
4.3 Mutations Quiz

Mutations II concludes with a mutations quiz about another novel trait – the arrow tail.

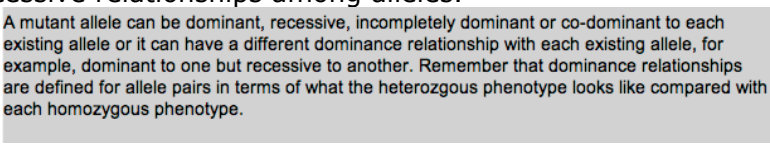
Step 1: Cross the parents using the Cross tool to create the F1 generation.



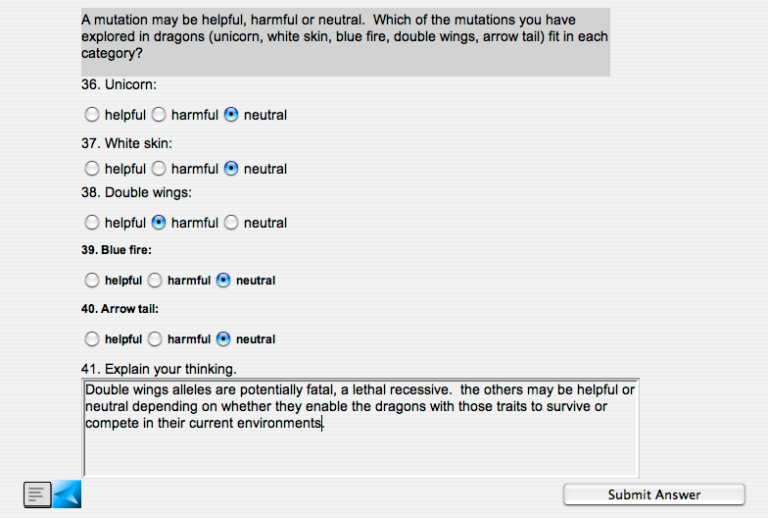
Step 2: Answer a series of questions about which genotypes produce which phenotypes and justify their answers.

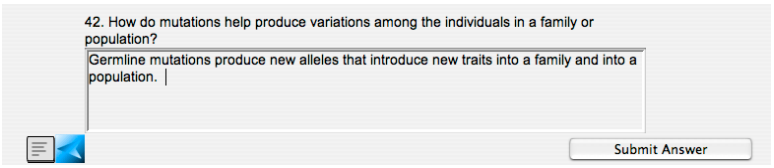


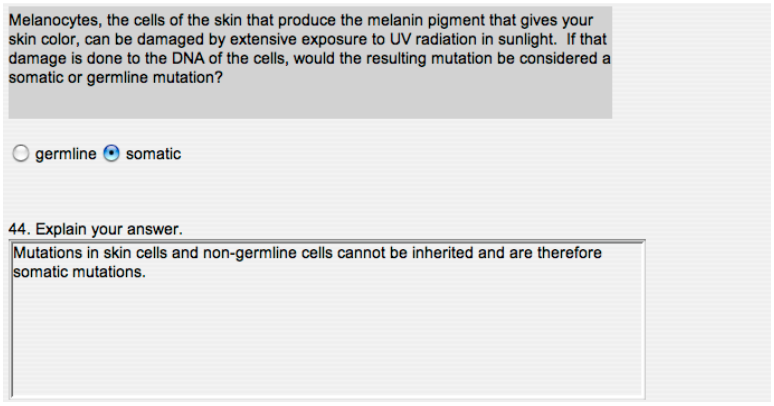
After students answer the questions, a summary reinforces the dominance and recessive relationships among alleles.



Step 3: Reflect on the effects of mutations they have seen.







You are correct that this is an example of a somatic mutation, meaning that it occurs in body cells (in this case, skin cells).

If the mutation occurs in a tumor suppressor gene, skin cancer can result.

If a mutation occurs in a germline cell or gamete of an individual it can be passed on to their offspring.

When offspring inherit a mutated tumor suppressor gene, it is present in all their cells and increases the risk of tumors throughout their bodies.

Step 4: Read the summaries.

Let's take a few minutes to review what you have learned:

· Mutation (change in the DNA) creates new alleles (mutant alleles).

· There can be more than two alleles per gene in a population.

· Mutation is rare and can be hidden through generations.

· A mutant allele will have a dominance relationship with every other existing allele.

· A mutant allele can be lethal.

· Somatic mutations can also occur in body cells and may result in abnormal growths or cancer, but are not inherited.

Why is this important?

Germline mutations are one of the factors that bring about change in a population. They are random. The effect of a mutation depends on how the mutation changes the structure, function, or behavior of an organism in relation to its environment. A mutant organism may be better or less well adapted to its environment than its normal counterpart. When a mutation helps an organism survive in its environment, it is considered helpful.

Somatic mutations occur in the body cells of an individual and cannot be inherited.

5.0 Student Reports

Your students' work with *Mutations 2* 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.

Students should now work through the *Dihybrid* activity. It guides students as they examine the different patterns that emerge when the genes for two traits are on the same chromosome versus different chromosomes.