Cow Exercise 1 – Answer Key

Goal

In this exercise, you will use StarGenetics, a software tool that simulates mating experiments, to analyze the nature and mode of inheritance of specific genetic traits.

Learning Objectives

After completing this exercise, you will be able to:

1. Identify the phenotype of a cow within StarGenetics.
2. Determine whether a phenotype is dominant or recessive relative to another phenotype through the analysis of results from genetic crosses.
3. Use Punnett Squares to predict and confirm expected genotypic and phenotypic ratios.
4. Explain the effect of sample size on observed phenotypic ratios.
5. Infer and assign genotypes of individual organisms using proper nomenclature of alleles.
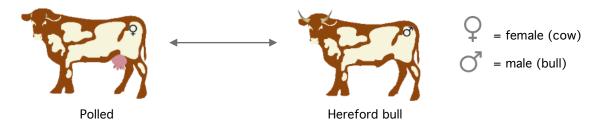6. Determine whether an allele is autosomal or sex-linked through the analysis of results from genetic crosses.

Getting started with StarGenetics

- To get StarGenetics, please navigate to: **http://star.mit.edu/genetics/**.
- Click on the **Start** button to launch the application.
- Click **Trust** when a prompt appears asking if you trust the certificate.
- Click on **File → New** in the main menu.
- Click on the **Cow Exercise 1** file.

In the **Strains** box, you will find two Hereford cows, called **Hereford cow** and **Hereford bull**, and one cow that does not look like the others, called **Polled**. The Hereford cows are homozygous (true-breeding) for the Polled allele.
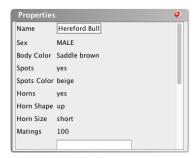
1 What is the sex of the Polled cow?
  - The sex symbol is indicated within the body of each cow.

Polled   Hereford bull

♀ = female (cow)

♂ = male (bull)

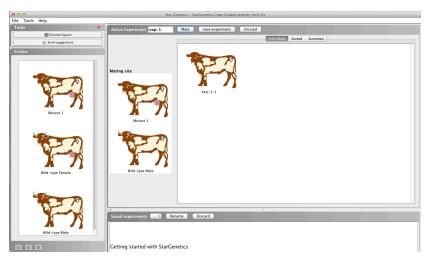| Answer |
| --- |
| |

2 What is the phenotype of the Polled cow?
  - Compare the color and features of the cows to determine which features are different. Hereford cows and bulls have brown bodies, beige spots, and horns. You can also click on a cow and look in the **Properties** box.

Properties	
Name	Hereford Bull
Sex	MALE
Body Color	Saddle brown
Spots	yes
Spots Color	beige
Horns	yes
Horn Shape	up
Horn Size	short
Matings	100

Answer

3 Is the Polled phenotype recessive or dominant to the Hereford phenotype?
- Mate the Polled cow with a Hereford bull by dragging both cows into the **Mating site.**
- Click on the **Mate** button.

What do you see? Let's take a look:

You can see all the cows resulting from this cross within the **Individual** tab or a summary of the experiment by clicking on the **Summary** tab. Within the **Summary** tab, all of the organisms are organized by <u>phenotype</u>.

a) How many progeny did you obtain? What phenotype(s) do you observe?

Answer

b) Fill in the Punnett Squares below with the expected results in the F1 generation for each of the following situations:

If the Polled phenotype is dominant to the Hereford phenotype:
   1. What results would you expect if the Polled cow is homozygous for the Polled allele?

   2. What results would you expect if the Polled cow is heterozygous for the Polled allele?

If the Polled phenotype is recessive to the Hereford phenotype:
   3. What results would you expect if the Polled cow is homozygous for the Polled allele?

Hint: Remember that the Hereford cows are homozygous (true-breeding) for the Polled allele.

| 1. Homozygous Dominant | 2. Heterozygous | 3. Homozygous recessive |

Hereford   Hereford   Hereford

Polled   Polled   Polled

Expected Genotypic
Ratio: _____   _____   _____
Expected Phenotypic
Ratio: _____   _____   _____

c) Can you conclude whether the Polled phenotype is dominant or recessive relative to the Hereford phenotype after analyzing the progeny that you obtained? Explain.

Answer

d) Increase the number of progeny. What do you observe now? How many phenotypes do you see? Is the Polled phenotype dominant or recessive to the Hereford phenotype?
- To add additional offspring to a cross, click on the **Add more matings** button and select the appropriate number of matings (or crosses) you would like to perform in the pop-up window to add the appropriate number of additional offspring. Repeat until you have **at least 12 cows**.
- To start a new experiment, click on the **New experiment** button. Your current experiment will be automatically saved for you and can be found in the **Saved Experiments** panel.

Answer

e) Based on your results, what is the genotype of the Polled cow?

Answer

4 a) Can a sex-linked allele produce the results that you obtained in question 3? Fill in the Punnett Square below with the expected results in the case that the Polled allele is sex-linked.
The hallmark of a sex-linked allele is differential partitioning of the allele in females and males. Males have one X chromosome and, as a result, carry one copy of each sex-linked allele. On the other hand, females have two X chromosomes and, as a result, carry two copies of each sex-linked allele.

Hereford

Polled

Expected Genotypic Ratio: _____

Expected Phenotypic Ratio: _____

Answer

b) To distinguish between the sex-linked and autosomal possibilities, cross a F1 Polled Cow with a F1 Polled Bull. Fill in the Punnett Squares below with the expected progeny from this cross if the Polled allele is sex-linked or autosomal. Indicate the expected genotypic and phenotypic ratios you would obtain in each case.

Sex-Linked

F1 Polled Cow

F1 Polled Male

Autosomal

F1 Polled Cow

F1 Polled Male

Expected Genotypic Ratio: _____   _____

Expected Phenotypic Ratio: _____   _____

c) Perform the F1 x F1 cross in part (b) in StarGenetics. How many progeny did you observe in each of the phenotypic classes? Can you conclude whether the Polled allele is autosomal or sex-linked? Explain.

Answer

_____ Hereford females

_____ Hereford males

_____ Polled females

_____ Polled males

Conclusions:

d) Now generate more progeny for your cross. Does your answer change as you increase the number of progeny in your cross? Fill in your results below. Is the Polled allele autosomal or sex-linked? Explain.

Answer

_____ Hereford females

_____ Hereford males

_____ Polled females

_____ Polled males

Conclusions:

BONUS QUESTION:

Can you think of another informative cross to distinguish between the sex-linked and autosomal possibilities? This cross must be different from the F1 Polled Cow x F1 Polled Bull cross in Question 4b. Specify your informative cross and how it enables you to distinguish between the two possibilities. Then, perform your cross in StarGenetics, and in the answer box, describe your results and explain how your results led you to your conclusion.

Answer