High School

MATH & SCIENCE LESSON 5

Hilleman & Vaccines

LEARNING GOALS

This series of lessons will allow students to use mathematics to improve scientific and mathematical literacy, and combine the two to help students understand where humans are in the context of a pandemic, especially during the development of an entirely new vaccine. Students will understand the development and use of a variety of vaccines.

WHERE DOES THIS FIT INTO YOUR CURRICULUM?

MATH

Using simulations as models and then applying computational thinking to understand processes

Using probability and statistics to understand population dynamics

SCIENCE

Understanding the spread of diseases in populations

Understanding the development and use of a variety of vaccines and the process of achieving herd immunity to stabilize the human population during a pandemic

Understanding how genetic mutations occur and their effect on organisms and the stability of a system

MATHEMATICAL PRACTICES

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Construct viable arguments and critique the reasoning of others.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.
- Look for and make use of structure.
- Look for and express regularity in repeated reasoning.

MATHEMATICAL STANDARDS

- Statistics and Probability: Interpreting Categorical and Quantitative Data (S.ID1,2,3, 5, 6a,6b, 6c).
- Conditional Probability and the Rules of Probability (S.CP 1,2,3,4,5,6,7,8).
- Making Inferences and Justifying Conclusions (S.IC, 1,2,3,4,5,6).
- Using Probability to Make Decisions: (S.MD 6,7).

NEXT GENERATION SCIENCE STANDARDS ALIGNMENT

***HS-LS2-1*: Interdependent Relationships in Ecosystems**

Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

***HS-LS3-2* Inheritance and Variation of Traits**

Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

***HS-LS3-3* Inheritance and Variation of Traits**

Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

MONTANA SCIENCE STANDARDS

Crosscutting Concepts: Cause and effect; proportion and quantity, and systems and system models.

Science and Engineering Practices: Developing and using models; analyzing and interpreting data; using mathematics and computational thinking, constructing explanations as it applies to science.

LS2. A: Use mathematical or computational representations to support arguments about environmental factors that affect carrying capacity, biodiversity, and populations in ecosystems.

LS3.B: Make and defend a claim based on evidence from multiple sources that inheritable genetic variation may result from:

- New genetic combinations through meiosis
- Viable errors occurring during replication
- Mutations caused by environmental factors

LS3. B: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Lesson 5

BRSV & Cattle Vaccination

Hilleman & Vaccines

LESSON INSTRUCTIONS
Lesson 5: BRSV & Cattle Vaccination

OBJECTIVE
This lesson is intended to make an agricultural connection to the use of vaccines and their effect on herd immunity.

BACKGROUND
Bovine Respiratory Syncytial Virus (BRSV) is an RNA virus classified as a pneumovirus and can affect sheep and goats in addition to cattle. It primarily infects newly weaned caves and is also common to incoming feedlot cattle. Typically, animals infected with BRSV show signs within 7 days, but signs have also been seen to develop as far out as 30 days in feedlots. Animals that do recover from the virus are not necessarily immune, so vaccinations are used to reduce infections and recovery time. Four-way vaccinations have revealed benefits including a decrease in respiratory morbidity, respiratory mortality, and overall mortality (Gordon & Thomson, 2009). In cattle, BRSV has been shown to be transmitted through the air (Mars, Bruschke, & van Oirschot, 1999). BRSV is often transmitted through nasal fluids (Van der Poel, Brand, Kramps, & Oirschot, 1994). Stressors on young cattle can affect the transmission of this virus (Campbell, 2015).

Human Respiratory Syncytial Virus (RSV) is a common respiratory virus that can cause mild, cold-like symptoms. Most who are infected recover within a few weeks, but serious cases of RSV can occur, particularly in infants and older adults. In children younger than 1 year of age in the US, RSV is the leading cause of bronchiolitis and pneumonia. It is estimated that 144,000 adults are hospitalized with RSV each year 17,000 adult deaths occur each year due to RSV (National Notifiable Diseases Surveillance System, 2019). An estimated 57,000 hospitalizations of children under the age of five occur each year in the United States due to RSV, but there are only 100-500 deaths annually amongst children under the age of five. Transmission of the virus occurs through droplets expelled by coughing and sneezing, by touching surfaces with the virus on them, or by direct contact with the virus (National Notifiable Diseases Surveillance System, 2019). People are contagious for three to eight days (CDC, 2020).

INSTRUCTIONS
This lesson is intended to make an agricultural connection to the use of vaccines and their effect on herd immunity.
Use a blank student worksheet to fill in the specific information you want for your class before you print.
Students could work in groups of two.

ANSWER KEY
Lesson 5: BRSV & Cattle Vaccination

Student Worksheet - Teacher Answer Key

1. On your ranch, you have 90 heifers and you have just purchased 10 more heifers at the sales barn and brought them to the ranch.
If your students are more advanced, change these numbers to be more challenging than 100. On a blank worksheet, fill in the numbers you want before making copies.

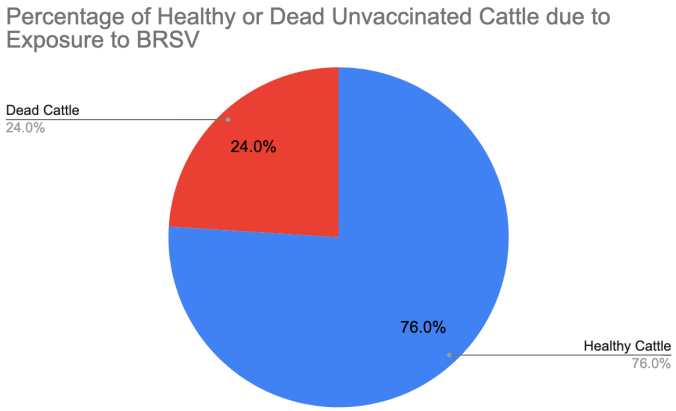
2. Choose a **percentage** from your teacher. Write your **percentage** below.
Use 5, 10, 15 and 20% as random draw choices. You could use fractions instead of percentages if you want your students to compare different fractions. The percentages students choose from should be between zero and twenty percent because that is the mortality rate for BRSV. On the blank worksheet, write in percentage or fraction on the blanks before you make copies. If you want them to draw from a hat, be sure and have them ready.

3. One of the new heifers has BRSV. Now, _____ percent of the herd you have chosen, has died. Have your teacher check your math. Use Google Sheets or another program to create a pie chart to represent this. Make sure you label your categories and give the graph a title. Include a legend or labels where needed. Show your math here.

Number of Deaths = _____
This can be done using a Google Sheet which is shared to the entire class. Each group could have their own page so that if you pull it up on the board, all of the graphs are there and students can compare graphs. However, if you are worried about copying or tampering, this is not the best choice. The teacher can easily pull up separate Sheets for each group. On the blank worksheet, write in percentage or fraction on the blank before you print.

Chart Example:

Percent of Unvaccinated Cattle that Died due to Exposure to BRSV	
Status of Cattle	Percentage of Healthy or Dead Cattle
Healthy	76
Dead	24



4. Brainstorm in which ways can this virus spread and spread easily amongst cattle? Write your ideas here.
Stressed cattle are more likely to acquire infections. Stressors can be transportation, being mixed with new cattle, being over-crowded, poor husbandry, and mixing age groups. The virus spreads through respiratory and nasal droplets and in the air.

5. Make up a scenario where you describe how your new heifers were introduced, transported, and housed to cause the kind of disease spread you witnessed. Write about your scenario here and be prepared to present it to the class.
If they had a high mortality rate, they may have let the new cattle out immediately into the pasture with the others. They may have had all of them in the corral together. The cattle may have been stressed after a long transport, or they may have all been mixed together in a closed area with poor ventilation. They may also consider the cleanliness or sharing of the water source or feed.

6. Now, you are beginning with a herd that is vaccinated but the vaccines had different percent efficacies. Choose your percent efficacy (between 50-75%) and write it below. Now, there is one new heifer that has BRSV. Predict how many heifers will be lost by using the mortality percentage or fraction that you drew above. Show your math below.

Percent Efficacy: _____

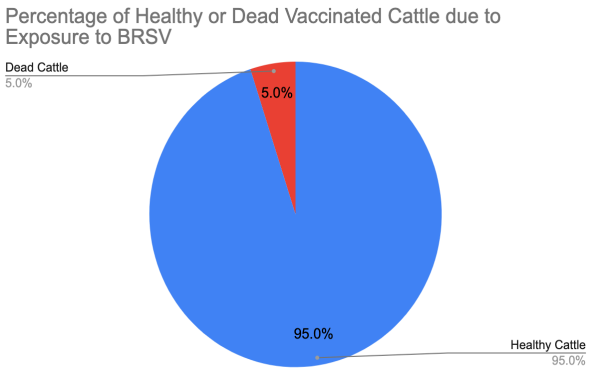
Number of cattle you could expect to lose: _____

Again, you can start with different numbers of cattle. Students will need to use the mortality rate that they drew above when calculating. If the vaccine had 75% efficacy, 25% of the cattle could catch the virus, and whatever percentage of those you drew above will die from BRSV.

7. Make another pie chart on the same spreadsheet, which shows the percentage of cattle that died when you started with a vaccinated herd.

Here is an example.

Percent of Unvaccinated Cattle that Died due to Exposure to BRSV	
Status of Cattle	Percentage of Healthy or Dead Cattle
Healthy	95
Dead	5



8. Calculate the monetary losses in numbers three and five. Show your math here. Assume that a heifer is worth $843.53 (USDA, 2021).

Monetary loss from number 3: _____

Monetary loss from number 5: _____

9. Below, discuss ways in which you could reduce exposure when introducing new cattle.

These answers should be related to those in number five.

STUDENT WORKSHEET
Lesson 5: BRSV & Cattle Vaccination

Name: _____ **Date:** _____

Student Worksheet

1. On your ranch, you have _____ heifers and you have just purchased 10 more heifers at the sale barn and brought them to the ranch.

2. Choose a percentage from your teacher. Write your percentage below.

3. One of the new heifers has BRSV. Now, _____ percentage of the herd has died. Have your teacher check your math. Use your Google Sheet or other program to create a pie chart to represent this. Make sure you label your categories and give the graph a title. Include a legend or labels where needed. Show your math here.

Number of Deaths = _____

4. Brainstorm in which ways can this virus spread and spread easily amongst cattle? Write your ideas here.

5. Make up a scenario where you describe how your new heifers were introduced, transported, and housed to cause the kind of disease spread you witnessed. Write about your scenario here and be prepared to present it to the class.

6. Now, you are beginning with a herd that is vaccinated but the vaccines had different percent efficacies. Choose your percent efficacy (between 50-75%) and write it below. Now, there is one new heifer that has BRSV. Predict how many heifers will be lost by using the mortality percentage or fraction that you drew above. Show your math below.

Percent Efficacy: _____

Number of cattle you could expect to lose: _____

7. Make another pie chart on the same spreadsheet, which shows the percentage of cattle that died when you started with a vaccinated herd. Show your math below:

8. Calculate the monetary losses in numbers three and five. Show your math here. Assume that a heifer is worth $843.53 (USDA 2021) .

Monetary loss from number 3: _____

Monetary loss from number 5: _____

9. Below, discuss ways in which you could reduce exposure when introducing new cattle.

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