INVESTIGATION

9B Genetics—Cards and Coins

The laws of probability can be used to describe how characteristics of humans, other animals, and plants are inherited. The inheritance of a trait such as eye color depends on chance, just as the selection of a club from a deck of cards, a roll of 7 with dice, or flipping heads with a coin depends on chance. All of these examples are chance events the occurrences of which may be predicted using the laws of probability. In this investigation, you will work with cards and coins to explore the laws of probability and relate them to patterns of inheritance.

OBJECTIVES

- ☐ Investigate patterns of chance occurrences.
- ☐ Express mathematically the probability of chance occurrences.
- ☐ Describe the laws of probability.
- ☐ Relate the laws of probability to the inheritance of genetic traits.

MATERIALS

deck of cards
2 pennies, 1 dull and 1 shiny

PRELAB

The probability that a chance event will occur may be expressed as *the number of times the event can occur out of the total number of possibilities.* Probability can be written mathematically as a percent, ratio, or fraction. In this investigation, you will use fractions. For example, the probability that a coin will land heads up when flipped can be written as 1/2. Heads can occur only once when a coin is flipped, and there are two possibilities—heads or tails. Thus, the chance of getting heads is 1 out of 2, or 1/2. Use fractions to express probabilities in the activity that follows.

1. Obtain a deck of cards. Remove the jokers and any extra cards if present so that you have 52 cards. Shuffle the deck once or twice and fan out the cards, facedown, on your lab table. Select one card from the deck, but do not look at it yet. Answer Prelab questions 1 through 3 on the Lab Report and fill in the first blank column of the data table shown in Prelab item 4 on the Lab Report. (Be sure to reduce your fractions to the lowest denominator.)
2. Look at your card. If you picked either any spade, any 9, or the 9 of spades, record your result in the second blank column of the data table on the Lab Report.
3. Replace the card in the deck, shuffle once, and continue picking cards in the same manner for 25 more trials. Using hatchmarks, record your team results in the data table.
4. When you are finished, obtain the counts of a nearby team and record them in the same data table. Combine your team results with those of the other team so that you have a total of 52 trials and calculate the total fractions out of 52 for each event. Write the final fractions in the last column of the data table. Answer Prelab questions 5 through 13 on the Lab Report.

INVESTIGATION PROCEDURE

1. In this investigation, you will flip 2 pennies (one shiny and one dull) simultaneously 40 times. The easiest way to do this is to shake both coins between your clasped hands and then use one hand to gently slap the coins onto your lab table. Various combinations of head and tails can occur. One

such combination is that both the shiny penny and the dull penny will come up heads. Before you proceed further, identify the other possible combinations that can occur and list them in the first column of the data table of Investigation item 1 on the Lab Report.

2. Answer Investigation questions 2 through 4 on the Lab Report. Then use your answers to calculate the predicted number of occurrences for each combination. Write your predictions in the second column of the data table of Investigation item 1 on the Lab Report.
3. Shake the pair of pennies 40 separate times and observe the combinations of heads and tails you obtain. Using hatchmarks to record your results in the data table, tally the number of times each combination occurs.
4. When you finish your team's 40 trials, count the hatchmarks for each combination and record that number in the data table.
5. Obtain the totals of all the other teams and write the class total for each combination in the last column of the table. Remember to add your team's totals to the class total. Calculate the total number of trials for the class and write that number at the bottom of the last column. Answer Investigation questions 5 through 11.
6. Before leaving the laboratory, return all your materials, as directed by your teacher.

INDEPENDENT INVESTIGATION

Find a board game that involves the use of dice. Study the instructions for playing the game. Determine how players would use the laws of probability in planning their strategy. Write a report explaining how probability is used in this game. Some games that you can use are backgammon, Parchesi, and Monopoly.

Genetics—Cards and Coins

NAME _____

CLASS _____ DATE _____

PRELAB QUESTIONS

1. What is the chance that the card is any spade? _____
2. What is the chance that the card is any 9? _____
3. What is the chance that the card is the 9 of spades? _____
4. Data Table

Card	Predicted Occurrence	Your Team's Actual Results	Second Team's Actual Results	Combined Results (Total Fractions out of 52)
Any spade				
Any 9				
9 of spades				

5. How do your predicted results compare with your team's actual results? _____

_____

6. How do your predicted results compare with the combined results of the two teams? _____

_____

_____

7. What conclusions, if any, can you draw from the actual results? _____

_____

_____

8. The event of drawing any spade and the event of drawing any 9 are each *separate* events. The chance of drawing a 9 of spades, however, is a *combined* event—the chance of two events occurring together. Look at the predictions you wrote in the data table for drawing any spade, any 9, and the 9 of spades. What is the mathematical relationship between the combined event and the two separate events? _____

_____

9. If you were to separate all the black cards from the deck and draw only from them, what is the chance you would draw a club? _____
10. What is the chance you would draw a black 7 from the same set of black cards? _____

_____

11. What is the chance you would draw a 7 of clubs from this set? _____

12. Look at your answers to questions 9 through 11. Is drawing a 7 of clubs a separate or a combined event? Explain.

13. The concept you have developed in your answers to questions 8 through 12 is actually the second law of probability. A textbook definition of this law is as follows: The chance that independent events will occur at the same time is equal to the product of their chances of occurring separately. How does this definition compare with your answers to questions 8 and 12?

INVESTIGATION

OBSERVATIONS AND DATA

1. Data Table

Possible Combinations	Predicted Occurrences out of 40 Trials	Tallies of Actual Results	Team Totals	Class Totals

Total Class Trials _____

2. What is the probability that the shiny coin will come up heads? _____ Tails? _____
3. What is the probability that the dull coin will come up heads? _____ Tails? _____
4. What is the probability of the combined event of each of the following:

Both coins heads _____

Shiny heads, dull tails _____

Shiny tails, dull heads _____

Both coins tails _____

Do your predictions agree with the second law of probability as described in the Prelab? Explain. _____

5. How do your team results compare with your predictions? _____