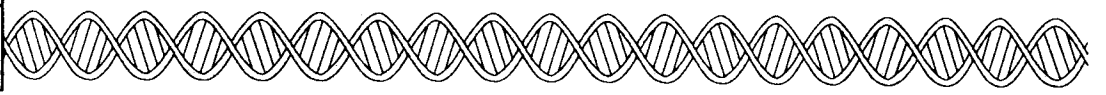
INVESTIGATION

4



How Are the Laws of Probability Applied to Genetics?

Purpose

To demonstrate the laws of probability by tossing coins, use the laws of probability to predict the outcome of certain events, and apply the laws of probability to genetics problems.

Concepts

- Probability
- Statistics

Background

When a coin is flipped the "chances" that heads will land facing up is 50:50. This is based on the *laws of probability*. Probability is always expressed as a fraction and the sum of the possibilities is always equal to one. For example, the probability that a coin will come up heads is 1/2, and tails also is 1/2. Their sum being equal to one. But the probability only tells what *might* happen. The difference between what might happen and what actually does happen is called *deviation*. If a coin is flipped 10 times, the expected result is five heads and five tails. If five heads and five tails are the result, your deviation is 0 percent because it didn't deviate from the expected result. But if six heads and four tails are the result, deviation is two; one from the expected five heads and 1 from the expected five tails. This is then divided by the total number of times the coin is flipped, or 10. Therefore, the deviation is 20 percent. In Part I, coins will be tossed and the deviation from the expected 50:50 heads/tails result will be determined.

A Punnett square is also an expression of probability, illustrating what might occur in predicted offspring. What actually happens can be quite different. In Part II a coin is used to represent the heterozygous genotype Hh (H = heads and h = tails). Recall that only one letter (allele) can end up in a gamete. Create a Punnett square to predict the outcome of flipping two coins at the same time and coming up with a predicted genotype. To determine the probability of two events happening at the same time, multiply the separate probabilities together. For example, to calculate the probability of getting heads on two coins at the same time, multiply $1/2 \times 1/2$, or 1/4.

In Part III, two coins will be flipped to determine which alleles (heads/tails) each parent contributes to the child. Comparison of the actual outcome will then be compared to the predicted outcome from the Punnett square.

Materials (per group of two students)

2 coins

Safety

There are no particular safety concerns for this activity, but follow all normal laboratory safety rules.

Procedure

Part I. One Coin

1. One partner will toss a coin 10 times and the other partner will record the data in Table 1 on the Probability Record Sheet.
2. Trade places and toss the coin 10 more times. Record the data in Table 1 on the Probability Record Sheet.
3. Trade places after each 10 coin tosses until the coin has been flipped a total of 100 times (ten trials).
4. Determine the percent deviation for each 10 coin tosses. Then determine the percent deviation for 100 coin tosses. (The last row on Table 1 is for the result of 100 tosses.)

Part II. Two Coin Prediction

1. Pretend that heads is dominant and tails is recessive (Heads = H and tails = h). Assume each of two coins represents one parent with two gametes and that both are heterozygous.
2. Fill in Table 2 (the Punnett square) on the Record Sheet to illustrate the predicted genotypic ratio resulting from these two parents.

Part III. Two Coin Actual

1. Together with your partner, flip two coins at the same time. In Table 3 on the Probability Record Sheet record whether the coins came up heads/heads, heads/tails or tails/tails.
2. Repeat step 1 a total of 10 times.
3. Determine the ratio of heads/heads to heads/tails to tails/tails for each series of tosses. (i.e., were heads/heads about 25 percent of the total?)
4. Compare the actual results from Part III to the Punnett square prediction in Part II. Recall that a Punnett square is just a prediction. Did your actual coin tosses come close to what the Punnett square predicted?
5. Answer the Analysis and Conclusion questions.

Name: _____

Probability Record Sheet

Table 1. Results of tossing one coin

Trial Number	Number of Heads	Number of Tails	Percent Deviation
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total			

Table 2. Two Coin Prediction—Punnett Square (predicted genotypic ratio)

Table 3. Results of tossing two coins simultaneously (actual genotypic ratio)

Number Coin Tosses	Heads/Heads	Heads/Tails	Tails/Tails

Analysis and Conclusions

1. When you tossed one coin 10 times, did heads or tails occur most often? When you tossed your coin 100 times, did the results come out closer to the expected results?

2. When doing your Punnett square in Part II, what was the predicted genotypic ratio?

3. What is the probability of getting heads/heads in tossing two coins simultaneously? In 10 tosses of both coins, how many times did this actually occur?

4. How did your predicted outcome (Punnett square) compare with your actual outcome (Table 3)?

5. What is the chance of drawing a **spade** in a single draw from a full deck of playing cards?

6. What is the chance of drawing an **ace** (any suit) in a single draw from a full deck of cards?

7. What is the chance of drawing the **ace of spades** in a single draw from a full deck of cards?

8. One girl in every two has brown hair. One girl in every three has dimples. What is the probability of meeting a dimpled, brown-haired girl?

9. What is the chance of getting an "A" gamete from an AA parent?

10. What is the chance of getting an "a" gamete from an AA parent?

11. What is the chance of getting an "A" gamete from an Aa parent?