Name _____ Date _____

Probability and Inheritance

Lab 34

Background

In 1866 *Gregor Mendel*, an Austrian monk, published the results of his study of inheritance in garden peas. Although Mendel did not understand the mechanisms of inheritance, his work became the basis for the modern study of genetics. From his studies on the inheritance of certain traits in pea plants, Mendel formulated three laws of inheritance: the law of dominance, the law of segregation, and the law of independent assortment.

Mendel thought that every trait was controlled by a pair of factors, which we now call *genes*. The *law of dominance* states that one gene, the dominant gene, prevents the appearance of the trait controlled by the other gene, the recessive gene. The *law of segregation* states that during gamete (egg and sperm) formation, the pair of genes for a trait separate, so that each gamete has only one of the genes for the trait. The *law of independent assortment* states that as gametes are being formed, the genes for various traits separate independently of one another.

In this activity you will learn some principles of probability. You will use these principles and Mendel's laws to predict the inheritance of traits.

Objectives

In this activity you will:

1. Predict the probability of the occurrence of a single event.
2. Predict the probability of two independent events occurring at the same time.
3. Apply Mendel's laws to predict the occurrence of certain traits in the offspring of parents exhibiting particular traits.

Materials

two pennies
masking tape

Procedures and Observations

PART I. OCCURRENCE OF A SINGLE EVENT

1. Toss a penny 20 times. Have your partner count how many times it lands heads up and how many times it lands tails up.
   a. *Write the totals under the Observed column for 20 tosses in Table 1*

The law of probability states that when a procedure can result in two equally likely outcomes (in this case, heads or tails), the probability of either outcome occurring is 1/2, or 50%.

2. Using the law of probability, decide how many times out of 20 tosses you would expect heads to appear and how many times you would expect tails to appear.

   b. *Write your answers in the Expected column for 20 tosses in Table 1.*

   c. *Calculate the deviation by subtracting the expected number from the observed number. Record these in the Deviation column for 20 tosses in Table 1. Make all numbers positive.*

3. Have your partner repeat Step 1, but tossing the penny 30 times. Count how many times heads and tails appear.

   d. *Record the observed numbers in the Observed column for 30 tosses in Table 1.*

   e. *Calculate the expected numbers of heads and tails and record them in the proper column in Table 1. Then calculate the deviations, and enter these in the proper column.*

4. Now repeat Step 1, tossing the penny 50 times. Your partner should keep track of the number of heads and tails.

   f. *Record the observed numbers, expected numbers, and deviations in the columns for 50 tosses in Table 1.*

   g. *Add the observed numbers of heads and tails from the three trials and record the totals in the Total columns in Table 1. Then calculate the deviations and record these numbers.*

Table 1. Probability of the Occurrence of a Single Event

		Heads	Tails
20 Tosses	Observed		
	Expected		
	Deviation		
30 Tosses	Observed		
	Expected		
	Deviation		
50 Tosses	Observed		
	Expected		
	Deviation		
Total	Observed		
	Expected		
	Deviation		

PART II. INDEPENDENT EVENTS OCCURRING SIMULTANEOUSLY

1. Toss two pennies simultaneously 40 times. Have your partner keep track of how many times headsheads, tailsheads, headstails, and tailstails occur. Count tailsheads and headstails together.

   a. *Record the numbers for each combination in the Observed column in Table 2.*

b. *Calculate the percent of the total that each combination (heads-heads, heads-tails, or tails-tails) occurred and record it in the proper column. To find the percent, divide each observed number by 40 and multiply by 100*

According to the law of probability, when there are four equally likely outcomes from a procedure, the probability that one of the outcomes will occur is 1/4 or 25%. We can see how this is calculated. For example, we know that in tossing two pennies, the probability of heads occurring on one penny is 1/2. The probability of heads occurring on the other penny is also 1/2. The probability of heads occurring on both pennies in one toss is 1/2 X 1/2 = 1/4.

2. Using the law of probability, predict the expected outcomes of tossing two pennies.

c. *Record the expected numbers in the proper column in Table 2.*

d. *Calculate the percent of the total that each combination is expected to occur, as you did above (problem 1-b). Enter these numbers in the proper column.*

e. *Calculate the deviation by subtracting the expected from the observed and enter your results in Table 2*

Table 2. Probability of Independent Events Occurring Simultaneously

Combinations	Observed	%	Expected	%	Deviation
Heads Heads					
Heads Tails Tails Heads					
Tails Tails					
Total	40	100%	40	100%	

PART III. PROBABILITY AND MENDELIAN GENETICS _____

We can use the law of probability to predict the probability of given genetic traits appearing in the offspring of particular parents. Punnett squares can also be used to make these predictions.

When gametes are formed, the pair of genes that determine a particular trait separate, and one gene goes to each gamete. When fertilization occurs, a male and a female gamete fuse. The resulting zygote, which develops into the new individual, now contains two genes for the trait. Which two of the parents' genes appear in the zygote is a result of chance.

In this case we will consider the inheritance in pea plants of round and wrinkled peas. *R* will represent the dominant gene for round peas and *r* will represent the recessive gene for wrinkled peas.

1. Put a small piece of masking tape on each side of two pennies. On one penny write *R* on each side. On the other penny write *r* on each side.
2. Toss the pennies several times.
   a. *What combinations of genes always appears?*

_____

   b. *Would the offspring with these genes be round or wrinkled?*

_____

3. Replace the old tape with new tape. On each penny, write *R* on one side and *r* on the other side. Toss the coins simultaneously until all possible combinations of genes have appeared.
   c. *What combinations of genes appear?*

_____

   d. *For each of the combinations, would the offspring be round or wrinkled?*

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Analysis and Interpretations

1. In Part I, what was the expected ratio of heads to tails for tosses of a single coin? Did your results always agree with the expected ratio? If not, what would be a reason for the deviation?

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2. Compare the deviations from the expected for 20, 30, and 50 tosses. What seems to be the relationship between the sample size and deviation?

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3. In Part II, what was the probability that tails would appear on both coins? How did you arrive at this answer?

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4. What was the probability that heads-tails (or tails-heads) would appear? Show your calculations. (Hint: The probabilities for these two combinations must be added together because they were recorded together.)

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5. If you tossed two coins simultaneously 400 times, would you expect the deviation to be greater or less than it was in tossing them 40 times?

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