Laws of Probability: Coin Toss Lab

Name(s)___________________
Period _____

Few concepts have had greater effect on the science of genetics than the laws of probability. Probability refers to the chance of something happening. Under normal conditions, probability calculations can give us good ideas of what to expect from different genetic combinations. A thorough understanding of probability was instrumental in leading Gregor Mendel to his basic conclusions about genetics, and these same laws of probability play an essential role in genetics today.

Objectives:

- Explain the role of sample size in estimating probability
- Calculate the probability of occurrence of a single event. Calculate the probability of simultaneous occurrence of two independent events.
- Compute a percent deviation from expected values for data gathered
- Apply the fundamental principles of probability to genetic problems

Materials:

- 2 coins (same size)
- lab write-up
- calculator
- textbook

Procedure:

This lab involves coin flipping. The two sides of a coin could also be thought of as dominant and recessive alleles for a given trait.

1. Fill in the EXPECTED results for each side of the coin AND for both the 10 and 50 tosses in Chart 1 (next page). Expected results can be determined based on probability.
2. **Toss a single coin 10 times**. Record the number of heads AND tails that result from the 10 tosses in Chart 1 under OBSERVED (keep tally marks on separate sheet of paper and place only the total in Chart 1).
3. **Toss the coin 50 times and again record the results**. Record the number of heads AND tails in Chart 1 under OBSERVED (keep tally marks on separate sheet of paper and place only the total in Chart 1).
4. After predictions are made for a given event and actual data are gathered, ***the deviation***, or difference between observed and expected, can be figured. This is usually expressed as a percentage and is an indication of the degree of error. If the percent deviation is small (approximately 10 % or less), we can say it is due to chance. If the value is large, other unknown factors may have entered into the experiment.
5. Use the formula to compute the percent deviation for each trait. What is the relationship between sample size and the degree of error for a chance occurrence?
6. Write your results from the tosses on the board. Once totals are calculated, write totals in Chart 1 in the row for "Class."

How to compute % deviation

% deviation = $\frac{\text{Sum of differences from expected}}{\text{Total occurrences}}$ X 100

Example: A coin is tossed 10 times producing 7 heads and 3 tails. The deviation is computed as follows

	Observed	Expected	Difference from expected
Heads	**7**	**5**	**2**
Tails	**3**	**5**	**2 (disregard negative value}**
Total Occurrences	**10**	**10**	**4 (sum of differences)**

Deviation $\frac{4}{10}$ **= .4 X 100 40%**

Chart 1: Tossing One Coin

Number of tosses	Heads			Tails			% Deviation
	Expected	Observed	Difference	Expected	Observed	Difference	
10							
50							
Class 10 Class 50							

Independent Events Occurring Simultaneously

How does chance operate with two independent events occurring simultaneously, such as two coins being flipped at once? Will the chance of flipping two heads at once be greater or less than ½ (50-50)?

1. Complete the EXPECTED results of Chart 2.
   The expected results can be generalized in the following manner
   a. The probability of two independent events occurring at the same time is the product of their individual probabilities.
2. Using your book as a backstop, **flip two coins 40 times**, recording the results under OBSERVED in the table below. Write your results on the board. ALSO record class results, once they have been totaled.
3. For the class results, what approximate fraction of the tossed turned out both heads (1/2, 1/4, 1/8)?____________ both tails?______________ heads and tails?____________ If the chance of flipping one head with a coin is 50%, then the probability of flipping two heads at once is achieved by (adding or multiplying)______________ the separate probabilities.
4. Which comes closer to the expected- the class or the individual results? ___________
5. If the probability of flipping a head or tail on a coin is ½, why did approximately ½, rather than ¼, of the tosses result in a heads-tails combination?

____

____

_

Chart 2: Tossing Two Coins

Tosses	Individual		Class	
	Observed	Expected	Observed	Expected
Heads-Heads				
Heads-Tails				
Tails-Tails				
Total Tosses				

Probability and Genetics:

1. The result of flipping two coins is much like the situation in a monohybrid cross when both parents have the genotype Aa. When Aa produces gametes (Sex cells) by meiosis, ½ will be A and ½ will be a.
2. Fill out the Punnett squares below to see the similarity between the results of the coin flips and the results of the monohybrid cross. What fraction of the offspring should receive the alleles aa?______________
3. It there is only one offspring, what are its chances of receiving the alleles Aa?____________

	Heads (H)	Tails (T)
Heads (H)		
Tails (T)		

	1/2 A	1/2 a
1/2 A		
1/2 a		

Analysis

1. Do the Punnett squares in genetics problems tell you what must happen or what might happen? Explain?

____

____

2. Why was it important to calculate the class data in a coin toss experiment?

____

____

3. Would a small deviation in an experiment mean that something was wrong with the experiment? Explain.

____

____

4. If three coins are flipped simultaneously, what is the probability that all three will be heads?

____

5. A man and a woman have five children, all girls. Is it correct to assume that, if they have another child, probability would favor it being a boy? Explain.

____

____

_

6. A penny tossed 120 times results in 62 heads and 58 tails. In the space below, calculate the expected number of heads and tails and determine the percent deviation.

7. In a monohybrid cross involving dominance, two purple flowers (Ff) are crossed producing 160 offspring. Of the offspring, 115 are purple (FF and Ff) and 45 are white (ff). Determine the expected results and, in the space below, calculate the percent deviation. The experimental hypothesis is that the purple color is dominant to white and that both parents are hybrid for purple color. Based on your work, do you feel the actual results are close enough to the expected results to make the experimental hypothesis acceptable? Explain.