Name Date

Finding Phenotypes And Genotypes For One Trait

18

In genetics, it is possible to calculate the results that should appear in offspring if the genotypes of both parents are known. These are called expected results. Expected results can be calculated by mathematics or use of Punnett squares. Thus, expected results are specific numbers and are not the result of random events. Observed results are those that appear in offspring in actual crossings. They are due to chance combinations of certain genes. Thus, observed results are always due to chance.

Expected and observed results may not always agree exactly, but there should be some agreement. Expected results are used to predict the results of a cross before the cross is done. If the expected results indicate that a certain type of offspring is likely, the cross can be carried out with some certainty that the type of offspring will appear in the observed results.

In this investigation, you will

(a) substitute properly marked coins for gamete cells.

(b) toss the marked coins 100 times to represent 100 offspring.

(c) determine the expected numbers of genotypes for 100 offspring and compare them with the observed numbers of genotypes obtained through 100 coin tosses.

(d) determine the numbers of expected phenotypes for a genetic cross, and compare them with the numbers of observed phenotypes obtained through coin tossing.

Materials

2 pennies
adhesive tape
pencil
scissors

Procedure

Part A. Determining Numbers of Expected Genotypes

How many of each genotype combination are expected in the offspring of a cross if both parents are *Ss* for a trait?

FIGURE 18-1

	S	*s*
S		
s		

• Use the Punnett square in Figure 18-1 to determine the genotypes. Record the number of each genotype in column A of Table 18-1.

• How many of each genotype combination are expected if there are 100 offspring? Multiply each number in column A by 25. Record this number in column B of Table 18-1.

Part B. Determining Numbers of Observed Genotypes

• Cover both sides of two pennies with adhesive tape. Trim off any excess tape with scissors. **CAUTION:** *Always be careful with scissors.* Print an *S* on one side of each coin and an *s* on the other side of each coin.

• Place both coins in cupped hands, shake, and then toss the coins onto your desk. Read and record the letter combination in column C (Toss Results) of Table 18-1. Make a slash (/) in the proper row of column C to indicate the letter combination. Repeat this process until the coins have been tossed 100 times. Record the coin combinations for each toss in Table 18-1.

• Record in column D the totals for each.

Part C. Determining Numbers of Expected Phenotypes

• Assume that *S* represents the dominant gene for normal skin pigment. Assume that *s* represents a recessive condition called albinism, no skin pigment. From the Punnett square (Figure 18-1), list in column A of Table 18-2 the number of offspring expected to have normal skin color (*SS* and *Ss*) and the number expected to be albino (*ss*).

• Calculate the number expected to have each trait if there are 100 offspring. Do this by multiplying column A figures by 25. Record these numbers in column B of Table 18-2.

Part D. Determining Numbers of Observed Phenotypes

From your data in column D of Table 18-1, total and record in column C of Table 18-2 the number of offspring who will have normal skin pigment (*SS*, *Ss*, and *sS*) and those who will be albino (*ss*).

TABLE 18-1. EXPECTED AND OBSERVED GENOTYPES

GENE COMBINATION	(A) EXPECTED GENOTYPE FOR 4 OFFSPRING	(B) EXPECTED GENOTYPE FOR 100 OFFSPRING	(C) TOSS RESULTS	(D) OBSERVED GENOTYPE FOR 100 OFFSPRING
SS				
Ss or *sS*				
ss				

TABLE 18-2. EXPECTED AND OBSERVED PHENOTYPES

PHENOTYPE POSSIBLE	(A) EXPECTED PHENOTYPE FOR 4 OFFSPRING	(B) EXPECTED PHENOTYPE FOR 100 OFFSPRING	(C) OBSERVED PHENOTYPE FOR 100 OFFSPRING
Normal Skin (*SS*, *Ss*, or *sS*)			
Albino (*ss*)			

Analysis

1. (a) What is meant by expected genotypes? ______________________________

   (b) Are expected results due to chance or are they arrived at mathematically? __________

2. (a) What is meant by observed genotypes? ______________________________

   (b) Are observed results due to chance or are they arrived at mathematically? __________

3. What does each side of each coin represent? ______________________________

TABLE 18-3. CLASS TOTALS OF ______ STUDENTS			
	(A) EXPECTED PHENOTYPES FOR 100 OFFSPRING	(B) EXPECTED PHENOTYPES FOR CLASS TOTALS	(C) OBSERVED PHENOTYPES FOR CLASS TOTALS
Normal skin	75		
Albino skin	25		

13. What is the advantage of comparing expected offspring with the many hundreds of observed offspring (class totals)? In other words, what is the advantage of a large sample size? ______

______

14. A number of actual families were observed that had albino children. All parents of the families had normal skin but were hybrid. The following figure shows the offspring. NOTE: A square represents a son, a circle represents a daughter, and shading indicates an albino. For example, family A has six children, two boys and four girls. One son is albino and the other five children are normal.

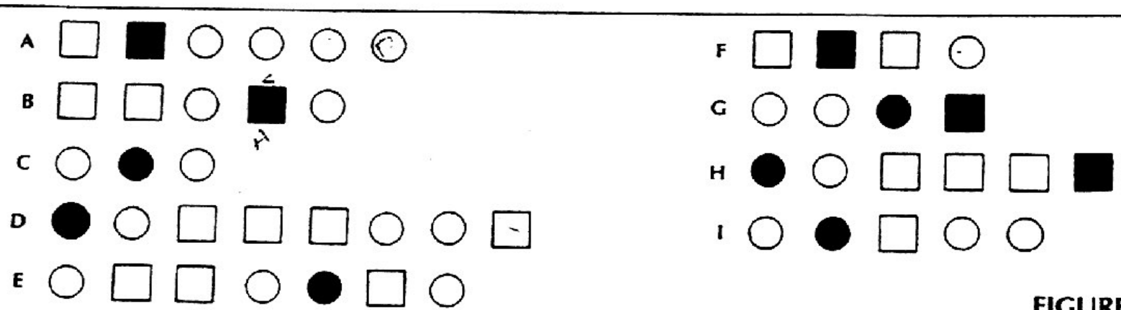


FIGURE 18-2

(a) What is the total number of children observed in all families? ______

(b) What is the total number of normal children observed in all families? ______

(c) How many children are expected to be normal in all families above? (Multiply answer to question (a) by 0.75 or 3/4.) ______

(d) Are your answers to questions (b) and (c) in close agreement? ______

(e) What is the total number of albino children observed in all families? ______

(f) How many children are expected to be albino in all families above? (Multiply answer to question (a) by 0.25 or 1/4.) ______

(g) Are your answers to questions (e) and (f) in close agreement? ______

(h) If only families D and E were used, would there be close agreement between observed and expected numbers of albinos? ______

(i) Is our understanding of genetics supported when observed results from these families are compared to expected results? ______

Name ____________ Date ____________

4. How does the chance of a coin landing on each side compare to the chance that a gamete cell will receive a particular gene at meiosis? ____________

5. (a) Why must two coins be used to determine the genotypes for the offspring? ____________

____

(b) What does the use of two coins compare to at fertilization? ____________

____

6. Compare the expected genotypes of 100 offspring with the observed genotypes.

(a) Do they agree or disagree? ____________

(b) If they disagree, how much do they disagree? ____________

7. Are your results wrong if they do not agree? ________ Explain. ____________

____

8. What is the advantage of comparing the 100 expected offspring with the 100 observed offspring rather than comparing only four expected offspring with four observed offspring? ____________

____

9. Compare the expected phenotypes for 100 offspring with the observed phenotypes.

(a) Do they agree or disagree? ____________

(b) If they disagree, how much do they disagree? ____________

10. Are your results wrong if they do not agree? ________ Explain. ____________

____

11. If expected and observed results are never in close agreement, then our understanding of the law of dominance and the chance combination of genes cannot be correct.

(a) Are expected and observed results in close agreement after many offspring are counted? ____

(b) Does our understanding of genetics seem to have support as illustrated in this investigation?

____

(c) Would you have good evidence if only one or two offspring were examined? ____________

(d) Explain. ____________

12. Class totals also may be used to show that expected and observed results will agree more closely when large numbers of offspring (coin flips) are counted. Record the total number of students participating in this investigation at the top of Table 18-3. Using expected phenotype data for 100 offspring from Table 18-2 (column A), record this same number in column A of Table 18-3. Determine and record in Table 18-3 the class total of expected phenotypes (column B) by multiplying column A by the number of students participating. In column C, record class totals from all students of observed phenotypes for 100 offspring from column C of Table 18-2.

Name Date

Finding Phenotypes And Genotypes For Two Traits

19

In genetics, a Punnett square is used to show the chances that certain traits will appear in offspring. If only one trait is involved, a Punnett square with four boxes is used. If two traits are involved, then a sixteen box Punnett square is needed. A Punnett square always gives you the expected results. Offspring, however, are produced by chance and may not agree exactly with expected results.

In this investigation, you will

(a) substitute properly marked coins for gamete cells and toss the coins to represent offspring.

(b) determine the expected offspring and compare it to observed offspring obtained through coin tossing.

(c) write a report based on your data explaining the similarity or dissimilarity of expected and observed results and how sample size affects results.

Materials

adhesive tape
scissors
pencil
pennies—2
nickels—2

Procedure

Part A. Cross Between Genotypes *AaMm* and *Aamm*

Expected Results

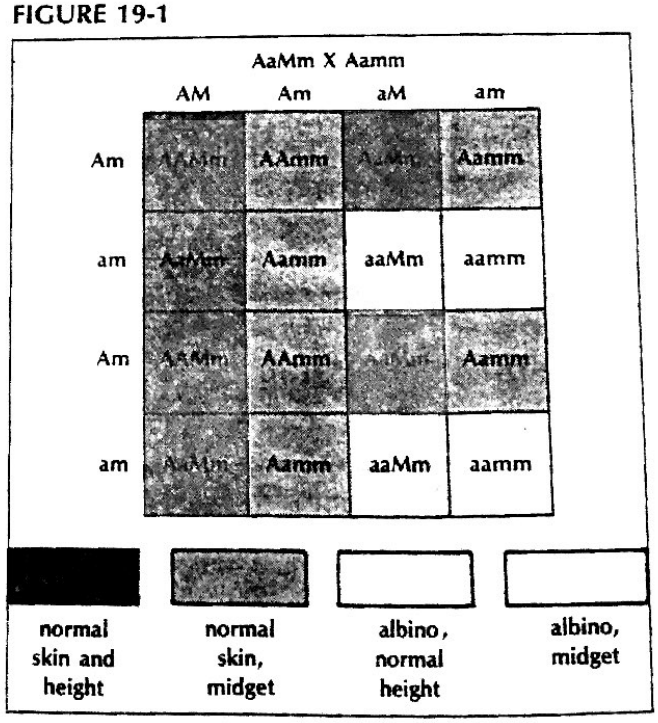
The Punnett square in Figure 19-1 represents a cross involving two characteristics, skin pigment and body height. The parents' genotypes are *AaMm* and *Aamm*. The gene *A* is for normal skin pigment. The gene *a* is for albinism (no pigment). The gene *M* is for normal body height. The gene *m* is for short height (midget).

The Punnett square shows the possible gametes of each parent and the possible offspring. The squares are shaded according to phenotype.

• Determine the four phenotypes and how many offspring of each there are.

• Record these numbers in the "Number expected for 16 offspring" column of Table 19-1. To calculate the number expected for 96 offspring,

FIGURE 19-1



multiply each number just recorded by 6. Record these new numbers in the "Number expected for 96 offspring" column of Table 19-1.

Observed Results

• Cover both sides of two pennies and two nickels with adhesive tape. **CAUTION:** *Always be careful with scissors.*

• Mark the four coins as shown in Figure 19-2.

• Toss the four coins (two pennies in one hand, two nickels in the other) onto your desk a total of 96 times.

• Read the genotypes that appear and record the phenotypes in Table 19-1. (Use the Punnett square as a guide if necessary.) Make a slash (/) in the proper row to indicate the phenotype represented by the coins.

• Place the totals for each phenotype in the proper column of Table 19-1.

Part B. Cross Between Genotypes *AaMm* and *AaMm*

Expected Results

The Punnett square in Figure 19-3 represents a cross between parents which are heterozygous for skin pigment and body height. As in Part A, the Punnett square shows gametes and possible offspring. Also, the squares are shaded according to phenotype.

• Determine the four phenotypes and how many offspring of each there are.

FIGURE 19-2

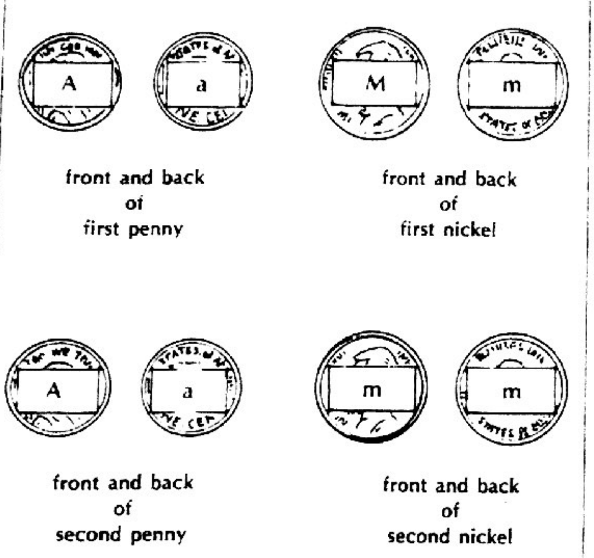


FIGURE 19-3 AaMm X AaMm

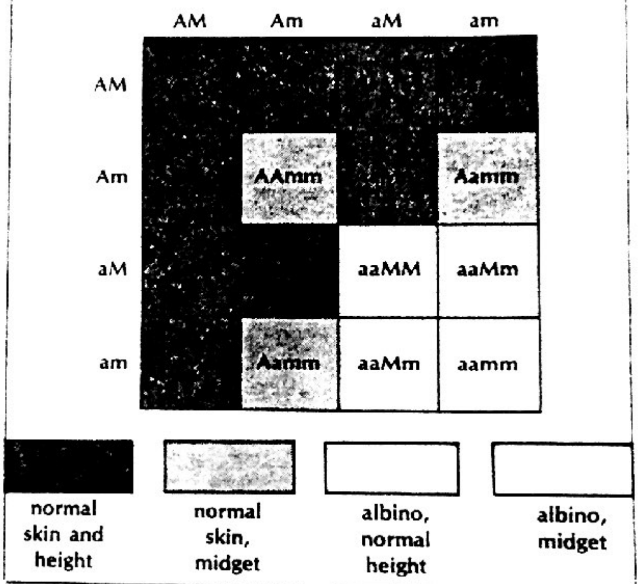


TABLE 19-1. RESULTS OF CROSS BETWEEN *AaMm* and *Aamm*					
PHENOTYPE COMBINATIONS	GENOTYPES	NUMBER EXPECTED FOR 16 OFFSPRING	NUMBER EXPECTED FOR 96 OFFSPRING	TOSS RESULTS	TOTAL NUMBER OBSERVED
Normal skin and normal height	*AAMm* *AaMm*				
Normal skin but midget	*AAmm* *Aamm*				
Albino but normal height	*aaMm*				
Albino and midget	*aamm*				

- Record these numbers in the "Number expected for 16 offspring" column of Table 19-2. To calculate the next column, multiply each number just recorded by 6. Record these new numbers in the "Number expected for 96 offspring" column of Table 19-2.

Observed Results

- Use the four coins from the first cross but change the nickel with *m* on both sides so that it has an *M* on one side. The coins should match Figure 19-4.

- Toss the four coins a total of 96 times.

- Read the genotypes that appear and record the phenotypes in Table 19-2.

- Place the totals for each phenotype in the proper column of Table 19-2.

FIGURE 19-4

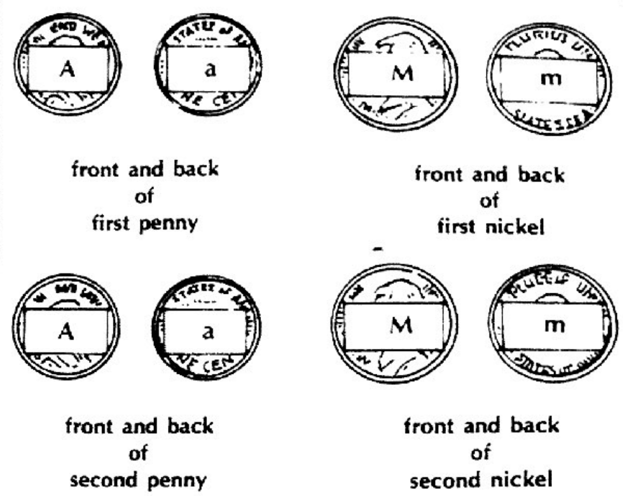


TABLE 19-2. RESULTS OF CROSS BETWEEN *AaMm* and *AaMm*

PHENOTYPE COMBINATIONS	GENOTYPES	NUMBER EXPECTED FOR 16 OFFSPRING	NUMBER EXPECTED FOR 96 OFFSPRING	TOSS RESULTS	TOTAL NUMBER OBSERVED
Normal skin and normal height	*AAMM* *AAMm* *AaMM* *AaMm*				
Normal skin but midget	*AAmm* *Aamm*				
Albino but normal height	*aaMM* *aaMm*				
Albino and midget	*aamm*				

Analysis

Summarize this investigation by writing a report on separate paper that includes

1. the purpose of the investigation.
2. (a) how the number of expected offspring in a genetic cross can be determined.
   (b) the exactness of expected results.
   (c) how the number of observed offspring in a genetic cross can be determined.
   (d) the exactness of observed results.
3. (a) how the number of expected offspring for Part A compares to the observed offspring for Part A. (Use specific data for your comparison.)
   (b) why the numbers in these two columns may not be equal.
4. how Part A supports our understanding of genetics. (Reread introduction if necessary.)

5. why the total of observed and expected offspring in Part A differ from the totals of observed and expected offspring in Part B.
6. (a) how the observed and expected offspring might have compared if only 16 coin tosses were used instead of 96.
   (b) the need for using large numbers of observed offspring when attempting to prove that genetic totals of expected results do agree with observed results.
7. how Part B supports our understanding of genetics.
8. (a) the advantage of tossing and reading properly marked coins over using living organisms.
   (b) whether the comparison between coins and living organisms is correct and why.

Extending Your Investigation

• Properly predict through the Punnett square in Figure 19-5 the expected phenotype combinations and number of each in a family with 16 offspring if one parent is *Aamm* and the other is *AAMm*.

• Properly mark four coins to agree with the parents' genotypes of *Aamm* and *AAMm*.

• Toss the four coins a total of 96 times, recording your observed results in Table 19-3.

FIGURE 19-5

Aamm X AAMm

	Am	Am	am	am
AM				
Am				
AM				
Am				

TABLE 19-3. RESULTS OF CROSS BETWEEN *Aamm* and *AAMm*

PHENOTYPE COMBINATIONS	GENOTYPES	NUMBER EXPECTED FOR 16 OFFSPRING	NUMBER EXPECTED FOR 96 OFFSPRING	TOSS RESULTS	TOTAL NUMBER OBSERVED
Normal skin and normal height	*AAMm* *AaMm*				
Normal skin but midget	*AAmm* *Aamm*				
Albino but normal height	*aaMM* *aaMm*				
Albino and midget	*aamm*				

Analysis, Extension

1. Explain why the results in Table 19-3 are not the same as in Part A or B of this experiment.