Problem Set 1
Due @ 10:35 AM January 14, 2011


Problem #1. For each of the terms in the left column, choose the best matching phrase in the right column

| a. Phenotype. 4 | 1. Having two identical alleles of a given gene |
| b. Alleles 3   | 2. The allele expressed in the phenotype |
| c. Independent assortment 6 | 3. Alternative forms of a gene |
| d. Gametes 7   | 4. Observable traits |
| e. Gene 11     | 5. A cross between individuals both heterozygous for two genes |
| f. Segregation 13 | 6. Alleles of one gene separate into gametes randomly with respect to alleles of other genes |
| g. Heterozygote 10 | 7. Reproductive cells containing only one copy of each gene |
| h. Dominant 2  | 8. The allele that does not contribute to the phenotype of the heterozygote |
| i. F_1 14      | 9. The cross of an individual of ambiguous genotype with a homozygous recessive individual |
| j. Testcross 9 | 10. an individual with two different alleles of a gene |
| k. genotype 12 | 11. the heritable entity that determines a characteristic |
| l. recessive 8 | 12. the alleles an individual has |
| m. dihybrid cross 5 | 13. the separation of the two alleles of a gene into different gametes |
| n. homozygote 1 | 14. offspring of the p generation |

Problem #4. An albino corn snake is crossed with a normal colored snake. The offspring are all normal-colored. When these first generation progeny snakes are crossed among themselves, they produce 32 normal colored-snakes and 10 albino snakes.

a. Which of these phenotypes is controlled by the dominant allele?

*The 3:1 ratio and the loss of the albino trait in the F_1 indicates that normal-colored is the dominant gene allele.*
b. In these snakes, albino color is determined by a recessive allele a, and a normal pigmentation is determined by the A allele. A normal-colored female snake is involved in a test cross. This cross produces 10 normal-colored snakes and 11 albino offspring. What are the genotypes of the parents and the offspring?

The normal-colored female must be heterozygous (Aa) and by definition of a test cross the male must be an albino homozygous (aa). Aa X aa should result in a 1:1 ratio as observed.

Problem #9. In a particular population of mice, certain individuals display a phenotype called “short tail,” which is inherited as a dominant trait. Some individuals display a recessive trait called “dilute,” which affects coat color. Which of these traits would be easier to eliminate form the population by selective breeding? Why?

The dominantly inherited trait is easier to select against. This means that short tail would be the easier to remove from the breeding population. Any mouse with the dominantly inherited short tail will exhibit it in the phenotype (assuming complete penetrance). Normal tail is homozygous recessive so mating normal tail to normal tail will give only normal tail offspring.

Problem #11. Among native Americans, two types of ear wax (cerumen) are seen, dry and sticky. A geneticist studied the inheritance of this trait by observing the types of offspring produced by different kinds of mattings. He observed the following numbers:

<table>
<thead>
<tr>
<th>Parents</th>
<th>Number of mating pairs</th>
<th>Offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sticky x sticky</td>
<td>10</td>
<td>Sticky: 32 Dry: 6</td>
</tr>
<tr>
<td>Sticky x dry</td>
<td>8</td>
<td>Sticky: 21 Dry: 9</td>
</tr>
<tr>
<td>Dry x dry</td>
<td>12</td>
<td>Sticky: 0 Dry: 42</td>
</tr>
</tbody>
</table>

a. How is earwax type inherited?

The strongest evidence for sticky being dominant and dry recessive is the first set of crosses (sticky x sticky). In this cross the dry phenotype re-appears in the offspring. The Second cross has preponderance of sticky phenotype offspring that support this. Finally that in 12 different families with dry x dry that all offspring are dry supports this conclusion.
b. Why are there no 3:1 or 1:1 ratios in the data shown in the chart?

This is the result of a problem common in trying to determine the nature of inheritance patterns in humans. The results are combined from offspring from several families. Thus the sticky x sticky cross includes families in which parents may be (SS x SS; Ss x SS). The results in each row are not a single type cross except for the last which must be ss x ss.

Problem #15. How many genetically different eggs could be formed by women with the following genotypes?

a. AabbCCDD

\[(2 \times 1 \times 1 \times 1) 2 \rightarrow AbCD \text{ and } abCD\]

b. AABbCcdd

\[(1 \times 2 \times 2 \times 1) 4 \rightarrow ABCd, ABcd, AbCd, \text{ and } Abcd\]

c. AaBbCcDd

\[(2 \times 2 \times 2 \times 2) 8 \rightarrow AbC\text{d}, ABcD, aBcD, aBcd, AbcD, abcD, abcd, \text{ and } Abcd\]

d. AaBbCcDd

\[(2 \times 2 \times 2 \times 2) 16\]

Problem #16. What is the probability of producing a child that will phenotypically either one of the two parents in the following four crosses? How many phenotypically different kinds of progeny could potentially result from each of the four crosses?

a. AaBbCcDd x aabbccdd

All dominant (.75 x .75 x .75 x .75) = 0.3164; all recessive = (.25 x .25 x .25 x .25) = 0.0039; like one or other parent would be 32%.

4 combinations of (dominant, recessive, recessive, recessive) Abcd, aBcd, abCd, abcD; 4 combinations of (dominant, dominant, recessive, recessive) ABcd, AbCD,
AbCd AbcD; 4 combinations of (dominant, dominant, dominant, recessive) ABCd, aBCD, AbCD, ABcD 16 phenotypes.

b. aabbccdd x AABBCcDD

100% only one genotype in offspring.

c. AaBbCcDd x AaBbCcDd

16 phenotypes (2 x 2 x 2 x 2) all dominant would be (.75 x .75 x .75 x .75) = .31 or 31% of offspring.

d. aabbccdd x aabbccdd

100% of offspring and only one phenotype

Problem #23. The achoo syndrome (sneezing in response to bright light) and trembling chin (triggered by anxiety) are both dominant traits in humans.

a. What is the probability that the first child of parents who are heterozygous for both the achoo gene and the trembling chin will have achoo syndrome but lack the trembling chin?

Achoo is .75 and trembling chin is therefore .25 so .75 x .25 = 18.75%

b. What is the probability that the first child will not have achoo syndrome or trembling chin?

Non-achoo is .25 and normal chin is .25 therefore .25 x .25 = 0.0625 or 6.25%
Problem #25. The following chart shows the results of different matings between jimsonweed plants that had either purple or white flowers and spiny or smooth pods. Determine the dominant allele for the two traits and indicate the genotypes of the parents for each the crosses.

<table>
<thead>
<tr>
<th>Parents</th>
<th>Offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Purple Spiny</td>
</tr>
<tr>
<td>a. purple spiny x purple spiny</td>
<td>94</td>
</tr>
<tr>
<td>b. purple spiny x purple smooth</td>
<td>40</td>
</tr>
<tr>
<td>c. purple spiny x white spiny</td>
<td>34</td>
</tr>
<tr>
<td>d. purple spiny x white spiny</td>
<td>89</td>
</tr>
<tr>
<td>e. purple smooth x purple smooth</td>
<td>0</td>
</tr>
<tr>
<td>f. white spiny x white spiny</td>
<td>0</td>
</tr>
</tbody>
</table>

A appears to be a classic dihybrid cross with a 9:3:3:1 ratio so white and smooth must be recessive. The other crosses seem to support this.

a. To give the 9:3:3:1 the cross must be \( PpSs \times PpSs \)
b. The purple cross give a 4:0 and the spiny x smooth gives 1:1 thus \( PpSs \times PpSs \) or \( P_Ss \times PPss \)
c. The purple x white gives a 1:1 ratio and the spiny x spiny give a 4:0 spiny. This is the opposite of above and \( PpS_ \times ppSS \) or \( PPSS \times pp_ \)
d. The purple x white gives 1:1 and the spiny x spiny gives a 3:1 \( PpSs \times ppSs \)
e. Purple x purple gives a 3:1 and smooth x smooth gives a 4:0 ratio; \( PpSs \times PpSs \)
f. Spiny x spiny gives a 3:1 and white x white gives a 4:0 \( ppSs \times ppSs \)
Problem #29. For each of the following human pedigrees, indicate whether the inheritance pattern appears to be recessive or dominant. What feature(s) of the pedigrees did you use to determine the inheritance? Give the genotypes of affected individuals and of individuals who carry the disease allele.

A appears to be recessive since it skips generations. Notice that the female with the trait in generation has neither parent showing the phenotype. Also a sanguineous mating leads to a male with the trait.
b is likely dominant since it does not skip generations. Every individual showing the phenotype has at least one parent with the trait.

\[
\begin{array}{c}
\text{b} \\
\text{b} \\
\text{b} \\
\end{array}
\]

C is likely recessive since it skips two generations.

\[
\begin{array}{c}
\text{C} \\
\text{C} \\
\text{C} \\
\end{array}
\]

Problem #31. A young couple went to see a genetic counselor because each had a sibling affected with cystic fibrosis. (Cystic fibrosis is a recessive disease, and neither member of the couple nor any of their four parents is affected.)

a. What is the probability that the female of this couple is a carrier?
   
   If the female has a sibling with CF then her parents must both be heterozygous \( CFcf \times CFcf = \frac{2}{3} \) \( 1:CFCF:2:CFcf:1:cfcf \)

b. What are the chances that their child will be affected with cystic fibrosis?
   
   This is complicated.
   
   odds of both being heterozygous is \( \frac{4}{9} \) \( (CFcf \times CFcf) \)
   
   If both parents are heterozygous then 25% chance of offspring being affected. \( \frac{4}{9} \times 25 \) is about 12%

   c. What is the probability that their child will be a carrier of the cystic fibrosis mutation?

   \[
   \begin{align*}
   CFcf \times CFcf & \rightarrow .5 \times .44 = .22 \\
   2 CFcf \rightarrow .25 \times .44 = .11 \text{ and two possibilities } = .22 \\
   \text{Total odd } = .44 \text{ or } 44%
   \end{align*}
   \]