Anwers to Extra Single-Trait Genetics Problems

Unit 6, Step 2B

5. Both a man and a woman are heterozygous for freckles. Freckles (F) are completely dominant over no freckles (f). What is the chance that their child will have freckles? Show the genotypes crossed, and the probability of each genotype and phenotype that may result from the cross.

genotype of man = Ff
genotype of woman = Ff

Thus, genotypes crossed = Ff X Ff

F is completely dominant over f; Thus,

FF = freckles, Ff = freckles, ff = no freckles

punnett square:

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probability for genotypes
from cross:

1/4 (25%) FF
2/4 (50%) Ff
1/4 (25%) ff

or 3/4 (75%) freckles, 1/4 (25%) no freckles

6. Both you and your sister or brother have attached earlobes, yet your parents have unattached earlobes. Unattached earlobes (E) are completely dominant over attached earlobes (e). What are the genotypes of the parents? What are the phenotypes of the parents?

genotype of man = E?
genotype of woman = E?

E is completely dominant over e; Thus,

EE = unattached earlobes, Ee = unattached earlobes, ee = attached earlobes

possible genotypes of parents to have unattached earlobes (showing crosses):

cross #1: EE X EE, cross #2: EE X Ee, cross #3: Ee X EE, cross #4: Ee X Ee

cross #1:

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cross #2:

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<td>Ee</td>
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<td>E</td>
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</table>
The only cross that can create children with the genotype “ee” is #4: Ee X Ee.

Thus the parents genotypes are both “Ee” and their phenotypes are “unattached earlobes”.

7. A father has dimples, the mother does not have dimples, and all five of their children have dimples. Dimples (D) are completely dominant over no dimples (d). Give the possible genotypes of all persons concerned.

- genotype of man = D?
- genotype of woman = dd
- genotypes of children = DD or Dd

Possible genotypes of man to have dimples = DD or Dd; therefore, there are 2 possible crosses:

- cross #1: DD X dd
- cross #2: Dd X dd

Both crosses can produce children that have dimples (Dd), but no children will have dimples with the genotype “DD”.

Thus, the woman is “dd”, the man could be “DD” or “Dd”, and the children can only be “Dd”.

8. Congenital night blindness is caused by a dominant autosomal allele (B). The night blindness allele (B) is completely dominant over the normal allele (b). A man is heterozygous for this trait. What is the probability that his first-born will have the trait, assuming his wife is normal? What is the probability that his second-born will have the trait? Does the man express the trait?

- B = night blindness
- b = normal
- B is completely dominant over b; Thus,
- BB = night blind, Bb = night blind, bb = normal

- genotype of man = Bb
- genotype of woman = bb
- genotypes crosses = Bb X bb
probability for genotypes
from cross:                     probability for phenotypes
from cross:

2/4 (50%) Bb  --------------------------  2/4 (50%) night blind
2/4 (50%) bb  --------------------------  2/4 (50%) normal

ALL children will have a 50% chance of being born with night blindness. It does not matter in what order they are born (the probability is the same for each)! The father is also night blind.

9. In humans, pointed eyebrows (B) are completely dominant over smooth eyebrows (b). Mary’s father has pointed eyebrows, but she and her mother have smooth. What is the genotype of the father?

   genotype of father = B?  B = pointed eyebrows
   genotype of mother = bb  b = smooth eyebrows
   genotype of Mary = bb     B is completely dominant over b; Thus,
                           BB = pointed eyebrows, Bb = pointed
                           eyebrows, bb = smooth eyebrows

possible genotypes of father to have pointed eyebrows = BB or Bb; therefore, there are 2 possible crosses:

cross #1: BB X bb, cross #2: Bb X bb

cross #1:                   cross #2:
   b   b                        b   b
  B  Bb  Bb                      B  Bb  Bb
  B  Bb  Bb                      b  bb  bb

The only cross to produce a child with the genotype “bb” is cross #2. Thus, the father’s genotype is “Bb.”

10. Parents who do not have Tay-Sachs disease (recessive) produce a child who has Tay-Sachs. What are the chances that each child born to this couple will have Tay-Sachs? (Note: The normal allele is completely dominant over the recessive allele)

   genotype of father = T?  T = normal
   genotype of mother = T?  t = Tay-Sachs disease
   genotype of child = tt   T is completely dominant over t; Thus,
                           TT = normal, Tt = carrier, tt = Tay-Sachs disease
possible genotypes of parents to be normal (showing crosses):

cross #1: TT X TT, cross #2: TT X Tt, cross #3: Tt X TT, cross #4: Tt X Tt

cross #1:

\[
\begin{array}{c|c|c}
T & T & T \\
\hline
T & TT & TT \\
T & TT & TT \\
\end{array}
\]

\[
\begin{array}{c|c|c}
T & t & t \\
\hline
T & TT & Tt \\
T & TT & Tt \\
\end{array}
\]

cross #3:

\[
\begin{array}{c|c|c}
T & T & T \\
\hline
T & TT & TT \\
T & Tt & Tt \\
\end{array}
\]

\[
\begin{array}{c|c|c}
T & t & t \\
\hline
T & Tt & Tt \\
T & Tt & Tt \\
\end{array}
\]

The only cross to give a child that has Tay-Sachs is cross #4; thus, the parents are both heterozygous, or carriers for the trait. The probability for the children would be (using cross #4):

<table>
<thead>
<tr>
<th>probability for genotypes</th>
<th>probability for phenotypes</th>
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<tbody>
<tr>
<td>from cross:</td>
<td>from cross:</td>
</tr>
<tr>
<td>1/4 (25%) TT</td>
<td>1/4 (25%) normal</td>
</tr>
<tr>
<td>2/4 (50%) Tt</td>
<td>2/4 (50%) carrier</td>
</tr>
<tr>
<td>1/4 (25%) tt</td>
<td>1/4 (25%) Tay-Sachs</td>
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</tbody>
</table>

Thus, each child born to this couple will have a 25% chance of having Tay-Sachs.

11. Mr. and Mrs. Jones are both carriers for sickle-cell disease. What is their chance of having a child with the sickle-cell trait?

Mr. Jones = Ss
Mrs. Jones = Ss

generotypes crosses: Ss X Ss

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<tbody>
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</tr>
<tr>
<td>1/4 (25%) SS</td>
<td>1/4 (25%) normal</td>
</tr>
<tr>
<td>2/4 (50%) Ss</td>
<td>2/4 (50%) carrier</td>
</tr>
<tr>
<td>1/4 (25%) ss</td>
<td>1/4 (25%) sickle-cell</td>
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</tbody>
</table>

or 1/4 (25%) probability of having a child born with sickle-cell.