Punnett square worksheet

Complete the following problems. List the parent genotypes, draw and fill in a Punnett square, and then list the offspring genotypes and phenotypes.

1. A homozygous dominant brown mouse is crossed with a tan mouse (tan is the recessive color).
   Parent genotypes: \(_{BB} \times \_b\)
   F1 Offspring Genotype Ratio: \(_{YY_2Bb: 0bb: 0_b}\)
   F1 Offspring Phenotype Ratio: \(_{YY_2Brown: 0Tan}\)

2. A white (brown fur is recessive) rabbit is crossed with a homozygous brown rabbit.
   Parent genotypes: \(\_\_\_\_\)
   F1 Offspring Genotype Ratio: \(\_\_\_\_\)
   F1 Offspring Phenotype Ratio: \(\_\_\_\_\)

3. Two homozygous red flowers (white flowers are recessive) are crossed.
   Parent genotypes: \(_{kk} \times \_r\)
   F1 Offspring Genotype Ratio: \(_{1RR: 2Rr: 1rr}\)
   F1 Offspring Phenotype Ratio: \(_{3Red: 1White}\)

4. A heterozygous tall plant is crossed with a homozygous tall plant (short is the recessive size).
   Parent genotypes: \(_{tt} \times \_t\)
   F1 Offspring Genotype Ratio: \(_{2TT: 2Tt: 1tt}\)  
   Phenotype: \(_{4Tall: 0Short}\)
5. In humans, dark hair (D) is dominant over blond hair (d). If a heterozygous dark haired man had a son with his blond haired wife, what would the probability be that the son would have dark hair like his father?

Father: Dd  
Mother: dd  
\[ \text{P: } Dd \times dd \text{ } \rightarrow \text{ 100% chance of } Dd \]

6. In tomatoes, red fruit (R) is dominant over yellow fruit.

   a. If a homozygous red fruit plant is crossed with a yellow fruit plant, what are the expected genotypic and phenotypic ratios of the F1 generation?

   P: RR \times rr \rightarrow Rr: Rr: rr: rr

   b. If two plants from the F1 generation were crossed what would be the resultant genotypic and phenotypic ratios for this cross?

   P: 1 Rr \times 1 Rr \rightarrow 1 RR: 2 Rr: 1 rr

7. In humans, earlobes that are suspended are dominant over those that are attached. If a mother has suspended earlobes (but her mother did not) and the father has attached earlobes, what are the chances that their first child will have attached earlobes? What about the fourth child?

\[ \text{Kr: } \text{mother} \quad \text{rr: } \text{father} \]

50% chance for 1st and 4th

8. In guinea pigs, short hair is dominant over long hair. A female guinea pig with short hair but whose father had long hair is mated with a male whose parents were both shorthaired, but who has long hair. Using a Punnett square, predict the genotypic and phenotypic ratios of their offspring.

\[ \text{female: SS} \quad \text{male: ss} \]

\[ \text{SS} \times \text{ss} \rightarrow 1 \text{SS: 2 Ss: 1 ss} \]

9. You are working as a genetics specialist in a hospital. A couple comes to you saying they want to have a baby, but they want the baby to have freckles and neither of the potential parents has this trait. You take out your trusty, always useful, grade 11 Biology textbook and find out that freckles are inherited as a dominant trait. What news can you now give the anxious couple? Support this wise knowledge you have imparted by setting up a Punnett square to prove your point.

\[ \text{ff} \quad \text{ff} \quad \text{ff} \quad \text{ff} \]

Their baby cannot have freckles. If neither of them have freckles (F) (which is dominant, freckless (f) is recessive), they are both ff.
Monohybrid Crosses

In the following 4 crosses T = tall and is dominant, t = short and is recessive.

1. A homozygous tall plant is crossed with a heterozygous plant. What are the ratios?
   **Genotypes**
   \[
   \begin{array}{ccc}
   & T & T \\
   T & TT & TT \\
   t & Tt & Tt \\
   \end{array}
   \]
   **Phenotypes**
   \[4 \text{ tall} : 0 \text{ short}\]

2. If a homozygous recessive plant is crossed with a homozygous tall plant, what will the offspring be like?
   **Genotypes**
   \[
   \begin{array}{ccc}
   T & t \\
   T & Tt & Tt \\
   T & Tt & Tt \\
   \end{array}
   \]
   **Phenotypes**
   \[4 \text{ tall} : 0 \text{ short}\]

3. If a heterozygous plant is crossed with a homozygous recessive plant, what will the offspring be like?
   **Genotypes**
   \[
   \begin{array}{ccc}
   t & T & t \\
   t & Tt & Tt \\
   t & Tt & Tt \\
   \end{array}
   \]
   **Phenotypes**
   \[2 \text{ tall} : 2 \text{ short}\]

4. If two homozygous recessive plants are crossed, what will the children be like?
   **Genotypes**
   \[
   \begin{array}{ccc}
   t & t \\
   t & tt & tt \\
   t & tt & tt \\
   \end{array}
   \]
   **Phenotypes**
   \[4 \text{ short} : 0 \text{ tall}\]
Monohybrid Crosses

In the following 4 crosses B = brown eyes and is dominant and b = blue eyes and is recessive.

5. Cross a homozygous brown eyed male with a heterozygous female.

<table>
<thead>
<tr>
<th>B</th>
<th>B</th>
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<tbody>
<tr>
<td>B</td>
<td>B</td>
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<tr>
<td>b</td>
<td>B</td>
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<tr>
<td>b</td>
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</tbody>
</table>

Genotypes:
- BB: 2Bb

Phenotypes:
- 4 Brown: 0 Blue

6. Cross two homozygous brown eyed adults to determine what eye color their child will have.

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<thead>
<tr>
<th>B</th>
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</tbody>
</table>

Genotypes:
- 4BB: 0Bb: 0bb

Phenotypes:
- 1 Brown: 0 Blue

7. Two heterozygous individuals decide to have children, what will there children's eye color be?

<table>
<thead>
<tr>
<th>B</th>
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</tbody>
</table>

Genotypes:
- 1BB: 2Bb: 1bb

Phenotypes:
- 3 Brown: 1 Blue

8. Please cross a heterozygous individual with a homozygous recessive individual.

<table>
<thead>
<tr>
<th>B</th>
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</table>

Genotypes:
- 2Bb: 2bb

Phenotypes:
- 2 Brown: 2 Blue
How to set up dihybrid crosses

A) Figure out the genotypes of both traits for both parents.

B) Write out the parents' genotypes together ex. AABB X aabb

C) Use the FOIL method to set up the test cross

1) Draw the arrows for each parent for the FOIL method. An example is given below.

<table>
<thead>
<tr>
<th>Parent 1</th>
<th>Parent 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A     A     B     B     X</td>
<td>a     a     b     b</td>
</tr>
</tbody>
</table>

2) Set up the cross for both sides.

<table>
<thead>
<tr>
<th>Parent 1</th>
<th>Parent 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>AB</td>
</tr>
<tr>
<td>a   b</td>
<td>a   b</td>
</tr>
<tr>
<td>a   b</td>
<td>a   b</td>
</tr>
<tr>
<td>a   b</td>
<td>a   b</td>
</tr>
</tbody>
</table>

3) Practice filling in the probable offspring below.

   | AB | AB | AB | AB |
   | a   b | AaBb | AaBb | AaBb |
   | a   b | AaBb | AaBb | AaBb |
   | a   b | AaBb | AaBb | AaBb |
   | a   b | AaBb | AaBb | AaBb |
4) To figure the phenotypic ratio, count the number of individuals with either the dominant or recessive phenotype for both traits! Then that ratio would be something like 4:4:4:4 or 9:3:3:1

<table>
<thead>
<tr>
<th>PTC-taster: TT, Tt</th>
<th>Attached earlobes: EE, Ee</th>
<th>Can roll tongue: RR, Rr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-PTC taster - tt</td>
<td>Free earlobes – ee</td>
<td>Can't roll tongue - rr</td>
</tr>
<tr>
<td>Hitchhikers thumb: HH, Hh</td>
<td>Straight pinky - PP, Pp</td>
<td>Widow’s peak: WW, Ww</td>
</tr>
<tr>
<td>Straight thumb: hh</td>
<td>Bent pinky - pp</td>
<td></td>
</tr>
<tr>
<td>Hair on mid-digit: MM, Mm</td>
<td>Widow’s peak: WW, Ww</td>
<td></td>
</tr>
<tr>
<td>No hair on mid-digit: mm</td>
<td>No widow’s peak: WW</td>
<td></td>
</tr>
</tbody>
</table>

Now practice!

Dihybrid Crosses. Set up the crosses using the rules and the letters from the other page.

1. If a woman who is a non-PTC taster (recessive) with heterozygous hitchhikers thumb has children with a man who is a heterozygous PTC taster with straight thumbs (recessive), what is the probability of them having each of the following types of children? (Fill in the Punnett Square and the blanks).

   Parents’ genotypes: ttHH X Tthh
   
   a. How many PTC taster, Hitchhikers thumb
   
   b. How many PTC taster, straight thumb
   
   c. How many Non-PTC taster, Hitchhikers thumb
   
   d. How many Non-PTC taster, straight thumb
   
   e. What is the phenotypic ratio?

2. If a woman who has no hair on her mid-digit (recessive) and is homozygous attached earlobes (dominant) has children with a man who has hair on his mid-digit and has attached earlobes (heterozygous for both traits), what is the probability of them having each of the following types of children? (Fill in the Punnett Square and the blanks).

   Parents’ genotypes: mmEE x MmEe
   
   a. How many hair, attached earlobes
   
   b. How many hair, not attached earlobes
   
   c. How many hairless, attached earlobes
   
   d. How many hairless, not attached earlobes
   
   e. What is the phenotypic ratio?

3. John Doe and Jane Doe want to have children and are thinking about how their children's hands might look. What would their children look like if they are both heterozygous for straight pinky and hitchhikers thumb? (Fill in the Punnett Square and the blanks).

   Parents’ genotypes: PpTH X PpTH
   
   a. Straight pinky, hitchhikers thumb
   
   b. Straight pinky, Straight thumbs
   
   c. bent pinky, hitchhikers thumb
   
   d. bent pinky, Straight thumbs
   
   e. What is the phenotypic ratio?
4. Dohn Joe and Dane Joe want to have children and are thinking about how their children’s hair line and tongues will turn out. They are both circus performers and want their children to follow in their footsteps. Their circus only accepts people with a Widow’s Peak and who can roll their tongues. What would their children look like if Dohn is heterozygous for both Widow’s peak and tongue rolling, and Dane is homozygous dominant for Widow’s peak and heterozygous for tongue rolling? (Fill in the Punnett Square and the blanks).

Parents’ genotypes \( Ww Rr \times Ww Rr \)

a. Widow’s Peak, Tongue Roller ____________________________

b. Widow’s Peak, non tongue roller ____________________________

c. Straight hair line, Tongue Roller ____________________________

d. Straight hair line, non tongue roller ____________________________

e. What is the phenotypic ratio? ____________

f. What are the chances of their child being able to join the circus? ____________________________

This problem will involve both a test cross and a Dihybrid Punnett Square.

Background information:

1. You are a pigeon breeder. In order to make the most money as a pigeon breeder, you must sell mainly checkered winged, red feather pigeons. Lucky for you checkered wings and red feathers are dominant in pigeons (plain wings and brown feathers are recessive). To breed as many checkered winged, red feather pigeons as possible, you need to breed homozygous checkered winged, red feather pigeons with each other (because all of the offspring would be checkered winged, red feather pigeons). You know you have a female homozygous checkered winged, red feathered pigeon (you bred her yourself!) She is so beautiful that she has won prizes in several pigeon beauty contests.

a. The Problem: You recently purchased a male pigeon that has checkered wings and red feathers from a shady pigeon dealer, who claimed it was homozygous. Before you breed this male with your prize winning female, you want to be sure that it is homozygous for both traits. Describe how you will be able to tell what the genotype for both traits of your pigeon in 1 generation. (test cross here) ____________

b. Illustrate the probable outcomes if your pigeon IS homozygous for both traits. (using a Punnett Square) ____________
Dihybrid Cross Worksheet

1. Set up a punnett square using the following information:
   - Dominate allele for tall plants = D
   - Recessive allele for dwarf plants = d
   - Dominate allele for purple flowers = W
   - Recessive allele for white flowers = w
   - Cross a homozygous dominate parent (DDWW) with a homozygous recessive parent (ddww)

2. Using the punnett square in question #1:
   a. What is the probability of producing tall plants with purple flowers? 100%
      Possible genotype(s)? DwWw
   b. What is the probability of producing dwarf plants with white flowers?
      Possible genotype(s)?
   c. What is the probability of producing tall plants with white flowers?
      Possible genotype(s)?
   d. What is the probability of producing dwarf plants with purple flowers?
      Possible genotype(s)?

3. Set up a punnett square using the following information:
   - Dominate allele for black fur in guinea pigs = B
   - Recessive allele for white fur in guinea pigs = b
   - Dominate allele for rough fur in guinea pigs = R
   - Recessive allele for smooth fur in guinea pigs = r
   - Cross a heterozygous parent (BbRr) with a heterozygous parent (BbRr)

4. Using the punnett square in question #3:
   a. What is the probability of producing guinea pigs with black, rough fur? 4/16
      Possible genotype(s)? BbRR, BbRr, BbRr, Bbrr
   b. What is the probability of producing guinea pigs with black, smooth fur? 3/16
      Possible genotype(s)? BbRr, Bbrr
   c. What is the probability of producing guinea pigs with white, rough fur? 3/16
      Possible genotype(s)? bbrR, bbrR, bbrR
   d. What is the probability of producing guinea pigs with white, smooth fur? 1/16
      Possible genotype(s)? bbrR, bbrR, bbrR
5. Set up a punnett square using the following information:
- Dominate allele for purple corn kernels = R
- Recessive allele for yellow corn kernels = r
- Dominate allele for starchy kernels = T
- Recessive allele for sweet kernels = t
- Cross a homozygous dominate parent with a homozygous recessive parent

```
RT RT RT RT
RT RT RT RT
RT RT RT RT
RT RT RT RT
```

6. Using the punnett square in question #5:
   a. What is the probability of producing purple, starchy corn kernels? 100%
   Possible genotype(s)? RT

   b. What is the probability of producing yellow, starchy corn kernels? N
   Possible genotype(s)? NA

   c. What is the probability of producing purple, sweet corn kernels? N
   Possible genotype(s)? NA

   d. What is the probability of producing yellow, sweet corn kernels? N
   Possible genotype(s)? NA

7. Set up a punnett square using the following information:
- Dominate allele for normal coat color in wolves = N
- Recessive allele for black coat color in wolves = n
- Dominant allele for brown eyes = B
- Recessive allele for blue eyes = b
- Cross a heterozygous parent with a heterozygous parent

```
NB Nb nB nb
NB NBB NnBB nBB
Nb NnB NBB nBB
nB NBB NnBB nBB
nb NBB NnBB nBB
```

8. Using the punnett square in question #7:
   a. What is the probability of producing a wolf with a normal coat color with brown eyes? 9/16
   Possible genotype(s)? NnBB NnBb

   b. What is the probability of producing a wolf with a normal coat color with blue eyes? 3/16
   Possible genotype(s)? NnBB Nnbb

   c. What is the probability of producing a wolf with a black coat with brown eyes? 3/16
   Possible genotype(s)? nnBB nnBb

   d. What is the probability of producing a wolf with a black coat with blue eyes? 1/16
   Possible genotype(s)? nnBB
9. A tall pea plant with **terminal** flowers (flowers on the ends of the stems) is crossed with a **short** plant that has axial flowers. All 72 offspring are tall with axial flowers. This is a dihybrid cross with the height and flower position traits showing independent assortment.

   a. Name the dominant and recessive alleles. (hint see textbook pg. 262)

   b. Give the genotypes of the parents and offspring in this cross.

   c. Predict the F2 offspring when the tall-axial F1's are allowed to self pollinate.

10. Suppose a white, straight haired guinea pig mates with a brown, curly haired animal. All five babies in their first litter have brown fur, but three are curly and two have straight hair. The second litter consists of six more brown offspring, where two are curly and four are straight haired.

   a. Assuming curly is dominant to straight, what are the genotypes of the parents and the offspring?

   b. What is the probability of getting two female guinea pigs with straight hair in a row?

11. About 70% of Americans get a bitter taste from the substance called phenylthiocarbamide (PTC). It is tasteless to the rest. The "taster" allele is dominant to non-taster. Also, normal skin pigmentation is dominant to albino. A normally pigmented woman who is taste-blind for PTC has an albino-taster father. She marries an albino man who is a taster, though the man's mother is a non-taster. Show the expected offspring of this couple.

12. In pigeons the checkered pattern is caused by a dominant allele. A plain (non-checkered) pattern is recessive. Red color is also caused by a dominant allele and brown color by a recessive allele.

   a. Show the expected offspring of a cross between a homozygous checkered red bird and a plain brown one. Carry out this cross through the F2 generation.

   b. Carry out to the F2 generation a cross between a homozygous plain red bird and its homozygous checkered brown mate.

   c. A plain brown female pigeon laid five eggs. The young turned out to be: 2 plain red, 2 checkered red, and 1 checkered brown. Describe the father pigeon. Give the genotypes of all birds in this cross. Could any other types of offspring have been produced by this pair?
Name: 

Punnett Squares – Dihybrid Crosses

Background
Punnett Square are used to predict the possibility of different outcomes. When looking at one trait at a time it is called a monohybrid cross. You completed these last year. Complete the review problem below.

Review: Cross a heterozygous male for tallness with a homozygous recessive female for tallness. Then give the genotype and phenotype ratios.

<table>
<thead>
<tr>
<th></th>
<th>Tt</th>
<th>tt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tt</td>
<td>1/2</td>
<td>1/2</td>
</tr>
<tr>
<td>tt</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\[ P: \frac{1}{4} T+: \frac{3}{4} \text{Sho} \]
\[ G: 2Tt: 2Tt \]

Dihybrid crosses involve tracking two traits simultaneously. For example, we can predict the outcome for offspring as the traits for both height and color are concerned.

Example 1: (Dihybrid Cross)
In garden peas, tallness (T) is dominant to shortness (t) and axillary flowers (A) are dominant to terminal flowers (a). What are the expected genotypes and phenotypes of the offspring if a heterozygous tall, heterozygous axillary plant is crossed with a heterozygous tall, terminal plant? Give your answers in probabilities (%).

Parents: Male = TtAa; Female = Ttaa

\[
\begin{array}{c|c|c|c|c}
 & T & t & A & a \\
\hline
T & TTAa & Ttan & TtAa & Ttaq \\
\hline
T & TTAa & Ttan & TtAa & Ttaq \\
\hline
T & TTAa & Ttan & TtAa & Ttaq \\
\hline
A & TtAa & Ttaa & TtAa & Ttaa \\
\hline
A & TtAa & Ttaa & TtAa & Ttaa \\
\hline
a & TtAa & Ttaa & TtAa & Ttaa \\
\hline
\end{array}
\]

F1 Offspring: Genotype Percent and Ratios =

\[
\begin{align*}
\text{TTAa:} & \quad 11 \\
\text{Ttan:} & \quad 11 \\
\text{TtAa:} & \quad 11 \\
\text{Ttaa:} & \quad 11 \\
\text{TaAx:} & \quad Cc \\
\text{TtAx:} & \quad Cc \\
\text{TtTe:} & \quad Cc \\
\text{TtTe:} & \quad Cc \\
\end{align*}
\]

\[
\begin{align*}
\text{Short Axillaries:} & \quad 2 \\
\text{Short Terminal:} & \quad 2 \\
\end{align*}
\]

Meiotic Distribution of Alleles

1. Purpose: to distribute the parental alleles into gametes (eggs and sperm or pollen and ovum) as would be predicted by meiosis.
2. Use the FOIL method from the binomial distributive property of multiplication.
3. Ex: gamete distribution for AaBb

\[ AB \quad Ab \quad aB \quad ab \]
Dihybrid Cross Problems

1. In horses, the coat color black is dominant (B) over chestnut (b). The trotting gait is dominant (T) over the pacing gait (t). If a homozygous black pacer is mated to a homozygous chestnut, heterozygous trotter, what will be the probabilities for genotype and phenotype of the F1 generation?

\[ BbTt \times bbTt \]

F1 Offspring: Genotype Percent and Ratios =

\[ BbTt = \frac{8}{16} \]
\[ bbTt = \frac{8}{16} \]

Phenotypes Percent and Ratios =

Black Trotter = \( \frac{8}{16} \)
Black Pacer = \( \frac{8}{16} \)
2. In rabbits, the coat color black dominant (B) over brown (b). Short hair is dominant (S) over long (s). In a cross between a homozygous black short-haired male and a brown homozygous long-haired female, what would be the probabilities for genotype and phenotype of the F₁ generation?

\[ BS \times bs \]

F₁ Offspring: Genotype Percent and Ratios =

16 BbSs

Phenotypes Percent and Ratios =

16 Black Short