Phenotypes and Genotypes of Single Crosses

Use these characteristics about plants to answer the following questions.
- Round seed is dominant over wrinkled seed
- Yellow seed dominant over green seed
- Colored seed coat is dominant over white seed coat
- Inflated pod is dominant over a wrinkled pod  (imagine a green pea over a raisin)
- Green pod is dominant over yellow pod
- Axial flowers are dominant terminal flowers
- Long stems are dominant over short stems

A. Write the genotype for each characteristic.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Genotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Round seed</td>
<td></td>
</tr>
<tr>
<td>2 Yellow seed</td>
<td></td>
</tr>
<tr>
<td>3 Colored seed coat</td>
<td></td>
</tr>
<tr>
<td>4 Inflated pod</td>
<td></td>
</tr>
<tr>
<td>5 Green pod</td>
<td></td>
</tr>
<tr>
<td>6 Axial flowers</td>
<td></td>
</tr>
<tr>
<td>7 Long stems</td>
<td></td>
</tr>
</tbody>
</table>

B. Write the genotype for the phenotypes given.

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Genotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Homozygous round seed</td>
<td></td>
</tr>
<tr>
<td>2 Wrinkled seed</td>
<td></td>
</tr>
<tr>
<td>3 Homozygous yellow seed</td>
<td></td>
</tr>
<tr>
<td>4 Green seed</td>
<td></td>
</tr>
<tr>
<td>5 Heterozygous colored seed coat</td>
<td></td>
</tr>
<tr>
<td>6 White seed coat</td>
<td></td>
</tr>
<tr>
<td>7 Heterozygous inflated pod</td>
<td></td>
</tr>
<tr>
<td>8 Wrinkled pod</td>
<td></td>
</tr>
<tr>
<td>9 Homozygous green pod</td>
<td></td>
</tr>
<tr>
<td>10 Yellow pod</td>
<td></td>
</tr>
<tr>
<td>11 Heterozygous axial flowers</td>
<td></td>
</tr>
<tr>
<td>12 Terminal flowers</td>
<td></td>
</tr>
</tbody>
</table>

C. Write the phenotype for the genotype given.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 LL</td>
<td>Homozygous round seed</td>
</tr>
<tr>
<td>2 rr</td>
<td>Wrinkled seed</td>
</tr>
<tr>
<td>3 li</td>
<td>Homozygous yellow seed</td>
</tr>
<tr>
<td>4 Aa</td>
<td>Green seed</td>
</tr>
<tr>
<td>5 yy</td>
<td>Heterozygous colored seed coat</td>
</tr>
<tr>
<td>6 Yy</td>
<td>White seed coat</td>
</tr>
<tr>
<td>7 Cc</td>
<td>Heterozygous inflated pod</td>
</tr>
<tr>
<td>8 Rrii</td>
<td>Wrinkled pod</td>
</tr>
<tr>
<td>9 GgYy</td>
<td>Homozygous green pod</td>
</tr>
<tr>
<td>10 IiAa</td>
<td>Yellow pod</td>
</tr>
<tr>
<td>11 llcc</td>
<td>Heterozygous axial flowers</td>
</tr>
<tr>
<td>12 LLCC</td>
<td>Terminal flowers</td>
</tr>
</tbody>
</table>
**Monohybrid Practice Problems**

1. In purple people eaters, one-horn is dominant and no horns is recessive. Draw a Punnett Square showing the cross of a purple people eater that is heterozygous for horns with a purple people eater that does not have horns. Summarize the genotypes & phenotypes of the possible offspring.

2. In guinea pigs, short hair is represented by B and long hair (recessive) by b. Cross a hom short hair parent and a heterozygous short hair parent.

3. Let's say that in seals the dominant allele (W) codes long whiskers & the recessive allele (w) codes for short whiskers. What percentage of offspring would be expected to have short whiskers from the cross of two long-whiskered seals, one that is homozygous dominant and one that is heterozygous?

4. In humans, **straight toes (S)** is dominant over **curled toes (s)**. What would be the result of a cross between a recessive male and a heterozygous female?

5. The ability to **roll the tongue (R)** is determined by a dominant gene while the recessive gene results in the **inability to roll the tongue (r)**. A man and his wife can both roll their tongues and are surprised to find that their son cannot. Explain this by showing the genotypes of all three persons. (Note: you still NEED to do a Punnett Square for this problem).

6. Suppose that the ability to read minds (ESP) is determined by a single gene in humans with the ability to read minds given by the dominant allele E and inability to read minds by the recessive allele e. Suppose two heterozygous mind readers have a large family.
   a. Predict the proportion of their children who will be mind readers and non-mind readers. Use a Punnett square to illustrate how you make these predictions.

   b. What is the likelihood that their first child will be a mind reader?

   c. What is the likelihood that their fourth child will be a mind reader?
7. The ability to use the force (F, force) is dominant to not being able to use the force. A woman, Padme, who cannot use the force, marries Anakin, a Jedi knight (a man strong in the force). They have fraternal twins. The girl, Leia, has her mother's phenotype and the boy, Luke, like his father is strong in the force. What are the genotypes of the Padme, Anakin, Luke, and Leia?

Padme: 
Anakin: 
Luke: 
Leia: 

In Martians, blue skin is dominant (B) over green skin (b). Long antennae (A) are dominant over short antennae (a).

8. Cross a homozygous long antennae Martian with a heterozygous long antennae Martian. What are the genotypes and phenotypes of the offspring?

9. Cross a heterozygous blue-skinned Martian with another heterozygous blue-skinned Martian. What are the genotypes and phenotypes of the offspring?

10. Could 2 blue-skinned Martians have a green-skinned baby? Why or why not?

11. Could 2 short-antennaed Martians have a long-antennaed baby? Why or why not?

12. If a green-skinned mother married a blue-skinned father and had ½ blue babies and ½ green babies, what is the genotype of the father?
Dihybrid Crosses

1. In pepper plants, green (G) fruit color is dominant to red (g) and round (R) fruit shape is dominant to square (r) fruit shape. These two genes are located on different chromosomes.

   a. If a plant has red, square-shaped fruit what is its genotype?

   b. If a plant is homozygous dominant for fruit color and fruit shape, what is its genotype?

   c. If a plant is heterozygous for fruit color and but the peppers are square, what is its genotype?

   d. If a plant has the genotype GGRr, what is its phenotype?

   e. If a plant has the genotype GgRr, what is its phenotype?

   f. What are the possible gametes for a plant with genotype GGRR?

   g. What are the possible gametes for a plant with genotype GgRr?

   h. If two plants that are heterozygous for both traits are crossed, what genotypes and phenotypes will be seen in the offspring? (GgRr x GgRr)

2. In guinea pigs, black coat color (B) is dominant over white (b), short hair (S) is dominant over long (s). In a cross between a homozygous black, short-haired guinea pig and a homozygous white, long-haired, guinea pig. What will the F1 offspring look like?
3. In certain bacteria, an oval shape (S) is dominant over round and thick cell walls (T) are dominant over thin. In a cross between a heterozygous oval, thick cell walled bacteria with a round, thin cell walled bacteria. Describe the phenotype of the F₁ offspring.

4. In summer squash, white fruit (W) is dominant over yellow (w); and "disk" fruit shape (D) is dominant over "sphere" shape (d). In a cross between a squash plant homozygous for yellow fruit color and disk fruit shape and one homozygous for white fruit color and sphere fruit shape, what will be the appearance, as to color and shape of fruit, of the F₁? Of the F₂ (for this cross 2 of your F₁ offspring)?
Non-Mendelian Problems

1. A cross between a blue blahblah bird & a white blahblah bird produces offspring that are silver.
   a. What pattern of inheritance is displayed?
   b. What are the genotypes of the parent blahblah birds in the original cross?
   c. What is/are the genotype(s) of the silver offspring?
   d. What would be the phenotypic ratios of offspring produced by two silver blahblah birds?

2. A very common phenotype used in questions about codominance is roan fur in cattle. Cattle can be red (RR = all red hairs), white (WW = all white hairs), or roan (RW = red & white hairs together).
   a. Predict the phenotypic ratios of offspring when a homozygous white cow is crossed with a roan bull.
   b. What should the genotypes & phenotypes for parent cattle be if a farmer wanted only cattle with red fur?

3. Cross type AB parent with a type O parent.

The following information should be used to solve question 4. Suppose we have two plants: one has red flowers and broad leaves, the other has white flowers and narrow leaves. Both plants are pure-breeding for these traits. We perform a cross between these plants, and all the F1 offspring have pink flowers and medium leaves.

4a. Which mode of inheritance best describes how flower color is inherited in these plants?

4b. Using the symbols \( R \) (red allele), \( R' \) (white allele), \( N \) (narrow leaf allele) and \( N' \) (broad leaf allele), what is the genotype of the F1 offspring?

4c. If we were to self-fertilize an F1 individual, what would be the expected phenotypic ratio of the F2 offspring?

5. Hemophilia is a sex-linked trait where \( X^H \) gives normal blood clotting and is dominant to the hemophilia allele \( X^h \).
   a. Give the genotypes of 1) a woman with normal blood clotting whose father had hemophilia and 2) a normal man whose father had hemophilia.
   b. What is the probability that a mating between these two individuals will produce a child, regardless of sex, that has hemophilia?
   c. If this couple has a daughter, what is the probability that the daughter will be a carrier of the hemophilia trait?
   d. What is the probability a daughter would have hemophilia?
   e. If this couple has a son, what is the probability he will have hemophilia?
6. A boy, whose parents and grandparents had normal vision, is color-blind. What are the genotypes for his mother and his maternal grandparents? Use X^B for the dominant, normal condition and X^b for the recessive, color-blind phenotype.

7. Clouded leopards are a medium sized, endangered species of cat, living in the very wet cloud forests of Central America. Assume that the normal spots (X^N) are a dominant, sex-linked trait and that dark spots are the recessive counterpart. Suppose as a Conservation Biologist, you are involved in a clouded leopard breeding program. One year you cross a male with dark spots and a female with normal spots. She has four cubs and, conveniently, two are male and two female. One each of the male and female cubs have normal spots and one each have dark spots. What is the genotype of the mother?

8. Coat color in cats is a codominant trait and is also located on the X chromosome. Cats can be black, yellow or calico. A calico cat has black and yellow splotches. In order to be calico, the cat must have an allele for the black color and an allele for the yellow color. Use a Punnett square to show why there are no male calico cats.

9. A female calico cat is crossed with a male black cat. What are the phenotypes of the offspring and in what proportion?

10. In an alien species, eye colors can be black, white, or gray. A white-eyed mother and a black-eyed father have all gray-eyed children.
   
   (A) What genetic pattern is most likely demonstrated here?

   (B) A gray-eyed couple has two babies: one white-eyed and one black-eyed. Does this confirm or deny your answer to part A?

   (C) A gray-eyed alien and her black-eyed husband want a white-eyed baby. Is this possible?

11. A rooster with gray feathers is mated with a hen of the same phenotype. Among their offspring, 15 chicks are gray, 6 are black, and 8 are white. What is the simplest explanation for the inheritance of these colors in chickens? What offspring would you predict from the mating of a gray rooster and a black hen?
12. Color patterns in a species of duck are determined by one gene with three alleles. Alleles Green, $G$, and White, $W$ are codominant, and allele, Indigo, $i$ is recessive to both. How many phenotypes are possible in a flock of ducks that contains all the possible combinations of these three alleles?

13. In tigers, a recessive allele causes an absence of fur pigmentation (a "white tiger") and a cross-eyed condition. If two phenotypically normal tigers that are heterozygous at this locus were mated, what percentage of their offspring will be cross-eyed? What percentage will be white?

14. Could this trait be inherited as a simple … 
- autosomal recessive? (yes / no)
- autosomal dominant?
- X-linked recessive?
- X-linked dominant?
- Y-linked trait?

15. Could this trait be inherited as a simple … 
- autosomal recessive? (yes / no)
- autosomal dominant?
- X-linked recessive?
- X-linked dominant?
- Y-linked trait?

16. Could this trait be inherited as a simple … 
- autosomal recessive? (yes / no)
- autosomal dominant?
- X-linked recessive?
- X-linked dominant?
- Y-linked trait?

17. Could this trait be inherited as a simple … 
- autosomal recessive? (yes / no)
- autosomal dominant?
- X-linked recessive?
- X-linked dominant?
- Y-linked trait?
Oompah Loompah Problems

Mendelian Genetics

1. Oompahs generally have blue faces which is caused by a dominant gene. The recessive condition results in an orange face. Develop a "key" to show the genotypes and phenotypes possible for Oompa Loompas.

2. Two heterozygous oompahs are crossed. What proportion of the offspring will have orange faces.

3. A blue faced oompah (homozygous) is married to an orange faced oompah. They have 8 children. How many children will have blue faces?

4. Odie Oompah has a blue face. In fact, everyone in Odie's family has a blue face, and the family boasts that it is a "pure" line. Much to his family's horror, he married Ondi Oompah who "gasp" has an orange face. What are the genotypes of their children. Is Odie's line still "pure"?

Non-Mendelian Genetics

5. Oompahs can have red, blue or purple hair. Purple hair results from the heterozygous condition. Make a "key" showing the genotypes and phenotypes for hair color. Is this an example of codominance or incomplete dominance?

6. Orville Oompah has purple hair and is married to Opal Oompah who brags that she has the bluest hair in the valley. How many of Opal's children will be able to brag about their blue hair also?

7. One of Opal's children is born with shocking red hair. Is Orville the father of this child (show the square to prove your answer)? But wait, Opal swears she has been faithful and claims that the hospital goofed and got her baby mixed with another. Is this a plausible explanation? Show the square to prove your answer.

8. In the land of Oompah, blue hair is highly valued, blue haired Oompahs even get special benefits. Oscar Oompah has purple hair but he wants to find a wife that will give him blue haired children. What color hair should his wife have? What would be his second choice?