Do you have dimples?

Do you have freckles?

What is the probability of not having dimples and not having freckles if both parents do?
Dihybrid crosses
Objectives

Predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance (TEKS 6F)

- Explain the principle of independent assortment with dihybrid crosses
- Describe how to solve dihybrid cross questions using probability.
Mendel & Independent Assortment

After showing that alleles segregate (separate) during the formation of gametes (sperm / egg), Mendel wondered if they did so independently.

• For example, does the gene that determines if a pea is round or wrinkled have anything to do with the gene for seed color (yellow vs green)?

In order to test his hypothesis for independent assortment he set up a **dihybrid cross**, which is a cross involving two different traits (genes).

Di= two hybrid = heterozygote

Example: First, let’s set up our P generation
Cross a true-breeding (homozygous) round and yellow pea plant to a true-breeding (homozygous) wrinkled and green pea plant

   Round (R) is dominant to wrinkled (r)
   Yellow (Y) is dominant to green (y)
Dihybrid Cross

All F1 offspring had round and yellow peas.

He then crossed these peas to themselves to create a dihybrid cross.
Dihybrid Cross

RrYy x RrYy

If independent assortment is true for these traits, then Mendel should get a combination of 4 different gametes for each parent.

Each gamete would have the same probability of occurring (like flipping a coin)

Possible gametes if independently assorting:

RY  Ry  rY  ry

Each gamete would have a $\frac{1}{4}$ or 25% chance of occurring
Dihybrid Cross & Punnett Squares

RrYy x RrYy

- Remember, the gametes of the parents go on the top and left side of the Punnett square.

- Also, remember each gamete should have 1 letter (allele) from each gene. For example, you should never have a gamete that is Rr because that is 2 alleles for the same gene. Each parent only gives half of their genes to their offspring.

<table>
<thead>
<tr>
<th></th>
<th>RY</th>
<th>Ry</th>
<th>rY</th>
<th>ry</th>
</tr>
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<tbody>
<tr>
<td>RY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Ry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Dihybrid Cross & Punnett Squares

**RrYy x RrYy**

- Now, let’s fill in our Punnett square!
- To keep things consistent (and easy to read), keep the “R’s” together and the “Y’s” together; with the big letter (if there is one) listed first:

<table>
<thead>
<tr>
<th></th>
<th>RY</th>
<th>Ry</th>
<th>rY</th>
<th>ry</th>
</tr>
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<tbody>
<tr>
<td>RY</td>
<td>RRYY</td>
<td>RRYy</td>
<td>RrYY</td>
<td>RrYy</td>
</tr>
<tr>
<td>Ry</td>
<td>RRYy</td>
<td>RRyy</td>
<td>RrYy</td>
<td>RrYy</td>
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<tr>
<td>rY</td>
<td>RrYY</td>
<td>RrYy</td>
<td>rrYY</td>
<td>rrYy</td>
</tr>
<tr>
<td>ry</td>
<td>RrYy</td>
<td>RrYy</td>
<td>rrYy</td>
<td>rryy</td>
</tr>
</tbody>
</table>
Now that we have the genotypes listed, what are the possible phenotypes of the offspring?

<table>
<thead>
<tr>
<th></th>
<th>Ry</th>
<th>rY</th>
<th>ry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ry</td>
<td>RRYy</td>
<td>RrYy</td>
<td>RrYy</td>
</tr>
<tr>
<td>RY</td>
<td>Round Yellow</td>
<td>Round Yellow</td>
<td>Round Yellow</td>
</tr>
<tr>
<td>Ry</td>
<td>Round Yellow</td>
<td>Round Green</td>
<td>Round Yellow</td>
</tr>
<tr>
<td>rY</td>
<td>Round Yellow</td>
<td>Round Yellow</td>
<td>wrinkled Yellow</td>
</tr>
<tr>
<td>ry</td>
<td>Round Yellow</td>
<td>Round Green</td>
<td>wrinkled Yellow</td>
</tr>
<tr>
<td></td>
<td>RrYy</td>
<td>RrYy</td>
<td>RrYy</td>
</tr>
<tr>
<td>RY</td>
<td>Round Yellow</td>
<td>Round Yellow</td>
<td>Round Yellow</td>
</tr>
<tr>
<td>Ry</td>
<td>Round Green</td>
<td>Round Yellow</td>
<td>Round Green</td>
</tr>
<tr>
<td>rY</td>
<td>wrinkled Yellow</td>
<td>wrinkled Yellow</td>
<td>wrinkled Green</td>
</tr>
<tr>
<td>ry</td>
<td>wrinkled Yellow</td>
<td>wrinkled Green</td>
<td>wrinkled Green</td>
</tr>
</tbody>
</table>
Dihybrid Cross

Results from Mendel’s dihybrid cross:
9 round and yellow
3 round and green
3 wrinkled and yellow
1 wrinkled and green

This is a phenotypic ratio of 9:3:3:1

Due to the ratio and phenotypes not seen in the parents but observed in this F2 generation, Mendel proved independent assortment WAS occurring between these two genes.
Conclusion: Mendel’s Laws

Law of segregation: During the production of gametes the two copies of each hereditary factor segregate so that offspring acquire one factor from each parent.

Law of Independent Assortment: The principle of independent assortment states that genes for different traits can segregate independently (random chance) during the formation of gametes.

Independent assortment helps account for the many genetic variations observed in plants, animals, and other organisms.
Objectives

Predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses and non-Mendelian inheritance (TEKS 6F)

- Explain the principle of independent assortment with dihybrid crosses
- Describe how to solve dihybrid cross questions using probability.
In humans, dimples are dominant (D) to not having dimples (d), and freckles are dominant (F) over not having freckles (f). If a man with the genotype ddFf and a woman with the genotype DdFF get married and have children...

1. What is the probability of producing offspring with the DdFF genotype?

   HINT: What is the probability of Dd **AND** FF?
In humans, dimples are dominant (D) to not having dimples (d), and freckles are dominant (F) over not having freckles (f). If a man with the genotype ddFf and a woman with the genotype DdFF get married and have children...

2. What is the expected phenotypic outcome in the offspring for the freckle gene?
   HINT: Just look at the freckle Punnett square
   A. 75% freckles, 25% no freckles
   B. 100% freckles
   C. 100% no freckles
   D. 50% freckles, 50% no freckles
In humans, dimples are dominant (D) to not having dimples (d), and freckles are dominant (F) over not having freckles (f). If a man with the genotype ddFf and a woman with the genotype DdFF get married and have children...

3. What is the expected genotypic ratio for the dimpled gene?

HINT: Just look at the dimple Punnett square

A. 0 DD: 2 Dd: 2 dd
B. 1 DD: 2 Dd: 1 dd
C. 2 DD: 0 Dd: 2 dd
D. 2 DD: 1 Dd: 0 dd
In humans, dimples are dominant (D) to not having dimples (d), and freckles are dominant (F) over not having freckles (f). If a man with the genotype ddFf and a woman with the genotype DdFF get married and have children...

4. What is the probability of getting a dimpled non-freckled child?

HINT: What is the probability of dimples AND no freckles?