# Case Study Exercise #1 – Holstein Coat Color

Let's look at coat color in Holstein cattle as an example of simple dominance, which is responsible for many physical traits in Holsteins.

Each animal has two alleles for coat color.
- Black hair color is dominant (labeled "B")
- Red hair color is recessive (labeled "b")

Holstein cattle can possess one of three genotypes for hair color:
- Homozygous for black hair color
- Heterozygous (called "red carrier")
- Homozygous for red hair color

1. Write out what the genotype (which alleles they have) and phenotype (what hair color they have) would be for each combination.

| | | |
|---|---|---|
| **Homozygous for black hair color** | Genotype | _____ |
| | Phenotype | _____ |
| **Heterozygous/Red Carrier** | Genotype | _____ |
| | Phenotype | _____ |
| **Homozygous for Red Hair Color** | Genotype | _____ |
| | Phenotype | _____ |

## Scenario:

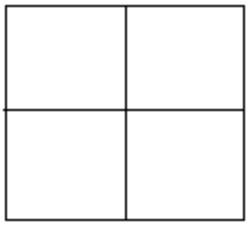
Your black and white Holstein cow, Holstein-Acres Daisy May, does not have any red and white cattle in her pedigree, so you know she is homozygous for black hair color. You are interested in red & white cattle though, and want to try to eventually get some red and white offspring from this cow family. Because of this you decide to breed her to a red & white Holstein bull to work towards this goal, and you choose Mighty-Fine Studly Brick-Red.

2. Start by writing out the genotypes for Daisy May and Brick.

Daisy May's genotype _____

Brick-Red's genotype _____

3. Now use a Punnett Square to see what type of offspring you could get if you bred Daisy May to Brick-Red.



What are the results? First tally the **genotypes** of the resulting offspring:

_____/4 calves would be **homozygous for black hair color**

_____/4 calves would be **heterozygous (red carriers)**

_____/4 calves would be **homozygous for red hair color**

Now look at the **phenotypes:**

_____/4 calves would be black and white

_____/4 calves would be red and white

Is it possible to get red and white daughters from Daisy May? Why or why not?

_____

_____

_____

## The Next Generation

4. You are lucky and Daisy May's first calf is a heifer, sired by Brick-Red. Because of the Punnett Square you know that this calf's genotype is _____.

5. When it comes time to breed this heifer, your parents give you the option of three bulls to pick from as a sire, all of about equal genetic merit. Because you would still like to try and get a red and white calf in your herd, which bull makes the most sense for you to pick? Draw a Punnett Square for each mating to justify your choice.

**Option 1: Ladys-Manor Shamrock (Homozygous for black hair color)**

**Genotypes** of the resulting offspring:

_____/4 calves would be homozygous for black hair color

_____/4 calves would be heterozygous (red carriers)

_____/4 calves would be homozygous for red hair color

**Phenotypes:**

_____/4 calves would be black and white

_____/4 calves would be red and white

**Option 2: Ronelee SS Durable *RC (Red Carrier)**

**Genotypes** of the resulting offspring:

_____/4 calves would be homozygous for black hair color

_____/4 calves would be heterozygous (red carriers)

_____/4 calves would be homozygous for red hair color

**Phenotypes:**

_____/4 calves would be black and white

_____/4 calves would be red and white

**Option 3: Tiger-Lily Ladd-Red (Homozygous for Red hair color)**

**Genotypes** of the resulting offspring:

_____/4 calves would be homozygous for black hair color

_____/4 calves would be heterozygous (red carriers)

_____/4 calves would be homozygous for red hair color

**Phenotypes:**

_____/4 calves would be black and white

_____/4 calves would be red and white

6. Your best chance at getting a red and white calf would be to breed your cow to _____.
7. By doing that you would have a _____% chance at getting a red and white calf.
8. Aside from the red gene, give an example of at least one other recessive trait that can be found in Holstein cattle.

_____

_____

_____

# Case Study #2 Polled Holstein Cattle

Animals that naturally do not grow horns are known as "polled." With the increasing emphasis on animal welfare, as well as practical on-farm management, interest in the polled gene is increasing, with naturally hornless animals becoming more popular.

Like coat color, each animal has two alleles for the polled gene.

- Polled is dominant (labeled "P")
- Horned is recessive (labeled "p")

1. It may come as a surprise that the polled gene is dominant over the horned gene, since most Holstein cattle are born with horns. How does this being a dominant trait help increase the number of polled animals more quickly than if it were a recessive trait?

   _____

   _____

   _____

2. Write out the three genotypes polled cattle can have, and the phenotypes that go with each. Remember, polled is dominant.

   Genotype 1 _____

   Phenotype 1 _____

   Genotype 2 _____

   Phenotype 2 _____

   Genotype 3 _____

   Phenotype 3 _____

## What would happen in the following scenarios? Use the Punnett Squares to justify your answers.

3. Horned Cow (genotype = _____) x Heterozygous Polled Bull (genotype = _____)

| | |
|---|---|
| | |
| | |

**Genotypes** of the resulting offspring:

_____/4 calves would be homozygous for the polled gene

_____/4 calves would be heterozygous for the polled gene

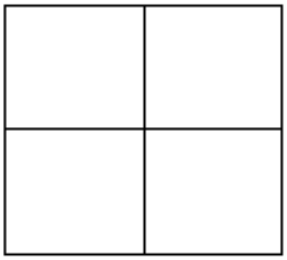
_____/4 calves would be homozygous for the horned gene

**Phenotypes:**

_____/4 calves would have horns

_____/4 calves would be naturally polled

4 Heterozygous Polled Cow (genotype = _____) x Heterozygous Polled Bull (genotype = _____)



**Genotypes** of the resulting offspring:

_____/4 calves would be homozygous for the polled gene

_____/4 calves would be heterozygous for the polled gene

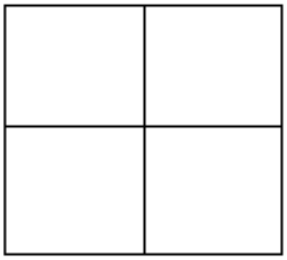
_____/4 calves would be homozygous for the horned gene

**Phenotypes:**

_____/4 calves would have horns

_____/4 calves would be naturally polled

5 Homozygous Polled Cow (genotype = _____) x Horned Bull (genotype = _____)



**Genotypes** of the resulting offspring:

_____/4 calves would be homozygous for the polled gene

_____/4 calves would be heterozygous for the polled gene

_____/4 calves would be homozygous for the horned gene

**Phenotypes:**

_____/4 calves would have horns

_____/4 calves would be naturally polled

6. Based on what you now know about the polled gene, is it possible to have a horned calf born from two polled animals? Why or why not?

_____

_____

_____

_____

7. How would you explain to a classmate the difference between dominant and recessive genes?

_____

_____

_____

_____

If you are still interested in learning more about genes and inheritance, ask a parent or teacher to help you research dominant and recessive traits in humans. Are there any traits that you can see expressed in yourself?

_____

_____

_____

## Use the activities below to the factors that influence genetic progress and selection.

### Matching Game!

Match the factor of genetic change with the example below that best describes fits it.

| | |
|---|---|
| Accuracy of selection | Sorting your heifers based on their PTPI and deciding NOT to use the bottom 20% for breeding purposes |
| Selection Intensity | Trying to breed cows that produce a lot of milk to bulls with high fat and protein percentages, instead of other bulls that are high for milk production. |
| Genetic Variation | Breeding all of your heifers to sexed semen from genomic young sires to be sure you get more heifers from your younger animals |
| Generation Interval | Studying the Sire Summaries and carefully reviewing all genetic information available to make sure you pick the best bulls to use on your farm |

## This or That - Which would lead to faster genetic progress?

In each pair, circle the phrase that would result in faster genetic progress in a dairy herd.

1. Selecting the bulls you want to use based on your neighbor's recommendation of which ones are the best right now

   OR

   Looking at genomic information on a group of bulls and using that to select the ones that you feel will work best in your herd.

2. Breeding cows in heat to a random assortment of bulls

   OR

   Picking individual matings for cows before breeding them

3. Breeding all of your heifers to one of five bulls, all with different pedigrees

   OR

   Breeding all of your heifers to one of five sons of your favorite bull

4. Selling your extra bred heifers to free up some space in your barns

   OR

   Selling some third and fourth lactation cows to a local dairy to free up some space in your barns