# Basic Mendelian Genetics & Color Genetics
## Basic Definitions

Mendel demonstrated with corn that genes could be predictably combined.

For horses, there are 32 pairs of chromosomes which hold 2.7 billion DNA base pairs. This is the equine genome. A group of DNA base pairs make a gene which carry the code for the protein and thus the trait.

Genotype refers to the genes present and the phenotype refers to how it is observed. Rn/Rn and Rn/N is the genotype and either of those will produce the roan color which is the phenotype. Genes can be dominant or recessive. Rn is dominant and a single Rn gene will produce the roan color. For homozygous Herda a genotype of Hrd/Hrd would have a phenotype of non-healing skin wounds. Since Hrd is a recessive gene then a single gene will not cause the disease state.

Each parent passes on one gene of its pair, 50%, to their offspring. So each offspring has a 25% average chance of having the same pair of that gene as it's full sibling. Each gene has this 25% chance to be the same. With so many genes in the whole genome, some diversity is still present even amongst full siblings. These are averages so a foal might not obtain exactly 25% of its grandmother's DNA since this is a random process; ie, 50% of the Granddam DNA is in the dam but so is 50% of the Grandsire and which of those genes are passed to the foal is random.

## Equine Color Genetics

With breeding color patterns, we can combine equine color genetics in a way to help gain color. Of course, we all likely would rather have a healthy champion horse of any color than to have a losing horse or one prone to disease and injuries. But if I can have both then I prefer the blue roan color, but also black, bay or any roan color horse. Someone told me nobody wants to breed to a bay stallion, despite high LTE. Bay or black with a blue roan cross significantly increases the chances for a blue roan foal which many people want. Also, we can breed for two roan genes so to increase the percentage of subsequent roan color.

The Animal Genetics lab or the UC Davis VGL lab are available to submit your equine hair sample for color genetics testing. Then use the available Animal Genetics Color Genetics Calculator on its website to see what the possible color outcomes will be. Good luck finding color genetics online for horses you don't own. It is a rarity for horse owner to have and/or publicize the genetic data. Even if you know your mare's color genetics you are missing 50% of the equation without the stallions results. The following website allows for calculating color.

https://www.animalgenetics.us/Equine/CCalculator3.asp

## Neidhart Cutting Horses, Inc Example of Equine Color Genetics in breeding

The following screen shots are for the planned breeding between my Armani Blue Blue roan 2016 stallion and our bay mare Blueberry Patches. The color genetics for each horse is provided below and then a screen shot of the Animal Genetics Color Calculator results for the planned foal.

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## HORSE COAT COLOR / PATTERN TEST RESULTS

| JEFFREY NEIDHART<br>4144 CRISTO REY ST<br>FARMINGTON, NM 87401 | Case: | **NQ46015** |
|---|---|---|
| | Date Received: | 09-Nov-2018 |
| | Print Date: | 15-Nov-2018 |
| | Report ID: | 3143-4025-2045-1117 |
| | | Verify report at www.vgl.ucdavis.edu/myvgl/verify.htm |

**Horse: ARMANI BLUE**  Reg: 5742699
DOB: 03/21/2016  Sex: **Stallion**  Breed: **Quarter Horse**

Sire: SMOOTH AS A CAT  Reg: 3808235
Dam: AUTUMN BOON  Reg: 4210858

| | | | | | |
|---|---|---|---|---|---|
| RED FACTOR | E/e | Both black and red factors detected. | SPLASHED WHITE (SW1, SW3) | N/N | No copies of SW1 or SW3 detected. |
| AGOUTI | a/a | If present, black pigment is distributed uniformly over the body. | SPLASHED WHITE (SW2, SW4) | N/N | No copies of SW2 or SW4 detected. |
| CREAM | N/N | No copies of Cream dilution detected. | TOBIANO | N/N | No copies of Tobiano detected. |
| PEARL | N/N | No copies of Pearl dilution detected. | LEOPARD | N/N | No copies of Leopard Complex detected. |
| SILVER | N/N | No copies of Silver dilution detected. | PATTERN-1 | N/N | No copies of PATN1 detected.* |
| DUN | nd2/nd2 | Horse is not Dun dilute. Primitive markings are absent. | BRINDLE 1 | | Not requested. |
| CHAMPAGNE | N/N | No copies of Champagne dilution detected. | TIGER EYE | | Not requested. |
| LETHAL WHITE OVERO | N/N | No copies of lethal white overo detected. | GRAY | Absent | Gray gene is absent. Horse will not turn gray. |
| SABINO 1 | N/N | No copies of Sabino 1 detected. | ROAN | Rn/N | 1 copy of classic Roan detected. |
| DOMINANT WHITE (W5, W10, W20) | N/N | No copies of W5, W10 or W20 detected. | | | |

*Pattern-1: In order for high levels of white spotting to be visible on horses that inherit PATN1, LP must also be present.

**For more detailed information on Horse Coat Color results, please visit:**
www.vgl.ucdavis.edu/services/coatcolorhorse.php

Tests for Gray, Leopard/Appaloosa, Lethal White Overo and Tobiano are performed under license.

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VETERINARY GENETICS LABORATORY
SCHOOL OF VETERINARY MEDICINE
ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8744

TELEPHONE: (530) 752-2211
FAX: (530) 752-3556

# HORSE COAT COLOR / PATTERN TEST RESULTS

| JEFFREY NEIDHART<br>4144 CRISTO REY ST<br>FARMINGTON, NM 87401 | | *Case:* | **NQ46071** |
|---|---|---|---|
| | | *Date Received:* | 16-Nov-2018 |
| | | *Print Date:* | 26-Nov-2018 |
| | | *Report ID:* | 0455-7744-1318-3122 |
| | | | Verify report at www.vgl.ucdavis.edu/myvgl/verify.htm |

*Horse:* **BLUEBERRY PATCHES**          *Reg:* **4643919**

*DOB:* **02/27/2005**  *Sex:* **Mare**  *Breed:* **Quarter Horse**

*Sire:* PEPTOBOONSMAL          *Reg:*
*Dam:* PATCHES OF BLUE          *Reg:*

| | | | | | |
|---|---|---|---|---|---|
| RED FACTOR | E/e | Both black and red factors detected. | SPLASHED WHITE (SW1, SW3) | N/N | No copies of SW1 or SW3 detected. |
| AGOUTI | A/a | 1 copy of agouti. If present, black pigment is restricted to the points. | SPLASHED WHITE (SW2, SW4) | N/N | No copies of SW2 or SW4 detected. |
| CREAM | N/N | No copies of Cream dilution detected. | TOBIANO | N/N | No copies of Tobiano detected. |
| PEARL | N/N | No copies of Pearl dilution detected. | LEOPARD | N/N | No copies of Leopard Complex detected. |
| SILVER | N/N | No copies of Silver dilution detected. | PATTERN-1 | N/N | No copies of PATN1 detected.* |
| DUN | nd2/nd2 | Horse is not Dun dilute. Primitive markings are absent. | BRINDLE 1 | | Not requested. |
| CHAMPAGNE | N/N | No copies of Champagne dilution detected. | TIGER EYE | | Not requested. |
| LETHAL WHITE OVERO | N/N | No copies of lethal white overo detected. | GRAY | Absent | Gray gene is absent. Horse will not turn gray. |
| SABINO 1 | N/N | No copies of Sabino 1 detected. | ROAN | N/N | No copies of classic Roan detected. |
| DOMINANT WHITE (W5, W10, W20) | N/W20 | 1 copy of W20 detected. | | | |

*Pattern-1: In order for high levels of white spotting to be visible on horses that inherit PATN1, LP must also be present.

**For more detailed information on Horse Coat Color results, please visit:**
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Tests for Gray, Leopard/Appaloosa, Lethal White Overo and Tobiano are performed under license.

# Coat Color Calculator

**Sire Color:** Blue Roan

| | | | |
|---|---|---|---|
| Agouti: | **aa** | Tobiano: | - |
| Red Factor: | **Ee** | LWO: | - |
| Cream: | - | Sabino: | - |
| Silver: | - | Splash: | - |
| Dun: | - | Roan: | **Rr** |
| Champagne: | - | Appaloosa: | - |
| Gray: | - | | |

**Dam Color:** Bay

| | | | |
|---|---|---|---|
| Agouti: | **Aa** | Tobiano: | - |
| Red Factor: | **Ee** | LWO: | - |
| Cream: | - | Sabino: | - |
| Silver: | - | Splash: | - |
| Dun: | - | Roan: | - |
| Champagne: | - | Appaloosa: | - |
| Gray: | - | | |

## Description:

Shown below are the possible offspring coat colors and the probability of each determined using the given information of the sire and dam. Accuracy of the calculations are increase when more genetic information of the parents is known.

### Offspring Color Probability

- 18.75% - **Blue Roan**
- 18.75% - **Black**
- 18.75% - **Bay Roan**
- 18.75% - **Bay**
- 12.50% - **Red (Chestnut/Sorrel)**
- 12.50% - **Red Roan**

### Details: All

Ee/Aa = 12.5000%
Ee/aa = 12.5000%
Ee/aa/Rr = 12.5000%
Ee/Aa/Rr = 12.5000%
EE/Aa = 6.2500%
EE/aa/Rr = 6.2500%
EE/aa = 6.2500%
ee/aa = 6.2500%
ee/Aa/Rr = 6.2500%
ee/Aa = 6.2500%
ee/aa/Rr = 6.2500%
EE/Aa/Rr = 6.2500%

# AQHA Genetic Disease Five Panel Test

We will just consider one of the five AQHA five panel gene to calculate the risk for a foal to inherit the diseased gene. Hereditary Equine Regional Dermal Asthenia (HERDA) is also called Hyperelastosis Cutis. Breeding two Herda carrier horses together could results with two Herda genes in the foal which would be a homozygous state and the disease would be expressed. The disease state causes severe skin lesions due to the separation of skin layers from genetic collagen defects. A single gene is a heterozygous state and since Herda is a recessive gene it will not be expressed with the disease state. Whether a single gene improves elasticity in cutting performance is not known.

If a sire with a single Herda gene is bred with a Dam without a Herda gene, or vice versus, then there is a 50% chance of the foal inheriting the Herda gene. If both the sire and the Dam carry the Herda gene then is it at 75% risk for the foal carrying the Herda gene, ie. 50% chance of single gene (heterozygous), 25% chance of two genes (homozygous) and 25% chance of not carrying the gene.

## Neidhart Cutting Horses, Inc Example of Equine Genetic Disease Five Panel Test

Again, my example of our planned breeding between Armani Blue and Blueberry Patches. The foal will have a 50% chance of inheriting a single Herda gene.

# Neidhart Cutting Horses, Inc Hypothetical Foal: Armani Blue X Blueberry Patches

This foal will have up to 37.5% Royal Blue Boon genes by three different RBB offspring improving diversity yet trying to keep RBB genetic with breeding – Autumn Boon, Peptoboonsmal, Patches of Blue . The phenotype is very important towards the ability of this foal to perform ranch work and to be a champion, ie conformation, athleticism, brains, heart. We give each of our foals the proper nutrition in utero and beyond along with a healthy and spacious playground and human interaction to grow and mature into champions.

We have more Royal Blue Boon offspring than anyone else in the world. If you are interested in buying Royal Blue Boon pedigree please check our Horses For Sale page.

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                                                          #Doc's Hickory-QH 73
                                       #High Brow Hickory-QH 83
                                 dun            Grulla San-QH 70
                        #High Brow Cat-QH 88        Smart Little Lena-QH 79
                          ch           Smart Little Kitty-QH 84
                                 sor            #Doc's Kitty-QH 66
             Smooth as a Cat-QH 99              #Peppy San Badger-QH 74
               ch                    #Wheeling Peppy-QH 80
                                 sor            Wheeling Princess-QH 74
                        Shes Pretty Smooth-QH 91    #Doc's Hickory-QH 73
                          sor          Smooth Hickory-QH 83
                                 b              Smooth Rosita-QH 78
   Armani Blue-QH 16                            #Mr San Peppy-QH 68
     bluro                          #Peppy San Badger-QH 74
                                 sor            Sugar Badger-QH 59
                        Dual Pep-QH 85          #Doc's Remedy-QH 73
                          ch           Miss Dual Doc-QH 80
                                 sor            #Miss Brooks Bar-QH 63
             Autumn Boon-QH 94                  #Doc Bar-QH 56
               bluro                 #Boon Bar-QH 72
                                 b              Teresa Tivio-QH 54
                        Royal Blue Boon-QH 80   #Royal King-QH 43
                          bluro        Royal Tincie-QH 65
                                 ro             Texas Dottie-QH 62
Hypothetical                                    #Leo San-QH 49
   Foaled                           #Mr San Peppy-QH 68
                                 sor            Peppy Belle-QH 55
                        #Peppy San Badger-QH 74 #Grey Badger III-QH 47
                          sor          Sugar Badger-QH 59
                                 sor            Sugar Townley-QH 43
             Peptoboonsmal-QH 92                #Doc Bar-QH 56
               red r                 #Boon Bar-QH 72
                                 b              Teresa Tivio-QH 54
                        Royal Blue Boon-QH 80   #Royal King-QH 43
                          bluro        Royal Tincie-QH 65
                                 ro             Texas Dottie-QH 62
   #Blueberry Patches-QH 05                     #Doc Bar-QH 56
     b                              #Doc O'Lena-QH 67
                                 b              #Poco Lena-QH 49
                        Smart Little Lena-QH 79 #Peppy San-QH 59
                          sor          #Smart Peppy-QH 66
                                 sor            Royal Smart-QH 58
             Patches of Blue-QH 94              #Doc Bar-QH 56
               blk                   #Boon Bar-QH 72
                                 b              Teresa Tivio-QH 54
                        Royal Blue Boon-QH 80   #Royal King-QH 43
                          bluro        Royal Tincie-QH 65
                                 ro             Texas Dottie-QH 62
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Inbreeding:  Royal Blue Boon-QH: 3S X 3D
                                      X 3D
             #Peppy San Badger-QH: 4S X 5S
                                      X 3D
             #Boon Bar-QH: 4S X 4D
                              X 4D
             Royal Tincie-QH: 4S X 4D
                                 X 4D
             #Doc's Hickory-QH: 5S X 5S
             Smart Little Lena-QH: 5S X 3D
             #Mr San Peppy-QH: 5S X 4D
             Sugar Badger-QH: 5S X 4D
             #Doc Bar-QH: 5S X 5D
                             X 5D
                             X 5D
             Teresa Tivio-QH: 5S X 5D
                                 X 5D
             #Royal King-QH: 5S X 5D
                                X 5D
             Texas Dottie-QH: 5S X 5D
                                 X 5D
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