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Donkey Color Genetics (11-May-2004)

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General Genetics Summary

Nearly all genetic information is paired, and this is the key to understanding how genetics work. Each animal receives one of each pair of genes from the sire, and the other one comes from the dam. In its own turn, when the animal reproduces, it will provide either one or the other (not both) to its own offspring. This pairing and resorting generation to generation is critical to understanding genetics.

The paired information can interact in different ways. Both members of the pair can be identical, and this is referred to as homozygous. Or, the pair can be made up of two different pieces of information, in which case the animal is called heterozygous.

The variants at each genetic address, or locus, are called alleles. These can interact in different ways. Dominant alleles can mask a recessive allele if they are paired together. So, for most systems, three types of animals are possible:

1. Homozygous Dominant - This means that both pieces of information are the same, and are the type that is expressed. The animal expresses the dominant type.
2. Heterozygous - This means that the animal has one copy of the dominant allele, and one copy of the recessive allele. The important detail here is that it can only express the dominant, so it hides the recessive. The key is that the animal can pass either one of these along to its offspring - so it could produce either type depending on how it is mated. While it is impossible to tell the difference between homozygous dominant and heterozygous animals by visual inspection alone, it is easily possible to assure an animal is heterozygous if it has a recessive colored parent, or has produced a recessive colored foal.
3. Homozygous Recessive - This means that the animal has two copies of the recessive allele. Since no dominant allele is present the recessive is expressed, and the animal can only provide the recessive allele to its offspring.

Other types of interaction are possible with alleles at some loci, but most of what little is known about donkey color is covered in the dominant/recessive model outlined above.

It is also wise to remember that genetics is a science of possibilities and is not a science of certainties. Genetics is great at predicting the range of possibilities in the next 100 foals – but not the details of the next one. The challenge, and the fun, is to figure out what hidden information is lurking in breeding animals - what possibilities are there and how to tease them out of the breeding combinations.

Color Details

Final donkey appearance is the result of a single color designation, plus any combination of white patterns superimposed over the color. The real complexity lies in that the final color arises from teamwork at several different genetic locations. Unraveling those combinations can be difficult. The important concepts are that color is distinct from white, and that color is the result of several different choices at several different genetic loci. It is the final combination of these that gives the final single color. Patterns of white can then be superimposed over the final single color, and can do this in any combination.

Most donkeys have an overall body color, and then can have "points" of a different color. In donkeys, the "points" are the

muzzle, rings around the eyes, and also the belly and upper legs. The "trim" can also vary from the overall body color, and includes the mane and tail. The combination of body, point, and trim color give several different possibilities to donkey color.

The relationships between several colors have been well documented. Others, at this point, are more of an educated guess.

Sorrel/chestnut is recessive to non-chestnut. The usual donkey nomenclature calls red donkeys "sorrel" rather than chestnut, but this is a similar genetic mechanism to that in horses. This specific genetic switch is easiest to observe in Mammoths, where the usual choices are black and sorrel. Blacks include two types: homozygous and incapable of producing sorrel, and heterozygous and capable of producing black or sorrel. Sorrels are of only one type - homozygous. The take-home message is that sorrels can pop up as surprises out of black to black matings. Non-sorrel animals that have a sorrel parent or have produced a sorrel foal MUST carry sorrel, and might be useful in a breeding program geared at producing sorrels. At least some Mammoth Jack breeders note that in a given line of breeding with both colors the sorrels tend to be heavier boned (some would say coarser) than the black ones.

Non-dun (or dark) is recessive to dun. The most common choices here include the usual grey dun as compared to black or nearly black. The important issue is that black animals can pop up from gray dun animals, but mating two blacks never yields a gray dun. A gray dun that has produced a black or has a black parent must carry black, and could therefore be useful in a breeding program geared towards producing black animals. This sort of variation is more common in Miniature, Small Standard, and Standard donkeys than it is in Mammoths, where the dun is quite rare.

By combining the information on black/sorrel and non-dun/dun the results are:

	Chestnut	**Non-chestnut**
Dun	Light sorrel/rose dun	Gray dun
Non-dun	Sorrel	Black

The exact shade of the combination of dun and chestnut is uncertain, and might be quite variable. The sorrels in the Mammoth breed almost certainly do not have the dun information in them, as dun is nearly absent in the breed. In contrast, the sorrels in the Miniature breed nearly all do have this information in them, and yet most are nearly identical to the Mammoth color. However, some sorrels are very light, and some reddish donkeys are very light with obvious striping like duns. These are likely to be combinations of dun and sorrel.

Ivory is recessive to dark colored. The usual ivory (blue eyed cream) in Miniatures is also genetically gray dun, but could be modified from any original color to the pale ivory color. Most ivories, however, do retain some barring suggestive of dun. Ivory is the recessive surprise, so the only way for a breeder to assure that the gene is in the mix is to use ivory animals, or ones with ivory parents or offsprings. Ivory is more common in the smaller size classes of donkeys, and is rare in large ones.

Light points are dominant to dark points. The result is that dark points can occur as a surprise, and if a light pointed animal has a dark pointed parent or foal then you know the light pointed animal carries the dark point gene. The dark points are dramatic on a black animal, for then the animal is completely black. The dark pointed variant does occur on any background color, but is more common on gray duns and blacks. It also occurs in any size class, but is more common among Miniatures than in the other size classes.

Other details of color do vary in donkeys, but the genetic basis of these is currently undocumented. Russet animals are similar to sorrels, but have black trim instead of red or flaxen trim (mane and tail). At least one result of a russet mated to a sorrel producing a black foal in the Mammoth breed suggests that russet and sorrel are at different genetic loci. Some few donkeys are bay, with black legs in addition to black trim. Other color variants include brown and smoky, which can be close to black but with obvious striping. How these behave in breeding programs is uncertain. It remains true that when two similar colors are crossed (smoky to smoky) the usual result is to get the same color back. The results following matings to other colors are much more variable.

Patterns of White
Patterns of white include both spotting patterns as well as roaning where the white hairs are mixed into colored hairs. Some of these patterns are obvious, others can be easily missed. Each is independent, and each can be superimposed over any background color. Some combinations are more common than others.

Spotting is dominant to non-spotted and homozygotes do not exist. Mating spotted donkeys to spotted donkeys gives some non-spotted foals (about one third of foals) while non-spotted to spotted usually gives about half spotted foals. The practical consideration is that every spotted animal can produce a non-spotted foal on occasion. This also means that a non-spotted animal cannot produce spots if mated to another non-spotted animal. Regardless of the presence of spotted animals in the background. An essential point is that donkeys with facial blazes but without body spots do breed as if they were spotted, so these animals might be valuable for breeding programs. Animals with only a star do not seem to be the same in this regard, and generally lack the gene to produce spots.

Spotting is most common in Miniatures, Small Standards, and Standards, but is increasing among Mammoths. In Miniatures the spotting is usually on a gray dun background, as this is the most common color in that size class. In Mammoths, the few spotted Jacks are generally on a black background.

Roan is very confusing genetically. It is probably dominant in black based colors, although it appears to be recessive in red based colors. The relationship between roan, frosted, and frosty is not obvious, and has not been well documented. Some of the difficulty may be in correctly assessing the color of all of these animals. Frosted is probably dominant, and its relationship to roan is confusing. When any of these roan patterns is combined with spotting the result can be white foals. The white donkeys, in turn, can produce spots, roans, solids, and whites. These whites are distinct from ivory in that they have dark eyes, and usually have residual small patches of color that rapidly fade while the animal is still young.