

The Genetics of Gait

by
Eldon Eadie

There are only two gene pairs that produce all of the different gaits that are in existence. They are the trot/pace pair and a gait gene pair that acts always as a main gene and sometimes as a modifying gene in a similar manner to the dilution gene that produces the palomino color. The modifier (gait genes) produces gait by changing the patterns of dominance and the way that the trot and pace genes interact. Each foal receives one of the trot/pace pair of genes from each parent. It will also receive a gait gene in varying degrees of intensity.

The trot/pace pair are the easiest to understand so we will talk about them first. They belong to a class of genes called Qualitative genes. They regulate the quality or kind of characteristics in the offspring. The best known qualitative gene pair in horses is the black/sorrel genes that produce color. These genes have a dominant/recessive relationship where black is dominant over sorrel. There are only three ways that qualitative genes can combine—Black/black, black/sorrel, or sorrel/sorrel. Since the sorrel gene is recessive only the double sorrel horse will be sorrel in color. The black/sorrel will be a pure black and you will not know that it has a sorrel gene unless it produces a sorrel offspring when bred to a sorrel horse. The recessive genes can remain hidden for many generations before they appear in a foal. The trot/pace gene pair act in a similar but not identical manner in a completely ungaited horse. You will never see a double trot horse pacing. A trot/pace horse will have a strong predisposition to trot but will sometimes pace, usually only as a foal. A pace/pace horse will have a strong predisposition to pace but will almost always trot as a yearling and even as an adult will occasionally trot or fox trot.

Now so far, this is fairly simple. When a horse has one or two strong gait genes the result is much more complex. Gait genes belong to a class of genes that are sometimes called Poly genes. Poly genes regulate the amount or strength of a characteristic. These genes produce such things as height, length, size, milking ability, speed, rate of hoof growth and so on. The characteristics produced by Poly genes are always evident in every individual of the species, but in different amounts. Let's take height for an example. Each horse has two height genes but there may be as many as a hundred different height genes in the equine species. If you breed a tall horse to a short horse, lets say a 14 hand horse to a 17 hand horse, there are a number of different heights that you may produce. It works like this: The short horse may have one gene producing 6 hands of height and one gene producing 8 hands of height. The tall horse may have one gene for 10 hands and one for 7 hands. The offspring will be either 13, 15, 16 or 18 hands high, depending on the gene it receives from each parent. (This assumes that there are no environmental factors in height and also oversimplifies the genetics of height but is given here as an illustration only.)

The gait genes area a complex type of Poly gene. The main function of the gait genes in horses is to produce the basic walk. All horses have them in some different among. In the ungaited horses they are so weak that they do not change the trot/pace pair. In gaited horses the walk genes (gait genes) are strong enough to interfere (modify) and the result is spectacular and produces a wide range of different gaits. There is only one "kind" of gait gene, but there may be as many as one hundred different "strengths" of gait genes. Each different "strength" of gait combined with the three different trot/pace "kinds" of gait produce variations of gait that we see in the gaited horse breeds. Since the "strength" of the two gaited genes are added together to determine the amount of gait in any individual, you need strong gait from both parents to produce a properly gaited horse. The strongest gait from only one parent will get you half way there. The horse with the strongest gait genes will be the one that can maintain an even gait at the highest speed for its trot/pace type. The only valid test on the strength of gait genes is with barefoot horses that have all received the same basic training, etc. This is an important concept. My great-grandfather spent the last 30 years of his life looking for patterns of dominance between the different variations of gait. He died long before I was born, but as a child I picked up his dream and now have spent over 30 years doing the same thing. It just is not there, and it has been proven many thousands of times by crossing different gaited breeds and by crossing different variations of gait within the same breed.

Now let's look at the different combinations of trot/pace—gait/gait genes. To keep it as simple as possible, we will just call the gait gene pair the modifying factor (modifier). Later on, we will get hopelessly technical about this and use a different set of symbols but for now, we will just use the symbol (M) for a strong modifier, (m) for a weak modifier and (o) for no modifier. The symbol for the trot gene will be (T) and pace will be (p).

Type one (TTo) - Double trot with no modifier - This is one of the most common genetic types in existence. The horse will do nothing but the trot and will likely break into a trot at a slow rate of speed. The basic walk of this horse will be slow and stiff with tight, short strides and very little articulation or flexing. Shoulder movement will be very limited. (Rough gaited at the trot)

Type two (TTm) - Double trot with a weak modifier - This is the fast walker of the trotting breeds. This horse will drift fairly quickly to a fox trot and then a two beat trot. It will not show much head nod at the fox trot. The fox trot may be so close to a trot that you need slow motion video to tell that it is a four beat. The modifier may be more common in the trotting breeds than we realize. (Smooth gaited, long striding, flat walker – strong trotter)

Type three (TTM) - Double trot with a strong modifier - This horse will do an extended walk, a good running walk of moderate speed, a rack, a fast four beat fox trot, and a two beat trot and nothing else. The fox trot will show a jerky kind of head nod. You will never see this horse pace even as a newborn foal. This horse will be an athletic, good moving horse but very obviously a trotter. With a lot of training it is possible to move the flat walk up into the range of the running walk but the horse will always break to a trot at high speed. Shoeing for the running walk does not work very well because you have to put heavy shoes on the back and this creates too much lift in the hind - too much hock action. (Smooth gaited at all gaits including two beat trot. Well, let's say relatively smooth two beat trot)

The five gaited American Saddlebred is a type three and deserves mention here. The pace gene has been completely eliminated from the Saddlebred and the claim is made that the slow gait and rack are not natural gaits of the breed, but are the result of training. Training alone could never produce the rack of the Saddlebred but without training the double trot - strong gait horse may never display that gait. It has a strong predisposition to trot and if just allowed to trot it will never develop an intermediate four beat gait of any kind. The double pace - strong horse is the same. Confirmation and temperament change the way that gait genes work and this is especially evident in the Saddlebred.

Type four (Tpo) - Trot/pace no modifier - This is the ideal horse for the Standardbred when both gaits are required. It will either trot or pace and never do an intermediate gait except the flat walk. Without training it will likely develop a preference for the trot but will do either gait with ease. It will break into the two beat gaits at a fairly slow speed. Makes a poor big lick horse because, even though it can pace, it trots too readily. You very seldom get a horse with two very weak walk genes in the gaited horse breeds.

Type five (Tpm) - Trot/pace with weak modifier - This is a dual gaited horse, common in the Walking Horse breed, but difficult to identify because training will mask the gait so easily. At moderate speed this horse will drift to a fox trot or stepping pace. With patience this horse is capable of a very good running walk. This is the type that must be started in training by flat walk. You fully develop the flat walk (taking months of work if necessary) before you ask for speed. Then you begin to extend that flat walk up into the range of the running walk. As soon as the horse drifts you correct it. Eventually, you will have a good quality walking horse but never one that can compete at speed. Speed is the acid test of the genetics of gait. Actually, type three and type nine are trained the same way if lite shod.

Type six (TpM) - Trot/pace with strong modifier - In my opinion, this is the ideal Tennessee Walking Horse. As a foal, this horse will either trot or pace and even as an adult will continue to do so when in the pasture. May experience some difficulty in sorting the gaits out when first put into training but soon becomes a horse that can easily hold an even gait at speed. Because of this it is easy to push the horse into an extended running walk to develop length of stride and over-stride while still maintaining head nod without heavy shoes. When pushed at extreme speed this horse will break into a canter. It may drift a little to the pace or the trot but not enough to be detected without slow motion video. The great horses from Midnight Sun and back were this type. The type six will be an athletic, loose moving, well balanced horse, but it should also be noted that the ideal gaited horse will have excellent conformation and temperament, etc. Just producing a type six does not mean automatic show quality. These horses may not even display much gait until training begins. Midnight Sun did not gait well until he was a four year old but once he got it together he was spectacular as a lite shod horse.

Type seven (ppo) - Double pace with no modifier - A hard pacer. Never trots except maybe a stumble as a foal. A horse that can pace while grazing. Moves stiffly. It cannot be made to nod properly even with pads, weights, shoes, chemicals, training or alligator clips.

Type eight (ppm) - Double pace with weak modifier - The ideal big lick horse. This horse holds the flat walk better than type seven and will not show the sharp transition to pace, but rather a fairly quick drift through the stepping pace and then to hard pace. This horse can be made to trot with extreme methods, so artificial devices have to be a little more subtle than some of the old-timers used. It can also be used as a heavy shod plantation horse but a but stronger modifier is better.

Type nine (ppM) - Double pace with strong modifier - The ideal heavy shod plantation horse. This horse will sometimes do a trot in the pasture but seldom as an adult and very rarely under saddle. Almost always will show some ability to trot as a yearling. Even the Peruvian Horse that has been bred for the pace gene for centuries will usually show some trot as a youngster. Squares up well with heavy shoes. This horse can even make a good lite shod running walk with a lot of training but can never handle speed without heavy shoes. Left barefoot, this horse will have only moderate head nod and become very racky at average speeds. If you want to promote this type as an ideal walker you either have to go to heavy shoes or start a strong movement among TWH owners to discredit the value of speed in the running walk.

This has been an attempt to lay-out some simple categories of gait, but in reality, there are many more variations and the borderline between types is by no means distinct. Often the only way to tell which type of horse that you have is to breed to a known type several times and classify the offspring. One of the most common variations is in the outcross to a non-gaited breed (one very strong gait gene and one very weak one). There are another half-dozen types from this, none of them properly gaited. Gait, confirmation and disposition are so interdependent that it would be foolish to even try to explain the different results of different combinations. Any attempt to categorize such as this will ultimately fall short of reality but it is useful as a tool in breeding for gait and gives a basic understanding of some of the problems and complexities involved.

Figure 1. The Genetics of Gait

NO GAIT	1. TTo The ungaited trotting breeds	4. Tpo Basic walk/trot/pace - no middle gait	7. Ppo Ungaited hard pacer
WEAK GAIT	2. TTm The fast walkers of the ungaited breeds	5. Tpm Poorly gaited walker - will trot or pace and show some evidence of gait	8. Ppm Big lick stock
STRONG GAIT	3. TTM The ideal Missouri Fox Trotter	6. TpM The ideal natural lite shod Tennessee Walking Horse	9. PpM The ideal stepping pace show horse