**Test Before Breeding**

Genetic Diseases in Quarter Horses and Related Breeds by Heather Smith Thomas
Equine Chronicle- July/August 2009

During the past two decades, research has shed light on a number of important genetic diseases in horses, including several defects that appear in Quarter Horses and other breeds that have utilized Quarter Horse bloodlines. Some of these diseases have cropped up in recent years, originating from mutations in popular animals. Thus the new trait was perpetuated in numerous offspring. Mutations are common in humans and animals, but generally don't cause problems because they are greatly diluted in a very large gene pool. If the genetic change occurs in an animal that has hundreds or thousands of descendants, however, this may affect a wide number of horses.

Some mutations that have caused concern include HYPP (hyperkalemic periodic paralysis), first identified in 1985 and eventually traced back to the Quarter Horse stallion Impressive. Another serious defect, originally termed hyperelastosis cutis and also called HERDA (hereditary equine regional dermal asthenia) was first documented in the late 1960s and finally traced back to Poco Bueno. More recently, a muscle disorder called GBED (glycogen branching enzyme deficiency) was recognized as a killer of foals, causing late-term abortions, stillbirths or weak foals that don't survive very long.

Some disorders are due to fairly recent mutations like HYPP and GBED, while others—like the muscle diseases that cause “tying up” episodes—have been with us a long time, maybe since the Middle Ages. Muscle cramping associated with exercise, or with exercise after a period of inactivity, has been recognized for more than a century. Terms such as azoturia (referring to dark urine), Monday morning disease, exertional rhabdomyolysis, etc. have been used to describe this abnormality and, in recent years, researchers have found there are several forms of this syndrome, with different causes.

Any horse may experience a “tying up” episode, if muscle stress is severe enough, with no underlying abnormality in muscle tissue or function. But some horses continually have problems because of a defect in which muscles collect an abnormal amount of sugar. The predisposing factor for this muscle malfunction is an altered carbohydrate metabolism, or polysaccharide storage myopathy. Some researchers call it PSSM, while others call it equine polysaccharide storage myopathy (EPSM or EPSSM). This muscle condition is inherited and occurs most frequently in heavily muscled horses such as Quarter Horses, draft horses, some warmbloods and other breeds that utilize Quarter Horse or draft horse bloodlines.

Dr. Nena Winand, a veterinary molecular geneticist at Cornell University, researched the HERDA mutation (an inherited skin disorder in some lines of Quarter Horses) and has worked on several muscle disorders in horses and other species. She owns cutting horses herself, and has a personal interest in Quarter Horse genetics.

“The big thing that strikes me about these diseases is the lack of awareness among breeders, even though there are now some genetic tests available. Dr. Stephanie Valberg at University of Minnesota recently developed a test for one type of PSSM. She also identified the genetic basis of GBED (glycogen branching enzyme deficiency), and a test for this disorder has been available since 2004,” says Winand.

**GBED (GLYCogen BRANCHING ENZYME DEFICIENCY)** – This is a mutation that causes inability to store sugar properly as big-branched glycogen molecules. “The glycogen in skeletal muscles, cardiac muscle, or liver can’t be mobilized very well so the foals are weak—and often die in the uterus or in the first days or weeks of life. They don’t have reserves to call on, so this becomes very serious,” says Winand.

This inherited defect was first noticed in 1997 when muscle biopsies from a foal at Kansas State University were submitted to the Neuromuscular Diagnostic Laboratory at the University of Minnesota. It took several more years to pinpoint the problem. Dr. Valberg (Director of the UM Equine Center) in 2001 found that the muscles of these foals had a lower than normal amount of glycogen and an overabundance of abnormal polysaccharide within the cells. Researchers realized that some of the mysterious late term abortions, stillbirths, and weak foals that die soon after birth are due to this condition. Valberg’s research suggests that at least three percent of abortions in Quarter Horses are caused by GBED, and that this defect may now be present in about 10 percent of all Quarter Horses and related bloodlines—such as Paints and Appaloosas—that have incorporated certain Quarter Horse bloodlines.

“Breeders need to become more aware of GBED because it’s not rare,” says Winand. “This disease is so misunderstood that people often don’t have a clue when they lose foals. Many people I talk to have lost several foals and don’t even think to test their stallions or dams for carriers of the affected gene.”

**Points to keep in mind**

PSSM and HYPP both physically affect the carrier horse even if they have only one copy of the gene. (Ex: HYPP: N/H or PSSM: N/P1).

GBED, OWLS, and HERDA only affect the horse physically if they carry two copies of the gene. Meaning for these two, both the sire and dam must be carriers to have an affected foal/horse.

**Test Before Breeding**
HERDA (HEREDITARY EQUINE REGIONAL DERMAL ASTHENIA) – This term simply means dermal weakness in certain areas of the body. It is an inherited connective tissue disorder characterized by abnormal skin that separates readily from the underlying tissues, and tears easily. Any trauma or pressure can literally pull the skin apart. The problem is often not discovered until a young horse goes into training, when the simple act of wearing a saddle creates massive injury to the skin.

In humans there are about 12 different types of this condition—a disorder known as Ehlers-Danlos syndrome—which is similar to the disease in horses. Research at Cornell led by Dr. Winand, and at UC-Davis, and Mississippi State University (where Dr. Ann Rashmir kept a group of affected horses in a study program) showed that the defective gene is a recessive (hidden) trait that must be inherited from both parents in order to show up in their offspring.

This trait has been associated with some of the most popular bloodlines in cutting and reining horses and found in many Quarter
Horse pedigrees—and some Paints and Appaloosas, since Quarter Horse genetics have been used in those breeds. The researchers traced the defect back to Poco Bueno and his immediate ancestors. Skin biopsies were used to diagnose this problem until a DNA test was created. Now breeders can readily determine whether any horse in their herd is a carrier.

All affected horses are related, and all of them are the result of inbreeding and line breeding links that have doubled up the recessive traits. The defective gene did not cause a problem in the earliest offspring of the mutant animal because those offspring only possessed half of the equation; it must be doubled up (one defective gene from each parent) to be expressed. Thus the defect was carried forward in a certain percent of the offspring, without the skin disease showing up, until some of the descendents were bred to each other.

Today, with the inbreeding and line breeding so prevalent in producing top athletes, we’ve seen the skin problem popping up with more frequency. Any horse that traces back to Poco Bueno has some chance of being a carrier. “Poco Bueno horses are a fundamental bloodline in the performance, pleasure and ranch horse industry, and a lot of horses have this in their background,” says Winand. “Some people say they have linebred these bloodlines for years and not had problems, but other foundation linebreeders have produced foals with HERDA.”

All animals have some undesirable recessive traits. “Some of the horses that are carriers are spectacular animals and very athletic, and if you don’t breed them to a related horse you will never double up the recessive trait; you’ll never see a problem. It’s not the carrier that’s the problem. It’s the way we breed them,” says Winand. If people can make informed decisions on how they breed these horses, by testing them first, they can safely continue to breed them, by breeding them to non-carriers.

HYPP (HYPERKALEMIC PERIODIC PARALYSIS) – First identified in 1985, by 1990 this muscle disease was finally linked to offspring of Impressive. He was very popular during the 1980s, especially in the halter horse industry, and his descendents now include Paints and Appaloosas as well as Quarter Horses. The defective gene is inherited as a dominant trait in both males and females and can be passed to offspring by any horse that has it, if the foal receives that gene. Breeding a heterozygous animal (N/H, with one normal and one HYPP gene) to a normal animal (N/N) will result in half the offspring being normal (50 percent chance) and the other half will have the defective gene. Breeding a homozygous animal (H/H, sometimes called a double positive) results in all the offspring inheriting the defective gene, regardless of the status of the other parent. Breeding a H/H horse to a N/H will produce offspring with a 50 percent chance of being H/H and 50 percent chance of being N/H. Breeding N/H to N/H gives 50 percent chance of being N/H, 25 percent chance of being completely normal (N/N) and 25 percent chance of being H/H.

HYPP affects muscle metabolism and affects the transport of sodium in and out of skeletal muscle cells. David McCarroll, DVM (Interstate Equine Services, Goldsby, OK) has dealt with many HYPP horses and he even treated Impressive, at Pilot Point, Texas, when he was in practice there. “I was called to treat him for colic in the late 1970s. In retrospect, he was having an HYPP attack, but we didn’t know it at the time. He was very, very weak, with his front legs and nose on the ground,” says McCarroll. The stallion had already had several colic surgeries during his lifetime, which may or may not have been necessary, since the pain from HYPP could easily be mistaken for colic.

“The primary problem in the muscle is in what’s called the sodium channel. The muscle is closer to being contracted than a normal muscle fiber,” explains McCarroll. “If it takes ‘x’ amount of influence to cause contraction of a muscle, a horse that has HYPP needs only about half the influence required, so that muscle to depolarize. It is thus more susceptible to contraction and will contract sooner, due to electrolyte abnormalities that occur at the cell membrane. The defective sodium channel does not open and close properly to allow the electrolytes inside and outside the cell to move in their normal manner, so the muscle contracts much more readily,” he says. Signs of this muscle problem include muscle tremors and occasional prolapse of the third eyelid. “The classic early sign is muscle twitching and the skin seems to crawl; there are intermittent tremors, especially in the skin of the flank or muscles of the face. The horses also flare their nostrils,” says McCarroll. The horse sweats and has an elevated respiratory rate, often making a raspy sound as he inhales, because the muscles around the pharynx at the back of the throat collapse. Affected horses may drool because of the throat paralysis.

“As the condition progresses, the horse will collapse. No amount of prodding or encouragement will get him up; he is physically incapable of rising,” says McCarroll. The horse may lie there for an extended period of time without treatment, and get up after several hours, but treatment such as fluid therapy can shorten the recovery time. Some horses cannot be saved, however; they collapse and die. Heavy sedation—as when a horse is sedated for dental work or surgery—may bring on an episode, or may result in death of the horse.

“Horses die from this condition either by asphyxiation (the pharynx and larynx collapse and they can’t breathe) or their potassium levels become too high due to the electrolyte imbalance. The heart muscle develops a fatal arrhythmia, blood pressure drops very low, and the heart stops,” explains McCarroll.

HYPP horses are more apt to have muscle problems during exertion. Any type of stress can trigger symptoms—stress of transport, weather changes, illness, or exercise. Whether a horse ever shows symptoms may depend on whether he is H/H or N/H. Being H/H can be fatal to a foal, and these horses may have to be on medication as well as dietary management their whole lives. “It is possible for an N/H horse, however, to live its entire life without a spasm, even though it is always at risk,” says McCarroll. Most N/H horses can be managed by feeding low potassium diets and maintaining a steady work regime, he says.
PSSM (POLYSACCHARIDE STORAGE MYOPATHY) – Symptoms of this condition can include more than just muscle cramping. Some owners report poor performance, lack of energy, trembling after exercise, unwillingness of the horse to move forward, difficulty in backing up, stiff gait, difficulty in performing a balanced canter, unwillingness to lift the feet for hoof care, weakness of the hind limbs, gait abnormalities in the hind limbs due to sore muscles, loss of muscle (atrophy), tense and swollen muscles in the hindquarters, or sensitivity to pressure over certain muscles of the back and hindquarters.

When research on tying up was first begun in the 1980s, people assumed that all muscle cramping was caused by the same reason, but Dr. Stephanie Valberg at University of Missouri recognized that it wasn’t just one syndrome. She used muscle biopsies to detect the different types, working with donated horses to provide a research herd, and using high speed treadmills in her studies. She found there were basically two categories of horses that tie up—those with PSSM (often found in Quarter Horses, warmbloods and draft horses) and those with recurrent exertional rhabdomyolysis (RER), most common in Thoroughbreds, Standardbreds and Arabians. The horses with PSSM accumulate an abnormal amount of sugar in the muscles, and this can be seen in biopsies. “Many of these horses are heavily muscled and generally tie up when they are not getting regular exercise,” says Valberg. “They develop this problem early in life, are very sensitive to insulin, and don’t seem to be able to regulate energy metabolism properly in the muscles,” she says.

Valberg recently found there’s more than one form of PSSM. “For now we are classifying them as Type 1 and Type 2 PSSM. We’ve learned that Type 1 accounts for more than 90 percent of PSSM cases in some breeds and is probably the classic azoturia or Monday morning disease people talked about in draft horses. The genetic mutation that causes this is in a gene called glycogen synthase, the primary gene responsible for making the protein that makes glycogen. In horses with Type 1 PSSM, this is always turned on. No matter how much the horse is eating, the muscles are always telling the body they need to keep making glycogen. They accumulate all this sugar in the muscles, and since the muscle thinks it has to keep making it, it has a much harder time accessing it. So when you start exercising the horse, when the muscles are supposed to be able to access it—to provide energy—they are not able to do that, and tie up,” says Valberg.

In the past, many horsemen inadvertently selected for horses with PSSM because they were trying to breed horses with more muscling. This trait may also go hand in hand with being an easy keeper and having a calm, mellow attitude. “We found this genetic mutation probably started about 1200 years ago, about the time people were breeding the Great Horse to carry knights in armor. These horses were the forerunners of several draft breeds. The mutation may have made horses a little harder (easy keepers), which was once an advantage, but today where we keep horses in stalls without much exercise, with more starch in their diet, this trait manifests as a disease,” explains Valberg.

PSSM Type 1 horses must be managed with a low-starch, high fat diet. “This keeps insulin levels low and doesn’t stimulate the enzyme to keep pushing the muscles toward making glycogen. We also tell people to keep these horses outside as much as possible and keep exercising them. This trains the muscles to both store and access the glycogen to burn it for fuel,” says Valberg. It also trains the muscle to burn fat. Fat in the diet can be used as an alternate source of energy during times the muscles have trouble accessing the glycogen.

Type 1 PSSM is very prevalent in Quarter Horses, and there is a genetic test for this mutated gene. Type 2 is more common in lighter breeds, and researchers are still looking for the cause, though it can be diagnosed by muscle biopsy. The AQHA is funding the University of Minnesota’s research to develop a DNA test for Type 2 PSSM. Both types seem to respond to similar diet therapy. “If a horse has Type 1 PSSM, owners need to realize that if they breed that animal, no matter what they breed to, there’s a 50 percent chance the foal will have this trait, because it is dominant. It is so common in draft horses that some foals end up with 2 copies of the gene and are homozygous for PSSM. Horses are much more seriously affected if they inherit this from both parents,” explains Valberg. “It is important to realize there are many causes of tying up. RER is often seen in Thoroughbreds, but sometimes also in racing Quarter Horses, especially those that have a lot of Thoroughbred blood,” she says. Type 1 PSSM seems most common in halter and pleasure horses. Halter horses, for instance, have been bred for a lot of muscle, and don’t have to excel in athletic events. They can be winners without having to exert very much, so the PSSM may be overlooked unless they have a severe incident. Valberg has seen some halter horses that have both PSSM and HYPP.

The biggest limitation in dealing with these diseases is lack of awareness in general, and lack of awareness of what bloodlines need to be tested. “The muscle diseases are fairly prevalent,” says Winand. “In my experience with tying up in performance horses, I realize that people still need to get this on their radar screen and start checking these horses when they are young—to find out if they will be affected—because they can be managed to reduce some of the symptoms. With good management you can have a horse with a...
Valberg has seen both forms of PSSM in horses as young as weanlings. “The foals seem stiff and may have trouble getting up after they’ve been lying down. They move with a stiff gait,” she says. It’s not uncommon to see the problem show up in halter foals and weanlings, especially if they are fed a lot of grain. “Sometimes the signs are very severe and the young horse has episodes of tying up, especially if it gets sick, such as a bit of pneumonia or diarrhea,” explains Valberg.

“With some youngsters, if you tested them you could know ahead of time and manage them really well from the time they are weaned and minimize the problems,” says Winand. “But some of them wind up getting sold repeatedly and no one really tries to identify or deal with what’s wrong with them.” She strongly recommends sending samples (hair, blood) for genetic testing to University of Minnesota.

Valberg has seen heartbreaking incidents in which a horse had such a problem with PSSM that it could no longer be ridden, so the owners decided to breed it. They thought it would be safe to breed to an animal from another line, then after the foal started to grow up discovered it had inherited the problem.

Every animal has two copies of every gene, one from the dam and one from the sire. A horse may inherit a mutant gene from one or both parents. Since PSSM is dominant, it only takes one copy of the mutant gene to cause it. This is different from HERDA or GBED, which are recessive (the horse must have two copies, one from each parent, to have those diseases). The risk of producing affected offspring from a horse with PSSM is much higher, since there is always at least a 50 percent chance of the foal inheriting the dominant gene. And if the foal gets two copies of the mutant gene (one from each parent) that foal is often more severely affected.

DIAGNOSIS, AND USE OF GENETIC TESTS – Genetic research regarding PSSM has been misunderstood, with some magazines reporting that the cause of this problem has been found. “This is confusing because Dr. Valberg found the cause of just one sub-type of this muscle disease,” says Winand. Further research will probably identify other gene defects that cause similar problems.

“It’s a bit like HERDA. These types of diseases are what we call genetically heterogenous. Mutations in different genes can cause disorders with similar or identical clinical signs. This is well-known in human medicine. In horses we see examples of this—animals that test negative for the known mutation but presumably have a different mutation causing a particular phenotype, and then you have to start the research over to figure out what is causing their problem. This is where we are with PSSM right now; they know that in addition to PSSM 1 there is at least one other fairly prevalent type. Dr. Valberg calls it PSSM 2. We don’t know what the cause is, but we go forward and look at that one, too,” explains Winand.

It is important for people to understand that you still have to do a clinical workup on these horses. “Getting a negative or positive on the genetic test isn’t the whole answer. If a horse with a history of tying up tests negative for PSSM 1, you may still need to do muscle biopsies,” she says. Dr. Valberg has a schematic on the University of Minnesota website that shows how to do this type of work-up to make as specific a diagnosis as possible.

“You can also test for MH (malignant hyperthermia) which is a different mutation which has been documented in a small number of Quarter Horses. This is a type of muscle disease that was already known to occur in humans, pigs and some other animals. Researchers at University of Minnesota have also been working on that,” she says.

Horse owners need to realize that research efforts are ongoing. “We’ve inadvertently selected for PSSM, especially in draft horses and Quarter Horses, perhaps in an effort to get more muscling. It is obvious that certain ancestral Quarter Horse lines had draft blood in them,” says Winand. Looking at photos of some of the old foundation animals gives a clue to this heritage. Breeders selected for muscling and accentuated the muscle problems with selective breeding that often doubled up these bloodlines.

“The PSSM Type 1 genetic test detects about 80 percent of the affected animals in both Quarter Horses and draft horses (though there is at least one other type of PSSM out there, too),” says Winand. Horse owners didn’t have much clue about this until recently, however. “Until the mid-1990s we didn’t have much to go on, regarding research. Now, with all the work being done with genetics, we have more understanding and can move forward, identifying the underlying mutations—and can work backward to see which bloodlines are affected,” says Winand.

“Any horse that has ever tied up, or has subtle indications of muscle problems, should be tested for the mutations we know about. The signs are not always clear. It may show up simply as a gait abnormality, resistance, or a poor response to training. It is important for trainers to first try to rule out a physical or medical basis for a problem if a horse is not responding,” she says. Discomfort may make the horse not want to perform.

“Everyone worries about how accurate these tests are, but they are a start, allowing us to rule in or rule out a specific disorder. We expect to find additional disease genes, or genes that modify the severity of particular disorders, as research progresses. A look at comparable human medicine shows there are ten different genes and probably a hundred or more different mutations in those genes that cause diseases in humans analogous to HERDA. The HERDA defect is responsible for one specific type of skin fragility that is prevalent in Quarter Horses. Eventually some other mutation will crop up in Quarter Horses, in which a normal/normal horse (for the HERDA defect) will develop skin disease that looks a lot like HERDA. This will happen at some point, and geneticists know this. We just have to move forward, knowing that genetic disease is often complex,” she says. New mutations occur all the time.
"At least we have ways now to rule in or rule out certain things, and this is a start. I test my horses now whenever there is a possibility of risk. There is no point, however, in testing clinically normal horses that are not at risk. For instance, there is little point in testing a horse for HERDA if it doesn't go back to Poco Bueno," she explains.

"If you have a clinical presentation of skin fragility, however, it is a good idea to test that horse, whether it looks like HERDA or not, just in case this is a result of a new mutation, or in case there is something we've missed in our understanding of this. We don't want to waste time testing everything, but we do want to test any horses that are at risk," she says.

The cutting horse people have been amazing with the HERDA testing. We have tested the core of the cutting industry—almost all the bloodstock of the major producers. The response has been great. This shows an incredible commitment to managing this problem. In five more years, if we don't have as many affected foals, our efforts will have been successful. And on down the road, if we see a decrease in muscle problems as well, we'll know that testing and awareness of that condition will pay off, too." At this point, however, it's still a learning process.

"One thing we struggle with in these diseases is not knowing how accurate our clinical diagnosis and histopath diagnoses are. This is a challenge, particularly in the early stages of studying a disease, and it remains a challenge in clinical practice," says Winand. "For instance, with HERDA, what we use is poorly healing wounds, wounded skin with no explanation, etc. This is our diagnostic crutch—the first thing we usually see. But this is very subjective, trying to evaluate how fast (or acceptably) something heals. With muscle diseases, if we use histopath, enzyme elevations (where there's muscle damage different types of enzymes leak out of the muscle cells), potassium levels to show muscle damage, etc., these are still somewhat non-specific things. Any kind of muscle damage can cause certain changes. So we do a biopsy and see these, yet this is not the most specific criteria—but in the absence of a specific DNA test, it's all we have. So we have to keep going forward, finding ways to rule in and rule out the possibilities. There is a process we have to go through and there's still a learning curve."

We have identified several genetic diseases in the Quarter Horse breed for two reasons: one is the fact that because of the way some of these horses are bred, there is a lot of opportunity for mutations to be passed to offspring. Second, there was money available from AQHA for research, so these mutations are being identified. Some of these diseases require a doubling up of defective genes from both parents, and due to the way Quarter Horses are often bred, these defective traits have come to prominent attention. With use of shipped semen and frozen semen, a popular stallion can sire hundreds of foals all over the country. And with intense single trait selection in certain disciplines, utilizing inbreeding and linebreeding, some of these genetic defects are now very prevalent in Quarter Horses.

"Any registry that allows (or did allow) use of Quarter Horse blood, whether it's Paints, Appaloosas, Palomino, Buckskin or any other color breed, half Arabs, Quarter ponies, etc. or crossbred horses utilizing Quarter Horse genetics—these horses are at risk of being carriers of these diseases," says Winand. It only takes one cross to a Poco Bueno descendent to have a possibility for a HERDA carrier, for instance, and you might not think about it if you're breeding Paints, Appaloosas, half Arabs, or something else. You might never know you have a carrier until you breed that horse to another carrier. So you need to be aware of these bloodlines, and which horses might be at risk.

In the Quarter Horse breed itself, some people continue to breed HYPP horses, in spite of the fact we now have a test for it, and in spite of the rule change stating that H/H horses can no longer be registered. "HYPP is still prevalent today," says Winand. "Some breeders keep trying to rescind the rules that prohibit registering them. Dr. Sharon Spier, who worked on tracking down the mutation, says that the incidence of the gene frequency in the Quarter Horse breed has not decreased since she developed the test and it became available to the public in 1992. So this is still a major problem in certain bloodlines," says Winand.

The list of genetic defects in Quarter Horses seems to be a long one. "Its not that mutations don't occur in other breeds. We've just become more aware of them in Quarter Horses," she says. No matter what breed you have, you need to pay attention to the animals you are breeding, and notice any abnormalities. "Most people don't clue in quick enough to realize a horse might have an abnormal trait or might pass it to offspring." For instance, there are other types of skin problems, similar to HERDA, in other breeds.

"Mutations keep happening. For in-stance, a young horse we tested recently for HERDA had an isolated area of loose, wrinkled skin on its head but all the rest of the skin was normal. This horse does not have HERDA bloodlines, but we are monitoring it to see what happens," says Winand. If you see anything unusual, have your vet work with a referral center or with experts who study these diseases, so that you can get the best diagnosis, and we can learn more about these conditions.

**A few more genetic defects** - There are several other defective genes that sometimes cause problems. One condition that occurs in certain families of Quarter Horses is MH (malignant hyperthermia). According to Beth Valentine, DVM, PhD, Oregon State University, "The genetic basis for malignant hyperthermia is thought to be the mutation detected by Dr. Monica Aleman at UC-Davis. This is the same mutation that Dr. Valberg at University of Minnesota is looking for as a modifier gene that makes things worse for horses that tie up with polysaccharide storage myopathy (PSSM). The MH mutation is similar to the situation in people. In most cases, however, we are not aware of it, because it generally does not cause problems until the person, or the horse, is exposed to gas anesthesia."

Dr. Valberg says the problem had already been identified in humans, dogs (such as Greyhounds) and pigs. "It's due to a mutation in a gene that regulates a protein that moves calcium around within the muscle cell. If this movement is not regulated properly and excessive amounts of calcium are exposed to the contractile filaments in the muscle (that enable the muscle to contract), then the..."
When Dr. Aleman had 2 Quarter Horses develop severe anesthetic reactions during an experimental situation, she looked at the gene that causes these same problems in humans, and was able to identify a genetic mutation in these 2 horses. "After her discovery we screened a large number of horses that had had muscle biopsies at our lab, plus a large number of normal horses, to see how common this is. We found that the MH mutation is only in Quarter Horses (one bloodline), and in less than 1 percent of Quarter horses," says Valberg.

"This does not explain all of the anesthetic reactions we see, but might explain some of the more severe reactions. Currently the AQHA has funded Dr. Erica McKenzie (Oregon State University) to look at blood samples from Quarter Horses that have had anesthetic reactions to see how much muscle damage develops, and we are working with her to test them to see if they are positive for the MH mutation," says Valberg.

"One thing we discovered, looking at muscle biopsies, is that there's a group of Quarter Horses that have both type 1 PSSM mutation and the MH mutation. This makes their signs much worse when they tie up. Owners have told us their horses not only tied up following very light exercise, but some of these horses died acutely—which is not common with PSSM. Some horses had very high temperatures (up to 106 degrees F) when tying up. When we looked at some of these horses we found they had both mutations. So now we are recommending that if a horse ties up severely it should be tested for both." PSSM is more common—affecting 10 percent of Quarter Horses—while MH is less common, but you might want to test for both if you have any reason to be suspicious. It might save your horse if you know ahead of time, in case he ever needs to be anesthetized. A horse with MH can be pre-treated (60 minutes ahead of giving the anesthesia) with a drug called dantrolene that may minimize the chances for severe reaction.

**End of article**