

Pure Ge



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Clones hit the heart of AQHA's

mandate to steward the breed and the registry.

FEQUINE CLONES. SAY THAT PHRASE TO ANY HORSE PERSON, AND you are likely to get an immediate and adamant response – for or against.

The subject raises a slew of questions: Is cloning morally wrong? Will it help or harm the equine gene pool? Is it an incredible boon for breeders? Does it harm the animals? Or will it help cure equine disease? These are just a sample.

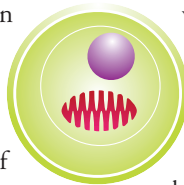
But equine clones are here. Since the first horse clone was foaled in Italy in 2003, the world's population of them has grown to approximately 30, including clones of American Quarter Horses. The commercial cloning company ViaGen Inc. based in Austin, Texas, reports almost 70 cloned foals due this year, from a variety of breeds. And more than 200 American Quarter Horses have their genetic material banked with ViaGen by their owners, in the event they might want to clone them in the future.

It's time for AQHA members to make decisions regarding clones.

AQHA rules currently prohibit registration of clones, but at the 2009 AQHA Annual Convention in San Antonio, a proposed change to Rule 227(a) will be on the Stud Book and Registration Committee agenda. The proposed rule change would allow a live foal produced via a specific cloning procedure – somatic cell nuclear transfer – to be registered if its DNA matches that of a registered American Quarter Horse. (See "AQHA Statement Regarding Cloning" on Page 47.)

Item No. 1 in AQHA's mission statement reads: "To record and preserve the pedigrees of the American Quarter Horse while maintaining the integrity of the breed." The reality of clones poses a challenge to all AQHA members: Could clones affect the Association's ability to fulfill that mission? Or are they one more progression in assisted reproduction technology?

In preparation for Convention, the *Journal* has compiled this article to inform AQHA members on the facts and issues surrounding clones so, as members, you can make the best long-term decisions you can. The breed depends on it.



The Journal staff

What Are Clones?

IN A NUTSHELL, CLONES ARE ALMOST EXACT REPLICAS OF AN original organism.

"There are a lot of factors that make a cloned animal different from the original," said Katrin Hinrichs, D.V.M., Ph.D., of Texas A&M University, a leading researcher in cloning.

"You have to look at the clone as an identical twin of the original horse," she said. "That's the very best way to look at it. And just as identical twins will have some differences, clones may differ from the original animal."

All horse clones thus far have been produced from adult cell donors using a method called somatic cell nuclear transfer. Three mule clones were produced using cells from a fetus.

In SCNT, scientists first take a sample of subcutaneous skin cells from the donor animal. They then transfer one of those cells, including the nucleus containing the donor's DNA, into an egg cell (or oocyte) that has had its nuclear DNA removed. The egg cell comes from any mare.

Scientists then use different methods to stimulate the egg with its new DNA to divide and develop into an embryo.

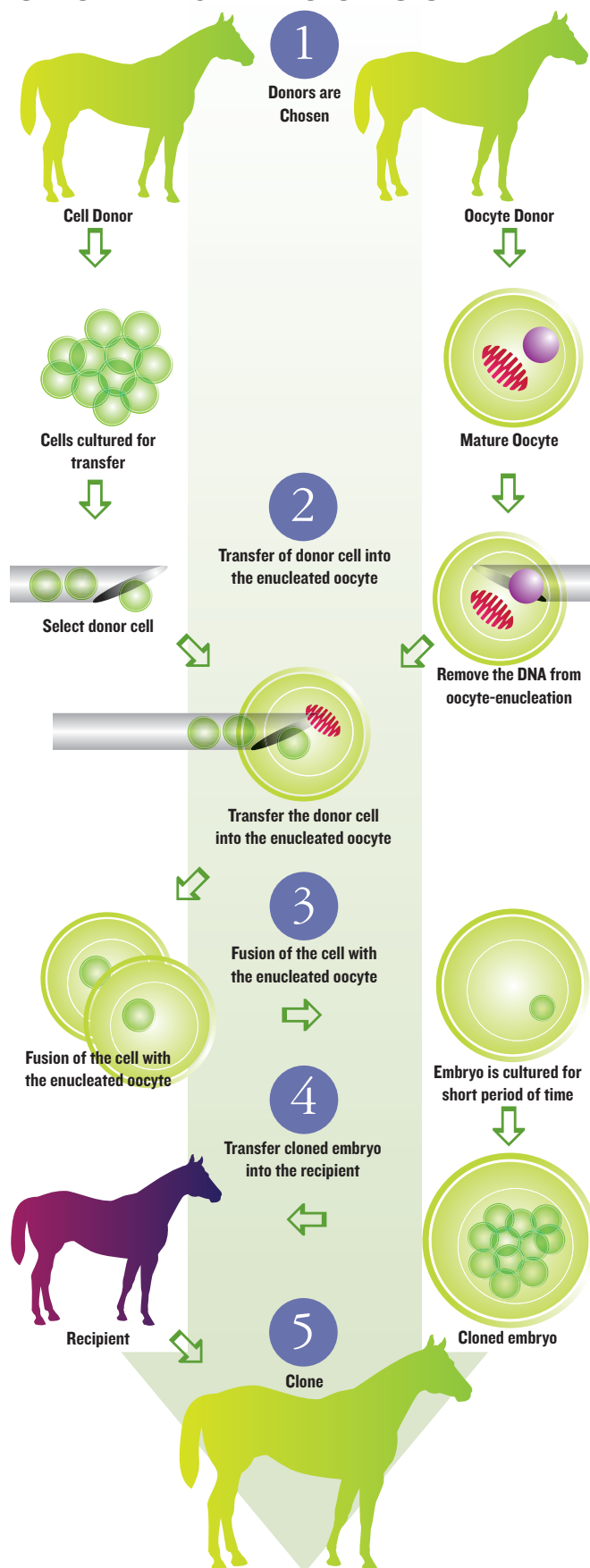
The embryo is transferred to a recipient mare to carry to full term. The embryo may be frozen for storage until it can be thawed and transferred. (See illustration.)

The original and the clone have the same nuclear, or chromosomal, DNA. But Hinrichs pointed out that the clone could have different *mitochondrial* DNA. Mitochondria are organelles inside a cell that produce a cell's energy, and they have their own DNA strand.

"The mitochondria are in a cell's cytoplasm," Hinrichs explained. "They divide on their own and replicate their own

"It's coming whether we're ready or not." AQHA Professional Horseman Jason Martin

CLONING PROCESS



DNA, independent of the nucleus of the cell. Thus, the mitochondria of the egg (used for the cloning) become the mitochondria of the embryo and the foal.”

Hinrichs further explained that cloned females will pass on to their offspring the mitochondrial DNA of the egg used in the cloning process, but cloned males will not. Why? In the normal fertilization process, the sperm cell’s mitochondria are eliminated and only the egg’s mitochondria are found in the resulting foal.

“When a cloned colt sires a foal, his sperm mitochondria are eliminated, and the foal only has mitochondria from the (egg) of its dam,” she said. “So a colt that is a clone will not contribute mitochondria to its offspring, just as a normally conceived stallion does not contribute mitochondria to its offspring.”

“This means that the offspring of the cloned colt should be of exactly the same genetic makeup as would be offspring from the original stallion; however, the offspring of a cloned mare will be different in the makeup of their mitochondria from the offspring of the original female animal.”

Aside from the mitochondrial DNA – which only store about 13 genes as opposed to the tens of thousands of genes in nuclear DNA – clones are genetically identical to the original animal.

Although clones develop from the same DNA as the original animal, environmental factors affect them differently, and they respond as individuals. They may not look or act exactly the same as the original.

Hinrichs gave as example the five clones of all-time leading cutting sire Smart Little Lena that her team produced in 2005 (foaled in 2006).

“We have five clones from one cell type,” Hinrichs said. “They’re all sorrel stallions, and they all have blazes, but the blazes go from being a full blaze to just a star and snip.”

The genetics simply call for white at the extremities and don’t control exactly where the cells actually migrate to on the face and legs, in utero. The Smart Little Lena clones also have slightly different conformation and heights, which could also be a product of the individual uterine environment each had.

A clone’s personality is also affected by how it grows up.

“What kind of environment is it exposed to?” Hinrichs said. “What kind of training is it exposed to? What is the personality of its dam or the recipient mare that carries it? Both the way it looks and how it acts is influenced not only by genetics, but also by environment and the interaction of environment on how the clone uses the genetic blueprint it has.”

Are Horse Clones Healthy?

FOR THE MOST PART, YES, BUT THERE HAVE BEEN PROBLEMS. IN other species, the placenta of many clones does not develop normally, and that is where, to date, most of the problems associated with cloned foals seem to originate.

“We know that in some of our clones, the placenta is not functioning as it should,” Hinrichs said. “We’ve had cloned foals that were born, hopped up, nursed and never looked back, and we’ve had cloned foals that were born and had to struggle to stand, were weak and needed nursing care, resembling a normally conceived foal that had placental insufficiency.”

According to Hinrichs, issues such as crooked legs and contracted tendons in the front legs were seen in some of the cloned foals; they cleared up with everything from no-treatment-but-time to wrapping the legs. Crooked legs have also been seen in cattle clones, and it is thought that their placentas might not be as pliable as normal, restricting movement of the legs while still in the uterus.

WHERE ARE THEY?

There are only three laboratories in the world that have reported the production of horse clones. The Laboratory of Reproductive Technology, in Cremona, Italy, produced the first cloned horse in 2003. Texas A&M University produced the first North American horse clone in 2005 and continues to perform cloning research. ViaGen Inc. is the only commercial equine cloning company in the world; the company has exclusive rights to the cloning technologies developed by the Roslin Institute of Edinburgh, Scotland, where Dolly the sheep was cloned.

These problems, as well as enlarged umbilical remnants and general weakness at birth noted in the clones, are also seen in regular foals, Hinrichs said, but in her experience, the problems were more common in the clones.

Regardless, she was pleased with the live foal rate for the Texas A&M clones. Researchers have produced 14 live foals from 2005 to 2008, of which 12 survived and are currently doing well.

"A little less than 50 percent of our pregnancies produced live foals," Hinrichs said. "And that's very, very good. Of the 54 cloned embryos we transferred, we got 31 pregnancies and 14 live foals. That's a 26 percent live foal rate per embryo transferred."

To put it into perspective, Hinrichs said the expected rate for live calves per cloned embryo transferred is 6 percent, and Russell stated that ViaGen's rate is double that number.

According to ViaGen, those apparent placental issues have been resolved. To date, the company has produced more live equine clones than any other company or research institution in the world – approximately 20, so far.

"There are significant variations in the way that placental formation occurs across species," said Blake Russell, ViaGen Inc. vice president of business development. He pointed out that cattle and sheep have had and continue to have significant problems associated with clone placental formation or development. But he and Hinrichs both said that the problems in horse clones have never been near what has been seen in cattle.

"We believe we had some issues early, but we've significantly evolved the process over the last couple of years," Russell said. "With the current techniques that we are using with horses, we have absolutely no placental issues."

Gregg Veneklasen, D.V.M., of Timber Creek Veterinary Hospital in Canyon, Texas, has foaled out ViaGen's clones since 2007.

"I didn't get to see (ViaGen's) first clones," Veneklasen said. "But I know there were problems. The first foals we had here (in 2007) had some contractions that we fixed. The foals that we foaled (in 2008) didn't have any problems. All of them were born perfect."

"It's like with any new technology, embryo transfer, frozen semen, whatever, you start out, and it gets better."

Currently, ViaGen reports a 50 percent pregnancy per transfer rate; roughly one in two of the cloned embryos the company transfers becomes a viable pregnancy.

"That is substantially better than our historical record," Russell said. "The 2008 transfers have nearly doubled in pregnancy rate relative to previous years."

"Our live foal rate is a function of historical pregnancy rates; that was running just above 25 percent," Russell continued. "For 2009, our expectations are that our foaling rate

will be significantly higher."

Comparable numbers for normally bred equine pregnancies vary and depend on a number of factors, including breed, management practices, etc., but typical live foal rates range from 60 to 80 percent.

Clones appear to age and reproduce normally; the world's first cloned horse, Prometea, foaled a healthy colt in 2008.

"In other species, there is quite a lot of data on offspring of clones, especially in cattle and pigs," Russell said. "There was a tremendous amount of data presented to an FDA risk assessment on livestock cloning (in January, 2008). The conclusion from thousands of data points is that the offspring of clones are completely normal."

"With horses, it's more difficult to supply data to prove that, because only now are the first horses produced reproducing," he added. "However, data from other species indicates that the offspring of equine clones are going to be completely normal."

At this time, David Brown of Gainesville, Texas, is expecting a foal out of his 2006 clone of cutting legend Doc's Serendipity. The clone was bred to High Brow Cat for an embryo transfer; the recipient is due in April.

What Do We Know from Mules?

IN 1999, A TEAM FROM THE UNIVERSITY OF IDAHO AND UTAH State University began work on cloning mules. In 2003, three cloned mules were born, full siblings to Taz, a champion racing mule owned by Don Jacklin of Post Falls, Idaho, president of the American Mule Racing Association.

Dirk K. Vanderwall, D.V.M., Ph.D., DACT, is an associate professor in the animal and veterinary science department at the University of Idaho and among the co-authors of the scientific papers on the team's project.

"Idaho Gem, the first clone, and the third clone, Idaho Star, in essentially all physical and behavioral characteristics, are as similar and identical as I think you can expect them to be," Vanderwall said. "It can be tough to tell who's who when they're standing next to each other."

The second clone, Utah Pioneer, is different.

"All three clones are essentially dark bay, almost brown in color," Vanderwall said. "They don't have lots of white patterning that you can compare from one to the other."

"But even without white markings, Utah Pioneer tends to have an overall darker coat color. Behaviorally, he's not as gregarious, not as people-oriented."

All three clones have been microchipped for identification.

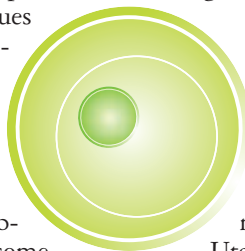
According to Vanderwall, their different behavior pattern can't be explained by the mothering the foals received from different recipient mares. Unlike himself,

Utah Pioneer's surrogate dam was very people-oriented. And people-friendly Idaho Star's surrogate dam would hardly allow herself to be caught.

CLONE ZONE

Researchers from The University of Idaho and Utah State University collaborated on cloning mules. They also created "The Clone Zone," a Web site that explains the cloning process in terms children and journalists can understand.

You can see it at www.uiweb.uidaho.edu/clonezone.



RECENT CLONING MILESTONES

1996 “Dolly” the sheep is born, the world’s first cloned mammal, produced by the Roslin Institute, Edinburgh, Scotland. It was the first time a nuclear transfer was done using nuclear material from an adult donor cell, not an embryonic cell.

1997 Infigen Inc. produces “Gene,” the first cloned cow, from a fetal cell.

2003 The world’s first cloned horse arrives in Italy, named Prometea. She is cloned from the skin cells of an Austrian mare.

The University of Idaho produces Idaho Gem, the first mule cloned from a mule fetus.

2005 Texas A&M University produces an equine clone named Paris Texas, a copy of Quidam de Revel, a European jumping stallion. Texas A&M is the first academic institution in the world to clone six different species: cattle, goat, pig, deer, cat and horse.

The Audubon Center for Research of Endangered Species breeds two unrelated African wildcat clones; the breeding produced the first naturally bred offspring of clones from a wild species.

2006 February 16, Royal Blue Boon Too is born, a clone of all-time leading National Cutting Horse Association dam Royal Blue Boon, the world’s first commercially cloned horse.

She is followed by clones of NCHA legends Smart Little Lena, Tap O Lena, Doc’s Serendipity, Playboys Ruby and 10-time PRCA world champion barrel horse Gills Bay Boy, “Scamper.”

2007 Clones of NCHA legends Lynx Melody and Jae Bar Fletch are born.

The remaining three equine processing plants in the United States close, ending easy access to equine ovaries and large numbers of oocytes necessary for cloning. ViaGen builds an equine cloning laboratory in Alberta.

A clone of Doc’s Serendipity is the first equine clone to be sold at public auction; she brings \$14,000.

2008 The United States FDA passes a final risk assessment on livestock cloning, a review of 700 research studies conducted for 30 years. It determines that food from animal clones and clone offspring are equivalent to food from other livestock.

The world’s first equine clone, Prometea, gives birth to a colt, Pegaso, on March 17.

ViaGen Inc. and U.S. Equestrian Federation formalize an agreement to gene-bank each horse selected for the 2008 United States Olympic Equestrian Team.

2009 Scamper’s clone, Clayton, begins a career at stud in Texas for \$4,000.

“Clearly, there was no direct association from the surrogate mare to the behavior of the foals from their people-interaction standpoint.”

In 2006, Idaho Gem and Idaho Star hit the mule racetracks to mixed success. Utah Pioneer went into racing training in 2007 but never competed. Both Idaho Gem and Idaho Star are owned by Jacklin, who put Idaho Gem into gymkhana competition training in 2008. Utah Pioneer now lives at the University of Idaho campus as a cloning “spokesmule.”

“With limited numbers, it’s hard to draw definitive conclusions on any sort of differences in competitive performance,” Vanderwall said.

Kenneth L. White, Ph.D., professor of animal, dairy and veterinary sciences at Utah State University, collaborated with Vanderwall and Gordon Woods, D.V.M., Ph.D. (now at Colorado State University) on the mule clones. Both White and Vanderwall shared several observations on the pregnancy rates they have seen in them.

“We see a high embryonic loss rate with our cloned mules,” Vanderwall said, “at about 80 percent. In contrast with a random group of mares, on average the early pregnancy loss rate is on the order of 10-15 percent.”

However, according to White, once the cloned pregnancies reach 60 days, “we haven’t really seen any losses.”

“One of the things we’re pretty excited about is that we haven’t seen placental abnormalities in cloned mule pregnancies as have been reported in other species,” White continued. “We feel like that may or may not be due to some of the differences in protocols that we use.”

Vanderwall sees many research questions that clones could help answer, such as what part genetics and nutrition play in osteochondritis dissecans or other developmental disorders. He sees applications in epigenetic research – studying nongenetic factors that cause the same genetic sequences to express themselves differently.

“What genes are ‘turned on’ or what genes are ‘turned off’ can vary from one individual to another,” Vanderwall explained. “They may have the same chromosomal DNA, but the expression of that DNA could differ from one animal to another.”

White agreed: “When you standardize the genetics, it really opens the door to do things that would help us better understand the effects and outcomes of traits and how they are manifested that have absolutely nothing to do with genetics.”

In the meantime, they’ve got three more mule clones due in 2009.

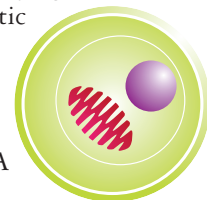
Why Clone Horses?

AMONG AMERICAN QUARTER HORSE OWNERS, THE REASON TO clone is largely for genetics, of course. A less common reason is a chance at repeating the original animal’s incredible performance. (See Page 45 for a list of known clones.)

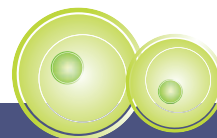
“Clayton,” a clone of 10-time Professional Rodeo Cowboys Association barrel racing world champion Gills Bay Boy, aka “Scamper,” was born August 8, 2006. From the beginning, his legendary rider and owner, Charmayne James, has said she wanted a stallion that could carry on the genetics of the tough and long-lived gelding.

“I know that we can benefit the barrel horse industry by continuing Scamper’s genetics,” James said in a January 2008 article in *Barrel Horse News*. A 1977 son of Gill’s Sonny Boy and out of Drapers Jay by Headed West, Scamper is now 32.

Thus far, James has not indicated a desire to compete on



KNOWN QUARTER HORSE CLONES



HORSE	CLONE	YEAR FOALED	OWNER	PURPOSE
*Doc's Serendipity, mare, 1977 NCHA Futurity reserve champion	Doc's Serendipity-1 (DNA Registry)	2006	David Brown	riding and breeding
*Smart Little Lena, all-time leading NCHA sire	Five clones	2006	Smart Little Lena Syndicate	breeding
Royal Blue Boon, all-time leading NCHA dam	Royal Blue Boon Too	2006	Elaine Hall	breeding
Playboys Ruby, mare, NCHA earnings \$262,441	Playboys Ruby Too (DNA)	2006	Waco Bend Ranch	in cutting training, breeding
Tap O Lena, mare, NCHA earnings \$450,639	Whats On Tap (DNA)	2006	Phil Rapp	in cutting training, breeding
Gills Bay Boy, "Scamper," gelding, ProRodeo Hall of Fame horse	Clayton (DNA)	2006	Charmayne James	stallion prospect
Lynx Melody, mare, American Quarter Horse Hall of Fame horse	Lynx Melody Too	2007	Gregg Veneklasen, D.V.M./Jason Abraham	breeding
Jae Bar Fletch, NCHA Hall of Fame stallion	Two clones	2007	Ernest Cannon	unknown

*performed by Texas A&M University; the remainder were produced by ViaGen Inc.

Clayton; it would be difficult to duplicate Scamper's feedlot-failure to king-of-the-barrels story. But Clayton will stand his first season at stud this year, at the age of 3, housed at Veneklasen's Texas facility; he is advertised at \$4,000, with consideration.

AQHA Professional Horsemen and multiple world-champion trainers Jason Martin and Charlie Cole of High Point Performance Horses in Pilot Point, Texas, have had three horses gene-banked with ViaGen Inc., all geldings.

"I think there are a lot of great horses in our industry that are geldings," Martin said. "I'm interested in cloning for putting new genetics into our breed."

He gave as example Majestic Scotch, a 1994 gelding by One Scotch Delight and out of Two Eyed Natches by Two Eyed Punk. Under the guidance of Martin and Cole, the horse has earned multiple world and reserve world championships in western pleasure and western riding.

"He's a nothing-bred," Martin continued. "Here's a phenomenal horse that definitely could add genetics to our industry if he were a stallion. We geld so many horses when they are young, before we ever find out if they are great or not."

"I'm not for bringing horses like Zippo Pine Bar back and breeding another thousand horses to him. He was a great leading sire and has passed on those genetics through his sons and daughters."

According to ViaGen, there are other genetic benefits to cloning, specifically in replicating individuals that are free of genetic disease or that do not carry a genetic disease.

"Cloning can be a tool to find exceptional individuals from an underutilized pedigree and either create outcrosses that allow you to broaden the genetic pool of animals, or to walk yourself out of genetic concentrations of a gene that was creating some kind of undesirable effect," Russell said.

He pointed out that the cattle industry has already done that in an effort to raise individuals free of curly-calf disorder

in the Angus breed.

National Cutting Horse Association \$2 million rider Lindy Burch of Weatherford, Texas, attempted to clone her 2000 NCHA Futurity winner Bet Yer Blue Boons, aka "Bet," a daughter of NCHA all-time leading dam Royal Blue Boon. In addition to being a top cutting trainer, Burch also has a master's degree in mammalian physiology.

Burch wanted clones of Bet that she could breed – Bet's reproductive success has been compromised by an ovarian granulose tumor – but Burch also wanted to compete on them.

"The reason I tried is because I wanted another chance at training her, to see if she would be the same," Burch said. "Obviously, the environment is different: I'm different, the cattle are different, feed is different, everything is different. Being the biologist that I am, I thought 'What a great research project, and I'm the only one who can do it because I trained Bet.'"

"I thought I'd enjoy her like I enjoyed Bet," she added. "It was a real personal thing for me. I had planned to keep a journal and add information to what we know about cloning."

COURTESY OF VIAGEN INC.



Whats On Tap, foaled in 2006, is a clone of cutting mare Tap O Lena, owned by NCHA \$6 million rider Phil Rapp of Weatherford, Texas.

Burch had no illusions that the clone was certain to perform as well as the original: "Just because the DNA is replicated does not mean you have a 'ditto.'"

Bet's two clones were due in 2006, the same year that Royal Blue Boon's clone successfully foaled at Royal Vista Southwest in Purcell, Oklahoma; all were produced by ViaGen. According to Burch, one of Bet's clones was born with an enlarged umbilicus that hemorrhaged, and the other "had all kinds of things going wrong" and was euthanized at approximately 30 days.

"I'm waiting until the technology gets a little more thorough; there are a lot of unanswered questions," Burch said. "Then I'll probably try it again."

Equine health-related research is another reason to clone.

For example, ViaGen announced in November 2008 that it is working

with the Monash Institute of Melbourne, Australia, to produce embryonic equine stem cells that can be used “to repair tendon, ligament, cartilage and bone damage in horses” without the risk of tissue rejection. Current stem cell treatments use adult cells from the injured horse. Cloning makes it possible to use more adaptable embryonic cells taken from an embryo cloned from the adult.

Why Not Clone Horses?

ODDLY ENOUGH, ONE OF THE BIGGEST REASONS SCIENTISTS GIVE against cloning is also genetics.

“It’s a reproductive technology the impact of which is hard to gauge,” said geneticist and Quarter Horse cutting enthusiast Nena Winand, D.V.M., of Cornell University. “We don’t really know the full effects of cloning right now; we don’t know if we’re introducing mutations (into clones). There is no evidence to suggest that this occurs, but on the other hand, establishing this with certainty isn’t practical.

“The bigger problem is the question of what you do with the clones. That will determine whether or not cloning has a negative impact on the breed.”

Winand said that there are models in the Quarter Horse industry that offer insight into how clones could affect the breed – artificial insemination and linebreeding. Cloning has one thing in common with those practices: It amplifies one individual’s impact on a gene pool.

“Poco Bueno had only 400 foals,” Winand said. “When we came to the next generation, Poco Lena had only two foals, Dry Doc and Doc O’ Lena, and they were great performers. That was about the era when AI was introduced, and you begin to get 1,000 offspring in the next generation.”

Dry Doc and Doc O’Lena each sired more than 1,300 foals. The success of the line in the performance arena resulted in breeders further enhancing its influence through linebreeding.

AI combined with linebreeding amplifies an individual’s ability to influence the breed, more than would happen in nature. The availability of clones, particularly multiple clones for breeding, could potentially amplify such influence further. How much of one individual’s influence is too much?

“I think it is useful to look at whether or not the expansion of an individual’s bloodline is causing the emergence of recessive traits and economic loss resulting from that,” Winand said. “That’s traditionally what we’ve looked at in livestock production as deleterious effects. Are single-trait recessives emerging, and do we have inbreeding depression?”

In Winand’s opinion, the answer is yes. The link between Poco Bueno as a common ancestor and the emergence of hereditary equine regional dermal asthenia is an example. A single trait recessive gene has emerged that causes HERDA and has resulted in a significant economic loss for breeders with affected horses. The prevalence of linebreeding and inbreeding has made the trait more common and made it more difficult for breeders to

breed away from it in the cutting horse population.

Sharon Spier, D.V.M., Ph.D., of the University of California-Davis agreed and gave another example.

“The mutation causing HYPP was found in descendants of the stallion Impressive, and linebreeding resulted in an alarming increase in the numbers of homozygous affected horses, which are more severely affected,” Spier said.

“We have already witnessed in the past two decades some of the positive and negative effects of linebreeding for specialization in the various disciplines of the Quarter Horse industry,” she continued. “Positives being horses suited to a specific discipline and negatives being a loss of versatility. Linebreeding to set type for specialization has certainly contributed to the increased occurrence of genetic diseases.”

If a population of horses is already in danger of being genetically “bottle-necked” with certain bloodlines, Winand pointed out that clones could further that problem.

“We have to maintain enough diversity in the breed through crosses,” Winand said. “What drives evolution is recombination, getting different combinations of alleles together by chromosomal crossing over, by mating different individuals. That’s part of the way genetic selection occurs.”

Ideally, the best clone candidates are animals with great performance records and/or a proven ability to pass on great traits. But what if those desired performance genes are linked to a genetic defect?



Lynx Melody Too is a clone of NCHA legend Lynx Melody, and is owned by Jason Abraham of Canadian, Texas, and Gregg Veneklasen, D.V.M., of Canyon, Texas.

CANDICE BOBSON - VIA GEN INC.

“Many geneticists believe that for a genetic trait to persist in a population, it must have some advantage that breeders purposely or inadvertently select for,” Spier said. “For HYPP, it has been shown that the gene is associated with a phenotype that has been selected for by halter judges.

“Because of the success in the show ring, some breeders have not had the incentive to decrease the frequency of that disease by not breeding affected horses.”

And there is a growing belief among geneticists that there is some link between the HERDA gene and cutting performance.

“We do not know what ‘advantage’ the HERDA carrier has, if any,” Spier said. “But it could possibly be related to performance. If that is true, I don’t believe all people would want to select away from this, even if by doing so it would help the long-term health of the horse as a breed. More research is needed to really understand the consequences of carrying this gene.”

Spier pointed out what would happen if a horse is cloned that is also affected with a genetic disorder, and that clone is introduced into the breeding population.

“We would increase the numbers of affected horses at a much higher rate than is occurring now, and that would not be a healthy situation,” Spier said.

Winand also brought up the scant mitochondrial DNA that clones carry from the egg that was used in the SCNT process (See “What Are Clones?” on Page 41).

“Even the very limited studies that we’ve done show that, among Quarter Horses, there are differences in the gene sequences

encoded by mitochondrial DNA,” Winand said. “There are also sequence differences between individuals from other breeds.”

The mitochondrial DNA an organism has is minuscule compared to its nuclear, chromosomal, DNA. You can test for mitochondrial DNA, but current, standard DNA testing – such as used by AQHA for parentage verification – does not test for it.

Winand pointed out that exactly how mitochondrial genetic variation functionally affects an organism – such as its impact on a horse’s metabolism – has not been well studied. But it could be important, given that mitochondria provide the energy needed for a cell’s basic function.

“It is hard to know whether the source of mitochondrial DNA – the source of the eggs used for cloning – will be an issue,” Winand said. “If mitochondrial genetic variation is a relevant issue, what implications will that have regarding the mares that are the sources of the eggs (or oocytes) used in cloning?”

Other Concerns

HORSEMEN EXPRESS A NUMBER OF ADDITIONAL CONCERNS.

For one thing, would clones reduce competition? It’s a concern that Martin and Cole share. They show primarily in AQHA shows, though Cole also competes as a barrel racer.

“One of my concerns is if it makes horse showing more of a rich person’s sport,” Cole said. “What if those that can afford it could feasibly dominate a part of the industry? I don’t like that. Then you’ve made the industry that much smaller and shoved someone out the door.

“And part of what makes what I do fun is the challenge of finding the next great horse and training it, finding it and bringing it along,” he added. “If you eliminate the finding it part, you take away part of what drives me in the industry.

“I’m fine with using the genetics and competing on the foals, but I don’t want people to be able to show a clone right now.”

It’s no surprise that the American Quarter Horse clones produced thus far have been cutting and rodeo performers, disciplines that don’t require horses to be registered to compete.

A frequent concern that many people express is ethical – they believe it’s wrong to do.

“Instinctively, I don’t believe in it,” said legendary breeder Carol Harris of Reddick, Florida, who owned two-time Superhorse and American Quarter Horse Hall of Fame stallion Rugged Lark. “I’m sure this is not the way God meant for us to treat our animals or ourselves.

“I have given this a great deal of thought and feel it is important to emphasize that cloning has nothing to do with breeding – it is merely a replication of genes. Breeding is creative. And if it is done well, it becomes an art. Cloning is an experiment that only replicates that which was already bred.

“If I claim that I’m a breeder, and if I do a good job, I don’t think I even have to freeze the semen of a great horse,” she added. “If he’s that great, he’s going to have offspring that will reproduce it. So what is the reason for cloning?”

AQHA Past President Frank Merrill added to Harris’ opinion.

“We are not using proper stewardship by using clones,” Merrill said, a longtime breeder and competitor from Purcell, Oklahoma. “Simply because a particular horse was great in our lives does not mean we copy it. We should be responsible for improving that great horse, not going back into the past and trying to continue with genetics that we’ve used over a period of time.”

Bernard Rollin, Ph.D., is a world-renowned bioethicist, animal welfare expert and distinguished professor at Colorado State University, where he teaches philosophy and animal science. He pointed out three primary ethical questions that

AQHA STATEMENT REGARDING CLONES

Within the past couple of years, commercial cloning of a number of horses, including American Quarter Horses, has been well publicized. However, under Rule 227(a) of the AQHA Official Handbook, a rule that became effective in 2004, American Quarter Horses produced by any cloning process are not eligible for registration. While AQHA may not know all of the moral or pragmatic considerations that lead its membership to pass a rule against the registration of cloned horses, one can reasonably assume that the existing science of and experience with cloning of horses at that time was not sufficient to satisfy AQHA’s members that cloning would promote the welfare and integrity of the American Quarter Horse, a fundamental purpose of AQHA.

At AQHA’s 2008 convention, the Stud Book and Registration Committee (SBRC) was for the first time presented with a proposed change to Rule 227(a) that would allow a live foal produced via “somatic cell nuclear transfer” to be registered if its DNA matches that of a registered American Quarter Horse. At that time, the SBRC recommended that any decision regarding the proposed change be postponed pending further study to be undertaken at the direction of the SBRC. The SBRC’s recommendation was adopted by the AQHA Board of Directors.

The SBRC study sought information on the subject of equine cloning from a variety of sources, including ViaGen, the principal producer of commercially cloned horses, and from educational research institutions. As a result, on October 15, 2008, representatives from Colorado State University, Texas A&M University and ViaGen met with the SBRC in Amarillo to discuss the topic of equine cloning.

The proposed change to Rule 227(a) will again be on the SBRC agenda at the 2009 Convention in San Antonio. In an effort to make the most recent information on equine cloning available to AQHA members, AQHA has scheduled an open forum at 2-4:30 p.m. Friday, March 6, at the Grand Hyatt Hotel. It is expected that the forum will include presentations by a panel of speakers from the equine industry and educational research institutions. This forum will be open to all interested AQHA members. Of course, the ultimate goal of this informational process will be to reach a sound decision on the proposed rule change that is consistent with AQHA’s purpose of promoting the welfare and integrity of the American Quarter Horse breed in the long term.

Rule 227(a)

227. Horses not eligible for registration

(a) Horses produced by any cloning process are not eligible for registration. Cloning is defined as any method by which the genetic material of an unfertilized egg or an embryo is removed and replaced by genetic material taken from another organism, added to/with genetic material from another organism or otherwise modified by any means in order to produce a live foal.

pertain to animal cloning: Is it dangerous to the population? Is it harmful to the animal? Is it morally wrong? The third is the hardest to answer because you can’t prove it, he said; it lies within a person’s beliefs.

“Should you clone a horse?” Rollin said. To answer that, you have to ask another question: “Why are you doing it?”

How Do Clones Affect Registration?

OUTSIDE OF ISSUES FOR THE BREED, CLONES POTENTIALLY REPRESENT a significant challenge to AQHA's registration department. There are methods available (age, markings, microchips, and testing of mitochondrial DNA) to differentiate a clone from the original donor horse. In this regard, according to Russell, Viagen would consider microchipping every clone it produced that would be presented to AQHA for registration even before the clone left the company's care. He also added there is the possibility of using iris scan technology to identify them.

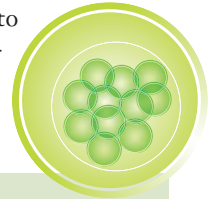
However, unresolved issues arise when it comes to verifying whether a particular offspring was sired by the original donor stallion a clone of the original stallion. That leads to the question: what implications and challenges does the registration of clones hold for maintaining the integrity of AQHA's pedigree and performance records?

So when asked how clones have the potential to impact the Association, Gary Griffith, AQHA executive director of regis-

tration, responded: "I don't think I can answer how it will affect AQHA without knowing whether or not clones will ever be approved for registration. But with that said, they have the potential to affect AQHA simply due to the fact that they exist."

"Cloning creates lineage verification issues when it comes to offspring. We use parentage verification tests to confirm whether a foal is the result a breeding between a specific sire and a specific dam. However, when clones are introduced into the equation, current methods used by AQHA for parentage verification cannot verify the parentage of the offspring of a cloned horse. While I understand that a more advanced DNA test could be used to differentiate the offspring of a cloned mare and the original donor mare because of different mitochondrial DNA, the same is not true for stallions," Griffith pointed out. "Likewise, if a stallion was cloned twice, we are currently unable to verify whether a particular foal was sired by cloned stallion No. 1 or cloned stallion No. 2.

This not only creates issues with respect to maintaining lineage records, but also poten-



CONTRACTING CLONES

ViaGen Inc. of Austin, Texas, is currently the only commercial entity offering horse cloning. The company charges \$150,000 for one clone.

"The client pays 10 percent up front to initiate the contract," said Blake Russell, ViaGen Inc. vice president of business development. "The client pays another 10 percent when the recipient mare is 120 days pregnant.

"The final 80 percent is not due until the foal is born healthy, is 60 days of age and has been examined by a veterinarian to be healthy, insurable and genetically verified to be a match to the original," he continued. "At that time, it is ready for the client to pick up alongside a recipient mare."

Before a contract is entered into, Russell added, ViaGen has a detailed conversation with a client regarding expectations for the clone.

"We discuss what the intended use is for the animal," Russell said. "Cloning is a certain tool to produce breeding animals, because we know that we are carrying the genetics from the original to the cloned animal.

"But from the performance perspective, the client has another set of things to consider," he added. "They are going to have the genetic potential to reproduce that original, but they also have an environmental component that goes into the production of any outstanding performer.

"We stress very clearly to our clients that what we are going to do is produce a healthy, genetically verified identical animal to the original."

Russell also pointed out that there have been no difficulties in insuring the clones for the full price, and there have been no claims to date.

ViaGen also offers gene banking, long-term storage of an animal's genetic material.

"We charge \$1,500 for the procedure, \$150 per year to store it," Russell said. "We store it in liquid nitrogen in multiple locations, so if any one location were to be hit by a tornado or fire, there is always a backup storage of cells."

Equine lawyer Julie Fershtman of Farmington Hills, Michigan, said she has yet to see a sale contract that includes a provision for gene banking or clones, but she knows it's only a matter of time.

"I have never seen a contract in the horse industry that covers that issue, but as technology changes and the way we deal with horses changes, we may have to begin to assess this," she said.

"For example, I'm working on a contract dealing with a stallion that is a

purchase back by the seller. The issue that I raise here is I had to specifically mention that the buyer did not retain any frozen semen. You never would have seen a provision like that in a contract until the last 10 to 15 years or even that. And now we have to worry about DNA."

Western Bloodstock added a clause to its sales contracts in July 2005 that deals with cloning issues. The Weatherford, Texas, auction company specializes in cutting horses.

The clause states: "Owner agrees that exclusive cloning rights to the animal sold pass to Buyer unless otherwise announced. Neither Auctioneer nor the pedigree research company retained by Auctioneer shall be responsible for providing information regarding tissue retained by Owner for future cloning or information as to same year siblings resulting from embryo transfer or for reporting multiple embryos (foals or embryos in utero in recipient mares of the same year) out of dams in the sale; nor shall Auctioneer or the sale catalog company be liable in any way for any Buyer's knowledge/lack of knowledge of information."

Western Bloodstock's attorney encouraged the company to add the cloning clause.

Although there was no legal precedent for cloning horses, there was a case that involved cloned pigs where the judge ruled that tissue samples belonged to whoever owned the animal at the time the samples were taken. The original owner had the right to clone the animal, and the new owner could also clone the animal.

One of the auction company's owners, Jim Ware, thinks the cloning clause is a good idea.

"We knew a lot of horses were going to be cloned and there were quite a few horses that tissue was being retained on, so we recognized the fact that it was something that needed to be addressed," he said. "Basically, our rule says a seller agrees to pass the exclusive right to the buyer unless otherwise announced. We felt a person buying a horse needed to know if tissue had been retained on that horse."

The company made the cloning announcement for the first time at the 2005 NCHA Futurity sales.

"We had quite a few mares that had tissue retained on them," Ware said.

At this time, only the National DNA Registry in Yukon, Oklahoma, is reportedly accepting cloned horses.

tially creates issues with respect to race, show, produce and get records being attributed to an incorrect parent.

“Although we don’t have a proposal to remedy those problems at this time, I have heard that there are people looking into ways of accurately tracking them.”

“When the rule passed there were many unknowns about the technology, about clones and about the entire process,” Griffith added. “It was the board of directors’ decision to prohibit registration of them until such time as those questions are answered and the board members decide they know enough to make an informed decision.”

However, some Association members have additional concerns about the implications to registration.

Griffith said, “Many of our members are concerned that the clones (of mares) will pass along different mitochondrial DNA than the donor animal. In many cases, it might not be from American Quarter Horses or even the various breeds that contributed to the foundation stock.”

All of these various issues could impact AQHA’s ability to maintain the integrity of the breed and the value of a horse’s registration papers.

“Clones can and will be a source of discord among the members of AQHA, with some wanting registration for them and others wanting to forever exclude them from registration,” Griffith added.

That discord on both sides often stems from a genuine desire to see the best for AQHA – the organization and the breed. Take the following opinions as example:

Carol Harris: “I absolutely feel that everyone should be able to experiment with their horses as they choose. But at no time should they attempt to impose that on any existing equine organization. Rules that are broken or carelessly changed can destroy good, old-fashioned respect for our successful past.”

Lindy Burch: “AQHA should control it, not some other pseudo-registry. To me, it would be better to embrace it, for AQHA to control it, not ignore it. It would be better to know what’s cloned and further the technology than to ban it or pretend it doesn’t exist.”

Meanwhile, as the members of AQHA continue to consider the conundrum of clones, NCHA became the first organization to allow cloned horses to compete in aged events. On September 9, 2008, the NCHA board unanimously approved a policy allowing clones to be shown. According to NCHA President Bronc Willoughby, the decision was made after NCHA member and attorney Lew Stevens suggested the committee adopt the policy.

“Lew Stevens recommended that, as a performance horse association, not a breed association, NCHA should allow clones to be shown,” Willoughby said.

Cutting horse trainer Phil Rapp of Weatherford, Texas, has clones of NCHA stars Whats On Tap and Playboys Ruby that he intends to compete on, according to a March 2008 article in *Barrel Horse News*.

Griffith suggests that members continue to learn as much as they can about cloning before AQHA Convention.

“I think members deserve the opportunity to educate themselves on the subject, discuss it with other members and make up their own minds whether or not they feel clones should or should not be registered based on an educated opinion, not just the fact that they don’t like the idea,” Griffith said.

“They should then work toward that end through our normal rule-making processes, and be prepared to accept the outcome at such time as those processes produce a result.” ■

REGISTERING CATTLE CLONES

“Our first clone was registered December 11, 2001,” said Bryce Schumann, registrar for the American Angus Association. “Since the first one was registered, we’ve registered 52.”

During that same time period, AAA has registered approximately 2.4 million cattle.

AAA differentiates cloned cattle by marking the pedigree of the cloned animal with a “clone” notation and the name of the cell donor is listed along with the cell donor’s sire and dam. Each cloned animal gets a unique tattoo or other form of permanent identification.

“The rules are in place to allow registration of the animals,” Schumann said. “It’s just not something that’s taken off to a great degree, while other areas of our registry, such as AI and embryo transfer, those technologies have shown consistent growth.”

Holstein Association USA has seen more use of clones, with about 160 animals registered. Tom Lawlor, director of research, said three types of Holstein owners have been interested in cloning: show breeders, owners of top bulls and sentimental owners.

“We have a big national show, the World Dairy Expo, and for the last several years, the winners of that show have been involved in cloning, so premier show cattle (have been cloned),” he said. “There was interest in cloning bulls because the top bulls would run out of semen. In other words, the demand would exceed the amount of semen they could produce.”

On January 15, 2008, the Food and Drug Administration issued a risk assessment stating “that meat and milk from clones of cattle, swine and goats, and food from the sexually reproduced offspring of clones are as safe to eat as food from conventionally bred animals.”

However, the agency reports that it’s unlikely that foods from clones or their offspring will arrive in supermarkets soon. The numbers are currently too small, and many consumer groups, including dairy producers, have expressed concerns over introducing products from cloned animals, for reasons ranging from persistent safety questions to ethical concerns.

“Many of the people involved are not doing this to make a return on their investment,” Lawlor said. “Most of them are doing it because they have a particular cow that they’re extremely fond of, and they want to hold onto that cow or have another just like her, and it’s more emotional.”

The organization adds an “ETN” suffix to the name of the cell donor when naming clones, indicating that the animal is a nuclear embryo transfer. Each clone gets a unique registration number so that the association can track performance records. There are no limits on the number of clones per cell donor, and the offspring of clones are eligible for Holstein registration.

“The people who have cloned their top cows, I think they find it a fascinating experience to have another one and evaluate the personality on those clones and see and discuss how similar they are to the original one,” Lawlor said.

“So from that feedback that I’ve had and the ones that I’ve seen, it’s been a nice experience.”

Journal staff members including Christine Hamilton, Tonya Ratliff-Garrison and Larri Jo Starkey contributed to this report. To comment, write to aqhjrnl@aqha.org.