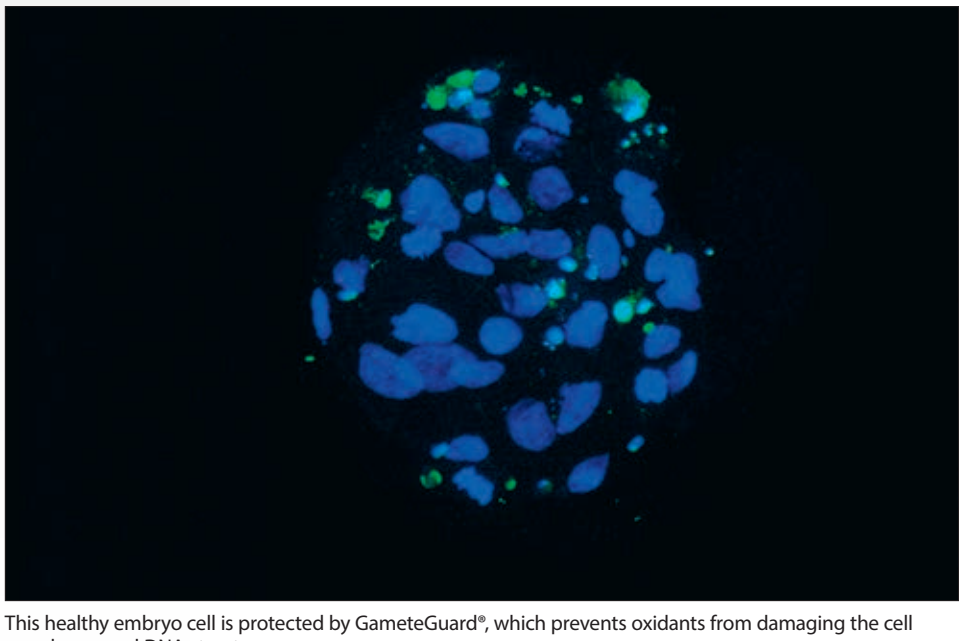
Advancing with Antioxidants

New technology is promising in protecting frozen genetics to significantly improve reproductive success.

by ***Heather Smith Thomas***

Serving as nature's oxidation inhibitors, antioxidants protect cells from damage to free radicals. While recognized as a crucial component of human health and nutrition, antioxidants have proven themselves useful in another arena — reproductive success.



This healthy embryo cell is protected by GameteGuard®, which prevents oxidants from damaging the cell membrane and DNA structure.

A decade ago, scientist Lisa Herickhoff, Ph.D., started Membrane Protective Technologies Inc. (MPTI), a research and development company that develops technologies to enhance success rates in artificial insemination (AI), embryo transfer (ET) and in-vitro fertilization (IVF) in livestock and horses. The company's products, collectively referred to as GameteGuard®, utilize antioxidants to protect gametes from damages caused by thawing and freezing.

Applying the technology

After college, Herickhoff was one of the first two employees of XY Inc. — a sexed semen developer that got its start at Colorado State University. The company's technology was later licensed to ST Genetics of Navasota, Texas, which eventually became Sexing Technologies. At XY Inc., Herickhoff says they were able to commercialize existing technology to increase the number of sperm cells sorted, as well as their health and survival.

"This enabled us to get reasonable pregnancy rates from sexed semen," she notes. "I was fortunate to be involved with this; it was a great way to 'cut my teeth' in this science and learn how to start a small company, and the science behind it."

Returning to the field of antioxidants, which she studied in graduate school, Herickhoff's next job focused on utilizing antioxidants to protect fresh-cut produce such as sliced mushrooms. In the food industry, antioxidants are essential in extending product shelf life. Exposure to oxygen triggers the process of oxidation, which causes the formation of free radicals like peroxides, ketones and

aldehydes. Oxidation results in browning or pigment loss and reduces nutrients like essential fatty acids and vitamins.

Then Herickhoff's dad came up with an idea to apply antioxidant technologies to sorted sperm. "We talked to a friend, Dr. Pat Burns, a scientist at University of Northern Colorado, and he graciously allowed us to work in his lab. We collaborated on developing our first product," she says.

GameteGuard®, as it came to be known, is a plant-based additive incorporated into a semen/extender mixture to protect the sperm cell membrane from harmful oxidants. Oxidants are a natural biproduct of cellular metabolism as well as the environment. They cause damage to the cellular membrane and can result in breaks in the DNA (irreversible in sperm) and can impair fertility. Extensive DNA damage can also cause early term pregnancy loss, about 15-45 days post insemination. The addition of antioxidants will inhibit the impact of naturally produced oxidants and neutralize the oxidants already in the solutions and caused by the environment.

The result is a dramatic increase in conception rates and in AI pregnancies carried to term. With the sperm cell membrane and DNA protected by the product, sperm cells stay healthy and viable. Since male fertility is most affected by sperm quality, protecting sperm cells results in a higher chance of offspring.

Through grants from the National Science Foundation and the United States Department of Agriculture, the company has bred approximately 1,000 cows in robust research trials. In a 2018 trial with Noble Foundation, 50 beef heifers bred AI to one bull resulted in pregnancy rates of 58% using GameteGuard®-treated sperm and 44% with untreated sperm. Currently, the MPTI team is working with a large bull stud to complete a multi-thousand cow breeding trial with dairy animals.

"We get between 10 and 35% improvement in pregnancy rates with AI, and this is exciting," Herickhoff says. "We applied this technology last summer breeding 1,400 sows with cooled semen, resulting in 9% increase in farrowing rate and 293 more piglets born alive."

The technology is also being applied to frozen embryos, as they suffer from the same stressors as cooled sperm. Supplementing the media for in-vitro fertilization and in-vitro culturing has resulted in a great increase in success rates — the embryo quantity and quality improves, with significantly more Grade 1 embryos. Herickhoff notes these protected embryos will be implanted in live cows in upcoming research trials, and hypothesizes pregnancy retention will be improved due to a higher quality embryo based on other research.

Third-party testing

Testing protective technology meant developing tools for appropriate sperm analysis, and in the process MPTI created a third-party quality control business.

"We can examine semen from any species people may be having problems with, or semen they want checked before they use it," Herickhoff describes. "Many people know how to synchronize their cows and detect estrus, but have no way to determine what's in that straw of semen."

MPTI's analyses helps remove risk by giving customers a better picture of the male component of fertility, which accounts for one-third of the fertility equation. It also can help identify if low pregnancy rates are attributed to poor semen quality, or due to human error.

Herickhoff recommends testing every batch of semen because sperm volatility can be affected by illness — it takes 60-90 days for semen to return to normal, including after a low-grade infection that went unnoticed. There is also the human factor. Sometimes batches of semen are not stored properly and harms what is assumed to be high-quality semen.

Veterinarians can also benefit from MPTI's third-party testing. "One of the things we do in our quality control program is help veterinarians with pre-purchase or breeding soundness exams," Herickhoff says. "We're not just looking at sperm motility and morphology, but also the other factors affect semen quality. We examine sperm cells to see if the acrosomes are intact, details about how sperm cell is swimming, and all these assessments that a veterinarian can't do out in the field with a semen check.

"If you know the sperm quality is good before you breed, you'll have a greater chance of a full term pregnancy and more babies on the ground," she adds. HW