The Time Traveler’s Brother
CSU Researchers and Twin Astronauts Investigate the Genetics of Aging
Stand with us and never stand still. In February 2016, the University launched its first $1 billion comprehensive fundraising campaign. The College of Veterinary Medicine and Biomedical Sciences has pledged to contribute to the University campaign by raising $250 million in private giving by 2020.

The magnitude of our goal is matched only by the audacity of our mission: to discover a better tomorrow. Our faculty, staff, students, and alumni are not content with humble goals. They aspire to do nothing less than save lives, cure cancer, eliminate malaria, feed the world, and prepare the next generation of veterinarians, doctors, and scientists.

*Impact* will share their stories of curiosity and discovery. We invite you to champion these individuals as they strive to be agents of change by investing in one of our five strategic campaign priorities.

1. **Competitive Student Scholarships and Fellowships** to attract and reward exceptional students dedicated to creating a better tomorrow for all.

2. **Outstanding Faculty and Research Programs** to inspire the next generation of veterinarians, doctors, and scientists.

3. **State-of-the-Art Facilities** to foster cutting-edge and collaborative research, teaching, and service in veterinary care and the life sciences.

4. **Secure the College’s Future** as a powerhouse in life sciences research and education by naming the College and endowing the Greatest Need fund.

5. **Launch the One Health Initiative** to deliver innovative interventions for healthy systems locally and globally.

To learn more about giving to the College of Veterinary Medicine and Biomedical Sciences, contact the Office of Advancement at *(970) 491-3507* or *cvmbs-giving@colostate.edu.*
Decode the Genetics of Aging
Radiation biologist Dr. Susan Bailey studies the cellular clocks of astronaut twins Mark Kelly and Scott Kelly.

Be a Biotech Entrepreneur
Miles McKenna will use cytogenetics to improve cancer diagnostics.

Save Limbs and Lives
Surgical oncologist Dr. Nicole Ehrhart challenges the limits of cancer treatment.

Stop Cancer in Its Tracks
Kaitlyn McNamara seeks a cure to cancer through clinical trials.

Eliminate Malaria
Vector biologist Dr. Brian Foy is developing malaria treatments to protect more than half the world’s population.

Feed the World Sustainably
Enrique Doster will use veterinary medicine and microbiology to improve food production systems.

Understand and Prevent Obesity
Neurobiologist Dr. Shane Hentges believes the key to prevention and treatment of obesity is in the brain.

Cure Heart Disease
Cardiologist Dr. Christopher Orton develops a treatment for the most common cause of canine heart disease.

Resolve Health Care Disparities
Meagan Chriswell will use culturally competent medicine to improve health care systems in Native American communities.
Astronaut Scott Kelly juggles fruit during his yearlong mission aboard the International Space Station.
In March 2016, astronaut Scott Kelly will complete his yearlong mission on board the International Space Station. As he orbits the Earth at an altitude of 250 miles, he has conducted experiments, repaired systems, tweeted photos of our planet, and watched *Breaking Bad*.

But one of Kelly’s most important contributions to science and humanity may well be both invisible and unavoidable: He is aging.

When Kelly returns from the ISS, he will have racked up nearly 540 days in space over the course of four missions and endured all of the associated stressors of space travel: rocket flight, microgravity, radiation exposure, isolation, and a space station diet.

During Scott’s yearlong mission, his identical twin brother, retired astronaut Mark Kelly, has been in Arizona with his wife, former Sen. Gabrielle Giffords, living a fairly typical Earth life, eating what he wants. (He declined NASA’s offer to provide him with the same diet as his brother) Aside from Scott’s time in space, the brothers have led remarkably similar lives and are nearly identical genetically, so Mark, who has spent 54 days in space, is the perfect control for NASA’s out-of-this-world experiment.

By Sarah Ryan

THE TIME TRAVELER’S BROTHER

AN UNTRADITIONAL TALE OF SCIENCE, SPACE TRAVEL, AND CELLULAR CLOCKS
Each time a cell in your body divides, that cell loses 50 to 250 pairs of telomeres. This is material that the cell can afford to lose. It does not contain crucial genetic information, but it prevents the chromosome from fusing together and harming the genetic code. The cell will divide 50 to 70 times, until the telomeres cease to protect the cell and it becomes pathological or dies. Due to age, environment, stress, exercise, and other factors, as you age your cells also age and begin life with shorter and shorter telomeres. If you live to retirement, your cells will typically have 1,500 pairs of telomeres, and so they will age and die – or become dangerous – much more quickly than those of your grandchildren.

**NEWBORNS TYPICALLY HAVE**

**8,000**
PAIRS OF TELOMERES AT THE END OF CHROMOSOMES

**AN ELDERLY PERSON TYPICALLY HAS**

**1,500**
BASE PAIRS OF TELOMERES

**HOW TO WIND A CELLULAR CLOCK**

In a research lab at Colorado State University, Dr. Susan Bailey, professor of environmental and radiological health sciences, and postdoctoral student Miles McKenna examine Scott Kelly's cells under a microscope, just 36 hours after Kelly's blood was drawn on the International Space Station – an amazing feat in and of itself. The team, including senior research associate Lynn Taylor, is evaluating both of the Kelly twins’ telomeres and levels of telomerase, the enzyme that regulates telomere length.

Telomeres are repetitive DNA sequences at the ends of chromosomes that keep them from fraying or tangling. However, with each cell division, telomeres incrementally shorten. How much telomeres shorten, and how long cells can divide before they can’t do so any longer, depends on both genetics and lifestyle factors. In essence, telomeres are cellular clocks – clocks that speed up or slow down depending on an individual's lifestyle and environment. Go for a long walk or enjoy a relaxing weekend, and your clocks might slow down. Smoke a cigarette or argue with a difficult coworker regularly, and your clocks might speed up.

"Telomere length is inherited at birth, but the rate at which they erode as we age can be influenced by an ever-growing list of lifestyle factors," said Bailey. "Telomeres can provide an informative biomarker of the stressors astronauts experience during space flight, especially during extended time in space. How does life in space impact telomere length, and therefore aging and risk of disease?"

Bailey hypothesizes that Scott's telomeres will be shorter than Mark's at the end of the yearlong mission. If that is indeed the case, Scott will return to Earth biologically older than his twin, and therefore potentially at an increased risk of diseases associated with aging, such as cancer and cardiovascular disease. This is the first time that NASA has embarked on an aging study, an important aspect of spending longer periods of time in space.

**MARS OR BUST**

As one of 10 primary investigators working on NASA's Twin Study, Bailey is responsible for analyzing the cellular changes caused by space radiation, which is far more damaging than the radiation we typically encounter on Earth. Bailey and her co-investigators are all contributing to NASA's understanding of the health risks of long-duration space travel, with the goal of preparing astronauts for the mission to Mars.

NASA plans to send humans to Mars in the 2030s, but before they can launch an astronaut on such a mission, they have to understand the health risks – both acute and chronic – of life in space. Will exposure to space radiation increase an astronaut's risk of leukemia or heart disease? If astronauts develop ill health effects during a mission, how will we treat them? Can we identify which astronauts are more or less susceptible to age-related diseases prior to space flight? If we can, should that influence mission decisions?
For Dr. Susan Bailey, professor of environmental and radiological health sciences, telomeres are an informative biomarker of the stressors astronauts experience in space.
Decade that NASA anticipates sending humans to Mars

54
NUMBER OF DAYS
MARK KELLY HAS SPENT IN SPACE

540
NUMBER OF DAYS
SCOTT KELLY WILL SPEND IN SPACE

23
NUMBER OF CHROMOSOME PAIRS IN EVERY HUMAN CELL

150,000,000
Base pairs of DNA in chromosomes

COMING TO A DOCTOR’S OFFICE NEAR YOU

Just as each star in the night sky hints at potential planets, so each question about space flight leads to a dozen more health concerns and scientific discoveries. But the tick-tock of Kelly’s telomeres is not significant just to the few men and women who will spend time in space. Bailey also contributes to population-based studies here on Earth that assess the impact of stressors such as displacement, wood-smoke exposure, and even oil and gas development on telomere length, which can then be related to other emotional, physical, and biological measures.

“I think that telomere length is a biomarker that could eventually become part of everyone’s typical annual exam,” said Bailey. “It involves only a blood draw, and it provides a very accurate indicator not only of how quickly, but also how well, one is aging.”

As Bailey and McKenna work to decode the telomeres of whole populations, they make it more and more likely that we will eventually be able to read our bodies’ cellular clocks, translating genetic codes that were once thought indecipherable into arguments for making healthy lifestyle choices.
MILES MCKENNA
RADIOLOGICAL HEALTH SCIENCES STUDENT ENRICHMENT AWARD
CLASS OF 2016

AMBITION: I’m a member of the CSU Ventures Ambassador Program, which prepares scientists to become entrepreneurs. It’s taught me to think much more expansively about the potential applications of a scientific discovery. After graduation, I hope to join the biotech industry and use cytogenetics to improve cancer diagnostics.

GRATITUDE: The Radiological Health Sciences Student Enrichment Award was the only reason I was able to attend a full-day training program for young scientists. I learned about securing funding, applying for postdocs, and transitioning to industry. It was a day of networking with scientists in academia and industry, and it was invaluable for my future as an entrepreneur.

STATE YOUR PURPOSE TO BE A BIOTECH ENTREPRENEUR

ENTREPRENEURIAL GRADUATES ADVANCE SCIENCE AND MEDICINE
GIVE TO THE RADIOLOGICAL HEALTH SCIENCES STUDENT ENRICHMENT AWARD

col.st/rhsaward
She might call herself “just a doggie doc,” but when Dr. Nicole Ehrhart operates on a canine sarcoma or peers into a microscope, she sees into the future of cancer treatment – for animals and humans.

Ehrhart is a professor of surgical oncology at Colorado State University. In 2015, she became the first woman in CSU’s history to hold a University Chair when she was appointed to the Ross M. Wilkins, M.D. Limb Preservation University Chair in Musculoskeletal Biology and Oncology. Ehrhart studies ways to prevent limb loss and to regenerate bones and muscle in people and animals whose extremities are threatened by cancer, infection, or trauma. She uses surgical and bone-grafting techniques, as well as biological products and stem-cell therapies.

By Kristen Browning-Blas
Dr. Nicole Ehrhart studies ways to prevent limb loss and to regenerate bones and muscles in people and animals with extremities threatened by cancer, infection, or trauma.
“We’re not just interacting on a mechanical or even cellular level with the body, but with the subunits of biology, using nanotechnology,” said Ehrhart. “That’s opening up an entire new world, one where we have the ability to change how cells interact with the extracellular matrix. It gives me goosebumps, because we are going to make leaps forward in the next 10 years in keeping people and animals whole.”

Ehrhart has been actively involved in limb-preservation research, regenerative medicine, tissue engineering, and sarcoma research for two decades. Her work epitomizes “translational medicine,” in which findings from research into animal disease are applied to human medicine. A recent study holds promise for animal and human cancer patients. “There is some concern that if stem cells can help bone heal, then could they also promote tumor growth. We found that when stem cells are placed at the site of the removed bone cancer, they did not promote regrowth of the bone cancer and could be safely used,” Ehrhart said. “This work answered an important question about the safety of stem-cell use in certain cancer patients.”

Translational research at the James L. Voss Veterinary Teaching Hospital means quicker answers, says Ehrhart. “We are able to make a difference in terms of providing a fast-track option that saves money and saves time to get research from the lab to patients, whether they be four-legged or two-legged. That’s what’s unique about cancer research at CSU.”

In 2015, Dr. Stephen Withrow and Dr. Ross Wilkins presented Dr. Nicole Ehrhart with the Ross M. Wilkins, M.D. Limb Preservation University Chair in Musculoskeletal Biology and Oncology.
SCHOOL: I am in my second year of the D.V.M. program, and I’m studying veterinary oncology with Dr. Nicole Ehrhart. I love working on the clinical trials team. It’s very rewarding to see our research go from the benchtop to the patient and extend lives. Dr. Ehrhart is a phenomenal leader. She gives plenty of support, she turns everything into a learning experience, and she lets you work through problems.

GRATITUDE: I am so appreciative of the alumni who support my scholarship. They’ve helped to alleviate some of my debt and lifted a burden from my shoulders so I can concentrate on school and research. I plan on supporting scholarships someday, because money should never stop a dedicated student from becoming a veterinarian.

KAITLYN MCNAMARA
D.V.M. CLASS OF 2003 AND 2004 SCHOLARSHIP
CLASS OF 2018

STATE YOUR PURPOSE
TO STOP CANCER IN ITS TRACKS

TRAIN THE NEXT GENERATION OF VETERINARY ONCOLOGISTS
AND SAVE COUNTLESS LIVES

col.st/cvmbsscholarship
STATE YOUR PURPOSE
TO ELIMINATE MALARIA

VECTOR BIOLOGIST DEVELOPS MALARIA TREATMENTS TO PROTECT
HALF THE WORLD

By Sarah Ryan

The child whimpering on the ground has a high fever and is too exhausted to sit up or nurse. This is his second or third bout of malaria this rainy season. If untreated, the parasite *Plasmodium* will continue to multiply in his body, and the infection could cause severe anemia, vomiting and diarrhea, brain damage, and even death. Fortunately, his death is preventable, and because he’s participating in a clinical trial led by Dr. Brian Foy, associate professor of microbiology, immunology, and pathology, he will receive the drugs he needs to stop the infection.

Malaria is both curable and preventable, and yet there were 438,000 deaths from malaria in 2015, mostly among children under 5 years old in sub-Saharan Africa. Approximately 3.2 billion people, or one-half of the world’s population, are at risk of malaria, and more than 2 million people will contract the disease this year. Scientists and governments understand how malaria works and have developed effective means of prevention and treatment, and yet the disease continues to take lives, and those are the lives that keep Foy up at night.

“Malaria is a disease of poverty,” said Foy. “The majority of deaths occur in rural areas where people live in huts without window screens and doors, and so they are easy prey for the *Anopheles* mosquitoes that are the primary vectors of the disease. We have to figure out how to break the cycle of transmission while economic development lifts health care systems and families out of poverty.”

Vector control is the best way to prevent and reduce malaria transmission. The two most common forms of vector control — insecticide-treated mosquito nets and indoor insecticide spraying — attempt to eliminate mosquitoes indoors or prevent biting at night, but mosquitoes have developed resistance to the insecticides used and also bite outdoors and during the day. Foy has developed a novel
third strategy, one that uses the mosquito’s food source to prevent transmission.

“The only way you can give me malaria is through a mosquito. After that mosquito bites you and picks up the parasite in your blood, it flies around for two weeks before it’s infectious. During that time, it will take many other blood meals, from humans and other animals depending on the mosquito species,” said Foy. “What if we made those blood meals toxic, so that the mosquito dies before becoming infectious and passing on the parasite to more humans?”

The Nobel prize-winning drug ivermectin is administered annually to villagers in Africa, Southeast Asia, and Latin America to kill the parasitic worms that cause river blindness and elephantiasis. After demonstrating that ivermectin makes human blood toxic to Anopheles mosquitoes, Foy hypothesized that if adults and older children received additional doses of ivermectin during the rainy season, then they would be less likely to pass their malaria infections to the young children in their communities because their blood would prematurely kill the mosquitoes that fed on them.

Last year, with support from the Gates Foundation, Foy conducted a clinical trial in Burkina Faso to test this hypothesis. He administered a higher number of ivermectin doses to villagers and then tracked the incidence rate of malaria among children in the test villages and the control villages, and treated the children for each infection. His data indicates that the ivermectin treatments led to 173 fewer cases of malaria than expected among the 329 children monitored in treatment villages.

It was a promising start, but not enough for Foy. This year, with another grant from the Gates Foundation, he will conduct the first trials of a prototype vaccine that is designed...
to kill mosquitoes that bite vaccinated animals. Like ivermectin, the vaccine targets the mosquito’s neurophysiology. Unlike ivermectin, it will produce an antibody response in the host that could be more potent and longer lasting. This year’s vaccine is for cattle, and the short-term goal is proof of principle, but the long-term vision is to develop a vaccine for people. This will be an altruistic vaccine, one that protects the community rather than the individual.

Altruism is the unnamed superdrug at the heart of the global campaign against malaria. The World Health Organization aims to reduce malaria incidence by 90 percent and to eliminate malaria entirely in at least 35 countries by 2030. Those goals are ambitious but achievable, so long as all of the stakeholders – from the village chief to international policymakers – hold all lives to be equal, regardless of income, age, or gender.

“Everyone deserves a healthy and happy life, not just people who live in wealthy countries,” said Foy. “If we help people who are poor or who live in remote areas, then elimination and even eradication of all malaria could become a reality in this century.”

LEAD THE CHARGE AGAINST THE WORLD’S WORST INFECTIOUS DISEASES
GIVE TO MICROBIOLOGY, IMMUNOLOGY, AND PATHOLOGY RESEARCH

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Women and children prepare food in a Burkinabe village. The World Health Organization’s goal of reducing malaria by 90 percent holds all lives to be equal, regardless of age and gender.

Photo: Hector Conesa
ENRIQUE DOSTER
KINGMAN INTEGRATED LIVESTOCK MANAGEMENT SCHOLARSHIP
CLASS OF 2019

SCHOOL: I am pursuing a combined D.V.M./Ph.D. with a focus on the epidemiology of antimicrobial resistance in food production systems. Our research will add to the understanding of antimicrobial resistance ecology in livestock communities and can help develop smarter solutions to mitigate the upsurge in antimicrobial resistance worldwide.

GRATITUDE: I’m a first-generation United States citizen and a first-generation college student. I’ve always worked to pay for school and to help my family, but with scholarship support I can focus full time on school and science. I’m thankful to scholarship donors who trust me to do something good with my education, and I won’t let them down. I will use veterinary medicine to face the challenge of sustainably feeding a growing global population.

ENCOURAGE THE DREAMS OF FIRST-GENERATION STUDENTS
GIVE TO THE CVMBS SCHOLARSHIP ENDOWMENT
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STATE YOUR PURPOSE TO FEED THE WORLD SUSTAINABLY
It’s a global health epidemic that no country has tackled successfully in 35 years. It’s a risk factor for cardiovascular disease, the world’s leading cause of death, and is linked to 1 in 5 deaths in the United States. More than 41 million children are at risk worldwide, and that number continues to climb. Obesity, a perfectly preventable disease, is one of the world’s biggest killers.

The common-sense solution – eat less, move more – is challenging to implement for reasons that may have more to do with our ancestors’ brains than individual willpower. Calorie-dense foods are cheap and abundant, these foods are
rewarding, and humans expend fewer calories than ever before in our daily lives. In other words, humans in the developed and developing worlds have stumbled into a metabolic Catch-22.

Dr. Shane Hentges, associate professor of neurobiology, believes the key to prevention and treatment is in the brain. Hentges studies the neural causes of eating disorders, including obesity and anorexia, and the long-term consequences these disorders have on brain circuitry. Her ultimate goal is to help identify ways to prevent and treat these disorders.

A variety of internal and external factors can lead to obesity, but Hentges believes that once someone is maintaining too high or too low of a body weight, their neurons are no longer responding normally.

“The imbalanced state becomes the body’s new normal and changing it requires overcoming a strong physiologic response,” said Hentges. “That takes a lot more than willpower.”

Hunger and satiation stem from neurons that send information about the body’s energy state to many different brain regions. When the neurons Hentges studies aren’t activating properly, or at all, obesity or overweight can occur. With anorexia, it appears that these neurons are hyperactivated and release a “don’t eat” signal. In order to better understand how neurons communicate

$2 TRILLION
Health care costs related to obesity worldwide per year

48% INCREASE FROM 2005
with other neurons, it’s helpful to be able to see through the brain. In 2014, Hentges received a Monfort Professorship, the highest honor bestowed by CSU on young faculty. Hentges used funds from the award to bring an imaging technology called CLARITY to campus. CLARITY allows Hentges’ lab to image through intact rodent brains at very high resolution and to study the neurons that are crucial for controlling food intake in ways that haven’t been explored in depth before.

“This capability is huge for us,” Hentges says. “It would be an amazing step forward to actually be able to pinpoint some of the underlying mechanisms of obesity or anorexia. We want to figure out what changes in the brain and metabolism occur under these conditions in order to help people.”

Dr. Shane Hentges prepares a mouse brain for CLARITY, a high-powered microscope. Her lab will use the three-dimensional, high-resolution images to trace the neurons that stimulate food intake.
THE greatest gift that Dr. Christopher Orton can give to a student of veterinary cardiology is confidence. It’s very difficult to detect the first symptom of the most common cause of heart disease in dogs: a heart murmur. When the student puts her stethoscope to a dog’s chest and tries to detect the whooshing or rasping sounds of turbulent blood, she may struggle to hear anything other than the heartbeat. It takes time, experience, and confidence to identify the first telltale sign of mitral valve disease.

Mitral valve disease is the most common cause of heart disease in dogs, affecting 2.5 million to 5 million dogs in the United States. It also affects 2 percent of the human population. The canine heart is very similar to the human heart, with four chambers connected by valves that prevent blood from flowing backwards. When the heart
An X-ray of an artificial mitral valve implanted via catheter through the apex of a canine heart.
contracts, all of the blood in the left ventricle should flow out into the body, but if a dog or a person has a faulty mitral valve, a small amount of blood will flow backward from the left ventricle into the left atrium, resulting in a heart murmur. As the disease progresses, the patient will develop other symptoms, including a cough, lethargy, high blood pressure, fainting, and eventually heart failure. There’s no cure for mitral valve disease. Veterinarians use medications to manage the heart failure and improve the dog’s quality of life for as long as possible. But dogs and their families will soon have a life-saving choice.

Orton, professor of cardiology and cardiothoracic surgery, has spent six years developing a minimally invasive treatment for mitral valve disease. Transcatheter mitral valve implantation, or TAMVI, uses a catheter to deliver an artificial valve through the apex of the heart.

“We have performed the procedure on a few dogs with short-term success,” said Orton. “This year, we are testing the second-generation valve and delivery device. If this works, it will offer a reliable treatment for a condition that is uniformly fatal in dogs.”

Orton is also working on a new drug therapy that will make it possible to prevent or slow mitral valve disease. His research group was the first to show that mitral valves produce serotonin locally, and that serotonin levels are elevated in dogs with mitral valve disease, indicating a potential drug therapy. By working on both drug therapy and valve replacement, his group is aiming both to prevent the disease and to help dogs with advanced heart disease that, until recently, faced certain death.
Dr. Christopher Orton, professor of cardiology and cardiothoracic surgery, has spent six years developing a minimally invasive treatment for mitral valve disease.
Deborah Van Dyke believes in putting her money where her heart is. She facilitated a generous gift of $1 million from The Pocket Foundation to the cardiology service at the James L. Voss Veterinary Teaching Hospital that will build a hybrid cardiac interventional suite that will be the first of its kind in veterinary medicine.

The suite will rival the best facilities in human medicine, and will integrate cutting-edge imaging technology with minimally invasive surgical techniques into one system. This system will make all of the images from a surgery – including the surgery itself, ultrasound, fluoroscopy, patient monitoring systems, and room cameras – available for real-time viewing or playback in classrooms and online.

“Ms. Van Dyke’s gift gives back to the animals that made it possible to develop therapies that are now mainstream in human medicine,” said Dr. Brian Scansen, professor of clinical sciences and cardiology service chief. “We will now be able to use interventional cardiology in animal patients and to share our discoveries more broadly with veterinary students, veterinarians, and doctors. These advances in cardiology and education will, in turn, accelerate the development of human medicine.”
MEAGAN CHRISWELL
DR. ALAN TUCKER MEMORIAL SCHOLARSHIP | BIOMEDICAL SCIENCES SCHOLARSHIP
CLASS OF 2016

ROOTS: My dad and my grandfather were inventors who raised me to be inquisitive. I view each new scientific problem through my inventor’s lens. I am always seeking a better solution, whether I’m working on infectious disease research or using music therapy to improve the well-being of Alzheimer’s patients.

AMBITION: After graduation, I hope to attend an M.D./Ph.D. program. I want to apply my training in infectious disease and immunology to mitigate health disparities in Native American and rural communities. I am a member of the Cherokee Nation, so I have a personal stake in using culturally competent medicine to improve health care systems on reservations and across reservation boundaries.

ADVOCATE FOR TOMORROW’S DOCTORS, SCIENTISTS, AND PROBLEM-SOLVERS

give to the biomedical sciences scholarship

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STATE YOUR PURPOSE TO RESOLVE HEALTH CARE DISPARITIES
For the first time in nearly 150 years, a herd of American bison has returned to its historic range in Northern Colorado. The Laramie Foothills Bison Conservation Herd will conserve heirloom genetics from Yellowstone National Park and play an important role in balancing the ecosystem health of the Soapstone Prairie Natural Area and Red Mountain Open Space.