Equine Guelph
Research Update

Fall 2014

helping horses for life

ETA for EAG?

FINDINGS COULD PROVE HELPFUL IN DIAGNOSING FETLOCK INJURIES

One cannot help but get excited about the possibilities for electroarthrography (EAG) as a diagnostic tool after speaking with Ontario Veterinary College researcher, Dr. Mark Hurtig. He is developing a non-invasive way to assess joint cartilage health in fetlocks (the most commonly injured joint in horses). Current technologies to assess fetlock health have their limitations. Veterinarians mainly use physical exams, diagnostic injections, x-ray images and ultrasound – yet these methods provide no information about the quantity or health of the articular cartilage that is critical for pain-free joint function.

Electroarthrography (EAG) is a novel method for easily assessing cartilage quality. Dime-sized electrodes are placed on the skin to record electrical signals produced by joint cartilage when loaded and unloaded. Researchers from the Université de Montréal and École Polytechnique reasoned that electrical signals might be measured on the skin surface similar to electrocardiography (ECG) for the heart. They found that people with knee arthritis had lower electrical potentials than normal people. So the concept of electroarthrography (EAG) was born. Hurtig's contribution—with his team of postdoctoral fellows and graduate students—is applying the technique to horses by performing validation studies in cadaveric limbs, in which electrical signals can be directly correlated to cartilage quality.

Electroarthrography (EAG) is a novel method for easily assessing cartilage quality.

Hurtig explains, *"We thought that the fetlock might be a good place to start in the horse since the cartilage surface is close to the skin without any bulky muscles overlying the joint."* Preliminary data from cadaveric forelimbs of horses under simulated weight bearing have shown that EAG signals can be easily recorded from the fetlock and are altered by damaged or osteoarthritic cartilage. When the cartilage is deliberately damaged with an enzyme like those found in osteoarthritic cartilage, it produces lower EAG signals. Once this validation study is complete, the next phase is to apply EAG to normal and lame horses.

In a preliminary live-animal test, electrical signals were recorded from fetlock joint cartilage while the horse was being pushed side to side while standing on a steel force platform. Human researchers have adopted the same technique using a Wii (game) platform. Software correlates the electrical signal on the skin surface of the knee to the timing of weight shift sensed by the platform. The strength of the EAG signal under the same weight indicates the status of cartilage health. In an eroded or damaged cartilage surface, the water and protein content changes resulting in a decline of electrical signals.

continued on page 2...

Welcome to the annual newsletter reporting on equine research activities. If you have read previous research newsletters, you will be familiar with the names of many of the world-class investigators at the University of Guelph. In this issue we will start introducing you to the supporting casts — the students, post-doctoral fellows and assistants who do much of the hands-on work. Cristin McCarty is the first of many.

Dr. Jeff Thomason, Co-Chair
Equine Guelph Research Committee

UNIVERSITY of GUELPH

CHANGING LIVES
IMPROVING LIFE

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Since a horse is too heavy for Wii and a platform will not be portable for on-farm assessment, an instrumented horse boot (capable of recording weight bearing while the EAG signal is recorded) is being developed by other collaborators in the University of Guelph, School of Engineering.

Future research will include localizing cartilage damage by loading different parts of the fetlock joint using wedge pads. Hurtig explains, "*If we are successful it could mean that we can diagnose cartilage damage years before conventional methods.*"

Electroarthrography could prove clinically useful in diagnosing hard to pinpoint lameness such as early osteoarthritis. Dr. Hurtig also points out EAG could be used in similar contexts as diagnostic ultrasound in tendon injuries, which has been useful in establishing when it is safe to step up rehabilitation or return a horse to work.

Funding for this research has been provided by Biomomentum Inc., Natural Sciences and Engineering Research Council of Canada (NSERC) and Equine Guelph.

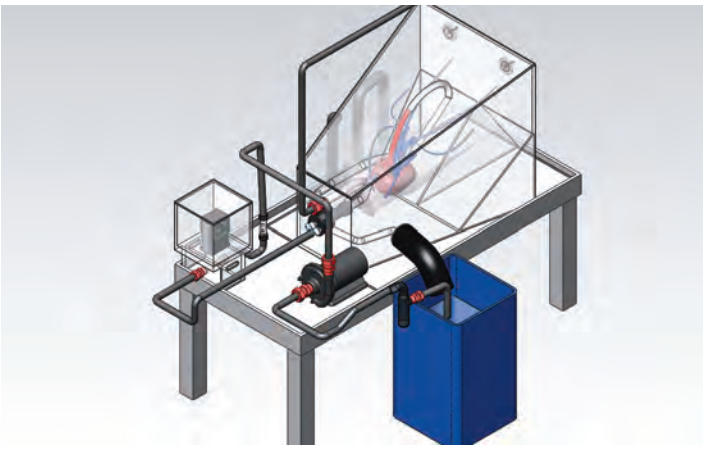
Story By – Jackie Bellamy-Zions

Investigating Arterial Calcification

In humans, the findings of arterial calcification in high pressure artery vessels and the links to cardiovascular mortality, coronary morbidity and fatal stroke are known. Why arterial calcification has been found in 80 percent of racehorses studied, is still under investigation. Diet and lack of exercise are culprits in humans. Dr. Luis Arroyo, Ontario Veterinary College researcher, can attest this is not the case in young, fit race horses (Thoroughbred, Standardbred and Quarter horses) he has examined post-mortem. Finding out what causes arterial calcification in horses in order to be able to screen for it in the future is one of the challenges. Interestingly, other breeds Arroyo has studied, such as Warmbloods and Arabs do not seem to be as affected.

Arroyo says, *"Recently funded intravascular ultrasound equipment is expected to bring about significant advancement in the research."* Researchers will soon be able to use a specially designed catheter and miniaturized ultrasound probe to provide imaging of blood vessels from the inside out. Perfecting catheter design is currently under development. Ensuring correct sizing is imperative as the frequency of the ultrasound will determine how deeply the catheter penetrates while maintaining a good visual.

Arroyo explains there are currently three branches of the study: 1) a histological assessment of damaged vessels using staining to determine the degree of the arterial wall damage, 2) ex vivo studies (using a model) looking at the effect calcification has on the physiology of the vessel and 3) measuring biomechanical changes and looking at the effect calcification has on vessels.



One branch of Arroyo's studies uses this ex-vivo model to study the effect calcification has on the physiology of muscle.

Before moving on to treatment and prevention, Arroyo and his team must establish how arterial calcification alters normal function of the arteries in horses.

Funding for this research has been provided by Canada Foundation for Innovation and Equine Guelph.

Story By – Jackie Bellamy-Zions

Join the Circle and 'Help Horses for Life'

FULL CIRCLE responsibility

Join the circle supporting Equine Guelph as we work together with the horse industry, to improve equine welfare with our Full-Circle-Responsibility program. Equine Guelph is teaching vital skills in horse care in order to contribute to the reduction of welfare issues.

"Your donation to Equine Guelph helps fund groundbreaking work that is making a significant difference in the lives of our horses. Your support is truly appreciated," Gayle Ecker, director, Equine Guelph.

All donations are eligible for a tax receipt, and every amount makes a difference.

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Tracking Map Aids Disease Prevention

A disease-tracking map created by Guelph veterinary experts might be the first step to preventing domestic animal diseases from spreading.

The interactive, online "Worms and Germs" map created by University of Guelph professor Scott Weese, Pathobiology, and former grad student Maureen Anderson, now at the Ontario Ministry of Agriculture and Food, is designed to track the spread of infectious diseases in dogs, cats and horses.

Veterinarians from around the world will be invited to provide animal data, allowing researchers and veterinarians to determine where important diseases are occurring and to help identify outbreaks.

Weese said the map could also help prevent zoonotic diseases that hop from animals to humans. Viruses and bacteria tend to travel along with their domestic hosts.

Canada's east coast has seen a recent increase in Lyme disease, a bacterial infection carried by ticks that bite domestic animals and then humans. The disease can lead to rashes and occasionally fatigue, joint and muscle pain. Until now, the extent of the problem in animals has been unknown, as experts have lacked a way to track these cases and make information publicly available.

"Knowing where pets are getting sick can help indicate where the same risks are present for people," said Weese.

"Since human diseases aren't being mapped like we are doing for animal diseases, we might have better data on animal aspects than human aspects for some conditions. Knowing where an infectious outbreak occurs in animals lets us know where it should also occur in people. If doctors and public health officials realize animal cases are occurring in the area, it increases the need for them to consider it in people."

Weese handled overall planning and content for the map and employed a website design company run by a veterinarian. He paid for the site through his Canada Research Chair in zoonotic diseases. Only veterinary technicians and veterinarians who register for the site will be able to enter clinical and test data.

Until now, disease monitoring has occurred informally and researchers often have had *to catch up to the spread of new diseases.*

"Often, questions come up about the distribution of diseases and knowing where and when diseases occur is an important aspect of figuring them out," Weese said.

"For zoonotic diseases, providing information about where animals are getting sick could be useful for public health and medical personnel. Another aspect is just increasing general understanding of infectious diseases by vets and the general public."

Weese said preventing spread of zoonotic diseases can be simple.

"Many zoonotic diseases aren't difficult to control and basic practices can reduce the risk. We can never eliminate the risk though and failure to use good practices is not uncommon. This map gives us one more tool to fight against the spread of these diseases."

For media questions regarding this article contact Communications and Public Affairs: Lori Bona Hunt, 519-824-4120, Ext. 53338, lhunt@uoguelph.ca; or Kevin Gonsalves, Ext. 56982, kgonsalves@uoguelph.ca

The Value of Research to the Health and Welfare of Your Horse

This summer we began a new initiative – tracking down the many places that research funded by Equine Guelph (EG) is used in the equine industry. Preliminary results surprised us pleasantly with the number and variety of places that our work appears – and we will be sending out short, targeted surveys to gather more information in the near future. Check the EG website in September to find them (and other equine organizations will also feature). Even at this early stage it is clear that EG-funded research and EG's education activities are bringing about positive changes in many sectors of the horse industry. From big companies and large stables to vets and farriers and one-horse owners, our research is benefiting the health and welfare of horses. We look forward to bringing you specific examples in a future newsletter.

EQUINE GUELPH
helping horses for life

Story By – Dr. Jeff Thomason, Co-chair, Equine Guelph Research Committee

Rhodococcus Retrospective

This research is not quite as "old as dirt" but *Rhodococcus equi* is an insidious soil bacterium that has kept Ontario Veterinary College researcher, Dr. John Prescott (along with many collaborators), busy for almost half his career. When a journal article suggests renaming the bacterium after you, an impact has definitely been made. Although Prescott modestly thinks that the official *R.equi* name may not change to *Prescotella equi*, his unwavering determination and contributions to the research for combating this nasty respiratory disease are admirable. Officially retired as of May 2014 but still weaning himself away from the laboratory, Prescott is a walking library of information on *R. equi*.

He can recall the bleak diagnosis 35 years ago for foals inhaling the horrible bacterium which would end in pneumonia and suffocation. Not much was known about the causes of this pneumonic disease back then but Prescott was resolute in his quest for understanding the bacterium to bring about a cure.

Horses were in Prescott's genes long before genomic discoveries furthered his extensive research on Rhodococcus.

Fearlessly climbing aboard work horses on the farm as a toddler, horses were in Prescott's genes long before genomic discoveries furthered his research. Armed with a background in diagnostic bacteriology, Prescott came to Guelph in the late 70's. Back then foals with *R. equi* (named Corynebacterium equi at that time) symptoms were treated unsuccessfully with antibiotics. Finding a more effective combination of drugs followed on the heels of much study into the pathology of the bacterium and the development of a capsular serotyping scheme to find out more about the make-up of the cells and how to get the antibiotics into the affected foal's macrophages. This six-week, fairly expensive treatment, remains the standard today as researchers continue to strive towards a vaccine. A vaccine that would need to be capable of fully protecting foals within the first three weeks after birth is a challenge since the foals' immune system is still maturing. Vaccinating the mare for *R. equi* has proven unsuccessful since the antibody passed on in colostrum will only last three to four weeks and foals can contract the disease up to eight weeks or more.

Researcher interest began to grow and a small group of scientists met for the first Havemeyer workshop to discuss their thoughts on the disease in 1986. Prescott credits the Havemeyer Workshops as being tremendous for focusing the ever-growing international community of researchers on *R. equi* and for cementing relationships, exchanging ideas and encouraging collaboration.

Prescott regards one of the greatest innovations of the research as being the discovery of the virulence plasmid (small piece of DNA) of *R. equi* in the early 1990's. This led to discoveries on how this soil organism becomes a pathogen capable of causing disease within the foal. The plasmid is thermo-regulated so that when it enters the foal from the soil, the

1979 — First paper on *Corynebacterium equi* published at Guelph, on immune response to infection

1980

1981 — Development of a capsular serotyping scheme *Corynebacterium equi*

1982 — Development of first effective "standard" combination drug treatment for foals

1983 — Description of detailed pathology of intestinal and pneumonic disease

1984

1985

1986 — 1st Havemeyer Workshop on *Corynebacterium equi*, Guelph; Broad acceptance of change of name to Rhodococcus equi

1987 — First demonstration of immunizing effect of oral infection with *R. equi*

1988

1989

1990

1991 — *R. equi* emerges in the 1990s as a major infection of human patients with AIDS; a 1991 review article on *R. equi* as a pathogen of animals and humans is Dr. Prescott's most widely cited paper

Association of a large plasmid with virulence in *R. equi*, a critical co-discovery with Japanese workers

1992

1993

1994 — Demonstration of resistance to the two "combination" drugs used to treat *R. equi*

1995 — Cloning sequen the ma plasmic encode virulenc associa protein *R. equi*

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increased temperature it encounters in the foal allows rapid adaptation and turns on the virulence genes. A well-known thermo-regulated virulence plasmid is also found in the "Black Death" plague pathogen of humans.

Another great advance in the mid 2000's was the assessment of oral immunization using a virulent *R. equi* which proved foals could be fully protected by three weeks of age. Realizing that the organism could be crippled by mutating some of its pathways established real possibilities for vaccine development using a vaccine that could be given orally to young foals.

"*The advances in genome sequencing were revolutionary in putting together the puzzle pieces,*" Prescott explains. "*We gained understanding about the virulence's metabolism, what it needed to survive, its weak spots and how we could go after it.*" The much needed vaccines currently in development are progressing ahead based on this illuminating insight. One of Prescott's Ph.D. students, now working in Edinburgh, Scotland, continues to work on an injectable vaccination based on using an antigen to interfere with the bacterium's ability to get inside of macrophages. Yet another study in Europe has been developing a live attenuated vaccine to be administered rectally.

When asked how research into *R. equi* has progressed over his career Prescott says, "*The field is immeasurably advanced compared to 35 years ago. Back in the 70's you would be lucky to find one page of literature on the topic and now the understanding has yielded a great many chapters. The end of the story has got to be vaccines.*"

Funding for this research has been provided by the Ontario Ministry of Agriculture and Food (OMAF), the Natural Sciences and Engineering Research Council of Canada (NSERC) and Equine Guelph. The T. Havemeyer Foundation has provided many invaluable opportunities for collaboration with its workshops.

R. equi is able to hide in the very macrophages which normally destroy invading bacteria. *R. equi* loves hot dusty environments and lurks in soil and manure. It is "coprophilic" (manure loving), easily extracting nutrients from manure. Foals should be closely monitored for signs, especially in those under six weeks of age.

Early warning signs for Rhodococcus include:
- Coughing or panting (monitor respiratory rates diligently)
- The young foal may go off its feed or stop suckling

Preventative Measures include:
- Avoiding turn-out in sandy environments
- Not overcrowding paddocks and removal of manure
- Taking temperatures (as foals may look fine and first signs can be subtle)

Diagnostic techniques include:
- Ultrasound
- Lung washes
- Cultures

Story by: Jackie Bellamy-Zions

1997 — Demonstration of immunizing potential of VapA in mice; demonstration of potential harmful effects of VapA immunization in foals if it drives the wrong type of immune response; Development of first *Rhodococcus-E. coli* plasmid shuttle vector so that DNA can be moved from *E. coli* into *R. equi*; Demonstration that virulent *R. equi* modulate the immune response of foals

1998 — 2nd Havemeyer Workshop on *Rhodococcus equi*, Guelph; Serological studies at Guelph show that antibody to VapA is widespread in horses.

2000 — Complete DNA sequencing of two *R. equi* virulence plasmids by a Japanese-US-Canadian researcher consortium

2001 — 3rd Havemeyer Workshop on *Rhodococcus equi*, Edinburgh

2003 — Demonstration that foals that develop *R. equi* pneumonia have a misdirected immune response; Demonstration of plasmid gene expression by *R. equi* growing inside phagocytes; Improved understanding of virulence plasmid gene function; Demonstration of importance of nutrient pathways for survival of *R. equi* in phagocytes

2006 — 4th Havemeyer Workshop on *Rhodococcus equi*, Edinburgh

Assessment of virulence of numerous targeted mutants to try to develop a live oral vaccine

2010 — Complete genome sequence of an equine *R. equi* strain originally isolated in Guelph by an international consortium of researchers

2012 — 5th Havemeyer Workshop on *Rhodococcus equi*, Normandy

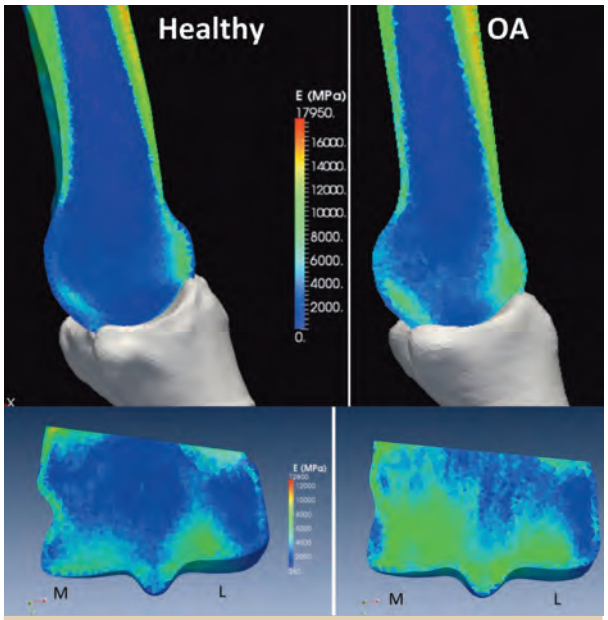
2013 — Proposal to rename *R. equi* as *Prescotella equi*

The Impact of Impact on Bone Health

Ontario Veterinary College graduate student, Cristin McCarty, is no stranger to joint health issues having to work through her own athletic injuries from rowing. As an avid rider since age five, McCarty bought an ex-racehorse in her early teens for repurposing into a hunter/jumper and immediately began an education in joint problems and maintenance options aimed towards keeping her newly purchased horse sound. McCarty's interest in how osteoarthritis begins was born from experience. After pursuing an education in biology, McCarty was very excited to be given the opportunity to work with Dr. Jeff Thomason and Dr. Mark Hurtig at the University of Guelph, where ground-breaking research is looking at joint loading of horses travelling at high speed. Thomason specializes in biomechanics, studying mechanics of locomotion in horses, in-vivo bone strain and finite-element (FE) modelling of skeletal mechanics. Hurtig is an expert on the mechanical causes of osteoarthritis.

McCarty has been working with FE, gathering and analyzing data on loads acting at the fetlock joint and stresses in the cannon bone. By creating a computer generated model using computed tomographic (CT) or MRI images of an equine fetlock joint, they are working on determining the internal bone stress under varying loading conditions (rates, directions and magnitudes) using FE software. This method of analysis could provide further insight into the biomechanical role that impact has on stress distribution in areas of high remodeling, which is associated with osteoarthritis in racehorses.

FE has been used for quite some time in the automotive industry in crash test simulations to assess material failure but it is a relatively new technology for applications in biology. McCarty, who has been working under Thomason for three years now, says, *"it was a steep learning curve to become familiar with the software to build complex models. That alone took almost two years."* FE, through complicated mathematical calculations, can test where stress points will occur under particular loading conditions. In a more dense bone (which occurs in osteoarthritis) these calculations can show how stress points may be transferred and put onto the cartilage of the joint. Using FE, researchers can also study how distribution of stress in a healthy, spongy, less dense bone differs from that of an osteoarthritic joint.



Healthy and Osteoarthritic Bone Density
Green = higher density bone

Mapped material stiffness on third metacarpal from micro-computed tomography images. Bottom images show the internal stiffness distribution through the medial/lateral plane of the distal end of MC3.

Contributing factors to osteoarthritis(OA) in the fetlock joint of a horse lies partly in conformation. A horse's large body mass is held up by four fairly small limbs and the fetlock joint is a small area to distribute the force and loading that occurs during high speed movement. Long pasterns and steep joint angles increase stresses on the back of the leg and can predispose a horse to issues. McCarty explains the incredible forces calculated from the horse's mass x acceleration (F=M x A) during the high speed work a racehorse performs. This can result in upwards of 2.5 times their body weight on one limb. Footing plays a role with harder surfaces resulting in higher strains on the hoof. A blunt force trauma could also predispose a horse to joint injury and make it more susceptible to the onset of OA.

Intense continuous training can set a horse up for OA and joint disease. McCarty goes on to talk about training programs and compares the training of human athletics to how we train race horses, *"If you wanted to run a 200 metre sprint, you would not sit on a couch all day; get up to sprint 50 meters then return directly to the couch. With no pre-conditioning of joints, this is asking for injury. So why would we ask a horse to stand in a stall all day and then take them out for a gallop?"* Chronic overloading of joints leads to problems over time.

One of the potential uses McCarty cites for FE modeling could be assessing the chronically lame horse. This technology may allow predications of where the bone may fracture and under what conditions. Also, with greater understanding of high stress point areas and what is creating them, mitigation may be possible; such as suggesting a change in the footing surface the horse trains on.

This research will be continuing in collaboration with the Robarts Research Institute, Western University and has been funded by the Ontario Veterinary College department of Biomedical Science, Ontario Ministry of Agriculture and Food, Natural Sciences and Engineering Research Council of Canada (NSERC).

Story By – Jackie Bellamy-Zions

Cracking Down on EPO Drug Use

Dr. Dorothee Bienzle has been working with the Ontario Racing Commission (ORC) developing further methods to regulate illegal erythropoietin (EPO) use in the racing industry. EPO triggers the production of more red blood cells in the bone marrow and is thought to improve a horse's performance by increasing the blood's oxygen carrying capacity. Due to the negative health and welfare effects there is a crackdown to eliminate its use.

Photo: Dave Landry

In an effort to protect the safety of racehorses and maintain the integrity of racing, the ORC has imposed severe penalties if EPO is found in a horse. According to the ORC Directive on Penalty Guidelines for Equine Drug, TCO2 and Non-Therapeutic Drug Offences, a first Offence for EPO can result in a suspension of 10 years plus a $40,000 fine.

Bienzle has been looking at the "blood picture" as a method to identify which horses have been treated with EPO by measuring how much hemoglobin they have in their blood. Bienzle outlines the health risks, "*Horses with exceedingly high amounts of hemoglobin in the blood are not fit to race, as they will be at risk for sudden death due to brain hemorrhage or a blockage of blood supply to the heart.*" EPO affects the viscosity of the blood, making it sludge-like and difficult to push through smaller capillaries. Irreversible anemia can also result from repeated EPO use as the horse's own natural EPO production is suppressed.

In the research that has concluded this past winter, Bienzle has found that within a breed, horses are relatively consistent regarding their blood hemoglobin concentration prior to and following race, making the idea of a "blood passport" for racehorses a viable future possibility. Blood samples were taken from 202 Thoroughbreds, 304 Standardbreds and 197 Quarter horses. There were significant differences in hemoglobin concentrations between the different breeds with thoroughbreds having the highest hemoglobin levels. If a "blood passport" was developed, allowable levels of hemoglobin in the blood would be unique to each of the three breeds. Changes in hemoglobin levels were consistent for samples taken before or after the race. Gender was not a factor for hemoglobin concentration.

Interestingly, the finish position of the race horses studied did not correlate with hemoglobin concentration.

Bienzle says, "*A regular regime of aerobic exercise is enough to stimulate red blood cell production in a healthy athlete.*" Red blood cell production is easy to check in a test called complete blood count (CBC). It is simple to ascertain if a horse is at a safe level. In developing a healthy athletic horse, trainers should not be looking for shortcuts but focusing on progressive training, lameness prevention, respiratory health and good stable management practices.

"*The ORC is committed to eliminating the abuse of performance enhancing drugs in racehorses*," said ORC Manager of Veterinary services Dr. Adam Chambers. "*Dr. Bienzle's work on equine hemoglobin has moved us one step closer to that goal.*"

Research funding has been provided by Equine Guelph, the Ontario Racing Commission and the Canada Research Chairs program.

Story By – Jackie Bellamy-Zions

Research Radio

Equine Guelph is proud to announce the launch of a new audio podcast on their popular web site.

Equine Guelph has teamed up with Trot Radio's Norm Borg and SSG Gloves to produce Research Radio, an online podcast updating you on the latest equine research by scientists at the Ontario Veterinary College and University of Guelph. It will highlight the cutting edge discoveries being made, and explain what they mean for the health and welfare of your horse.

Equine Guelph director, Gayle Ecker says, *"Our partners at Ontario Veterinary College are producing ground breaking research designed to improve the health, welfare and safety of the equine athlete. The more widely we can publicize their findings the more likely their work will be put to use to find concrete solutions as a means to that end."*

Listen to podcasts: EquineGuelph.ca/research/radio.php

Equine Guelph Provides Education at all Levels

From its online and travelling youth education program, EquiMania!, right up to 12-week intensive online courses, Equine Guelph serves the needs of both the equine hobbyist and the industry professional.

Lack of knowledge can be very costly and can easily result in tragic loss where horse care is concerned. *"Horse owners with basic knowledge that's evidence-based can make educated decisions on how to best manage and support the welfare of the horse,"* says Equine Guelph director, Gayle Ecker.

With flexible online programs from one of Canada's top universities, students from around the world are eager to participate in Equine Guelph's courses.

Visit EquineGuelph.ca and click on the education tab to learn more about programs ranging from 2-week online workshops to Equine Studies Certificates and Diploma.

EVENTS

Mark your calendar!

Erin Fall Fair
(EquiMania!) Oct 10 -13

Royal Agricultural Winter Fair
(EquiMania!) Nov 7 - 16

Equine Guelph's Online Courses
(Next offering January 2015)

Anyone wishing to excerpt Equine Guelph should contact:
Jackie Bellamy-Zions ext 54756
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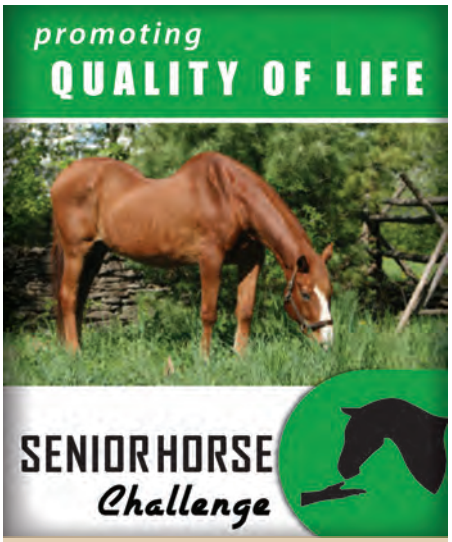
If you are interested in bringing EquiMania! to your event, contact Eq4kids@uoguelph.ca

Visit EquineGuelph.ca education page to select award-winning online programs – over 20 to choose from!



Check out this new tool presented by Boehringer Ingelheim

Equine Guelph thanks the following animal health companies for sponsoring our online healthcare tools:

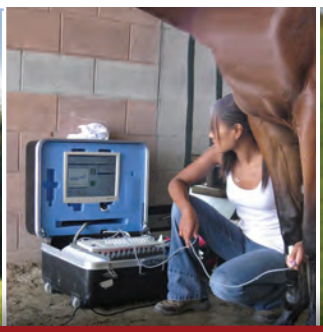
Boehringer Ingelheim — Senior Horse Challenge

MERCK Animal Health — HEALTH*flash*

Vétoquinol *a Sign of Passion* — HEALTH*flash* & Biosecurity Risk Calculator

zoetis — Lameness Lab & Journey through the Joints

educating horsepeople



funding industry research

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