STRATEGIC DISCUSSIONS FOR NEBRASKA

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ONE ENVIRONMENT, ONE HEALTH

ANIMALS | PLANTS | US

2015

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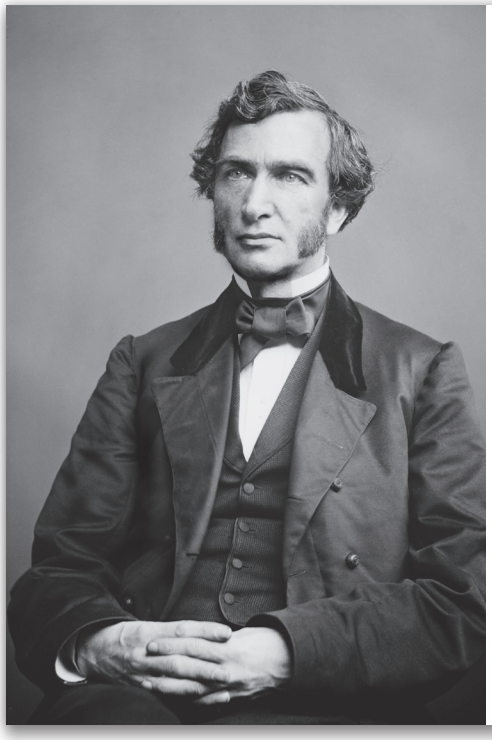
EVERY BLADE OF GRASS IS A STUDY; AND TO PRODUCE TWO, WHERE THERE WAS BUT ONE, IS BOTH A PROFIT AND A PLEASURE.

ABRAHAM LINCOLN | SEPTEMBER 30, 1859



THE MORRILL ACT OF 1862

JUSTIN SMITH MORRILL

Representative from Vermont, Thirty-fifth Congress

On July 2, 1862, President Abraham Lincoln signed into law a bill that donated land to each state for the establishment of colleges to provide a liberal and practical education to the "industrial class," or the common person. These colleges would provide instruction in agriculture and the mechanic arts, such as engineering. Because of the land granted to each state and territory, the Morrill Act of 1862 became known as the land-grant act.

Sponsored by U.S. Congressman Justin Smith Morrill of Vermont, the bill allotted 30,000 acres of public land for each sitting senator and representative in Congress to establish these colleges. Morrill could not have known the future impact this law would have in providing equal opportunity to education in the United States and its territories.

Today, there are more than 100 land-grant institutions in the United States and its territories, each focusing on teaching, research and outreach – taking new knowledge to the people.

The University of Nebraska was founded on February 15, 1869 and designated a land-grant institution under the 1862 Morill Act.

INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES

IMPACT ON NEBRASKA

In the Institute of Agriculture and Natural Resources (IANR) we are all about people, and the food, water, and natural resources that sustain them. IANR innovation in research, teaching, and Extension education places Nebraska on the leading edge of food production, environmental stewardship, human nutrition, business development, and youth engagement. Composed of the College of Agricultural Sciences and Natural Resources (CASNR), the Agricultural Research Division (ARD), UNL Extension, and the ARD and Extension components of three departments in the College of Education and Human Sciences, IANR is committed to growing the future of Nebraska's people, businesses, and communities.

ABOUT STRATEGIC DISCUSSIONS FOR NEBRASKA

2015

Strategic Discussions for Nebraska is a program in the University of Nebraska–Lincoln Institute of Agriculture and Natural Resources (IANR) with the mission of training students to communicate research so it can be easily understood. An SDN publication has been produced annually since 2008, each focusing on a different topic.

This year's publication is written by a team of students majoring in Agricultural and Environmental Sciences Communication (AESC), Hospitality, Restaurant and Tourism Management or in Broadcast Journalism. The AESC students are in the UNL Department of Agricultural Leadership, Education and Communication (ALEC). This is their capstone course, which brings together their prior coursework and developed skills and provides a learning experience similar to those they will encounter in the workplace.

During the spring semester of 2015, the students learned about the concept of One Health and the interconnectedness of the environment, plants, animals and people. They interviewed university scientists and wrote stories that communicate complex science with clarity, accuracy and objectivity.

UNL IANR Media specialists provided videography and video editing expertise, which you may see on the SDN.UNL.EDU website. University Communications provided photography and website services, and Jon Humiston, an independent contractor, provided creative and graphic design expertise. The UNL Institute of Agriculture and Natural Resources provided funding, business and liaison services for the production of this publication.

As coordinator of Strategic Discussions for Nebraska, I express sincere appreciation for the original vision and financial support of the Robert and Ardis James Family Foundation, which founded Strategic Discussions for Nebraska in 2007.

Strategic Discussions for Nebraska now receives the majority of its funding from, and is housed in the UNL Institute of Agriculture and Natural Resources' College of Agricultural Sciences and Natural Resources, in the Department of Agricultural Leadership, Education and Communication.

Please visit our website at SDN.UNL.EDU, where you will find the complete publication and a video montage of scientists explaining their work.

Thank you for your interest in our publication!

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SPECIAL APPRECIATION

STRATEGIC DISCUSSIONS FOR NEBRASKA EXTENDS SPECIAL APPRECIATION FOR THE VISION, GUIDANCE, SUPPORT AND ASSISTANCE OF THE FOLLOWING INDIVIDUALS AND GROUPS

- RONNIE GREEN, University of Nebraska–Lincoln Senior Vice Chancellor for Academic Affairs and Harlan Vice Chancellor, University of Nebraska–Lincoln Institute of Agriculture and Natural Resources (IANR).
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- STEVEN WALLER, Dean, University of Nebraska–Lincoln College of Agricultural Sciences and Natural Resources (CASNR).
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- MARK BALSCHWEID, Head, University of Nebraska–Lincoln Department of Agricultural Leadership, Education and Communication.
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- JILL BROWN, Assistant to the IANR Vice Chancellor.

- UNIVERSITY OF NEBRASKA–LINCOLN ADMINISTRATORS, faculty and staff. We are fortunate to work with these outstanding individuals.

- UNIVERSITY OF NEBRASKA–LINCOLN EXTENSION, led by Charles Hibberd, Dean, and its specialists and educators, who take objective university research to the people of Nebraska.
  EXTENSION.UNL.EDU

- UNIVERSITY OF NEBRASKA–LINCOLN AGRICULTURAL RESEARCH DIVISION (ARD), led by Archie Clutter, Dean. The ARD is the major research unit of the UNL Institute of Agriculture and Natural Resources and is the Agricultural Experiment Station.
  ARD.UNL.EDU

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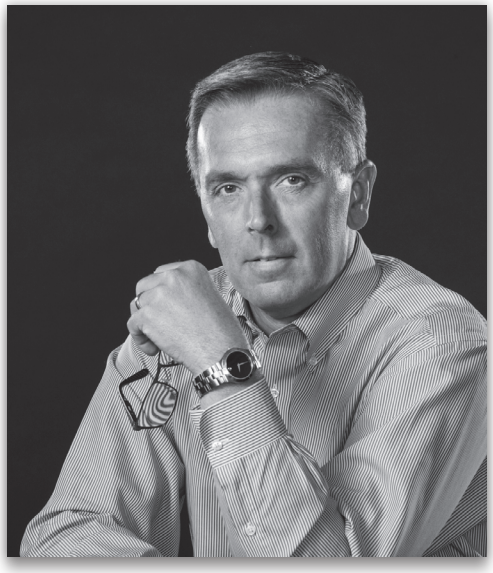
IF WE'RE GOING TO HAVE LONG-TERM SUSTAINABILITY OF OUR WORLD THAT WE LIVE IN, THAT LONG-TERM SUSTAINABILITY IS GOING TO BE BECAUSE WE BETTER UNDERSTAND THE WORLD, THE ENVIRONMENT THAT WE LIVE IN.

RONNIE GREEN, Ph.D.

UNL Senior Vice Chancellor for Academic Affairs;
NU Vice President for Agriculture and Natural Resources;
UNL Harlan Vice Chancellor of the Institute of Agriculture and Natural Resources



NEBRASKA AS AN INTERNATIONAL AGRICULTURAL EPICENTER

A MESSAGE FROM RONNIE GREEN

Nebraska's place as an international agricultural epicenter is important for feeding a hungry world, but the work that makes that position possible is truly incredible. Thanks to research conducted at the University of Nebraska–Lincoln by many of the world's finest scientists, discoveries are being made that improve the health of all kingdoms – plant, animal, human and the natural environment.

The UNL Institute of Agriculture and Natural Resources scientists are *Growing a Healthy Future* through their work in laboratories on campus and in the laboratories of the world – fields, rivers, pastures, feedlots, swine facilities, hen houses, zoos and public health clinics. They are the pioneers who are learning to prevent and cure plant, animal and human diseases and protect the biodiversity of the natural environment.

We are fortunate to have outstanding programs and facilities in addition to outstanding people, among them: the Nebraska Center for Virology; Nebraska Center for Prevention of Obesity Diseases; UNL Center for Biotechnology; Doctor of Plant Health program; Gut Function Initiative; Great Plains Veterinary Educational Center; School of Veterinary Medicine and Biomedical Sciences; and the Nebraska Veterinary Diagnostic Center. The scientists in these programs and facilities are protecting the health and well-being of all.

University of Nebraska scientists from all four campuses and the Nebraska College of Technical Agriculture, as well as other educational institutions are reaching out to one another, bringing in scientists from around the world and working together to learn more about the biology shared by all living things. They are using that knowledge to grow a healthier future for all of us.

In this 2015 Strategic Discussions for Nebraska publication, you will find stories that explain the importance of *One Environment, One Health: Animals, Plants and Us*. Many stories refer to the concept of One Health, which was first articulated in the early 2000s by the United States veterinary community. Concern that animal disease might jump from animal to human initiated the One Health concept, which explains that all kingdoms are interlinked. As you read this publication, you will learn about astounding progress in solving the puzzles of disease, saving crops, lives and billions of dollars in economic activity.

A friend's daughter had a third-grade teacher who taped a memorable phrase to the wall of the classroom: "Through hard work and perseverance, you have the potential to achieve excellence." That's quite a goal for a class of eight-year-olds, but here at the University of Nebraska–Lincoln, our hard work and perseverance are reaping excellence that is improving the health of the environment, plants, animals – and us. +

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ALPHABETICAL ARRANGED BY SUBJECT'S LAST NAME, OR PAIRED BY SUBJECT

"I STUDY BIOLOGICAL CONTROL AGENTS TO MANAGE DISEASE

TONY ADESEMOYE, Ph.D.

Assistant Professor of Plant Pathology and Cropping Systems Disease Management Specialist, UNL West Central Research and Extension Center, North Platte, Nebraska

CONTROLLING PATHOGENS IN SOIL:

the basics of protecting crops

by JEANNA JENKINS *and* TONY ADESEMOYE

Tony Adesemoye calls soil pathogens "silent yield robbers," because they are stealing crop yield.

Adesemoye is cropping systems disease management specialist at the University of Nebraska–Lincoln West Central Research and Extension Center (WCREC) in North Platte, Neb.

Most of the organisms in the soil are not intentionally causing harm; they simply interact with the roots of the crops while they are belowground looking for something to eat, Adesemoye explained.

Each gram of soil contains millions of microorganisms and some of those organisms are considered pathogens. A pathogen is defined as a "disease carrying agent" and is most commonly identified as a virus, bacteria or fungi.

BIOLOGICAL CONTROL: GOOD GUYS AND BAD GUYS

Some pathogens, like *Fusarium*, *Macrophomina* and *Rhizoctonia* interfere with a plant's basic processes and cause commercially significant cases of wilt and rot. "Plants will release some substances called root exudates," Adesemoye said. The root exudates attract bacteria as well as some fungi and in some cases, will initiate the interactions between those organisms and the plants.

"I look at my discipline as focusing on designing new plant disease management methods by identifying biological control organisms that can be used to improve what we have now. As we are generating biology-based technology, we can begin to draw down on the amount of chemical inputs that we need to use," he added.

"In the soil you have the 'bad guys' that will cause disease in the crops. And in that same soil, you have some microorganisms that will also fight against those bad guys," Adesemoye explained. "So I try to study those two groups of organisms, to use those that are the 'good guys,' the ones we call biological control agents, to manage the disease."

Like pathogens, a biological control agent can be any kind of free-living organism: bacteria, fungi or products from them. These biological control agents, in their natural interactions with other organisms, can help control the population of

pathogens that cause diseases in crops. Adesemoye's work is focused on finding and better understanding the "good guys."

Most harmful pathogens are controlled with chemical treatments, he said. "Over time, there can be a development of what is called resistance by the 'bad guys,' the pathogens, against the chemicals that you are using," Adesemoye said, "and I should mention that this is not only peculiar to chemicals; this may also happen with biological control agents. So these are the downsides that science continues to work on to find answers to."

PLANT GROWTH-PROMOTING RHIZOBACTERIA

Adesemoye also works with a unique group of organisms called Plant Growth-Promoting Rhizobacteria (PGPR), which can assist with plant utilization of soil nutrients, thus promoting growth.

"When you apply your fertilizer it goes in the soil. Phosphorus, for example, can be bound up in the soil," Adesemoye explained. "So when it is bound up, it is not available for the plant's use. But our intention when we applied the fertilizer was to make it available to the plant."

This group of bacteria (PGPR) has the capacity to release phosphorus and other nutrients from the soil, thereby "mobilizing" it into a form that the plants can use. Better use of inputs, like fertilizers, could result in higher productivity of crops, resulting in a more sustainable system.

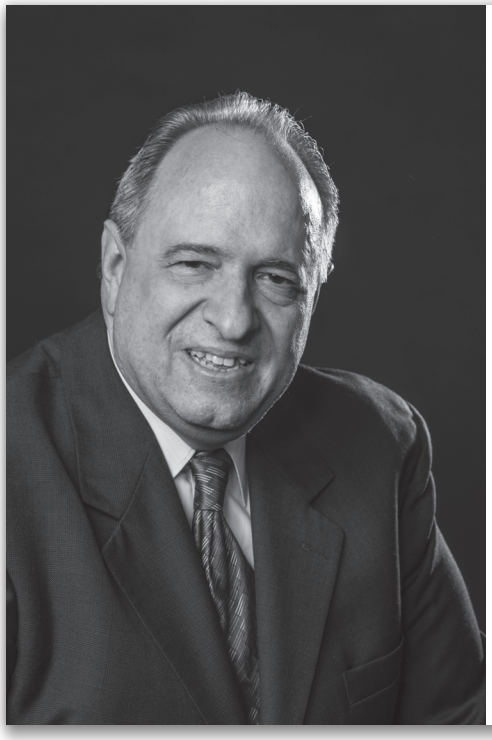
"I'm hoping that the discipline of plant pathology and biological control will be able to design measures and develop new products and technology that can help in better, sustainable management of crop diseases," he added.

TECHNOLOGICAL ADVANCEMENTS

With so many different microorganisms in existence, proper identification is essential to a successful battle against disease. "Some of the diseases have symptoms that are similar, and so for you to be able to say 'This is the pathogen that is causing the disease,' you need to isolate it from that infected plant, and you need to study that pathogen, spending hours, in some cases days, looking at it under a microscope and conducting a lot of tests to be able to identify that organism," he said. But by leveraging with DNA technology, the process is faster and the diagnosis certain. "And that helps you to be able to quickly design a management strategy for that organism, where you have done a rightful identification of the organism," Adesemoye explained.

"I am upbeat about my research in Nebraska. I am very optimistic that I'll be able to make contributions to the protection of our crops in a way that will help to enhance profitability to our growers," Adesemoye said.

He is currently working on proposals to collaborate with other scientists within the country and in other countries in Africa, Asia and South America to look at disease management on a global scale. +



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AS A SCIENTIST I'M LOOKING FOR THE TRUTH

RAUL BARLETTA, Ph.D.

Professor and Microbiologist, UNL School of Veterinary Medicine and Biomedical Sciences

'LOOKING FOR THE TRUTH' IN TUBERCULOSIS, CROHN'S, JOHNE'S DISEASE RESEARCH:

Barletta looking for commonalities, new-age vaccinations

by HOPE HEMME *and* RAUL BARLETTA

Raul Barletta joined the University of Nebraska–Lincoln faculty in 1991. His main focus was to study mycobacterial infections of animals and humans, in particular Johne's disease and tuberculosis. Johne's disease affects cattle and other ruminants on a worldwide basis, including Argentina, his home country, and the United States.

TUBERCULOSIS

Barletta, a Ph.D. microbiologist in the UNL School of Veterinary Medicine and Biomedical Sciences, said tuberculosis is a disease that affects the lungs and respiratory system in humans caused by an organism called *Mycobacterium tuberculosis*. Worldwide, about 2 billion people – or one-third of the world's population – are infected with this microorganism, Barletta said. According to the World Health Organization and the United States Centers for Disease Control and Prevention, only a fraction of those infected become sick. Still, with so many infected individuals, on a worldwide basis, there are about 2 million deaths per year, making tuberculosis one of the deadliest infectious diseases, second only to AIDS, Barletta said.

Moreover, tuberculosis is a disease that can be hard to diagnose. Once infected, a person may not show signs or symptoms of tuberculosis for many years; this bacterium can remain dormant up to 50 years. The major risk factor for becoming sick is a low-functioning immune system, Barletta said. Tuberculosis is rarely seen in the United States due to preventive measures, especially due to our improved living conditions. However, people in many other countries do face enormous risks from tuberculosis, in spite of vaccination campaigns and drug treatments.

BOVINE TUBERCULOSIS

"There is another disease, called bovine tuberculosis, that is a very close relative, perhaps a 'brother' of *Mycobacterium tuberculosis*, and that is *Mycobacterium bovis*," Barletta said.

Cattle also can contract this form of tuberculosis, but the difference between the two diseases is that the cattle form is zoonotic, meaning it can infect both animals and humans.

JOHNE'S-CROHN'S DISEASE LINK

There is yet another form of a tuberculosis-like disease, Barletta said: *Mycobacterium avium* subspecies *paratuberculosis,* or MAP. The MAP bacteria causes Johne's disease, a chronic intestinal disease of ruminant animals – animals with four stomach chambers. The MAP bacterium is a cousin of the organism that causes tuberculosis, Barletta said. According to the National Johne's Education Initiative, the small intestine of an animal that has contracted Johne's disease becomes inflamed and unable to absorb nutrients. The infected animal has rapid weight loss and diarrhea, even while appearing with a healthy appetite. After diarrhea has started, the animal may only live for a few weeks. Contraction of Johne's disease happens shortly after birth when an animal is introduced to MAP in feces-contaminated soil or water due to shedding of previously infected animals. The weight loss and diarrhea symptoms are not generally seen for two years, when the animal reaches maturity.

Barletta is trying to discover if Crohn's disease in humans is related to Johne's disease, as they are similar diseases. This research is hard to prove as testing cannot be done on humans to determine any relationship. "Johne's disease and Crohn's disease have so many similarities on the pathological level," Barletta said. Crohn's disease is an inflammatory bowel disease that specifically affects the bowel lining and is characterized by fatigue and frequent diarrhea, according to the Crohn's and Colitis Foundation of America.

"The scientific community is skeptical that this could cause Crohn's disease," Barletta said. The medical community leans toward a noninfectious autoimmune cause. Some say that maybe other agents such as *Escherichia coli* (*E. coli*) could cause Crohn's disease. "I think something in between might be the situation," he said. Strains of the disease may have organisms with a common protein antigen, perhaps with similar structures that could cause an autoimmune disorder, he added. "There are trials now with antibiotics against *Mycobacterium paratuberculosis* and they sometimes have a beneficial effect on Crohn's disease patients."

VACCINES AND DRUGS

Barletta is researching ways to prevent and treat these diseases. It is important to have an effective diagnosis to create a vaccine that will be effective in treating the disease, he said. Barletta was part of the first trial of Johne's disease vaccine testing.

One possible way to vaccinate cattle would be through edible vaccines that could be introduced into grass or feedstuffs. These edible vaccines would be developed through genetic engineering; for example, placing the desired medicinal trait in the plant as a transgene. In past work with Anne Vidaver, professor emerita in the UNL Department of Plant Pathology, microbial endophytes (harmless microbes naturally present in many grasses and prairie plants) also were studied as a potential carrier of recombinant antigens. This strategy would ameliorate the risks of creating a true transgene, since the antigen coding sequence would not be directly placed in the plant genome.

"Nonetheless, the problem with all this is consumer acceptance of these plants and cattle that eat them," he said. Barletta suggests open-forum discussions where individuals can exchange the pros and cons of these vaccines. There are not currently any edible vaccines available for humans or animals. Nonetheless, he said, consumers not wishing to have these vaccines should be protected, as well. In that context, diagnostic tests could be used to make sure that, if developed, these recombinant edible vaccine products would not cross-contaminate other cultivars.

RESEARCH IMPORTANCE

Barletta is a founding member of the UNL Redox Biology Center, an interdisciplinary center where UNL researchers collaborate on projects and jointly use equipment. The term "redox" means the research done at the center focuses on chemical reactions where electrons are transferred from one atom or molecule to another. Barletta also collaborates with other researchers in the Departments of Chemistry (Robert Powers and Patrick Dussault) on drug targets, and Chemical and Biomolecular Engineering (Hendrik Viljoen) on diagnostics.

Barletta's research into human and animal tuberculosis will be important for both producers and consumers. Animal producers will have a better way to prevent and treat diseases like tuberculosis and Johne's disease, which will make food prices lower for the consumer. The public also will have a better vaccine and treatment for tuberculosis and possibly more information about Crohn's disease.

ETHICS IN SCIENCE

"Ethics in science is very important; the highest ethical standards need to be enforced," Barletta said. Sometimes his research may yield negative results, but Barletta said this gives him information about what does not work. This information may be used by himself or other scientists who are doing work in the same area. Research cannot cut corners, he said. "As a scientist, I am looking for the truth."

Barletta hopes to see human medicine become personalized, meaning that each person can receive vaccinations or treatments based on that individual's medical needs. +

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THE GOAL OF THE INITIATIVE IS TO BENEFIT HUMAN HEALTH

ANDREW BENSON, Ph.D.

Professor, UNL Department of Food Science and Technology and Co-Founder, Gut Function Initiative

THE HUMAN GUT:
what does it do?

by JOSHUA POORE *and* ANDREW BENSON

Interventions in your diet may help you to overcome genetic predispositions to certain types of complex diseases, according to Andrew Benson, professor in the Department of Food Science and Technology at the University of Nebraska–Lincoln. Complex diseases, such as inflammatory bowel disease and coronary heart disease, arise from a combination of genetic predisposition and environmental factors, he said. Benson is a co-founder of the UNL Gut Function Initiative, a multidisciplinary group dedicated to understanding the relationship between the gastrointestinal or "gut" ecosystem and health in humans and animals.

Within the microbiome, certain species take on separate critical functions. By understanding the microbiome and the role of these key organisms, scientists hope to understand and develop cures or interventions for complex diseases such as cardiovascular disease, coronary heart disease, Type 1 and 2 diabetes and inflammatory bowel disease, Benson said.

Scientists within the Gut Function Initiative ask three fundamental questions during their studies:

- What are the host factors that help shape the gut ecosystem?
- What are the dietary factors and how do they impact that system?
- What are the microbial factors?

The ultimate goal of the initiative is to learn how they can manipulate the gut ecosystem to benefit human health, he said.

UNDERSTANDING THE MICROBIOME

The microbiome refers to all of the microbes that are present in an individual's gastrointestinal (GI) tract. "Each individual will have somewhere between 500 and 1,000 different species of microorganisms in the GI tract," Benson said. Of those, only about 50 of them can be found in everybody. "Your gut, to some degree, doesn't care so much which organisms are there; it cares more about what functions they're doing," he added.

Complex carbohydrates, such as whole-grain breads and green vegetables, are found in the diets of many people. The body alone cannot break down some of the complex carbohydrates found in these foods; the microorganisms in the gut are able to break them down and use them for energy, which creates a collaboration between the body and the microorganisms. "They have a substantial genetic capacity that we don't have," Benson said. "They function along with us; collectively, they're a part of who we are."

In addition to harvesting energy from complex carbohydrates, the microbiome helps to train the immune system. Early in life, the microbiome somehow helps to educate the immune system about what things it should respond to and what things it should ignore. This is a critical function, especially in early life, he said.

THE PROCESS

The majority of data collection is done through DNA sequencing, Benson said. Researchers use this systematic process to collect massive amounts of data on the composition of the microbiome itself. This data is processed and analyzed by an interdisciplinary team of faculty, including Benson. This team hails from several departments, including computer science, statistics and biological sciences. Because DNA sequencing now is the primary analytical platform used to quantify the microbiome, Benson and his team have had to become proficient in the field of data sciences and learning to mine data for information.

"Ninety percent of what we do in the laboratory is focused on DNA sequencing; harvesting the DNA out of the organisms, getting it ready for sequencing, and processing and analyzing the data," Benson said. This technique helps researchers to draw associations between abnormalities in the microbiome and complex diseases.

DISEASE PREVENTION

"The long-term goal of the group is to be able to understand how that system develops normally, understand what happens when it is abnormal, and try to come up with either preventions or interventions where we can change it back to a state that is much more functional," Benson said.

Creating new types of nutraceuticals, prebiotics and probiotics is a major goal of this research, according to Benson. Rather than broad-scope antibiotics, these prebiotics and nutraceuticals will be refined, targeted medicines capable of encouraging growth of key species within the microbiome or specifically discouraging growth of unwanted species. Manipulating and restoring key organisms will cause the entire gut ecosystem to shift back to a normal, healthy state.

Benson hopes to see some of these new and targeted prebiotics and nutraceuticals come out by the year 2025. "This is a complex system that we as microbiologists have dreamed of studying for a couple hundred years; and now we can study it. Stay tuned," he added. +

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WHAT WE DO IS A HUGE HELP FOR THE ECONOMY IN THE STATE

BRUCE BRODERSEN, D.V.M., Ph.D.

Associate Professor, UNL School of Veterinary Medicine and Biomedical Sciences and Diagnostic Pathologist, Veterinary Diagnostic Center

DETECTING VIRUS INFECTION IN CATTLE:
implications for human health

by BROOKE JINDRA *and* BRUCE BRODERSEN

The detection of viruses in cattle affects not only producers in the state of Nebraska, but the health of its residents as well, said Dr. Bruce Brodersen, associate professor and veterinary pathologist at the Nebraska Veterinary Diagnostic Center at the University of Nebraska–Lincoln.

According to Brodersen, bovine viral diarrhea virus, or BVD virus, is one of the primary viruses tested for at the Nebraska Veterinary Diagnostic Center. "That virus is somewhat unique in the cattle industry because it can harbor itself in animals for their lifetime," he said.

Once an animal has BVD virus it is more susceptible to secondary infections, such as other viral diseases or bacterial diseases, Brodersen said. Infected cattle also serve as a source of infection to other cattle within their herd.

In addition to the cost of treatment, BVD virus affects the cattle industry because it causes cattle to decrease their productivity, Brodersen said. Loss in production due to BVD can cost between $20 and $150 per animal, adding up to several hundred million dollars nationwide.

To detect the BVD virus in cattle, Brodersen and his colleagues use immunohistochemistry. The test uses a tissue sample to identify a certain protein specific to the virus, he said. This form of testing is more specific, sensitive and allows for results within 24 hours.

Immunohistochemistry is not only used in the cattle industry; other applications include characterizing tumors in cats, dogs and horses, Brodersen said. Human health also benefits from the use of immunohistochemistry with the ability to help diagnose breast cancer and prostate cancer, to mention just a couple, he added.

IMPACT IN NEBRASKA AND BEYOND

BVD virus testing has greatly reduced the prevalence of the virus, Brodersen said. Certain areas of the United States have even begun their own eradication programs to ensure the BVD virus is completely removed from that specific area. In an eradication program, animals infected with the virus are isolated from other animals to prevent the disease from spreading, he said. These programs are active in certain

parts of Nebraska and other states, including Michigan and Kentucky, he added.

Brodersen's work has an impact on cattle producers in Nebraska, the state's economy and individual consumers. Nebraska's livestock industry, worth $8 billion, relies on exporting a high-quality product to other countries, he said. The state's agricultural exports – nearly $7 billion in 2013 – translated into just more than $8 billion in economic activities. "What we do is a huge help for the economy in the state," Brodersen said.

The Nebraska Veterinary Diagnostic Center's impact on the state comes from its work on other diseases in addition to BVD virus, such as Trichomoniasis, *E. coli*, influenza, rabies virus and porcine epidemic diarrhea virus.

Being aware of a disease's exposure and circulation among humans is another significant portion of Brodersen's work. With certain diseases, such as influenza and rabies, the possibility of transmission from animals to humans is an important concern.

NEW FACILITIES, NEW OPPORTUNITIES

While the current VDC provides many research capabilities, its layout prevents an adequate working environment to ensure its workers' biosafety, which is the protection against disease or harmful biological agents.

Groundbreaking for a new VDC began in spring 2015, with an estimated completion date of 2017. The new VDC will cost $45 million to complete; of that, $41 million was donated by Nebraska and $4 million was raised from private support. The new VDC will have better space utilization to prevent possible contamination of samples, and improved biosafety for the staff, Brodersen said.

Additional research opportunities in the new VDC will be possible with its Biosafety Level 3 research facility. Biosafety levels range on a scale from one to four, Brodersen said. "Biosafety Level 3 is the next step up as far as what can be infectious to humans and the severity of diseases are concerned," he said. A Biosafety Level 4 facility would allow the study of diseases such as Ebola.

Researching Biosafety Level 3 diseases allows researchers to better understand potentially lethal diseases, while having a safe environment to isolate and study them. For example, a Biosafety Level 3 safety will allow researchers to study tularemia, a bacterium that can spread from animals to humans by inhalation or ingestion, and can cause swollen glands, fever, nausea and severe pneumonia, he said. +

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OUR HYPOTHESIS IS THAT SICK ANIMALS EXPERIENCE CHANGES IN GUT MICROBIAL COMMUNITIES

THOMAS BURKEY, Ph.D.

Associate Professor and Swine Nutritionist, UNL Department of Animal Science

NUTRIENT REQUIREMENTS OF ANIMALS RECOVERING FROM DISEASE:

could impact human nutrition, global malnutrition

by CHELSEA TAYLOR *and* THOMAS BURKEY

Thomas Burkey's research focuses on swine nutrition, but he believes the similarities between pigs and humans also can lead to innovations in human health.

Burkey, associate professor of animal science at the University of Nebraska–Lincoln, studies the impact of disease on nutrition and growth in pigs. "I recently looked at a statistic that states there's a greater than 80 percent similarity in all immunological parameters analyzed between humans and pigs. That is greater than any other animal research model, in terms of the comparison between humans and pigs," he said.

Burkey said scientists already know a lot about nutrition for healthy pigs and healthy people. But what scientists want to learn more about is how nutrient requirements change when pigs are sick, or when people are sick. Using pigs as a research model, there could be answers to both.

PORCINE REPRODUCTIVE AND RESPIRATORY SYNDROME VIRUS AND NUTRITION

The Porcine Reproductive and Respiratory Syndrome virus costs Nebraska swine producers upward of $640 million annually, Burkey said. The PRRS disease impacts both the respiratory system and the reproductive system. Many pigs die from the disease, but those that survive have trouble catching up with their healthy peers, Burkey said. They need to stay on feed for up to three weeks longer than healthy pigs, which increases producers' cost of production and affects the overall nutrition of the animals.

"No matter what you feed an animal, it doesn't mean that nutrient is being utilized," he said. "Being able to do research to see if we can deliver the specific nutrients the animal needs relative to how the requirements of the animal have changed, I think is very important."

Pigs, like people, may not want to eat when they are sick, he said. Learning how to intervene with nutritional strategies not only helps pigs to recover more quickly; it helps producers economically.

There are at least 40 essential nutrients, including 10 amino acids, vitamins and minerals, Burkey said, and those nutrients will be used differently in a sick animal. "Depending on what disease you're talking about, or what metabolic disorder, those requirements may change and vary by disease," he explained. In addition to the PRRS virus, Burkey also studies the nutrient utilization of pigs who are sick with the Porcine Epidemic Diarrhea (PED) virus, which also is a major swine disease.

"Think about all the different systems that kick in when you're sick," he said. The immune system has cells that synthesize proteins that need nutrients. "When you're sick, the energy you consume is shuttled toward fighting off that infection rather than shuttled toward putting on lean tissue or growing. One of the unknowns right now is exactly what nutrients are shifted toward the immune response versus shifted toward growth," he said. Research is focusing on how to feed the animals differently so the immune response stays strong, yet some of the nutrients are shuttled toward growth and not all to the immune system.

When an animal is sick (e.g., infected with the PRRS virus), nutrient digestibility and utilization may be affected; nutrients are utilized differently in a sick animal compared to a healthy animal. "Our hypothesis is that sick animals experience changes in gut microbial communities, which may, in turn, affect nutrient digestibility and utilization," he said. Burkey is looking more closely at alternative feeds, such as prebiotics and probiotics, to see how they affect nutrient absorption and utilization.

"We've done quite a few studies looking at feeding prebiotics," he said. Although results are variable, there is evidence that prebiotics impact gut microbial communities and may affect how nutrients are utilized by the animal.

THE RESEARCH PROCESS

Burkey said the research process begins with a hypothesis and gathering data in a laboratory setting. If the hypothesis includes the effect of prebiotics or probiotics on nutrient absorption in pigs, he would begin by looking at epithelial cells of the pig's intestine. "We can use that cell line to get preliminary data, or to gauge what might be the immunologic or metabolic effects when you treat those cells with a prebiotic or a probiotic," he said. Based on those laboratory results, he might choose to feed the prebiotic or probiotic to a group of pigs to see if the same effects occur in the animals.

Burkey collaborates with Samodha Fernando, UNL assistant professor of animal science, and Phil Miller, UNL professor of animal science, as well as with Nick Gabler, associate professor of animal science at Iowa State University. Fernando is a microbiologist, Miller is a swine nutritionist and Gabler's research specialty is PRRS, Burkey said.

THE GOALS

"My main interest is looking at nutrient-by-disease interactions," he said. "A second goal would be to try to help producers find economically viable ways to feed their animals, whether they're healthy, whether they're sick, or both." Producers need more information about how to feed and treat sick animals, Burkey said.

There may be a day when antibiotics in animal feed will not be used, he said, so there always will be a need for keeping pigs healthy through appropriate nutrition, and at the same time, doing it economically, he added.

Burkey said humans in the United States typically do not think about malnutrition because of the reasonable cost and unlimited access to food.

"We don't really spend a lot of time thinking about the 40 essential nutrients because we don't experience those deficiencies on a regular basis," he said. However, there are many countries in the world in which malnutrition is a big problem, he added. "If we know more about how essential nutrients are utilized in healthy and sick animals, maybe we can do a better job of making an impact on the problem of malnutrition," he said. +

"THE VETERINARY SCIENCE DEGREE PROVIDES AN EDUCATION IN A BROAD RANGE OF SCIENTIFIC FIELDS

MICHAEL CARLSON, Ph.D.

Assistant Professor of Practice and Undergraduate Program Coordinator, UNL School of Veterinary Medicine and Biomedical Sciences and Toxicologist, Veterinary Diagnostic Center

TO BE A VETERINARIAN – OR NOT?

Carlson advises students for academic and career success

by JESSIE HORN *and* MICHAEL CARLSON

Preparing to become a veterinarian starts years before a student walks across the graduation stage to receive the Doctor of Veterinary Medicine diploma. It starts early in a student's educational career, with outstanding performance in the right classes, involvement and leadership in organizations and exploration of the career to be certain it's the right choice.

Besides all that, it takes the guidance of an experienced college advisor. Michael Carlson is the lead undergraduate advisor in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln. Carlson and colleague Lila Tooker also are responsible for undergraduate recruiting efforts for the school.

Sometimes, the Doctor of Veterinary Medicine goal is not the right choice for a student, giving Carlson the chance to direct students toward another UNL academic program, or even toward another career option offered by the School of Veterinary Medicine and Biomedical Sciences (SVMBS).

VETERINARY MEDICINE

The University of Nebraska–Lincoln does not have its own veterinary school, but has a collaborative agreement with the Iowa State University College of Veterinary Medicine. Students accepted into the veterinary medicine program take the first two years of veterinary education and training at UNL and the last two years at ISU, giving it its informal name: the 2+2 program. Of those applying to the UNL-ISU Professional Program in Veterinary Medicine from UNL, usually about one-third are accepted.

Veterinary school is not graduate school, Carlson explained; it is a professional school, similar to medical, dental or law school. Many veterinarians continue their education to earn a master's degree or a Ph.D., he said.

Carlson said all the SVMBS undergraduate advisors work with students to help them be competitive for admission to a veterinary school. Academic preparation is important, he said; students must excel in academics, including science courses.

"Each veterinary school decides what courses they want their applicants to have taken and that list of courses is called a Pre-Veterinary Medicine, or Pre-Vet program," Carlson said. Common to all Pre-Vet programs are courses in chemistry, biology and physics. Other courses sometimes are required, such as math, statistics or animal nutrition.

Leadership development also is important when a student considers applying to veterinary school, Carlson said, so the student is encouraged to get involved in extracurricular organizations and to seek leadership responsibility in them. Carlson also tells students to explore the career field they wish to pursue. If a student wants to be a veterinarian, the student needs to learn what a veterinarian does.

"Some students want to be veterinarians because they do not want to work with people," Carlson said. However, people own the animals under the veterinarians' care and the owners pay the fees charged by the veterinarians. So, it is important to recognize the veterinarian has two challenges: to serve the patient and to satisfy the billpayer."

OTHER CAREER OPTIONS

"Most everyone thinks that vet science means you have to be a veterinarian to be a part of animal health, and that's not true," Carlson said. "We tend to have tunnel vision – we let majors and traditional disciplines define the scope of what we think we can and can't do," he added. If students decide veterinary medicine is not for them, there are many other choices in animal health-related career fields.

Health care professions all deal with mammals, whether animal or human. "Some of the details are different, but biochemical and physiological processes are basically the same," Carlson said. Students may find that something else interests them related to human or animal health, whether it's designing artificial limbs or working to create treatments for diseases caused by bacteria or viruses.

"Career opportunities exist in pharmaceuticals, microbiology, genetics, physiology, biochemistry, toxicology and veterinary medical assisting. The veterinary science degree provides an education in a broad range of scientific fields that can help graduates enter more specialized areas related to veterinary science and the biomedical sciences," Carlson said. An education in veterinary science can equip students with knowledge across a wide spectrum of sciences, and with a science degree, there are many career possibilities.

The UNL School of Veterinary Medicine and Biomedical Sciences plans to add a practice management option, as well as a research animal option as alternatives for undergraduates. The practice management option would enable graduates to help manage a veterinary, dental or allied health clinic.

PHARMACOLOGY, TOXICOLOGY AS A CAREER

Carlson is not a veterinarian; instead, he holds a bachelor's degree and a master's degree in chemistry and a Ph.D. in pharmaceutical science with a toxicology emphasis. He teaches pharmacology and toxicology courses in the School of Veterinary Medicine and Biomedical Sciences and an introductory veterinary science course.

"I like understanding poisons and drugs, how they work, what they do and how the body deals with them," he said.

Carlson's interest in toxicology and pharmacology developed when he got a job as an analytical chemist, he said. "The fact that I was a chemist and got involved in this thing called veterinary toxicology was a real eye-opener; it opened up an opportunity that I had no idea existed," he added. Today, he takes that personal experience to help students open their minds to careers other than just veterinary medicine.

Kelly Scribner, one of Carlson's former students, was focusing on a career in veterinary medicine but developed such an interest in toxicology after taking one of Carlson's courses that she went on to earn a Ph.D. in toxicology. She now is a responding toxicologist for the Center for Toxicology and Environmental Health (CTEH®) in Arkansas (read the story about Scribner in this publication). Even though Scribner did not earn her Ph.D. from UNL, Carlson said it was the rigor of the UNL program that made her a competitive applicant for a Ph.D. program at another university, which culminated in a job Scribner says she loves.

The difference between a drug and a poison, Carlson said, is that a drug cures and a poison kills. "There's an old adage in toxicology: 'the dose makes the poison.' That means any chemical can be a poison if you get enough," he said. Even drinking too much water can kill, as it disturbs the electrolytic balance in the body, and nerves and muscles don't work well, he said; acetaminophen is the same. In the correct dose, it is an effective painkiller; if you get too much, it's a liver poison. Chemicals do not necessarily have to kill to be considered poisons. For example, some poisons cause cancer and are called carcinogens.

It all comes down to problem solving, Carlson said. If there is a specific problem, like how to get a drug delivered into a joint to treat an infection in that joint, then pharmacology and an understanding of the disease process impact the solution.

Non-pharmaceutical interventions may also be used. "When you look at it from the problem basis, you realize that the problem is not simply solved by one person. It opens the possibilities for people educated in many different disciplines to help develop a solution," he said. +

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OBESITY INCREASES THE RISK OF A VARIETY OF CONDITIONS

TIMOTHY CARR, Ph.D.

Professor and Department Chair,
UNL Department of Nutrition and Health Sciences

FINDING ANSWERS TO OBESITY:

UNL awarded $11.3 million grant to study scientific reasons

by KELLI GREEN *and* TIMOTHY CARR

Nutrition is the foundation of health, according to Timothy Carr, head of the University of Nebraska–Lincoln Department of Nutrition and Health Sciences. The role of nutrition scientists is to provide tangible explanations for the effects of nutrition in people, Carr said. Expansion in research opportunities at the University of Nebraska–Lincoln allow Carr and other scientists to provide more of these explanations.

RESEARCH EXPANSION: NPOD

A five-year, $11.3 million grant was awarded to UNL in August 2014 by the National Institutes of Health Centers of Biomedical Research Excellence (COBRE) to establish the Nebraska Center for Prevention of Obesity Diseases (NPOD). Janos Zempleni, UNL professor of nutrition and health sciences is director; Robert Lewis, professor in the Eppley Cancer Institute at the University of Nebraska Medical Center (UNMC), serves as co-director. The two facilitate research collaboration between UNL and UNMC. This collaboration is focused on dietary molecules and their connection to obesity. The COBRE grant can be renewed up to 15 years and currently provides support and training for five early-career faculty members at UNL and UNMC.

WHY OBESITY?

Obesity is a medical condition in which excess fat accumulates to the extent that it may have negative effects on health. Obesity increases the risk of a variety of conditions: diabetes, high-blood pressure and increased blood triglycerides, Carr said.

We know that eating too much leads to obesity, Carr said, but why do people eat too much? Social and behavioral factors contribute to the type of food and amount of food that people eat. Family eating habits, access to grocery stores, modes of transportation, economic level, health and agricultural policies all contribute to food consumption and nutrition, Carr explained.

"We've seen a shift in our food supply over the last 40 or 50 years that has been significant in terms of the nutrient profile of what Americans eat," Carr said. "Those are things that are less well-understood, but nevertheless contribute to overconsumption of calories."

GOALS OF NPOD

The Nebraska Center for Prevention of Obesity Diseases focuses on fulfilling its main goals, Carr said. "The main thrust of the NPOD is to connect those dietary molecules that are found in the average everyday diet and how those might prevent or contribute to obesity," he explained. The grant provides support and training for high-quality, early-career faculty so they can conduct this metabolic research and establish themselves on a national and international stage. The resulting information from the research will be available to the public. "If the information can be translated to the real world and to actual improvement in public health, that's the most important goal," Carr said.

EXPERT COMMUNICATORS

Clinicians, community health workers and dietitians are essential to help translate research information into real application. Individuals on supplemental nutrition support are more susceptible to obesity and need to learn how to use their food dollar wisely, Carr said. Experts in the nutrition field need to be able to communicate and translate their information into tangible ways of helping people improve their health, and dietitians and health workers are leading these efforts.

COLLABORATION

Transferring information across research fields also is important, and the National Institutes of Health requires that research extends beyond disciplines, Carr said. The COBRE grant for the Nebraska Center for Prevention of Obesity Diseases requires collaboration of different areas of study. "It brings people together from computer sciences, from nutrition and health sciences, and from the medical center who are all working toward a common goal, and that's obesity prevention," Carr said. The World Health Organization and Food and Agriculture Organization also encourage global collaboration and hold international conferences on nutrition. Pooling resources is economically efficient and allows for new perspectives, Carr said.

ONE HEALTH PERSPECTIVE

In modern times, the One Health concept has been promoted by a group of individuals that includes physicians, veterinarians, ecologists, agricultural scientists and environmentalists, Carr said. One Health is an all-encompassing concept that can be looked at from different perspectives, he added. "It's probably important to recognize that the human nutritionist would say the most important piece of the One Health concept is the human nutrition piece. The veterinary scientist would say the most important part of the concept is the animal health. And you get the idea," Carr said.

Human health outcomes depend on people working together, Carr said. In many areas of the world, food is not distributed properly or grown where people need it most, he added. Government policies can act as barriers to building infrastructure, proper transportation or the distribution of food. "The human health outcomes that we're looking at, whether it's malnutrition or overnutrition, clearly depend on those practices that feed into the food supply that provides the food for human consumption," Carr said. To create agricultural practices that are sustainable and to provide enough food and the right kinds of food to the world's population, people from all disciplines need to be talking to each other, he added.

NEW FACULTY MEMBERS, NEW EXPERTISE

Solving the health challenge of obesity requires the assistance of many experts, Carr said. A multidisciplinary team is studying not only the microbiological interactions in the human body, but also behaviors and income levels that may make obesity more likely. "The NPOD is focused primarily on the metabolic aspect of it. However, we on the UNL campus are putting a lot of effort into expanding the level of expertise on campus to look at those social behavioral issues," Carr said.

The University of Nebraska–Lincoln has hired key faculty members specializing in child, youth and family studies, behavioral economics, epidemiology and intervention types of research, community health and health communication and messaging, Carr explained. All of these scientists from different fields collaborate and provide expertise in the work toward obesity prevention. Carr encourages collaboration and different perspectives in the future. "These people weren't here three years ago. This level of expertise didn't exist at UNL, and I'm happy to say that it does now. And we're continuing to build it. It is going to be a really important aspect of the Institute of Agriculture and Natural Resources as we move forward with trying to understand all of the factors that contribute to obesity." +

"EVERYTHING IS EXTREMELY COMPLEX BUT THE OUTCOME COULD PROVIDE TREMENDOUS BENEFITS

DANIEL CIOBANU, Ph.D.

Associate Professor and Molecular Geneticist, UNL Department of Animal Science

RESEARCH AIMS TO IMPROVE FITNESS-RELATED TRAITS IN SWINE:

may help in understanding human disease

by CHELSEA TAYLOR *and* DANIEL CIOBANU

A single strand of DNA sequenced across different pigs contains millions of polymorphisms, including a set of 60,000 DNA markers used in the genetic dissection of complex phenotypes. Daniel Ciobanu, associate professor of animal science at the University of Nebraska–Lincoln, studies reproductive longevity in swine as well as disease resistance at the molecular level, based on genetic analysis. Ciobanu's research focuses on swine, but he said pigs and people have similar genetics. Because of that, much of Ciobanu's animal research could be translated to humans.

SWINE AND HUMANS: SIMILARITIES

Ciobanu, who earned his Ph.D. in animal genetics, uses swine not only to improve traits important in swine production but also as a potential model to better understand disease in humans. Swine and humans have similar anatomy, genetics and pathophysiology — changes in the body resulting from disease or injury — which make pigs a good model for human disease. When comparing the DNA sequence of a pig to that of a human, there are substantial similarities across genes. "Of course, there are enough differences that make us humans, and pigs are still pigs," Ciobanu said.

SUSCEPTIBILITY TO VIRUS

Most of the diseases present in humans and in other animal species are influenced by both genetics and the environment. One of Ciobanu's research projects is focused on locating genes and functional mutations that could explain genetic susceptibility to porcine circovirus 2, a virus associated with several diseases in swine. An effective vaccine is available, but at a cost of nearly $2 per animal, it can be costly to vaccinate every pig. Ciobanu conducts his research with UNL swine populations and industry genetic resources.

"We have identified two genomic regions and DNA markers that explain about 15 percent of the genetic variations for

viremia (level of virus in the blood) for this particular virus," he said. These DNA markers can be used to predict, early in life, pigs that likely will express higher susceptibility if exposed to the virus. The porcine circovirus is particularly interesting to study, Ciobanu said, because the virus influences the ability of the immune response to recognize other pathogens and as a result, favoring co-infections. Interestingly, one of the candidate genes identified is a repressor of immune response and known to affect the response in many human viral pathogens, including human immunodeficiency virus type 1 (HIV-1) and hepatitis C virus (HCV). "We will follow up to identify the actual functional mutations in the candidate genes and look at possibilities to transfer the knowledge to humans and other diseases," Ciobanu said.

FERTILITY IN SWINE, HUMANS

Ciobanu said the progression of molecular biology research is also being used to find the relationship between genetics and fertility in swine. In the future, he hopes those results can be used to better understand fertility in humans. This research studies the age of puberty and the effect of diet in relation to the pig's fertility and ability to produce multiple litters during its lifetime. The earlier a sow — a breeding female — expresses estrous, he said, the longer it will stay in the herd and produce litters. That consistent fertility translates to improved welfare and economics.

Ciobanu's research is focused on the genetics of age at puberty, the earliest indicator of reproductive longevity. One of the mutations identified is located in a gene that influences sexual and social interactions in various mammals, including humans. In the link to humans, it is not certain whether a younger age of puberty is linked to reproductive longevity. Early puberty in human females has been identified as a risk for cardiovascular disease and breast cancer, he said. Studying both pigs and humans makes sense, he said, and it is important to have a model for human research; in this case, it is pigs.

Ciobanu has collaborated on this research project with UNL swine nutritionist Phillip Miller; with UNL geneticists, including Rodger Johnson and Matt Spangler; with statistician Steve Kachman; with UNL bioinformatician Jean-Jack Riethoven; and Clay Lents, a US-MARC neuroendocrinologist. The research also has involved the effects of diet on pigs and how that relates to both swine and human fertility. An original hypothesis was that if humans were to eat less and consume fewer calories, they were expected to live longer, healthier lives. Using swine as a model, Ciobanu and his colleagues used both a standard diet and an energy-restricted diet — a diet with fewer calories. There is now evidence that an energy-restricted diet in swine prior to breeding will have a favorable, long-term effect on fertility, Ciobanu said. A better understanding of complex genetic determinants will provide a better selection of animals for breeding purposes.

Ciobanu's research is funded by the USDA National Institute of Food and Agriculture as well as the National Pork Board. Genome Canada also funded the research relating to porcine circovirus 2.

"Everything is extremely complex and as a result, the progress may appear slow but the outcome could provide tremendous benefits," Ciobanu said. He hopes that the research done in pigs today will impact the modern swine industry and even more human research in the future. ✚

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MOSQUITOES ARE THE MOST IMPORTANT VECTORS OF DISEASE WORLDWIDE

ROBERTO CORTIÑAS, D.V.M., Ph.D.

Assistant Professor of Practice and Parasitologist, UNL School of Veterinary Medicine and Biomedical Sciences

MOSQUITOES, TICKS AND OTHER PARASITES:

linkages between people, animals and the environment

by MARY GARBACZ *and* ROBERTO CORTIÑAS, *based on an interview by* JAMES ANDERSON

That mosquito or tick bite may be nothing more than an annoyance. On the other hand, it may have transmitted a disease, such as West Nile Virus or Lyme disease.

Interests in ecology, medicine and animals led Dr. Roberto Cortiñas to study the disease components of parasites, such as mosquitoes, ticks, fleas, lice and other organisms. Cortiñas is an assistant professor of practice in the University of Nebraska–Lincoln School of Veterinary Medicine and Biomedical Sciences. He also is the diagnostic parasitologist at the Nebraska Veterinary Diagnostic Center.

Cortiñas earned a bachelor's degree in ecology, then a Doctor of Veterinary Medicine degree. "I was already interested in ecology and also interested in medicine. Parasitology was a natural fit for both," he said.

The One Health concept is the idea that there are linkages between plants, people, animals and the environment, he said. Cortiñas' research looks at the parasites, but also at human behavior and ways to mediate the risks of being bitten. "If I have an acreage, should I burn it to get rid of the ticks? Does that have an effect on the ability for the tick hosts to be there? If I have a big forest, should I cut down some of those trees? All the things you do influence your risk for acquiring a disease. All of it is a part of the One Health idea that if you do something over here, it's going to have an impact over there," Cortiñas explained.

"Parasitism is a behavior," he said. Unlike the beneficial relationships between bees and flowers, for instance, parasitism is a relationship between a host and a parasite, which is ecological. There is usually a cost to the host and that is usually reflected with sickness or disease, he said.

Diseases that can affect both animals and humans are called zoonotic diseases. Lyme disease, for example, can be caused by a bite from an infected deer tick, Cortiñas said. "Lyme disease is maintained by white-footed mice. When the deer tick is small, it feeds on the mouse and becomes infected with the

organism that causes the disease. That tick ends up biting you or me, transmitting the organism the mouse had and it gets us sick," he explained.

It's not just humans who get sick, though; so do animals.

"Humans are definitely where a lot of the research is, but animals are susceptible to a lot of tick-borne diseases," Cortiñas said. "Dogs can get Lyme disease; so can horses. Some of the spotted fever diseases are seen in animals, too." Spotted fever diseases also are tick-borne. There also are diseases that are specific to various animals.

TICKS

There are many kinds of ticks in the world; the blacklegged, or deer tick, is the one that transmits Lyme disease. They are present in many areas of the world, including the United States, but they are not yet in Nebraska, based on Cortiñas' research. The most common tick is the American dog tick, he said. The second most common tick is the lone star tick, which is moving north from the southern part of the United States. Another kind of tick, the brown dog tick, is found in kennels and clinics, he added.

Ticks have four life phases: they are born as eggs, then become larvae, nymphs and adults. When they go from one stage to another, they must take a blood meal, which usually comes from a small animal. As ticks become larger, they feed on larger mammals. Their habitat generally is wooded areas, or areas with tall grass.

"It's a risk for farmers and ranchers to walk those shelterbelts because they are going to get exposed to ticks," Cortiñas said.

"One of the biggest diseases that really impacted the livestock industry was cattle fever. Cattle fever was a disease that was devastating," he said. Cattle fever was the first disease scientists recognized in the 1880s as being transmitted by ticks. The cattle drive moved from the southern to the northern part of the United States to get the cattle to slaughterhouses. Sometimes a cattle drive took the animals on trails, putting the animals into contact with cattle that were not part of the cattle drive. "All their cattle would die. Nobody was quite sure what was going on, but it got so bad that people who were leading the cattle drives were threatened with their lives to not bring those cattle back through those trails," Cortiñas said. This tick, called the cattle fever tick, caused economic loss because of the cattle who died of cattle fever. The cattle fever tick had been eradicated in the United States, he said, but recently has been showing up in southern Texas, likely as a result of white-tailed deer moving the ticks from Mexico.

Diseases such as Lyme disease or Rocky Mountain spotted fever can make people very sick, Cortiñas said. It can be a strain on a person's ability to earn a living and can strain health care resources. From a scientific standpoint, the diseases give scientists insights into parasitism and the complex associations among animals and ticks, the environment and people. "There definitely is a need in our society to understand what these organisms are doing," he said.

MOSQUITOES

Mosquitoes are the most important vectors of disease worldwide, including West Nile Virus, Cortiñas said. West Nile Virus has been found in Europe, the Middle East, Africa, India, Asia and Australia. It was first detected in North America in 1999 and has now been detected throughout the continental U.S. and Canada. Dengue virus, once only found in the tropics, has been found in southern Florida. Chikungunya is a mosquito-borne virus that reached epidemic status in East Africa, India and Southeast Asia, then occurred in travelers in Europe and in the U.S. In 2013, chikungunya was first detected in the Western Hemisphere, in the Caribbean (http://www.cdc.gov/chikungunya). "Chikungunya is probably going to move north. It's called the 'bone-crushing disease' because that's how it feels when you get infected with it," Cortiñas said.

Mosquitoes lay their eggs in standing water, such as ponds, lakes and wetlands, and thrive in hot, humid conditions. Cortiñas has studied Nebraska's pivot and surface irrigation systems to learn whether mosquitoes use the irrigated land as habitat for mosquito larvae. "We saw that the mosquitoes responsible for West Nile are there and are found in the fields," he said.

Mosquitoes also transmit heartworms from animal to animal. "If you take your animal to the veterinarian on an annual basis, it's because of a heartworm test, heartworm preventative and flea and tick control products," Cortiñas said. "The big issues, besides vaccinations, are parasitology-related issues."

RESEARCH: NATURAL INSECTICIDES

Cortiñas' background in ecology and his fascination with the ability of plants to create compounds has led him to a research project, funded by the National Center for Veterinary Parasitology at Oklahoma State University, to develop natural insecticides. Nebraska ranks third in the nation for organic broiler chicken production, and organic producers can only use natural, organically derived compounds to keep their

certification, he said. Cortiñas started thinking about possible alternatives to commercially produced synthetic insecticides. One of the possible alternatives is plant extracts.

"Plants get mites that feed on them, but the plants produce compounds that try to get rid of the parasites, or at least repel them. Why not test those compounds to see if they have activity related to parasites on animals?" Cortiñas said. His research is studying the effect of those plant-derived compounds to control northern fowl poultry mites, which could benefit the organic production of hens in Nebraska, he said.

The research first will look at individual constituents of essential oils, then will move on to complete essential oils distilled from plants. "If you take a peppermint plant and crush it up, what you're smelling are the essential oils," he said. "Why not look at the activity of those compounds?"

Though plants have been used to treat medical conditions in many cultures for millennia, Cortiñas said this approach will use evidence-based research to assess the effectiveness of plants and botanicals in treating animals with these conditions. The research also could be beneficial since veterinarians are seeing issues in some parasite populations with resistance to commercially produced dewormers and insecticides, he said, similar to issues physicians are seeing with resistance to antibiotics. +

PREVENTING TICK BITES

Ticks transmit disease pathogens more diverse than mosquito-borne pathogens, according to Dr. Roberto Cortiñas, a veterinarian and an assistant professor of practice at the University of Nebraska–Lincoln. The most common tick-borne disease in the United States is Lyme disease. It is critical to have an understanding of the factors that increase the risk to acquire disease in animals and humans, he said. There are chemical, physical and behavioral barriers that can lessen the chances of tick bites, as well as bites from mosquitoes:

CHEMICAL BARRIERS

- Products containing DEET, picaridin, IR3535 and some natural plant oils repel most biting insects. DEET is long-lasting and very effective in repelling ticks. If you are going into an area where ticks are common, spray exposed surfaces and clothing with these products to reduce the risk of tick bites.
- Clothing, such as trousers and socks, can be purchased that is treated with a pyrethroid insecticide, such as permethrin. However, unprotected skin still must be treated with an insect repellent. These items can be purchased at sporting goods stores.

Physical barriers

- Placing tape around the entire bottom of each trouser leg prevents ticks from having access to your legs.
- Wearing light-colored clothing, long-sleeved shirts and pants.

Behavioral barriers

- Learn about when ticks are most active so you can decide whether to visit an area when ticks are most active.
- Animal producers who must move animals into wooded areas can wait until ticks are less active.

IF YOU FIND A TICK ON YOUR BODY:

- Check yourself thoroughly after being in an area where ticks are common.
- If you find ticks that are not attached, remove them immediately.
- If a tick has bitten you, take a pair of forceps or tweezers, grab the tick as close to the skin as possible and slowly pull it out.
- Save the tick in alcohol.
- Monitor your health; if you have been infected with a disease pathogen, you should feel the effects of the disease within two weeks.

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SCIENTISTS ARE THERE TO MAKE OBSERVATIONS TO HELP ANIMALS AND PEOPLE

ANDREA CUPP, Ph.D.

Irvin T. and Wanda R. Omtvedt Professor of Animal Science, Reproductive Physiology, UNL Department of Animal Science

REPRODUCTIVE SCIENCE HELPS ANIMALS *and* HUMANS

by MARGARET BAKER *and* ANDREA CUPP

More animal protein must be developed and produced to feed the increasing world population, and researchers are working to enhance the fertility of cattle to meet those demands.

Andrea Cupp, professor of animal science at the University of Nebraska–Lincoln, has identified cows in the UNL research herd that may have problems with ovulation; understanding what is wrong in these cows helps cattle and beef producers and also enhances human fertility research. "My research is not just benefiting the beef cow producer, but it's also benefiting humans and their reproductive health," Cupp said.

INCREASING PRODUCTION

In 2008, Cupp and her research team began working to determine the cause of infertility and reproductive inefficiency by studying a population of cows within the UNL research herd that had reduced calving rates.

Ultimately, beef cattle need to produce one calf per year, and if that is not happening, then the cow will be culled, or removed from the herd, Cupp said. The majority of the cows that had problems with reduced calving rate also had problems with ovulation. This may have been caused by an increased production of androgen in the dominant follicle, which did not allow for ovulation to occur. "By understanding why ovulation is not occurring, or not occurring at the appropriate time, we can enhance reproduction in these cows or find ways to select against them in the herd," she said.

According to Cupp, the cows she has identified represent a naturally occurring research model. "We're just identifying them through altered endocrine patterns and steroid hormone secretion, and so it's natural."

HUMAN CORRELATION

Cupp's research determined that the cows were either not ovulating at an appropriate time or they weren't ovulating at all. "What's interesting about that is in the human population, in women, the major infertility problem is anovulation," Cupp said. Anovulation is a condition in which ovulation does not occur. "We know that women have anovulation problems,

even those that we think are having normal reproductive cycles, and now we have evidence that it is similar in the cow population we are studying. I believe this is happening in cow herds all over, as well as in the human population," she said.

The research discovered an excess of a hormone called androgen, which is a similar condition as women who have a disorder called polycystic ovarian disease. "Initially, when we found this increased androgen we were actually looking at another gene so in several ways it was serendipity that we found this population of cows that were subfertile, " Cupp said.

PROJECT COLLABORATORS

Several of Cupp's colleagues contribute to research that translates to humans while helping agricultural producers. "As luck would have it, a colleague in my department, Jennifer Wood, has worked on ovarian samples from women who have polycystic ovarian disease," she said. Wood has discovered a series of genes that are altered within the egg and thecal cells of these women.

John Davis of the University of Nebraska Medical Center Department of Obstetrics and Gynecology (OBGYN) and Rebecca Krisher of the National Foundation for Fertility in Lone Tree, Colo., also are project collaborators. According to Cupp, Davis works on bovine corpus luteum, a reproductive structure in mammals that forms after the egg has ovulated from the remaining somatic cells (granulosa and theca). "And Krisher has an animal science background, but she's actually working as the research director in a human fertility clinic," Cupp said.

The research team obtained a three-year grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture (NIFA) to study this population of cows and determine the cause of reproductive problems. "We've made a lot of progress and we're pretty excited about some of the things we'll be able to do with this," Cupp said.

FUNDING, COMMUNICATION

Reproduction is a complex trait and there are probably differences in genetics, the environment and nutrition that may impact whether a cow is reproductively efficient. She also may be impacted by her mother's nutrition and environment during gestation that they were exposed to, Cupp said.

With continued funding, this research project is starting to find how endocrine hormone patterns may affect ovulation or delay it in these cows. "In the future, we also may be able to determine if maternal environment affected these cows and the reproductive potential of offspring," Cupp said.

"It is important to communicate the significance of research and how it translates to both animal and human health," Cupp explained, stressing the importance of scientists explaining things in a way that people can understand.

"Scientists are there to make observations to help animals and people," Cupp said. "I would like to see my research having an impact on reproductive efficiency in both cows and women." +

"THE DIRECT BENEFIT OF OUR RESEARCH IS TO COMMUNICATE WITH OTHER SCIENTISTS WHO ARE TRYING TO UNDERSTAND OVARIAN FUNCTION AND EGG QUALITY

JENNIFER WOOD, Ph.D.

Associate Professor and Molecular Reproductive Physiologist, UNL Department of Animal Science

EGG QUALITY IMPORTANT FOR COWS, WOMEN:

research addressing female infertility

BY ASHLEY MAHER AND JENNIFER WOOD

Jennifer Wood is fascinated by the science of reproduction, "particularly the process by which an egg from a girl and a sperm from a boy creates a whole new person or animal." As an associate professor of molecular reproductive physiology in the Department of Animal Science at the University of Nebraska–Lincoln, Wood's research is at the intersection of animal health and human health.

Wood collaborates with Andrea Cupp, UNL professor of animal science, to better understand and improve the fertility of cows. Cupp's focus is on the regulation of ovarian function by hormones, while Wood's focus is on the quality of the egg produced by the ovary each reproductive cycle. "How does the egg mature so that it can be fertilized and develop into an embryo? How does maternal health and nutrition influence this process as well as how the baby grows and develops? Answering these fundamental questions will have application across much of the animal kingdom, including domestic livestock and people," Wood said.

Cupp and Wood study the endocrine hormones and how they change during the reproductive cycle of the cow.

"We stumbled upon animals that make too much androgen," Wood said. "It's usually considered a male hormone, but female animals make small amounts of androgen, too. Not only did the cows make more androgen, they were also not able to efficiently convert the androgen to estrogen (the female hormone) like the normal cows in the herd," she added. This characteristic is similar to a human disease called Polycystic Ovary Syndrome, or PCOS. Women who have this condition experience fertility problems and are often susceptible to obesity, diabetes or cancers of the reproductive system, she said.

Although the animal model does not replicate the human condition, it does mimic several aspects of PCOS, making it an important tool for understanding how the disease develops and progresses. Cows with the condition seem to ovulate less frequently and tend to have reduced calving rates. "If you are a producer, you want cows to get pregnant and produce

a calf each breeding season. If they do not ovulate or if they ovulate but the egg has poor quality, they may not have a calf each year," she said. "Therefore, we are trying to understand why cows make excess androgen and how this impairs their fertility."

Because of the similarities between the subpopulation of cows and women with PCOS, Wood uses the cow as a research model. "Cows are really good models for humans and they are really good models for cows, so that comes in quite handy," Wood added.

ECONOMIC EFFICIENCY

There is a significant cost associated with developing a female cow through puberty and breeding her with the end goal of her producing a calf. When animals have reduced reproductive efficiency, Wood said. "You may end up feeding an animal that isn't going to give you a product. You need a cow to produce three calves to recoup the costs that you've spent on developing her for breeding," she explained. "And, you haven't made money from her until she's had a fourth or a fifth calf." The more calves she has, the more economically valuable she is, Wood said. How a cow is managed during the development phase and maintaining her health once she attains puberty raises the chances of her being able to reproduce reliably, year after year. Despite the best efforts of a producer, some cows still experience infertility. Because of this, it would be valuable to determine or predict the reproductive health of the cow when she is young, before puberty. "It is our goal to use the results from our research on what causes cows to make the excess androgen and why excess androgen seems to cause infertility to better predict the reproductive health and longevity of a cow," she said.

"The direct benefit of our research is to communicate with other scientists who are trying to understand similar mechanisms of ovarian function and egg quality," Wood said, but an additional, applied benefit is to livestock producers.

"Ultimately, we would like our research to help producers identify the cows that will develop the excess androgen trait and make the decision whether to keep the animal in the breeding herd," she said. Wood and Cupp also are trying to see if excess androgen is causing other metabolic problems in cows that could affect the way the animals grow, or whether specific management techniques might be needed to keep the animals in the herd longer. Furthermore, the effect of maternal excess androgen on the development of the fetus is an additional area of future research focus. This is important because exposure to excess androgen during development could impact important traits in the calf, including how much muscle or fat the calf has, how well the calf uses nutrients and even how reproductively capable the calf will be.

Wood and Cupp are coinvestigators on the USDA National Institute of Food and Agriculture (NIFA) Agriculture and Food Research Initiative (AFRI) grant. Wood also is the principal investigator on competitive USDA multistate research funds from the UNL Agricultural Research Division (ARD).

"SINCE BSL-3 FACILITIES BEGAN OPERATING IN OUR COUNTRY, THE NUMBER OF ACCIDENTS HAS DROPPED DRAMATICALLY

GUSTAVO DELHON, D.V.M., M.S., Ph.D.

Research Associate Professor and Director of Biosafety Level 3 Core Facility, UNL School of Veterinary Medicine and Biomedical Sciences

BIOSAFETY LEVEL 3 FACILITIES:

protecting people, animals, the environment

by COLLEENE MARRIOTT *and* GUSTAVO DELHON

Infectious diseases impact both animal health and human health. Changing technology has made possible the kinds of research that can help scientists understand the mechanisms that cause disease, which results in ideas that stop disease before it happens.

Working with these disease agents can be hazardous, so research facilities are built with features to protect lab workers, the community, animals and the environment. These biosafety containment facilities are ranked according to the danger associated with the disease agents. The facilities at the University of Nebraska–Lincoln are Biosafety Level 3 (BSL-3) facilities. Biosafety Level 4 facilities are the most secure and include the study of disease agents for which there is no cure, such as the Ebola virus. BSL-3 facilities work with serious diseases, but there are treatments for them.

Dr. Gustavo Delhon is director of the UNL Biosafety Level 3 Core Facility. Delhon earned his Doctor of Veterinary Medicine degree in Argentina, and then earned his master's and doctorate degrees at UNL. His work with the U.S. Department of Agriculture Plum Island Animal Disease Center, which is a Biosafety Level 3 animal facility, gave him experience with biocontainment facilities.

One University of Nebraska–Lincoln BSL 3 facility is in the Nebraska Center for Virology and another is outside of that building.

WHAT IS A BIOSAFETY LEVEL 3 FACILITY?

"A Biosafety Level 3 facility allows you to do safe research with serious pathogens or their toxins, which can cause disease to humans, animals or both," Delhon said. The biocontainment security of the UNL laboratories is above the standard level of most laboratories on university campuses, he said.

In the past, infectious agents or toxic substances produced by them were studied in standard labs. Because of a lack of proper containment measures, workers were exposed to these agents and substances, which were released into the environment, Delhon said. "Since BSL-3 facilities began operating in our country, the number of accidents has dropped dramatically. They have had a huge impact in terms of biosafety, both for the laboratory workers and the community," Delhon said.

Before a person begins to work in a BSL-3 laboratory, a committee does a risk assessment of both the pathogen and the research the scientist plans to conduct. As a result of the assessment, a protocol is developed to create the best possible working situation for that particular pathogen, Delhon said. The protocol must be approved by a safety committee, which mandates the safety measures for that pathogen and that research, he added.

"There is a general series of rules you have to follow in BSL-3," Delhon said. "Entering the lab is restricted to authorized personnel; eating and drinking are prohibited; people working there have to be trained in BSL-3 lab practices and use a number of protective devices that are not used in standard labs," he said.

Additionally, a BSL 3 facility is different from a standard laboratory in design. "As an example, the air inside the building is under negative pressure," he said. The air never goes outside the building directly, but is sucked up into specific points where the air is filtered with special filters before the air goes out. Scientists who work with Level 3 pathogens must work with pathogens exclusively in a safety cabinet, wearing one or two layers of protective clothing, a disposable gown and mask; a respirator; and goggles for eye protection.

RESEARCH AND ONE HEALTH INITIATIVE

Delhon originally wanted to practice veterinary medicine in the countryside with large animals, but one of his professors introduced him to research. His interactions with other researchers led to an interest in virology and a career in research and teaching.

Delhon teaches graduate virology courses, as well as histology and virology courses to veterinary medicine students. He also conducts research – two of his projects relate to viruses affecting sheep and goats, with the goal of learning more about the mechanisms that cause disease. A third project relates to developing a vaccine for a virus that affects swine.

"Infectious diseases in general, and viral infections in particular, have a big impact in animal health," he said. By working in virology, he believes he is contributing to the well-being of animals, and since most viruses that affect people come from animals, his work also is connected to human health.

That interconnectedness is the foundation of the One Health Initiative, a global strategy that links human, animal and environmental health and promotes interdisciplinary collaborations and communication.

Delhon said veterinarians will be much more involved in the One Health concept in the 21st century than they were in the past. "This is particularly clear in my field of study with infectious diseases, because a significant proportion of infections in humans has an animal origin," he said. The One Health concept is being introduced to students, especially in virology and microbiology courses, showing them connections that are important for animals and humans. Delhon said veterinarians currently communicate with physicians and public health agents, and expect to do much more of that in the future.

"Think of influenza, a viral disease affecting people and certain domestic animals such as poultry, pigs, horses and dogs. We know that certain animal influenza viruses can jump into people, causing pandemics. Certain animal species, on the other hand, can be infected by human influenza viruses," Delhon said. Veterinarians can greatly contribute to tackling the burden caused by influenza viruses by making and communicating critical early observations during influenza outbreaks in animals, he added.

In the past, veterinarians focused mostly on outbreak management and vaccination strategies for the affected animal population. Today, data on severity of infections, transmission, human involvement and vaccine failure, as well as sampling of infected animals to get knowledge on the genetic makeup of viruses, provide critical information to assess the risk of these viruses for the community. "Clearly, the role of veterinarians in scenarios like this, expands well beyond traditional animal-focused intervention."

"THE VDC IS A FULL-SERVICE LABORATORY FOR ANIMAL DISEASE DIAGNOSIS

ALAN DOSTER, D.V.M., Ph.D.

Professor, UNL School of Veterinary Medicine and Biomedical Sciences and Director, Veterinary Diagnostic Center

NEBRASKA VETERINARY DIAGNOSTIC CENTER:

safeguarding the health of animals and people

by ASHLEY MAHER *and* ALAN DOSTER

The primary goals of the Nebraska Veterinary Diagnostic Center (VDC) are to safeguard and improve the health of animals and humans, ensure the safety of animal by-products, protect Nebraska's wildlife population and further the knowledge of diseases of man and animals.

Understanding the disease process and how diseases spread can help producers and the public by providing knowledge regarding certain diseases and their transmission in order to keep animals healthy. Research is being conducted every day to better understand causes of diseases, how they are transmitted, and how they can be treated.

"The VDC is a full-service laboratory for animal disease diagnosis," according to Dr. Alan Doster, director of the VDC. "We are accredited by the American Association of Veterinary Laboratory Diagnosticians (AAVLD), the United States Department of Agriculture (USDA) and the National Animal Health Laboratory Network (NAHLN)."

The VDC's staff includes veterinarians and technicians who specialize in pathology, bacteriology, toxicology and virology. These disciplines cover the spectrum of diseases the center is asked to analyze, he said.

DIAGNOSING DISEASE

Doster said if a referring veterinarian suspects a certain disease, an appropriate sample is sent to the center for analysis. A pathologist determines what tests are most appropriate to conduct to determine whether a disease is present. Samples then are sent to individual laboratory units, where specific testing is conducted. In most cases, results can be available in 24-72 hours, depending on the test required.

A diagnostician may perform an animal autopsy, called a necropsy, to determine the disease, Doster said. At that point, samples may be taken to a VDC laboratory for further examinations to determine whether a virus, bacteria, toxin or other issue has caused the animal's illness, he added.

Diagnosing animal disease is critical in Nebraska. Diagnosing disease is the first step in controlling an outbreak; however, diagnosing animal disease also is important for human health. Human health is impacted when an animal disease, such as salmonella, West Nile Virus or rabies, is transferred from an animal to a human. These diseases are called zoonotic; they can be transferred from a specific animal to another species, including human.

"The public needs to know that these diseases are out there; they need to have caution handling animals or being in certain situations," Doster said. West Nile virus is transferred to humans by mosquitoes; rabies usually by bites from infected animals; and salmonella by human or animal feces, or by food preparation areas that have come in contact with raw meat or poultry.

"We are at the stage where we can't separate veterinary medicine from human medicine from the animal sciences, from ecology, plant sciences. All are involved in the One Health Initiative," Doster said.

VDC services are available not only to Nebraska, but to the region. "We are known as a center for the diagnosis of Bovine Viral Diarrhea virus in cattle, so we get a lot of samples from other states for diagnostic purposes," Doster said.

Another service provided is surveillance testing for the state and for the federal government. "Many of our trading partners, such as Russia, Japan, China, Mexico and Canada, require that we test for certain diseases and that samples are negative before importation of live animals or animal products is allowed. If samples are positive, it interferes with trade," Doster said.

NEW VDC IN 2017

The current Nebraska Veterinary Diagnostic Center was built in 1975 and at the time, was one of the nation's premier laboratories. However, after 40 years, the current facility is short on space and needs technological updates, including updated biosecurity. Doster said the air going out of the VDC will be filtered so it is safe for the environment. No animal or human pathogens will be released. "We aren't going to be able to release pathogens; our air quality will exceed the EPA requirements," he said.

Doster said a new, 65,000-square-foot VDC is under construction and will be completed in late 2017. The current facility has 11,000 square feet and has been remodeled several times to accommodate new technology and equipment, but additional space is needed for future growth and expansion.

"Our new laboratory will be biosecure," Doster said. Only authorized staff will be able to access the laboratories in the new VDC, he added. This security will ensure that animal disease does not spread and that VDC staff are safe from exposure to disease. The new building will be located on the north side of the UNL East Campus, he said.

The ground level of the two-story facility will include offices that will be accessible to the public and to students, he said. There also will be a large "interaction" room that will be used as a classroom; it also will be available to the public for meetings.

"We are going to incorporate teaching into that laboratory," Doster said. The VDC is an integral part of the Professional Program in Veterinary Medicine, in which students accepted into the post-graduate veterinary program take two years of basic veterinary medicine instruction at UNL and two years of clinical instruction at Iowa State University's College of Veterinary Medicine. Doster teaches pathology to sophomore veterinary medicine students, as does his VDC colleague, Dr. Bruce Brodersen. "It's going to be a real emphasis to get those kids in the laboratory instead of (just) seeing pictures," he said. "We are not going to use it just as a diagnostic laboratory; it is a diagnostic and teaching laboratory where students will be exposed to real life situations involving real animal diseases."

Additionally, the Extension veterinarians will be located in the new facility, Doster said. If diagnosticians are seeing an increased number of animals with a specific disease, that information will be sent to the Extension veterinarians and to health laboratories so they can be aware that there is an increase in certain diseases and vice versa. +

For more information on the Nebraska Veterinary Diagnostic Center, visit: vbms.unl.edu/nvdls.

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OUR GOAL: TO FIND OUT WHAT THESE EMERGING VIRUSES ARE

SAMODHA FERNANDO, Ph.D.

Assistant Professor, Nutritional Biochemistry, UNL Department of Animal Science

STUDY OF MICROBES IN THE ENVIRONMENT LEADS TO STUDY OF ANIMAL, HUMAN HEALTH

by MADELINE CLARK *and* SAMODHA FERNANDO

Samodha Fernando studies microbes – organisms so tiny they can't be seen with the naked eye – such as bacteria, fungi, protozoa and viruses. Microbes affect the health of humans, animals and the environment, in both beneficial and detrimental ways.

Fernando is an assistant professor of nutritional biochemistry at the University of Nebraska–Lincoln and is finding ways to improve animal efficiency, food safety and overall human and animal health.

He became interested in investigating microbial communities and their roles when he conducted postdoctoral research at the Massachusetts Institute of Technology; there, he studied microbes in corals, especially bacterial species that cause coral diseases. Now at UNL, Fernando is interested in bacterial and viral pathogens and how microbes found in animals can jump the species barrier and become a human pathogen.

HEALTH CONDITIONS AND THE MICROBIOME

There are many studies showing that microbes in the intestinal tract, or gut, play a role in obesity and other human health conditions, such as type 2 diabetes and cardiovascular disease. Fernando also performs research to understand the role of gut microbes in human health and disease. As a pilot project leader for the Nebraska Center for the Prevention of Obesity Diseases (NPOD) at UNL, which was launched in 2014 as a Center of Biomedical Research Excellence (COBRE) with support from UNL and the National Institutes of Health, Fernando and other investigators at NPOD are finding ways to decrease risks of obesity and related diseases through altering nutrient-dependent cell signals. Fernando's role is to study the role of the microbes and their role in obesity and related diseases using pigs as a model; pigs are physiologically similar to humans. "There is research showing that certain microbes in obese individuals have an increased capacity to harvest energy from the diet," he said.

Fernando's goal is to understand microbial structure-function relationships to improve human and animal nutrition. Part of that means he is investigating the role of the gut microbiome in humans, pigs and ruminant animals, such as cattle, to understand their role in energy utilization and pathogenesis.

CATTLE

In an ongoing study, Fernando investigates the role of viruses within the rumen. "When we talk about viruses, they actually help the rumen ecosystem increase feed efficiency by increasing nutrient flow of the animal," Fernando said. More efficiency means an animal can eat less feed and get more energy from that feed, reducing production costs.

"The reason ruminants can survive on low-quality forages is because of the microbes in the rumen (ruminants have a four-chambered stomach, which includes the reticulum, rumen, omasum and abomasum)," Fernando said. "We can't eat grass and survive because we don't have the amounts and the types of microbes, or the digestive tract that ruminants have to digest cellulose-rich diets. The rumen allows the feed to stay longer in the gastrointestinal tract of ruminants so the microbes can break down the cellulose," he explained. This longer digestion process makes it possible for cattle to get energy from low-quality forages high in cellulose that humans cannot digest, such as cornstalks or grass.

A group of viruses he studies are called bacteriophages – these are viruses that attack bacteria. Fernando is studying whether these viruses can be used to control bacterial populations, especially pathogens. This strategy is called phage therapy; instead of using antibiotics, viruses are used to control bacterial populations. Currently, phages are being used as a post-harvest intervention strategy to reduce *E. coli* in beef, he said. But developing phage therapy is not straightforward; the bacteria try to evolve so the phage cannot find it. "It is like someone coming to catch us and we are running away from that person," Fernando said.

Fernando is finding that the viruses affect the microbial community, impacting the nutrition and performance of the animal. "We see these viruses are helping animals adapt to different environments," he said. In beef cattle production systems, animals are fed different diets, ranging from forage-rich diets to high-starch diets. "These viruses move metabolism genes to help bacterial species adapt to different diets. By doing that, the virus is ensuring its survival as the virus depends on the bacteria as its host for replication," he explained.

FROM OCEAN CORAL, TO CATTLE, TO SWINE

Fernando plans to study new and emerging viral and bacterial pathogens in swine. "Currently, the way we are approaching it is rather than waiting until an outbreak comes, we are looking at the natural population of viruses in pigs to identify zoonotic pathogens (pathogens in swine that can jump the species barrier and infect humans)," he said. The tools he uses to study viruses in animals are tools he learned studying microbes and viruses in the ocean, he said.

"We are using this as a proof of concept," he said. "If it works on pigs, we can expand it to look at other species to identify zoonotic pathogens. That is our goal – to find out what these emerging viruses are and especially, what is the infectivity and pathogenicity of novel viruses in humans and pigs," he said. +

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WE STILL NEED TO FIND MORE EFFICIENT WAYS TO GROW OUR CROPS TO KEEP A FOOD SUPPLY FOR EVERYBODY

RODRIGO FRANCO-CRUZ, Ph.D.

Associate Professor and Biomedical Scientist, UNL School of Veterinary Medicine and Biomedical Sciences

ENVIRONMENT, CHEMICALS AND DISEASE:

finding exposure triggers that cause Parkinson's, other diseases

by MADELINE CLARK *and* RODRIGO FRANCO-CRUZ

To most, chemicals that are sprayed on crops or home gardens just keep pests and weeds away. To Rodrigo Franco-Cruz, they are more than just chemicals. They are part of the environment and the foundation of his research on how environmental toxicity impacts human and animal health.

Franco-Cruz, an assistant professor in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln, earned his Ph.D. in Biomedical Sciences at the National Autonomous University of Mexico, focusing on the chemical aspect of the neuronal response to stress (neurochemistry). His research at UNL now looks at how environmental exposures to toxins (natural) or toxicants (human-made) affect neuronal function. One of the diseases that has been largely associated with environmental toxicants is Parkinson's disease, Franco-Cruz said. During part of his post-doctoral research training at the National Institutes of Environmental Health Sciences (NIEHS), he became interested in how the environment affects human health and since starting his own independent research program in 2009, he has uncovered novel molecular mechanisms by which exposures to environmental contaminants can affect neuronal cell function.

ENVIRONMENTAL EXPOSURES AND HEALTH

Environmental exposures have been linked to a number of diseases, such as asthma and cardiovascular disorders, Franco-Cruz said; with pesticides the evidence is particularly strong for a link with Parkinson's disease. Parkinson's disease is a progressive neurodegenerative disorder that primarily affects motor movement and coordination. "Unfortunately, to date we don't know exactly what's triggering it," he said. Only around 10 percent of the cases have a hereditary aspect. Ninety percent are completely sporadic – meaning there is no clear cause associated with them, he added.

The pesticides themselves are likely not the single cause of Parkinson's disease, "but it is pretty much clear that they are altering neuronal function and eventually or progressively leading to neuronal cell death," he said. "My research group at the UNL Institute of Agriculture and Natural Resources is trying to understand how agricultural pesticides lead to human disease and what makes an individual susceptible to them," Franco-Cruz said.

NEURONAL DYSFUNCTION, PESTICIDES AND AGE

Two primary pesticides have been linked to Parkinson's disease: paraquat and rotenone. Within the last five years, the evidence linking those two pesticides to neuronal dysfunction has strengthened, Franco-Cruz said. Although there is evidence linking those pesticides to Parkinson's neurodegeneration, they are most likely not the only ones, he added. This is because there is a general association with pesticide exposure and Parkinson's disease but in agriculture, many different pesticides are used. This leads to multiple hypotheses in which a combination of different stressors and different pesticides, along with different habits of an individual, can act in conjunction to cause Parkinson's disease.

Even though pesticides and other toxicants are linked to this disease, the major risk factor is age. "For Parkinson's disease, after 60 years the risk of presenting Parkinson's disease just increases exponentially. So, the major risk factor is age. But not everybody who ages gets Parkinson's, so we and many other research groups think that together with genetics, the environment plays an important role," he said.

"It is evident that we still need to find more efficient ways to grow our crops to keep a food supply for everybody, so there is no way to avoid the use of pesticides. However, we need to understand the risk of exposure," he said. Franco-Cruz and his research team aim to understand how pesticides cause neuronal dysfunction. They have found that the mechanisms by which pesticides promote neuronal degeneration are very diverse and depend on their interaction with other risk factors (genes).

"This disease is more like a syndrome in which the intrinsic susceptibility of neuronal cells to the combination of different risk factors, including pesticides, can trigger the degeneration," Franco-Cruz said.

UNDERSTANDING PARKINSON'S VIA AN INTERDISCIPLINARY APPROACH

Approximately 4 million people worldwide suffer from Parkinson's disease and about one in 20 are diagnosed when they are younger than 40. Parkinson's disease selectively targets "dopaminergic" neurons in a region called the substantia nigra, localized in the midbrain. Dopamine, the neurotransmitter used by these cells to communicate, is involved in the control of movement and coordination. By the time Parkinson's disease is detected, 50-80 percent of the neuronal population is lost. "By the time symptoms start to appear, there is not much prevention you can do, unfortunately," Franco-Cruz said. Currently, there is no therapeutic approach to stop the disease progression or cure it. Current research efforts are aimed at restoring those neuronal populations and identifying biomarkers for its early diagnosis.

Another important area of research is attempting to understand the mechanisms of the disease. "By understanding the basic mechanisms involved, we may be able to learn ways to diagnose it early and prevent or reduce the degenerative process," he explained.

ONE HEALTH: INTERDISCIPLINARY COLLABORATIONS

"The One Health concept is a strategy for expanding interdisciplinary research collaborations between scientists and other health and environmentally related disciplines in all aspects of health, including research, for humans, animals and the environment," he said. "Research at our school places an emphasis on collaborative efforts toward the advancement of biomedical knowledge. My research program is very interdisciplinary as we collaborate with chemists, engineers, veterinarians and the medical college in Omaha to understand how the environment contributes to disease progression."

Franco-Cruz's research aims to identify novel mechanisms of disease. "We have made important contributions in three major areas: redox biology, energy metabolism and protein quality control. For example, we have recently demonstrated that impairment in the ability of the cells to tag and degrade proteins regulates cellular homeostasis and death. Furthermore, we have also uncovered a very important role of energy metabolism. Glucose is the obligatory energy substrate of the adult brain. Neurons require energy for a number of functions, including communication, homeostasis and antioxidant defense. Dopaminergic neurons in the substantia nigra consume a significant amount of energy. Energy failure is the hallmark of Parkinson's disease and we have demonstrated that alterations in energy metabolism have important implications for neurogeneration," he said. Franco-Cruz's research also looks at genetic traits that can increase the risk of acquiring the disorder. Many kinds of pesticides are used in agriculture, so one idea used in the Franco-Cruz team's research is that multiple factors may combine to cause the disease. It could be many different types of pesticides, combined with the different habits of an individual. The pesticides that have been most commonly used in the past now are used less often due to more stringent regulations. However, the prevalence of Parkinson's disease is increasing, he said. "While our research is primarily focused on determining the basic mechanisms involved in neuronal dysfunction, eventually, I will hopefully see this research evolving so we can identify individuals that can be more susceptible to pesticides and try to avoid or reduce their exposure, and also identify potential exposure combinations (genes and environment) that will make an individual more susceptible to develop Parkinson's disease," he said. +

"I HOPE WE'LL LOOK BACK AND SAY 'THE GOAL WAS FOR US TO COMBAT DISEASE, BUT ALONG THE WAY, WE FIGURED OUT HOW TO SOLVE WORLD HUNGER, TOO'

RONNIE GREEN, Ph.D.

UNL Senior Vice Chancellor for Academic Affairs; NU Vice President for Agriculture and Natural Resources; UNL Harlan Vice Chancellor of the Institute of Agriculture and Natural Resources

ONE ENVIRONMENT, ONE HEALTH:

Ronnie Green explains its importance

by HOPE HEMME *and* RONNIE GREEN

"It's the big umbrella that's important here. The tactical things underneath that are the impacts we have today: improved human health, improved animal health and improved plant health are the logical outcomes. It's this bigger picture of understanding that coexistence that's ultimately most important."

Nebraska is an agricultural powerhouse and University of Nebraska Vice President for Agriculture and Natural Resources Ronnie Green wants the university to be considered the leading institution of higher education in sustainably feeding the world in the future. The state also has an economy and culture that is largely based on agriculture, bringing in over $23 billion in 2013, according to the Nebraska Department of Agriculture.

Nebraska's large input in the agricultural world lends itself to being a great place to study the concept of One Health. The One Health initiative was developed by the collaboration of the American Medical Association and American Veterinary Medical Association in 2007. As a result of the 2008 avian influenza outbreak, many people became fearful of zoonotic diseases, which are diseases that can be transmitted from animals to humans or from humans to animals. One Health was created to discuss and learn more about how humans, animals, plants and the environment are all interlinked. "If we're going to have long-term sustainability of our world that we live in, that long-term sustainability is going to be because we better understand the world, the environment that we live in," Green said.

The University of Nebraska–Lincoln helps to further develop the agricultural capabilities of Nebraska and its role in One Health. All 15 departments within the Institute of Agriculture and Natural Resources (IANR) contribute to One Health. *Growing a Healthy Future* is the mission of IANR and it coincides well with One Health, Green said.

RESOURCES AT THE UNIVERSITY

Green said transdisciplinary research is solving problems related to plant, animal and human health. Many groups are involved in such research, but a few are the Nebraska Center for Virology, the Redox Biology Center and the UNL Center for Biotechnology.

The Nebraska Center for Virology and the Redox Biology Center are interdisciplinary centers across multiple departments and programs at UNL, Green said, representing significant research into plant, animal, and human health. Scientists in both centers are mainly from the UNL Institute of Agriculture and Natural Resources and from the UNL College of Arts and Sciences, but also collaborate with scientists from the University of Nebraska Medical Center and Creighton University.

The Nebraska Center for Virology's scientists are discovering more about viral diseases of humans, plants and animals. The Redox Biology Center's scientists study how the human metabolism interacts with the body's immune system that results in health or health challenges.

The UNL Center for Biotechnology not only focuses on studying the mechanisms of disease; it offers innovative technology that can be shared by many researchers.

Current research at UNL that pertains to One Health includes: tuberculosis, Johne's disease, bovine respiratory disease, women's health and HIV/AIDS. The future may include edible vaccines for diseases that currently have no cure.

WHY IS ONE HEALTH IMPORTANT?

One Health focuses on improving and protecting the health of all kingdoms of living organisms. One Health allows people to "understand how we can control these diseases, how we can better live in concert with pathogens that are in the natural environment," Green said. As microorganisms and pathogens change as the world changes, researchers are continuing to learn new things all the time. When veterinarians developed the idea of One Health, they wanted to learn how to protect people from zoonotic diseases. Now, they also hope to understand how microbes, animals, plants and humans can exist together safely while sharing one environment.

Green said he hopes "we'll be able to understand better and find ways that we can live in harmony with the greater natural environment that's out there; that includes all these microbes." By living in harmony with the environment, researchers will help humans to have a better quality of life. "I hope we'll look back and say, 'the goal was for us to be able to combat disease better as it moves amongst the organisms in the environment, but along the way we figured out how to solve world hunger, too.'"

CRYSTAL BALL GAZING

"If I'm crystal ball gazing, I'm guessing that the One Health agenda will never be completely solved, that we'll always be looking at microbes that are evolving and are adapting to coexist in the world as it adapts and changes," Green said. "Researchers always will have more to look at to keep humans, plants and animals healthier, but the research that is going on now will certainly be helpful in the future. People are naturally curious and will always want to know more."

AGRICULTURE'S ROLE

Agricultural research is vitally important in an ever-changing world that is expected to feed nine billion people by 2050. Sustainable agriculture will allow the planet and environment to continue to house people, plants and animals.

"It is the entire world's obligation to make this happen and Nebraska is at the epicenter of this issue," Green said. +

"ANIMAL AGRICULTURE IS PART OF THE HUMAN FOOD SYSTEM. HOW WE FUNCTION IS A BENEFIT TO EVERYONE

DALE GROTELUESCHEN, D.V.M., M.S.

Professor, UNL School of Veterinary Medicine and Biomedical Sciences and Director, Great Plains Veterinary Educational Center, Clay Center, Nebraska

GREAT PLAINS VETERINARY EDUCATIONAL CENTER:

providing training and continuing education for veterinary students, practitioners

by MARGARET BAKER *and* DALE GROTELUESCHEN

The future may mean an increased need for food supplies, recognition of limitations on resources and attention to consumer food preferences, which can impact the production management-focused mission of the Great Plains Veterinary Educational Center (GPVEC) and its director, Dr. Dale Grotelueschen.

What can we do to best manage these resources? "We begin thinking more in the mode of stewardship," according to Grotelueschen, who is also a veterinarian and professor of the GPVEC. "How do we manage that to which we've been entrusted?"

THE MISSION

Based near the U.S. Meat and Animal Research Center (USMARC), outside Clay Center, Neb., the GPVEC fulfills its mission through research, service and Extension, with a primary role of providing education for veterinary students. "Education of veterinary students is a high priority and may well be the highest priority," Grotelueschen said.

According to Grotelueschen, the GPVEC emphasizes the importance of participating in food systems. "In animal agriculture, we are part of the food system: the human food system. How we function and how we advance the good of human food systems is a benefit to everyone."

With an emphasis in production management in beef cattle, the GPVEC leads and serves as a state, national and international source of information. "We believe the mission of GPVEC is science based and provides innovative options for food animal health and production management," Grotelueschen said.

CLINICAL ELECTIVES AND WORKSHOPS

The GPVEC offers one-week clinical rotations for veterinary students. Examples of clinical electives include

calving management, preconditioning, feedlot management and swine husbandry.

The center's faculty also focuses on serving the continuing education requirements of practicing veterinarians and extends it to professionals in the beef industry. For example, in the fall of 2014, there was a generational transition workshop for young feedlot managers. Grotelueschen said two or three annual workshops are currently held, but more are planned for the future.

THE MULTIPLIER EFFECT

Grotelueschen describes continuing education at the GPVEC as a multiplier effect. "Our education of a veterinary practitioner will multiply itself when that veterinary practitioner goes back and interacts with people in his or her community and with clients. The veterinarian serves right at that interface with the public."

Production management teams at the GPVEC design, implement and operate preventive health care production systems. Preventive medicine is important not only for the beef system itself but also for the entire food system. "Good animal husbandry promotes good animal welfare, increasing productivity, increasing animal health. It's a positive production cycle," Grotelueschen said.

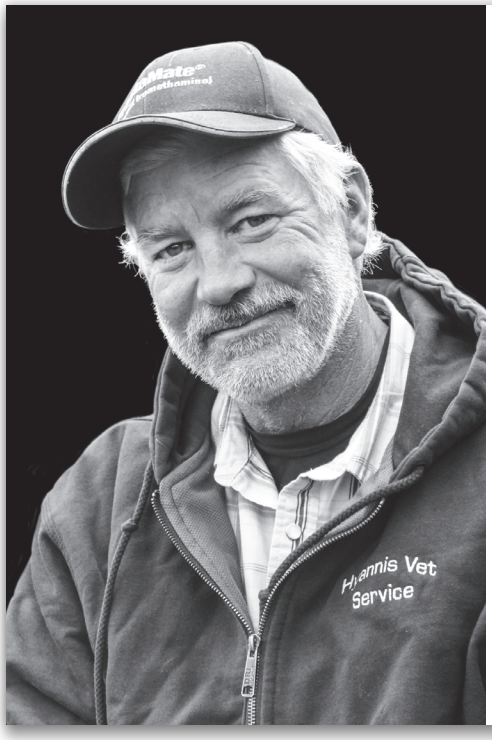
For example, a prominent issue is antimicrobial resistance. "Better preventive strategies in beef production will result in less need for antimicrobial use in the beef systems, and would help us to decrease the risk, or perceived risk, of antimicrobial resistance in the human food system," Grotelueschen said.

RELATIONSHIPS AND ENGAGEMENT

The University Nebraska–Lincoln offers a cooperative Professional Program in Veterinary Medicine (PPVM), also known as a 2 + 2 program, with Iowa State University College of Veterinary Medicine (ISU–CVM). The first two years of curriculum take place on the UNL campus and the final two years are completed at the ISU–CVM campus. The PPVM, GPVEC and USMARC collaborate with this 2 + 2 program, meeting the needs of veterinary students and practitioners. The GPVEC is highly regarded by veterinarians across the state. "Having Great Plains Veterinary Educational Center, that's just a gem," said PPVM coordinator, Dr. Renee McFee.

Grotelueschen said the USMARC serves as an excellent resource for training and learning with its beef cattle herd, swine population and sheep flock. "Clay Center is an excellent location and it goes without saying that a large reason for that is the proximity of the U.S. Meat Animal Research Center."

Though the greatest benefactors are the stakeholders and residents of Nebraska, students come to the GPVEC from across the nation. "In 2014, slightly over 200 veterinary students visited GPVEC for some aspect of veterinary training and in most years they represent about 15 colleges of veterinary medicine," Grotelueschen said. +



"LESS THAN 2% OF THE AMERICAN POPULATION IS INVOLVED WITH AGRICULTURE, SO 98% CAN BE SWAYED BY POTENTIALLY INACCURATE INFORMATION

BILL BAKER, D.V.M.

Veterinarian, Hyannis Veterinary Service, Hyannis, Nebraska

CONTINUING EDUCATION AND A NEBRASKA SANDHILLS VETERINARIAN:

Doc Baker talks about professional development, life as a veterinarian

by MARY GARBACZ *and* BILL BAKER, *based on an interview by* MARGARET BAKER

Dr. Bill Baker is a veterinarian at the Hyannis Veterinary Service in Hyannis, Neb., deep in the Nebraska Sandhills. It is in the heart of cattle country; mile after mile of grassy hills and water that bubbles up from the High Plains Aquifer, also called the Ogallala Aquifer. It's a magic combination for growing millions of the world's best beef cattle.

Doc Baker was board-certified in 1997 as a beef cattle specialist by the American Board of Veterinary Practitioners. It wouldn't make sense to be board-certified in anything else in that part of the world. "God's country," he calls it.

He doesn't get out of the Sandhills too often; the demands of his veterinary practice mean he's on call much of the time. He did get away in the spring of 2015 to attend a continuing education course at the Great Plains Veterinary Educational Center (GPVEC) in Clay Center, Neb., just over a four-hour drive south and east of Hyannis. The GPVEC is a University of Nebraska–Lincoln facility, dedicated to the continuing education of the country's current and future veterinarians in a cooperative agreement with Iowa State University and the U.S. Meat Animal Research Center (USMARC). The facility is located near USMARC, 30,000 acres of land, where both federal and UNL scientists work together to improve animals' efficiency and find answers to the puzzles of animal disease.

The mission of the GPVEC is to optimize efficiency and profitability of beef cattle, sheep and swine production while ensuring animal well-being, maintaining a safe food supply and promoting prudent use of environmental resources through education, research and service in health and production management and focus on food animal health and production management of beef cattle (http://gpvec.unl.edu/home/mission.asp). Dr. Dale Grotelueschen is the director of the GPVEC, overseeing teaching faculty and staff that provide the education, research, service and extension.

"I try to be aware of new developments," Baker said. "You never know what each new day is going to throw at you. Most of

the people we work for are extremely good producers and they have realistic questions. Being able to answer those questions is a challenge sometimes, but it is definitely something that we consider part of our job. And if we don't know the answer, we're going to find out."

CONTINUING EDUCATION AND DOC BAKER'S CAREER

Baker first began attending GPVEC continuing education seminars to develop professionally and personally – "hopefully, into a better veterinarian," he said.

"It gave me more confidence when making recommendations – and people can spot confidence a mile away. With confidence comes more credibility," he said.

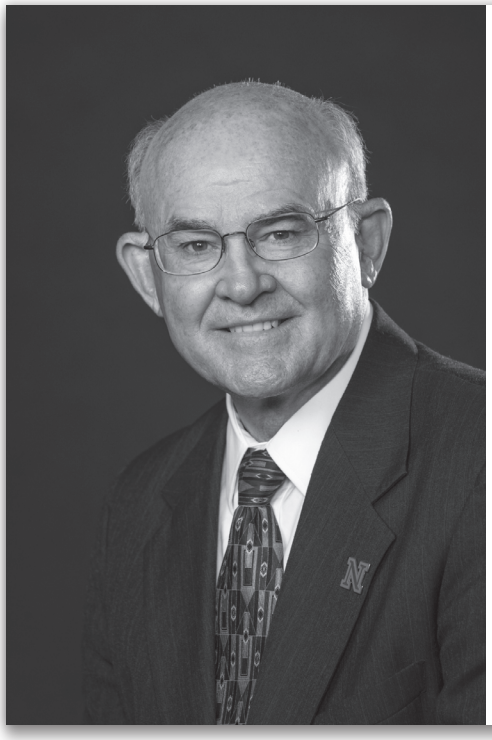
Baker said every ranch is a business and every business has to produce in order to stay in business. "We have to produce more beef every year just compared to a short number of years ago. I think these higher-producing cattle have higher requirements and part of our job is to recognize those higher requirements," he said. "Maybe management techniques need to change, or nutrition needs to change. There's a lot to it. It's more than just a bunch of cows out there on grass. There's a lot behind it."

Continuing education gives a veterinarian the incentive to improve, Baker said. Maybe it's using those new techniques, maybe it's talking to other veterinary practitioners. "It just helps you think more broadly," he said.

VETERINARY MEDICINE NOW, IN THE FUTURE

Doc Baker's life as a large-animal veterinarian includes physical, intellectual and time demands. Someone in veterinary practice has to be on call at all times. "You never know when that cow is going to calve, or when you're going to have a bunch of cows get into some corn and get acidosis at 10 o'clock on a Sunday night," he said. There are unofficial veterinary visits, too – for instance, when he is in the checkout line at the grocery store and someone engages him in conversation about a sick animal at home. "No matter where you are, you're still a vet," he said.

One of the main challenges Doc Baker sees in the veterinary medicine profession, now and in the future, is communicating the truth about agriculture to the public. "Less than two percent of the American population is involved in any way with agriculture, so you're dealing with 98 percent of the population that can be swayed by potentially inaccurate information about agriculture. Presenting accurate information to the public is our challenge." +



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WHAT'S ONE HEALTH ABOUT?

ONE HEALTH IS ABOUT PEOPLE

DAVID HARDIN, D.V.M.

Professor, UNL School of Veterinary Medicine and Biomedical Sciences

HEALTHY ANIMALS, HEALTHY HUMANS

by KELLI GREEN *and* DAVID HARDIN

One Health integrates everything that contributes to the health of animals, plants and humans, according to Dr. David Hardin, professor of veterinary science in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln. Animals can serve as "reservoirs" where diseases are developed and transmitted into humans or as vehicles that aid the transmission of diseases, he said.

Hardin became interested in veterinary medicine after his father contracted brucellosis from cattle. Brucellosis is an infectious disease caused by bacteria that can be transmitted between animals and humans. This is an example of a zoonotic disease, or a disease that can be transferred between animals and humans. Viruses, bacteria, parasites and fungi can cause zoonotic diseases.

Hardin was director of the UNL School of Veterinary Medicine and Biomedical Sciences until late 2014, when he stepped back into the faculty and began developing a research program focused on evaluating social dominance in cattle. He plans to use sensors that measure movement to study the behavior of bulls that father calves. Hardin hypothesizes that there is a genetic marker or way to select for bulls that are more even-tempered and easier to manage, which would improve production practices in cattle.

NEBRASKA VETERINARY DIAGNOSTIC CENTER

The Nebraska Veterinary Diagnostic Center is critical to the understanding of the One Health concept, Hardin said. The center assists veterinarians, their clients and others responsible for animal and public health in the detection, prevention and understanding of disease in both animals and humans.

The current building is outdated and undersized, Hardin said. Consultants determined the cost of renovating the old building would be close to building a new facility, he added. The estimated total cost of the new facility is approximately $45 million in both public and private funding. The new building will have added space for the technology and equipment necessary "to accommodate for what we hope will last the next 30 years," Hardin added.

The new Nebraska Veterinary Diagnostic Center also will have teaching and outreach space that does not exist in the current building. This space will help provide an open forum for inviting people in, Hardin said. "We expect outside groups in the community to come into our building, and then we can educate them about the role that diagnostics plays," he said.

Another element added in the new building is a Biosafety Level 3 laboratory that allows researchers to work with highly contagious agents and diseases, Hardin said. According to the Centers for Disease and Disease Control, Biosafety Level 3 is applicable to clinical, diagnostic, teaching, research or production facilities where work is performed with native or exotic organisms. The new facility will have a Biosafety Level 3 animal containment laboratory that will put scientists at an advantage when competing for grant funding, Hardin added.

The Nebraska Veterinary Diagnostic Center and research conducted by scientists at the University of Nebraska–Lincoln are critical pieces that contribute to One Health every day. "Every piece of it is important, and if you take one piece away, it's probably a little weaker than it would have been if we had all the pieces. And I really appreciate the fact that the plant side is just as important and just as critical a part of that because without the plants you don't have animals," Hardin said.

SERVING THE ANIMALS THAT SERVE MANKIND

Overall, the central theme of One Health is people, according to Hardin. "What's One Health about? One Health is about people. And then all the others, whether it's plants or animals, and how we serve them to really give people the opportunity to live their dreams around the globe." +

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SOME OF THESE DISEASES COULD CRIPPLE THE AGRICULTURAL INDUSTRY

SETH HARRIS, D.V.M., Ph.D.

Associate Professor, UNL School of Veterinary Medicine and Biomedical Sciences and Veterinary Anatomic Pathologist, Nebraska Veterinary Diagnostic Center

UNDERSTANDING DISEASE:

veterinarians' research impacts world health

by KELLY SCHNOOR *and* SETH HARRIS

Veterinary diagnostic pathologists like Dr. Seth Harris may not often find themselves in the public eye. However, their work in diagnosing animal disease can be important to human health as well as animal health. Veterinary pathologists study diseases and how they occur in animals.

"As a pathologist, I'm doing a lot of work with diagnosing animal disease. Probably what's less evident is some of those diseases cross over into humans, and those are called zoonotic diseases," said Harris, an associate professor and diagnostic pathologist in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln.

ANIMAL HEALTH IS FUNDAMENTAL

Although he works with a variety of species, well over half of the cases Harris encounters are beef cattle because of the abundance of cattle in Nebraska and their importance to the state.

"Nebraska is an agricultural state and we have an agriculture-based economy. The beef industry itself is known to contribute over $12 billion to the economy. So keeping a healthy herd is necessary," Harris said.

Keeping the cattle herd in Nebraska free of disease is important for the well-being of the animals, for the health of the people of the state and for the economy. Veterinary pathologists such as Harris pride themselves on the safety of the herd.

"There's two ways for getting known because of an animal disease outbreak: you can either be known as the person that diagnoses it or the person that missed it. And you never want to be found as the latter. So, this work is important because some of these diseases could cripple the agricultural industry," Harris said.

Some diseases, such as mad cow disease or foot-and-mouth disease, could potentially halt beef production in the entire state, according to Harris. They would affect cattle transportation and would lead to quarantines or killing animals to stop spread of the disease. Even if the disease were confined to one state, Harris said, it could affect international trade for U.S. beef products, not just products from Nebraska.

Harris also works with companion animal, exotic and wildlife cases.

"Wildlife has an exposure to domestic animals, and that's an exposure you really can't stop. So there are certain diseases that are never going to be able to be eradicated because they have a wildlife 'reservoir,'" Harris said.

A disease like rabies is a classic example. Because wild animals can contract rabies, it is not possible to completely eradicate the rabies virus and wildlife can spread it to domestic animals or even humans. Harris has had experience with this firsthand in a cow with rabies, an incurable neurological disease that is spread through contact with saliva.

"It came in for necropsy because it lost use of its hind legs, and when I did the microscopic evaluation on the spinal cord I saw classic lesions of rabies. And because of that, we were able to contact the people, and they were able to get their post-exposure vaccinations. There were over 20 people who ended up getting vaccinated from that one instance," Harris recalled.

VETERINARY PATHOLOGY RESEARCH HELPS HUMANS

Veterinary pathologists have varied skills that assist them in disease diagnosis, including necropsies (animal autopsies), microscopic evaluations and lesion grading, which is the evaluation of damaged tissues. According to Harris, veterinary pathologists can be helpful to researchers studying human diseases using animal models, and he routinely collaborates with researchers on the UNL campus.

Discrediting aspartame study

"Normally when I meet with researchers, I talk to them specifically about the value that veterinary pathologists bring to their studies. My favorite example is the aspartame study. People had thought for years that aspartame causes cancer in lab rats. But about five years ago, veterinary pathologists evaluated the images and publicly available data from those studies and came to the conclusion that the rats didn't have lymphoma," Harris said. Instead, the rats had changes that were typical of a *Mycoplasma pulmonis* bacterial infection that looks somewhat similar to lymphoma. It was veterinary pathologists who looked into the study and found the misdiagnosis. They published their findings, and the original interpretation was discredited, according to Harris.

Blast studies

One of his more interesting collaborative studies, Harris said, was with a group from the UNL College of Engineering, which was studying blast injury in rats. "What we did was look at blast injury in rats. This was basically a pressure wave injury that simulates what soldiers on a battlefield would be exposed to if a bomb exploded relatively near them and sent a concussive wave," Harris said. This research has the potential to lead to changes in body armor design that may be able to protect soldiers from brain trauma as a result of bombs exploding nearby.

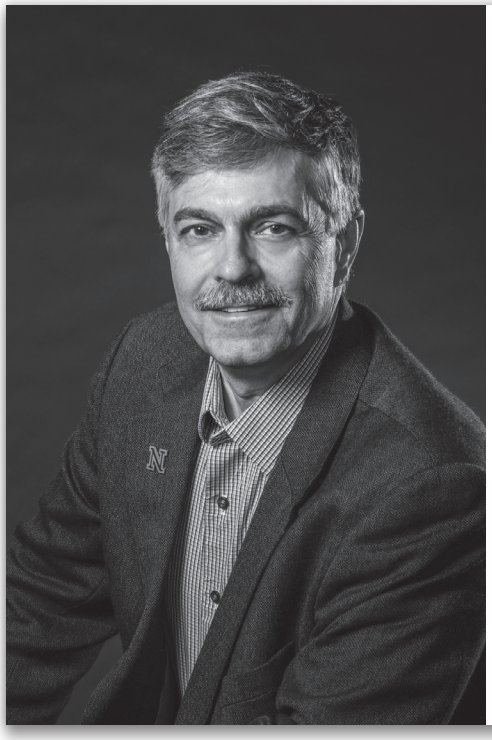
TECHNOLOGY AND DIAGNOSIS IMPROVEMENTS

Changes in technology have assisted veterinary pathologists in their ability to make accurate diagnoses. According to Harris, molecular-based diagnostic technologies are now being heavily used to aid in those diagnoses, in addition to more traditional approaches.

"If you went back 30 years ago, people diagnosed viral diseases with a microscope or virus isolation techniques, and while we still do that, we now have better ways to make a diagnosis. Every test we do has what's called a sensitivity and specificity, which establishes how efficient and accurate that test is," Harris said. "As we go on and do more of this molecular-based work, we can detect pathogens more efficiently and identify what's really of major concern in the group and what isn't."

Harris has high expectations for his generation of veterinary pathologists.

"I hope my generation advances the field of diagnostics, that we come up with additional tests and diagnose new diseases. I hope we end up training the next generation of veterinarians and veterinary pathologists to be better than we are," Harris said. +



"TRAINING PLANT PRACTITIONERS IS CRITICAL BECAUSE THERE'S A TREMENDOUS NEED

GARY HEIN, Ph.D.

Professor, UNL Department of Entomology and Director, Doctor of Plant Health Professional Program and Professor of Entomology

ECONOMIC, ENVIRONMENTAL, SOCIAL SUSTAINABILITY:

Doctor of Plant Health program meets global need

by JESSIE HORN *and* GARY HEIN

The Doctor of Plant Health program at the University of Nebraska–Lincoln is a professional program that educates and trains plant practitioners to work with the spectrum of plant health issues. "Students must have a desire to lead in taking agriculture and landscape systems into the future," said Gary Hein, director of the Doctor of Plant Health program.

The program is the plant equivalent of a veterinary, dental or medical professional degree. Students who graduate from the four-year program will play a critical role in addressing the need to sustainably feed 9 billion people on Earth by 2050, Hein said.

OPPORTUNITIES, VISION

The Doctor of Plant Health program was started in 2009 and is one of two in the world. The other is at the University of Florida, which was founded 10 years prior to the one at UNL. The goal of the DPH program is to educate students in all areas of plant health and train them as practitioners, or plant doctors. "What really sets the program apart is the application of the knowledge base through internships," Hein said. Six months of internship experience is required of each student and is an extension of each student's area of interest. "We want the internships to take those students to a career path that they envision for themselves," he added.

Opportunities for DPH program graduates include careers in industry, government, applied research, diagnostics and consultancy. "Several of our students have had job offers from where they have done their internships, and some have actually had specific positions written for them after their employer has experienced their capabilities," he said.

"The DPH program was the brainchild of the late Earle Raun and UNL Emeritus Professor Anne Vidaver," Hein said.

Raun was head of the University of Nebraska–Lincoln Department of Entomology in the 1960s and in UNL Extension administration in the early 1970s before starting

the first independent crop consulting firm in the Midwest. Raun had a distinguished career in the areas of crop and pest management as a crop consultant in the Lincoln area and early on, saw the need for professionals who could address a range of soil and plant issues. Raun was passionate about the future success of the program, and felt a need to send better-educated plant practitioners into future generations, through expertise earned in the Doctor of Plant Health program.

Vidaver also served as Plant Pathology department head and interim director of the Nebraska Center for Biotechnology. She navigated the program through the developmental details within the university, and Hein started in 2009 as the program's first director.

PROGRAM REQUIREMENTS

The program requires 100 credit hours for graduation, plus internship responsibilities. The program's coursework base covers five major disciplines: entomology, plant pathology, soil science, weed science and plant science.

"Students entering the program come from quite varied backgrounds," Hein said. Most of the students in the DPH program have undergraduate degrees in agronomy, plant pathology, entomology or horticulture, but a good general science base is key, he added.

"Students need to have a very sound science background, and if they come to the program with that background, they will do well," he said. In addition to the need for scientific knowledge, DPH students apply scientific principles to solving practical problems in the field.

Although the DPH program has a set curriculum, it offers flexibility for students to structure their experience toward their specific needs and interests. The curriculum offers 12 credits of electives and internship experiences in students' interest areas.

"It's not an easy program. But it is one way students can set themselves apart in an increasingly knowledge-based industry," Hein said. The DPH program provides students the chance to become more educated in all areas that affect plant health and to become leaders in taking this agricultural knowledge into the next generation.

FEEDING THE FUTURE SUSTAINABLY

By 2050, the world is expected to have a population of about 9 billion, which is about 2 billion more than Earth currently supports. Feeding this growing population sustainably is a challenge Hein and the Doctor of Plant Health program take seriously.

"That will not be done sustainably if we do not put more knowledge at the field level, and that's really what the DPH program is all about," Hein said. Putting knowledge at the field level means plant practitioners can make smarter decisions not only from the standpoint of economic sustainability, but also environmental and social sustainability, he added. In addition, a greater emphasis from a multidisciplinary perspective will stimulate more systems-based questions and bring disciplines together to address these questions.

The knowledge gained through research at UNL and other universities will be extended to crop producers, helping to educate the world on how to build a more sustainable Earth.

"Training plant practitioners is particularly critical because there's a tremendous need for this, and as we move forward that need is only going to increase," Hein said.

Changes in agricultural technology and management will mean that farmers will need to rely more on people who have more expertise, Hein said. Even though there are many excellent field professionals now, the increasing demand and impending retirement of the most experienced professionals necessitate that many more will be needed to address this critical need.

"And that's what we're trying to do with the DPH program. We need more people out there who can work at this high level. We need to get people to that level of functioning a lot faster than we used to. The best way to do this is to provide them with a comprehensive base of knowledge." +

JOSHUA MILLER, M.S.

UNL Doctor of Plant Health Program Student and UNL Plant Pathology Doctoral student

DEREK PRUITT, M.S.

UNL Doctor of Plant Health Program Student

PURSUING A DOCTOR OF PLANT HEALTH DEGREE:

the student perspective

by VALERIE KESTERSON, JOSHUA MILLER *and* DEREK PRUITT

The Doctor of Plant Health Program (DPH) at the University of Nebraska–Lincoln provides students the graduate education and hands-on experiences to become "plant doctors" who are in demand around the world – in the lab, the field or in business – bringing with them the education and training to address the challenges facing agriculture today and into the future.

Graduates of the program earn a professional degree similar to that of a medical doctor or a veterinarian.

WHAT IS A DOCTOR OF PLANT HEALTH?

The DPH program began in 2009. It is a four-year post-baccalaureate professional program that includes varied coursework and internship experiences. Students learn to analyze and solve industry problems that threaten the global food supply. Students enter the program directly after earning a bachelor's, master's or Ph.D. degree, or after having earned a degree and spent some time in the workplace.

"I want to be part of the solution. I want to contribute to society," said Derek Pruitt, a student currently enrolled in the program. Pruitt, who is from Utah, was a high school science teacher in Utah with a UNL master's degree in entomology when he decided to enroll in the UNL Doctor of Plant Health program. A month after he heard about the program, he and his family had moved to Lincoln so he could start classes.

BENEFITS TO AGRICULTURE

The agricultural community is finding new and better ways to raise food, fuel and fiber that can sustain the world population. Doctors of Plant Health help put the science behind the innovation. "We've got to be able to feed ourselves," Pruitt said. "It's going to be important to address a lot of the issues that we now face, or will face in the future." Pruitt added that the DPH program helps equip students to take a more proactive role in solving issues on both a local and global scale.

As much as the DPH program is about preparing students, it's also about educating employers on the value of the degree and about reaching out to future students.

FLEXIBILITY IN THE CLASSROOM

The DPH program includes coursework and experience in agronomy, horticulture, entomology, plant pathology, soil science and weed science. "The ultimate goal of this program is to train people not only to have a background knowledge in different fields, but to have an ability to talk, communicate and collaborate with people of different disciplines," said DPH student Joshua Miller. Miller, who had earned bachelor's and master's degrees from the University of Maryland, was a crop consultant in Pennsylvania when he heard about UNL's Doctor of Plant Health program from the program's director, Gary Hein.

"I talked to my wife about it, and we decided it was the right time, if there ever is a right time to quit a job and move a family of five across the country to start school again," Miller said. "We did that and we haven't looked back. It's been a great experience so far."

Being a specialist in multiple fields attracted Miller to the DPH program. "We need to know a mile-wide worth of information and be able to apply that to the field," Miller said.

In addition to pursuing a degree through the DPH program, students can simultaneously work toward a master's or Ph.D. Miller is also working toward a Ph.D. in plant pathology.

The Doctor of Plant Health program is interdisciplinary, Miller said. When he was working as a crop consultant, he was working with farmers. "Farmers need to know everything. They have to know what seeds to plant, how to market their grain, how to deal with the weather, how to deal with pest problems, whether disease or insect. They need to know soils and fertility. It's a robust discipline to be a farmer," he said. When he heard about the UNL DPH program, he knew that this degree was vitally important to the continued success of agriculture.

"Society is so complex that whether it's agriculture or education or whatever it is, if you want to solve the problems that we're facing, you need to have that multidisciplinary approach," Pruitt added.

UNIQUELY QUALIFIED GRADUATES

"Graduates of the DPH program are uniquely qualified to address the big challenges and opportunities facing agriculture today and will be tremendous assets to the companies, agencies or universities that employ them," Miller said. +

For more information, contact Program Director Gary Hein at (402) 472–3345; ghein1@unl.edu, or find information about the program at www.dph.unl.edu.

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MAYBE WE CAN
LEARN
TO PREVENT SOME
OSTEOARTHRITIS

DOUGLAS E. HOSTETLER, D.V.M.

Associate Professor, UNL School of Veterinary Medicine and Biomedical Sciences

CHANGING THE FUTURE OF JOINT REPLACEMENT:

research may postpone or eliminate the need for procedures in humans, animals

by MADELINE CLARK *and* DOUGLAS HOSTETLER

Dr. Douglas Hostetler performs many kinds of needed veterinary surgeries that improve the lives of animals in the herds and flocks at University of Nebraska–Lincoln. A veterinarian, Hostetler's surgeries include arthroscopic procedures on animals that not only relieve pain and suffering of animals, they serve as models for human medicine. Hostetler is an associate professor in the UNL School of Veterinary Medicine and Biomedical Sciences.

Hostetler collaborates with Anuradha Subramanian, UNL professor of biomolecular engineering, on a project that may eventually postpone or eliminate the need for joint replacements in both humans and animals. They are growing cartilage in a laboratory that could be implanted into animals or humans to relieve damage caused by osteoarthritis.

One of the research goals is to demonstrate the long-term feasibility of producing a cartilage graft from bone marrow, derived from adult stem cells, Hostetler said. "The benefit of doing this is that if we can grow a graft large enough to replace a large defect, we can postpone when a replacement will have to be done in a human," Hostetler said.

"Knee replacements wear out over time, so if a younger person has to have a knee replacement, in 20 years when that knee replacement wears out, it's much harder to replace a replacement. So if we can postpone when that person has to have a knee replacement, we can make that knee replacement last longer."

OSTEOARTHRITIS

Hostetler said animals develop osteoarthritis, just like humans. Proposed research will be conducted on the knee joint in pigs, which is quite similar to humans in many ways, he said. A pigs' body weight and joint conformation is similar to humans, and both have naturally occurring cartilage

defects. He added that the knowledge obtained from research with the knee joint could be applied to other joints as well – likely shoulders and elbows.

Arthroscopic and joint replacement procedures are performed on high-value livestock, such as breeding animals, but also on domestic animals that have high value to their owners, Hostetler said.

The process of growing new cartilage starts with taking adult stem cells from bone marrow and then applying different growth factors to urge the cells to turn into cartilage instead of other cell types and cell lines. Scientists ensure the developing sheet of cartilage is uniform and that it matures into hyaline cartilage, a connective tissue that is tough and flexible. It becomes cartilage that would be able to take the force of body weight on a knee joint, he said. Hostetler said the surgical implantation of the cartilage involves finding the joint defect, inserting the cartilage and securing it with fiber glue and anchoring its edges with absorbable fasteners. The animal, like a human, would have its mobility limited for a few days, but exercise would be implemented as part of the animal's recovery.

Currently, the goal of the research is to "make sure it works," Hostetler said. Some commercial companies have done cartilage grafting and performed cartilage implants, "but nobody has been able to generate one of this size," he said.

ONE HEALTH: HUMANS AND ANIMALS

Hostetler said research into human health can be adapted to improve the well-being of animals.

"That's sort of the way One Health ties in from the veterinary perspective," he said. "Eventually, we'll learn more and more about osteoarthritis in animals and maybe we can learn to prevent some osteoarthritis. And for an expensive breeding animal, we could do a cartilage replacement," he added.

The One Health initiative involves the ties between veterinary medicine and human medicine, Hostetler said, including biomechanics and tissue engineering. "Much of the research has been done in veterinary medicine that has carried over into human medicine," he said. "We've been doing total hip (replacements) in dogs for decades and now they are doing total hips in humans.

"One Health really fits with orthopedics very well." +

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WE'RE TRYING TO MAKE BETTER VACCINES

CLINTON JONES, Ph.D.

Charles Bessey Professor and Virologist, UNL School of Veterinary Medicine and Biomedical Sciences

BOVINE HERPES VIRUS 1 RESEARCH IMPROVING CATTLE HEALTH:

research also applies to human health

by MARY GARBACZ *and* CLINTON JONES, *based on an interview by* JAMES ANDERSON

Bovine Herpes Virus 1 is an important pathogen in cattle and a co-factor in Bovine Respiratory Disease Complex (BRDC), which is the major cattle disease in the world. BRDC costs the cattle industry about $1 billion each year.

Clinton Jones, professor in the University of Nebraska–Lincoln School of Veterinary Medicine and Biomedical Sciences, is a virologist who studies both cattle and human viruses with the goal of developing vaccines for each species.

Cattle with Bovine Herpes Virus 1 basically stop eating for four or five days and the young calves get so sick they can die, Jones said. The virus suppresses the animal's immune system, causing secondary bacterial infections. Some strains of bacteria are common in cattle and remain dormant until an animal becomes stressed, as with a viral infection. When that occurs, bacteria can get into the lungs and can cause life-threatening pneumonia, Jones said.

When Bovine Herpes Virus 1 infects a calf, the infection begins in the nasal cavity, eyes or mouth, causing an upper respiratory tract infection. The airway can become inflamed and close, causing a sore throat; bronchial tubes also close, making it difficult for the animal to breathe. The animal stops eating and stops drinking water; this can last several days. In addition to the possibility of pneumonia, the virus can cause an eye infection in cattle, called conjunctivitis.

If there is no secondary bacterial infection, the animal will recover, but the virus remains in the body, Jones said. "It's now entered the peripheral nervous system and has established a latent infection in sensory neurons," Jones said. His research looks at why the virus survives in the neurons and what genes are expressed in the neurons. He also studies why an infection of epithelial tissues makes a lot of virus, but sensory neurons do not.

"We're interested in this disease, how the virus contributes to Bovine Respiratory Disease Complex and how it makes the bronchial tubes and airways more conducive to the bacteria-

causing pneumonia," he said. He also studies how the virus "wakes up" and reactivates from latency.

There is one region of the viral genome that is expressed in latently infected neurons and this region encodes some proteins and small non-encoding RNAs. All of the functions of these products are geared toward keeping the neuron alive, preventing the virus from replicating and maintaining a normal neuronal phenotype, Jones said. "It helps the neurons behave themselves and do what they're supposed to do – which is kind of exciting that the virus would consider that it needs to keep the neuron happy, or the neuron dies and the virus is extinguished," Jones said. Vaccines that are available also establish a latent infection and when the animal is stressed, the virus will reactivate. These modified live vaccines can then be transmitted to baby animals or animals that weren't vaccinated, causing disease, he explained. There also is concern that the vaccine, which is made from live virus, may cross the placenta in a pregnant cow, entering the developing calf and destroying it.

"The cattle industry is a business. If you have fewer cows in a herd that don't give live birth, then the producer is losing money and this can turn into an economic disaster for these large cattle producers," Jones said.

"We're trying to make better vaccines," he said.

HUMAN HERPESVIRUS

Animals and humans both are affected by herpes viruses, though they are different viruses.

Many kinds of herpes viruses affect humans. A common one is the Herpes Simplex Virus, which causes cold sores and eye disease. "People who are latently infected with the Herpes Simplex Virus can get recurrent eye disease and that is the number one infectious agent that causes blindness," Jones said. "Understanding how the virus wakes up and comes back to the eye, creating multiple episodes of problems in the eye that can lead to blindness – that would be nice to understand."

Another common human herpesvirus, Varicella zoster virus, causes chicken pox and later in life, shingles. The only vaccine for human herpesviruses is directed against the chicken pox vaccine, which has proven to be very effective, Jones said. People who have had chicken pox as children also have the latent virus in the body's nervous system. As a person grows older, the immune system declines, which can lead to the reactivation of the chicken pox virus, including the vaccine virus. Shingles can cause significant and intense pain, but there is a vaccine for shingles recommended for people age 60 and older, Jones said.

Stress may cause a dormant herpes infection to wake up, he said, but there are several kinds of stress, some leading to increases in corticosteroids in the body and some leading to an inflammatory response. For example, heat stress, such as a fever, results from inflammation. Psychological stress does not result from inflammation, but usually leads to increased corticosteroids. Psychological stress affects the immune system. "That's kind of opening the window to viruses to wake up and start growing again," he said. +

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UNL REALLY UNDERSTANDS, APPRECIATES AND SUPPORTS TEACHING

JOHN KAMMERMANN, Ph.D.

Associate Professor, Veterinary Anatomy, UNL School of Veterinary Medicine and Biomedical Sciences

COMPUTER TECHNOLOGY ENHANCING TEACHING, STUDY OF ANATOMY

by JOSHUA POORE *and* JOHN KAMMERMANN

Dr. John Kammermann, associate professor in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln, is changing the way veterinary anatomy is taught. He is developing digital dissection guides for students to use during their studies and throughout their professional careers. These guides enhance student learning by providing a step-by-step visual record of the dissection as it progresses.

Kammermann teaches anatomy to students in the Professional Program in Veterinary Medicine (PPVM), which begins after two to four years of undergraduate study. Most students have a Bachelor of Science degree before being admitted. "The biggest complaint I hear from students is the lack of good pictures," Kammermann said. Currently available anatomical atlases and textbooks contain numerous pristine drawings and photographs that are not realistic of what students encounter in the dissection laboratory, he said. In response to this, he started developing digital dissection guides for each animal species. These guides are provided to students on USB drives containing specific instructions for the dissection procedure, descriptive information on most structures encountered and a minimum of 2,500 photos. At present, Kammermann has completed guides for dogs, cats and cattle. Currently, he is working on a guide for horses. Longer term, he wants to complete guides for sheep, goats and chickens.

BENEFITS OF GOING DIGITAL

Gross anatomy is a difficult, time consuming, and messy course of study. According to Kammermann, there are multiple benefits to going digital. First, there is a large volume of information veterinary students need to access during their laboratory dissection and study. Two or more traditional anatomical reference books would be required to match the amount of information contained on a USB drive. Digital guides provide this material in an easily accessible and portable format. Second, conditions in the anatomy lab are at times quite messy; it is easy to damage traditional textbooks. Digital guides allow students access to detailed information without damaging reference materials. All that is required is a sheet

of plastic wrap placed over the computer laptop keyboard. Third, the study of gross anatomy requires students to gain a three-dimensional understanding of the body through visual and spatial observation. Digital guides allow access to an enormous number of photos with multiple orientations, magnifications and perspectives. Fourth, gross dissection is a highly detailed activity, requiring significant instructor direction and oversight. Digital guides provide a sequential format, instructing students on the disassembly of a specimen, while simultaneously discussing the important anatomical and clinical concepts. Capturing and editing digital photos, and writing dissection instructions and descriptive summaries is a time-consuming process; the small animal guides took a little over five years to reach a usable format. However, these activities have dramatically improved instruction and student learning, to the point where, according to Kammermann, "routine identification and procedural questions during laboratory sessions have been reduced by over 50 percent."

A UNIQUE PLACE TO TEACH AND LEARN

The Professional Program in Veterinary Medicine at UNL is a unique endeavor, he said. It has flourished since its inception in 2007, and currently serves as a national model for states looking to start up their own veterinary medicine programs.

"The PPVM program is essentially one-half of a traditional veterinary school. It consists of two years of didactic study at UNL, followed by two years at the Iowa State University College of Veterinary Medicine (ISU-CVM)," he said. Following successful completion of the four-year program, Nebraska veterinary students receive the Doctor of Veterinary Medicine Degree from the ISU-CVM. The first two years of veterinary medical training is similar throughout the country. However, the UNL PPVM has a big advantage over traditional programs in several ways, he said. First, the small class size provides for more individualized attention with a lower student-to-instructor ratio. Easy access to instructors both inside and outside of class creates a more personalized learning environment. Second, foundation courses like anatomy are emphasized and provided plenty of contact hours. The initial goal when designing the PPVM curriculum was to create a strong basic science component. Traditional veterinary programs have eliminated some of their anatomy contact hours. Third, this program is the only one in the United States that incorporates hands-on, live animal handling as part of its curriculum. "The UNL PPVM has a great working relationship with the Capitol Humane Society of Lincoln, Nebraska; students are allowed to assist Humane Society staff and veterinarians with cases. In addition, a small number of greyhounds are held on campus and cared for by the UNL PPVM students," he said. Also, extra opportunities are provided for work with cattle, laboratory animals and horses.

The live animal experiences, in tandem with training in anatomy, provide an invaluable perspective that helps students recognize the importance of anatomy and its relevance to their future clinical studies. In the words of Kammermann, "UNL really understands, appreciates and supports teaching. It has allowed me to focus the majority of my time on perfecting my skills, and serving our students. In my opinion, there is no better place to study veterinary medicine." +

"WE CAN DEVELOP VACCINES, ANTIBIOTICS AND TREATMENTS THAT SAVE ANIMALS, SAVE HUMANS AND REDUCE THE ECONOMIC COST OF DISEASE

J. DUSTIN LOY, D.V.M., Ph.D.

Assistant Professor, UNL School of Veterinary Medicine and Biomedical Sciences and Veterinary Diagnostic Microbiologist, Veterinary Diagnostic Center

DIAGNOSING, PREVENTING, TREATING DISEASE:

technologies provide faster, more accurate methods

by COLLEENE MARRIOTT *and* J. DUSTIN LOY

Classical veterinary diagnostic technique relies upon a veterinarian recognizing lesions or other signs of disease and taking a sample to a laboratory, where scientists isolate the bacteria, grow it to a sufficient amount that it can be tested, and eventually, identify the disease.

Technological advancements have added molecular diagnostics to the veterinary toolbox, enabling veterinary scientists in diagnostic laboratories to examine the pathogen at the molecular level to determine the type of bacteria and what sort of toxins it might have.

"You can use molecular diagnostics for things like cancer, to see the different proteins they might express," said Dr. J. Dustin Loy, veterinary diagnostic microbiologist at the Nebraska Veterinary Diagnostic Center at the University of Nebraska–Lincoln School of Veterinary Medicine and Biomedical Sciences. A benefit of molecular diagnostics, he said, is that it's faster. "We don't have to wait for the organisms to grow," he said, and the technology helps with the interpretation of the test results. It also is possible to test for a large number of pathogens at the same time, rather than for just one at a time. A pathogen is a bacterium, virus or other microorganism that can cause disease.

Loy also is the case coordinator for the VDC, assisting veterinarians, their clients and livestock producers in diagnosis, detection and prevention of infectious diseases. He also leads the bacteriology laboratory in the VDC, which involves developing, implementing and validating new diagnostic tests to enable veterinarians to more rapidly and accurately diagnose animal diseases.

GOAL: PREVENTING DISEASE

Infectious diseases generally are caused by pathogens, Loy said; anything from a virus to a bacterium to a fungus to even misfolded proteins, like prions. "If they're infectious, they can spread from one animal or person to another person," he added.

Infectious diseases can cause economic losses, mortality and death in the agricultural sector, as well as in humans.

"By studying these infectious agents, we can develop vaccines, antibiotics and treatments that can intervene. You can help save animals, save humans and reduce economic cost of disease. If you can control and treat the pathogen, you can treat the disease," he said.

Loy said the Nebraska Veterinary Diagnostic Center has three main goals: surveillance testing for foreign animal diseases; regulatory testing to keep economically significant pathogens out of Nebraska; and performing everyday testing and diagnosis on livestock, companion animals and zoo animals.

Surveillance testing includes testing for diseases like bird flu (avian influenza), foot-and-mouth disease, classical swine fever – "diseases that would be economically devastating if they were in the United States," Loy said. "We want to be able to detect them immediately to try to stop the outbreak."

Loy said the VDC works with the Nebraska Public Health Laboratory, located at the University of Nebraska Medical Center, in bioterrorism and hazardous human pathogen surveillance. "We are always looking for cases of things like anthrax, tularemia and other pathogens that would have not only animal significance, but human significance," he said. Some diseases move from animals to humans; commonly known examples are rabies, Lyme disease and West Nile virus.

Regulatory testing to keep pathogens out of Nebraska involves a close working relationship with the Nebraska Department of Agriculture, Loy said. If pathogens are present in other states, "we want to keep them out of Nebraska," he added. The scientists in the VDC perform testing for economically significant diseases, such as bovine trichomoniasis, brucellosis and pseudorabies virus. Testing also is performed on animals that people wish to bring into Nebraska from other states; when the animals test negative for specific diseases, the VDC issues paperwork that allows animals to come into Nebraska.

Everyday testing and diagnosis, Loy said, is a significant part of the VDC workload. "If your cat has a tumor or your dog has diarrhea, we get samples every day that require routine diagnostics. It could be anything a practitioner might see in the state or in the area that we would test to try to help them achieve a diagnosis of what's causing the disease in the animal so it can be treated appropriately," he explained.

PRUDENT ANTIBIOTIC USE IN ANIMALS

Treating sick animals requires careful assessment of the animal's illness and treating it appropriately, Loy said. Instead of automatic administration of antibiotics, veterinarians now do antimicrobial susceptibility testing to make sure antibiotics are required and if they are, that the correct antibiotic is administered. The VDC tests the pathogen causing the illness against a panel of antibiotics, to help the veterinarian determine which drugs may be most effective.

"I emphasize prudent usage of the right drug, the right dosage and the right time so we treat them appropriately," Loy said.

Testing, detecting and treating

A specific testing process is required for each disease, called a protocol. Loy said there is an extensive process to "validate" the testing process. That validation ensures that anyone who conducts a test on blood, saliva or feces, for example, will follow exactly the same protocol, ensuring testing consistency for every sample, in every laboratory in the country, no matter who is performing the test. Developing these testing protocols and having them validated is a significant process, Loy said, but one that helps ensure accuracy.

"When we have those test protocols in place and they are validated, we can be confident that when the state or federal veterinarian calls and asks 'are you sure these results are right?' we can say 'absolutely; we've put all the proper procedures in place.' We're confident that those results are accurate," Loy said.

Once the validated tests are in place, they can be used for disease surveillance or other purposes, depending on the disease. Loy said some diseases have vaccines; some diseases require antibiotics or other drugs; some diseases may have to be eliminated. In the case of avian influenza in a bird barn, for example, the disease would have to be eliminated before it could spread further.

RESEARCH

Loy's specialization in diagnostic microbiology has led him to research in several projects, including pinkeye in cattle, called bovine keratoconjunctivitis; the swine enteric coronaviruses called Porcine Epidemic Diarrhea Virus; and Porcine Deltacoronavirus.

Bovine Pinkeye

Next to enteric disease and respiratory disease, pinkeye in cattle is the third most costly cattle disease in Nebraska, he said.

The disease primarily affects calves in the first six to eight months. It can cause eye pain and blindness and, because they may be blind, they don't grow or perform as well as they should. "It's an animal welfare issue. We don't want those calves to have painful, blind eyes," he said.

Loy's research goal is to develop a vaccine that can be administered to calves before they get pinkeye, he said. His current research focuses on characterizing the different kinds of bacteria that cause pinkeye – what drugs are the bacteria susceptible or resistant to, what types of virulence factors they have.

"By looking at the ecology of those organisms, we can get an idea of how to make better vaccines so we can vaccinate those calves before they get pinkeye," he said.

Porcine Epidemic Diarrhea virus and Porcine Deltacoronavirus

Coronaviruses were not highly recognized until Severe Acute Respiratory Syndrome (SARS) appeared in 2003, Loy said. SARS is a coronavirus.

Another coronavirus that infects animals is Porcine Epidemic Diarrhea virus (PED). "There is a tremendous amount of mortality in pigs caused by this virus," Loy said. It affects young pigs, causing severe diarrhea. The young pigs become dehydrated and die. The economic losses from the PED outbreak in the U.S. are estimated to have been nearly $1 billion.

"We're looking at understanding how to reduce that," Loy said. One of the questions is how to reduce the spread on a farm. This project includes a collaboration with Amy Millmier Schmidt, UNL assistant professor of biological systems engineering, in the safe disposal of the infected animals, he added.

Porcine Deltacoronavirus is related to the Porcine Epidemic Diarrhea virus and in his research, Loy is learning how the virus affects pigs so that the disease can be rapidly diagnosed, a vaccine may be developed or strategies implemented to increase the animal's immune response to lessen the impact of the disease. ✚

"IF YOU WANT TO BE IN THE VETERINARY FIELD, WE ARE THE PLACE TO COME TO GET THAT EDUCATION

RENEE McFEE, D.V.M., M.S.

Lecturer and Coordinator, Professional Program in Veterinary Medicine, UNL School of Veterinary Medicine and Biomedical Sciences

HIGH STANDARDS:

UNL-ISU Professional Program in Veterinary Medicine

by MARGARET BAKER *and* RENEE McFEE

A veterinarian can have a career that not only impacts animal health, but also can impact human health through work in a research laboratory, educational institution, governmental organization, production facility or pharmaceutical industry.

But, first, a student must earn a Doctor of Veterinary Medicine (DVM) degree.

The Professional Program in Veterinary Medicine (PPVM) in Nebraska provides small class size and in-state tuition for veterinary students. The cooperative program between the University of Nebraska–Lincoln (UNL) and Iowa State University College of Veterinary Medicine (ISU–CVM) enhances services and supports the potential of each student, according to Dr. Renee McFee, PPVM coordinator.

The PPVM 2 + 2 program comprises two years of veterinary education at the UNL School of Veterinary Medicine and Biomedical Sciences, followed by two years at ISU–CVM. The program begins after a student has completed the prerequisite requirements for entrance into the UNL–ISU program. By partnering with ISU–CVM, Nebraska residents are admitted through UNL, then the Doctor of Veterinary Medicine (DVM) degree is granted by Iowa State University.

Since the program began in 2007, UNL has admitted 25 students from Nebraska each fall. "We have an agreement with Iowa State that they will admit those 25 students every fall at the start of their third year," McFee said.

QUALITY OVER QUANTITY

McFee, also a veterinary practitioner and lecturer for the UNL–ISU program, said the small class size provides an engaging and hands-on learning atmosphere. McFee said other programs have larger class sizes, but the small class size in the Nebraska portion of the program allows students more opportunities to ask questions, contribute to discussions and build relationships with professors and classmates.

McFee said that Dr. Don Reynolds, director of the UNL School of Veterinary Medicine and Biomedical Sciences, focuses the UNL-ISU program on quality over quantity. "We have quite a bit of hands-on activities in the first two years," McFee said. "It's more planned activities in the courses

themselves. The advantage we have with only having 25 students is it's much easier for an instructor to plan those hands-on activities and find that number of animals."

HIGH STANDARDS, FORWARD-FOCUSED

The PPVM integrates interdisciplinary coursework. In addition to science classes, communications, ethics and law courses are now a part of the core program. "You can be the most intelligent, well-educated veterinarian but if you can't communicate with other people and clients, it's rough," McFee said. She added that veterinarians communicate with patients' owners who may have little or no knowledge of veterinary science. Knowing how to talk to people can make a big difference in how the owners care for the animals.

McFee said 50 percent of the evaluation in the application process is based on academic performance, including the applicant's grade point average in science; the grade point average of the last 45 credit hours; the Graduate Record Exam (GRE) score; and the nature of the applicant's academic course load. The PPVM program is rigorous and heavily weighted with science courses; students typically take 20 credit hours a semester. "Even if we want our veterinarians to be good business people, they still have to get through the science curriculum," McFee said. "We want them to pass. Because if they start and they fail out, we all fail."

McFee said the other half of the selection process is a more subjective evaluation. "Do they have the maturity, the experience, the knowledge? Are they good, moral, ethical people?"

The integrated coursework helps prepare students for the challenge of matching the high standard of veterinary care to real-world circumstances. "Nowadays, with that pressure, we need to provide that high level of care, but costs are a big issue," McFee said. "You have to be a proponent for the animal, but you have to be a proponent for the owner."

ONE HEALTH CONCEPT

The One Health concept is the interconnectedness of people, animals and the environment – the One Health triad – and it advocates an integrative effort of multiple disciplines working together globally for the health of all. It is endorsed by the American

VETERINARY MEDICAL ASSOCIATION

"Veterinarians have embraced the One Health concept for decades," McFee said. She discussed learning about not only what happens in the animal, but "the really big thing is, how do we prevent it from being spread to people?"

McFee emphasized the importance of more people outside veterinary medicine understanding the benefits of research on animals and how everyone can work together to expand the body of knowledge.

More projects are collaborations focusing on treatments for animals and humans, according to McFee. Information born of experience with animal health often can be applied to human health and human health information can also be applied to animal health. "Working as a team will be very big in the future."

McFee said that with the Professional Program in Veterinary Medicine, Nebraska is working to be a central place for veterinary education and collaboration. "If you want to be in the veterinary field, we are the place to come to get that education, whatever it may be." +

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WE HAVE A LOT TO BE THANKFUL FOR IN OUR FOOD, BOTH IN TERMS OF SAFETY AND COST

RODNEY MOXLEY, D.V.M., Ph.D.

Professor and Veterinary Pathologist, UNL School of Veterinary Medicine and Biomedical Sciences

RESEARCH WORKS TO LOWER RISKS OF *E.coli*

by KELLY SCHNOOR *and* RODNEY MOXLEY

The safety of meat products is at the forefront of the innovative research conducted by Dr. Rodney Moxley at the University of Nebraska–Lincoln. A veterinary pathologist in the School of Veterinary Medicine and Biomedical Sciences, Moxley is project director of a grant that is funded by the United States Department of Agriculture (USDA) studying multiple pathogenic strains of Shiga toxin-producing *Escherichia coli* (STEC). "We have a lot to be thankful for in terms of our food and both in terms of safety and cost," Moxley said.

WHAT IS *E. coli*?

"All warm-blooded animals have *Escherichia coli*, or *E. coli*, in their intestinal tract; all of us do. It's normal for us to have non-disease producing strains of *E. coli* in our intestinal tracts. So we call this nonpathogenic," Moxley said.

What isn't normal is when pathogenic strains get into the human intestinal tract. According to Moxley, these pathogenic strains are able to attach to the lining of the intestine or produce toxins to ensure the bacteria's survival. However, these toxins are harmful to tissues. These *E. coli* strains can even be infected by viruses, making them Shiga toxin producers. The Shiga toxin is a poison that binds to receptors on cells lining blood vessels in the body. It then enters these cells and shuts down protein synthesis, the process of making proteins that will be used for functions of the cell and the body.

"Once the cell has protein synthesis shut down, it dies. Once it dies, then you start having thrombotic disease, blood clots and kidney failure, that kind of thing," Moxley said.

While STEC can be detrimental to human health, many ruminant animals like cattle, sheep and deer, have STEC in their digestive systems and are not negatively affected. Additionally, the gut of ruminant animals is very conducive to the growth of *E. coli*, Moxley said.

"In cattle, they have the receptor in different cells but they don't have it in the blood vessels. So the cattle aren't susceptible to blood vessel damage, which essentially means that the infection causes very minor disease problems," Moxley said.

The problem arises when cattle shed the STEC bacteria in the feces. If feces get on the hide of the animal, it has the

potential to become a contaminant in the slaughter plant as the particulate matter, or very small particles, can aerosolize and then settle on the animal carcass.

"If that de-hided carcass surface is contaminated with these bacteria and that carcass surface isn't effectively decontaminated by some intervention that may be in place in the packing plant, therein lies the risk for these organisms to get into the beef product," Moxley said.

Many interventions already are in place in packing plants, and more are being researched to prevent contamination from occurring and to keep carcasses and the packing plants clean. One intervention can be used to clean the cattle before they enter the plant by wetting the animals' hides with a product containing a virus that kills the *E. coli*, according to Moxley.

"In terms of the interventions that they would be using, there are washes which can be hot water washes, there could be cold water washes, there could be organic acid sprays," Moxley said.

Moxley said there also are washes containing vinegar-like substances, or other organic substances that kill bacteria. These all are USDA-approved and are sprayed directly on the de-hided carcass. Additionally, packers have cleaning regimens in place to keep facilities sanitary with entire work shifts devoted to routine cleaning.

One particularly effective method of getting rid of *E. coli* on the carcass is through irradiation. However, it's not yet commonly used.

"You could have meat irradiated, and it would kill these organisms. But that is essentially not done much. So for all practical purposes, it's correct to say that meat is not sterile. And since meat isn't sterile that means that it has to be properly handled, properly cooked. And that means consumers do have a responsibility in knowing how to handle it and to do their part," Moxley said. "The infections can be life-threatening. On the other hand, U.S. beef is as safe as any in the world, or the safest in the world. And it is a very good, healthy product. But these organisms do exist in the intestinal tract and complete prevention of any form of contamination is almost impossible today."

WHAT CAN CONSUMERS DO?

"It's become a shared responsibility by producers, packers, consumers and all involved to be aware and hopefully to do their part as much as they can," Moxley said.

Contamination can occur even after meat products leave the packing plant.

"Probably one of the best examples is to have a cooked product get contaminated from instruments or other things that the food would get in contact with," Moxley said.

According to Moxley, plates and utensils used for raw products could come into contact with cooked products and cause contamination. The USDA encourages consumers to clean, separate, cook and chill according to their guidelines as prevention. More information on the guidelines can be found online at http://www.fsis.usda.gov under the Food Safety Education tab.

One big concern is that consumers may unknowingly cross-contaminate cooked meat with raw meat through cooking utensils. Instruments and receptacles used for raw meat should be cleaned thoroughly before being used on the cooked product. According to Moxley, "It may look completely clean. There may not be anything visible or maybe somebody just rinsed it off in the sink and didn't do anything else and assumed that it was good enough, and then they put a cooked burger back on it."

Moxley said this contamination or cross-contamination with other meat products or with fresh produce can be a really big issue. Hand washing also is very important in prevention of contamination because STEC can also be spread from person to person.

Cooking to proper temperatures is also invaluable, according to Moxley. Ground beef should reach an internal temperature of 160˚F, and whole beef products should reach a temperature of 145˚F and be held to that temperature for three minutes. A meat thermometer is the best way to determine doneness of the meat product.

WHAT RESEARCH IS BEING CONDUCTED?

The USDA awarded the University of Nebraska–Lincoln (UNL) and other collaborating institutions with a $25 million grant in January of 2012, which is currently scheduled to end December 31, 2016.

"It is the largest USDA grant ever funded at UNL, and one of the largest grants of any kind funded to UNL. And it's one of the largest USDA grants ever given to any institution," Moxley said.

Moxley said work funded by the grant revolves around five main objectives:

- Development, improvement and validation of detection methods
- Biology, epidemiology and ecology of the STEC
- Development of interventions
- Development of a quantitative microbial risk assessment (QMRA)
- Education and outreach

"This grant is restricted to beef and cattle, and it involves everything from live cattle to the consumer and in between," Moxley said.

Moxley highlighted accomplishments of the grant research, which so far have included discoveries in effective temperatures to kill the six strains of STEC included in the grant; developing new molecular detection methods for these organisms; improving culture methods; and developing a model used to address risk of contamination based on data collected, known as a QMRA.

"So it's saying, 'What is the risk of someone to get a STEC infection if we vaccinate cattle, for example, with or without it? What would be the risk if cattle are fed this diet? What would be the risk if a certain intervention is used in the packing plant? What would be the risk if we did all of these things?' And so it's looking at the prevalence and the concentration and thereby the risks to people all the way down the chain," Moxley said.

THE FUTURE OF *E. coli*

Moxley has been involved in several studies on strategies to lower the risk of *E. coli* from getting into the meat supply before the animal even gets to the packing plant.

Vaccination

"One (strategy) would be to vaccinate the cattle, and we were part of the work that led to the first licensing in the world of a cattle vaccine. It's sold in Canada. This vaccine works because it stimulates the production of antibodies against proteins secreted by the bacteria that allow them to attach to the cells that line the intestine. Those antibodies are secreted by the cow and bind to the proteins, preventing the bacteria from attaching to the intestinal cells," Moxley said.

However, this only reduces the numbers of *E. coli* growing in the intestine, and the length of time they are shed in the feces; it does not completely get rid of the bacteria from the gut.

Direct-fed microbials

"Another intervention has been the use of direct-fed microbials. These are live bacteria that the cattle are fed that don't cause disease. Most of them would be very similar to what's in yogurt – e.g., *Lactobacillus*. Lactobacilli, depending on the strain that's used, have been effective in reducing *E. coli* to some extent," Moxley said. "Since the microbial is put into the feed, it does not result in an increase in animal handling, like one would have with vaccination. So that would be the kind of thing that would be the most easily used by producers."

Much more research must be done to keep reducing the risks of pathogenic *E. coli*, from the producer to the packer to the consumer. ✚

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MY CURRENT GOAL IS TO DEVELOP A BROADLY-PROTECTIVE VACCINE AGAINST ANY STRAIN OF PRRS

FERNANDO OSORIO, D.V.M., Ph.D.

Professor, UNL School of Veterinary Medicine and Biomedical Sciences and Nebraska Center for Virology

DEVELOPING A SAFE, BROADLY PROTECTIVE PRRS VACCINE

by MADELINE CLARK *and* FERNANDO OSORIO

Porcine Reproductive and Respiratory Syndrome (PRRS) is a virus that produces reproductive failures in pigs and costs the United States more than $650 million each year in animals lost to the disease. PRRS does not just affect pigs in the United States; it affects pigs all over the world.

Dr. Fernando Osorio has devoted his life as a veterinarian to researching this disease, as well as other diseases that affect livestock, mainly swine. Osorio is a professor in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln and in the Nebraska Center for Virology.

WHAT IS PRRS?

The viral agent of PRRS was discovered in 1990 in Europe, and in 1992 in the U.S. "It was undetected before then; we don't know the origin. It is a mystery where the reservoir was for this virus," Osorio said. "It became the big, explosive disease, with a lot of reproductive failures in sows. It has caused tremendous impact in the fertility and reproductive efficiency of the herds," he said, adding that even if piglets survive their birth, it will take five or six months before each pig's immune system clears the virus from its body.

PRRS is not a zoonotic disease, so it does not cross from animals to humans or from humans to animals, Osorio said. However, the virus spreads quickly in swine herds through respiratory symptoms. Reproductive problems include female pigs' inability to conceive, as well as premature birth and stillborn piglets. The disease can be passed to breeding females by other pigs through respiratory symptoms, but also can be by male pigs through infected semen.

The economic loss comes not only from the potential earnings that would have resulted from the sale of those pigs, but also from the slow growth of the surviving pigs.

The PRRS virus affects the swine population in the U.S., but also in European countries, Russia and China, which also rely heavily on swine production for the pork products the animals provide to humans.

AWARENESS AND ERADICATION EFFORTS

A national effort targeting the Porcine Reproductive and Respiratory virus, funded by the National Pork Board and the National Pork Producers Council, is establishing awareness of the virus as a disease to control, Osorio said.

Veterinarians use many techniques to fight PRRS, Osorio said, including infecting the whole herd with the virus, then closing down the herd for three months, and then bringing in animals that test negative for the disease. "But it takes a while to have protective immunity" with this technique, he said.

Vaccination of animals can provide immunity to the disease, Osorio said, but it can be costly to vaccinate an entire herd. Current vaccines sell for between 50 cents and $1 per dose, but only 40-50 percent of swine producers use the vaccine because of the cost and a lack of trust of the current vaccine, he said. It currently is not mandatory to vaccinate.

Successful vaccines have been developed for other viruses, Osorio said, including the porcine circovirus-2 (PCV2), which was a co-infection of PRRS. "Good PCV2 vaccines took care of PCV2 and put it under control," he said. However, PRRS continues to be a great problem for the producers.

Osorio and his research team have learned that attenuated live vaccines can prime a pig's immune system to produce a PRRS virus-specific antibody response and that such antibodies are important mediators to prevent infection with this virus.

A major obstacle for betterment of current vaccines is the great strain diversity of PRRS virus, which is caused by extensive mutation of the PRRS virus in the field. "My current goal is to develop a broadly-protective vaccine; that is, a vaccine that can protect against any strain of PRRS circulating in the field. As simple as that," Osorio said. "Vaccination against the PRRS virus infection is a multimillion dollar enterprise worldwide and a safer and more effective vaccine is badly needed," he added. "We are certain that our aim should have significant, wide impact." +

"THE DISEASES WE'RE TARGETING WILL BE THINGS LIKE EBOLA, INFLUENZA, MALARIA, TUBERCULOSIS

ANGELA PANNIER, Ph.D.

Associate Professor and Biomedical Engineer and William E. Brooks Engineering Leadership Fellow, UNL Department of Biological Systems Engineering

USING DNA FOR INTESTINAL DISEASE TREATMENTS AND VACCINATIONS

by BROOKE JINDRA *and* ANGELA PANNIER

DNA, the acronym for deoxyribonucleic acid, is a molecule present in all living organisms. Responsible for carrying genetic information, DNA gives each cell that builds an organism its unique qualities. DNA is a stable molecule and has the potential to change how vaccines are administered, which is the end goal of the research of Angela Pannier, University of Nebraska–Lincoln associate professor and biomedical engineer.

Pannier, along with her team of researchers in her lab, is working to develop an oral method of delivering genetic information into a cell. "DNA is the same whether it's gene A or gene B, and so I can basically come up with this drug delivery strategy and click in new genes as I need them," Pannier said. This strategy has the potential to cure a disease or vaccinate against a disease with a single pill.

The human intestinal tract, or gut, became Pannier's region of focus due to the wide array of diseases that affect that tissue. Her research results could help people with diseases such as Crohn's disease or Irritable Bowel Syndrome, but she could apply her work to other diseases as well. In addition to delivering genes to treat disease, Pannier also wants to deliver genes that could result in an immune response, as a type of vaccination strategy. "The (diseases) that we're really targeting would be things like Ebola, influenza, malaria, tuberculosis," Pannier said.

Much of Pannier's work uses components found in nature, such as zein, a protein found in corn. In her delivery system, zein serves as a protective shell against the large number of enzymes found in the stomach, Pannier said.

By packing particles loaded with DNA into a zein coating, the DNA is able to safely travel through the stomach. Then, once the delivery system reaches the intestines, the zein coating comes off and the DNA can then enter into the cells in the intestine that need to be treated, she said.

While the gut is an ideal target for Pannier's research, it also poses challenges, such as the harsh enzymes and pH levels found in the stomach. "That's the number one challenge: trying to protect something through the stomach," Pannier said. Another challenge is getting the DNA to cling to the intestinal mucus long enough for it to find its target cell so the disease can be cured, she added.

POTENTIAL BENEFITS

Once developed, oral DNA vaccinations would not have to be kept refrigerated or be administered by medical personnel like injectable vaccines are, Pannier said. This would allow international adaptation of the vaccinations: current vaccines must be kept refrigerated. Refrigeration is not available in many parts of the world, excluding those populations from current vaccines.

Another benefit of the oral DNA vaccine is how quickly it can be made, she said. "DNA is very quickly altered and made in the lab and so if there's a pandemic, we can respond very quickly, synthesize our DNA, put them in these oral particles and mobilize them across the world," Pannier said. Traditional vaccines, such as the flu vaccine, must be grown in advance before they can be administered. Pannier believes her research could decrease that to a timeframe between weeks and months.

Oral DNA vaccines have the potential to change how people are vaccinated by providing an alternative method of vaccination that is less expensive, safer and faster. "If you think about worldwide, I think it could affect many people," Pannier said.

Pannier's research currently is in vitro, meaning it takes place in a laboratory outside of a living organism as she and her team work to refine the delivery system.

COLLABORATORS AND STUDENTS

Pannier said her research on oral DNA vaccinations is made possible because it is truly a collaborative effort. She collaborates with experts in different fields of study. These professionals include UNL Assistant Professor of Food Science and Technology Amanda Ramer-Tait, who focuses on immunity in the gastrointestinal area; University of Nebraska–Omaha Assistant Professor of Biology Paul Davis, an infectious disease expert; UNL Associate Professor of Biological Sciences Deborah Brown, a vaccine development specialist; and UNL Professor of Computer and Electronics Engineering Tadeusz Wysocki, a mathematical modeling expert. Currently Pannier's research is done at the Pannier Lab, located in the UNL Department of Biological Systems Engineering.

The Nebraska Research Initiative currently funds a portion of Pannier's research. This program, funded by the state of Nebraska, was developed to promote new research in the University of Nebraska to enrich economic growth. According to Pannier, pre-proposals for additional funding for her research have been submitted to the Gates Foundation and the National Institutes of Health.

Pannier's work with developing oral DNA strategies began as a project with one of her undergraduate students five years ago. She believes in the experiences undergraduate research provides students, and values the opportunity to teach future engineers and scientists. "I have high confidence that they're going to go out and do bigger and better things," Pannier said. ✚

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SCIENCE TAKES A WHILE, BUT HAVE FAITH IN IT

ANGELA PANNIER, Ph.D.

Associate Professor and Biomedical Engineer and William E. Brooks Engineering Leadership Fellow, UNL Department of Biological Systems Engineering

GROWTH PLATE CARTILAGE RESEARCH:

changing the future for children

by ASHLEY MAHER *and* ANGELA PANNIER

Many diseases affect stature and growth potential in children, and research being conducted at the University of Nebraska–Lincoln is directed toward growing growth plate cartilage tissue that can change the future for children.

Angela Pannier, associate professor of biological systems engineering, is a biomedical engineer who is growing this engineered tissue, with the hope that it can eventually replace a child's malfunctioning growth plate tissue.

"Growth plate cartilage is a very unique kind of cartilage that is only in your body for a short amount of time," she said. It exists at the end of long bones and allows for growth of long bones during adolescence and pre-puberty. "Our goal is to grow growth plate cartilage in the lab," she said. She believes if successful, this engineered growth plate cartilage could not only be used in children with growth defects, but that this cartilage could be used to replace damaged cartilage in adults.

Growth plate cartilage is an early, temporary cartilage that contains a very intricate infrastructure and is the precursor of mature adult cartilage and bone. Cartilage is a simple tissue, she said, but even so, no one has been able to successfully grow functional cartilage in the lab. One of the reasons, Pannier thinks, is that everyone else is trying to grow mature cartilage, like that found in the knee. However cartilage in the knee did not start as cartilage. It started as growth plate cartilage and then matured, she said.

For this research, Pannier collaborates with Andrew Dudley, associate professor in the Department of Genetics, Cell Biology and Anatomy at the University of Nebraska Medical Center. "He has spent his career studying limb development and cartilage development," she said, adding that "he is a biologist; he is very strong in his field, but he also respects and understands tissue engineering."

"What really makes us unique is that it is a developmental biologist and an engineer working together and trying to understand how the tissue formed in the first place. Whenever we try to grow a tissue or an organ in the lab, all we are ever doing is looking at the final product. Now, we are going to watch how growth plate cartilage builds," Pannier explained.

IMPORTANCE

"Our idea is if we can grow this growth plate cartilage, we could mature it into articular cartilage. It could be an alternative to hip or knee replacements," she said. Articular cartilage covers the ends of bones and has a smooth surface that minimizes friction as a person moves. "The idea is if we can come up with a tissue replacement, it can be a living tissue that could last, hopefully, the rest of their life," she added.

"Additionally, we are trying to understand how cartilage natively develops. By understanding that, we can start asking questions about diseases within cartilage and that new understanding could enable treatment options for joint diseases," she said.

Until engineered cartilage is available, "hip and knee replacements are very successful," Pannier said. "It is an example of a biomaterial that changes people's lives." Hip and knee replacements currently can last only about 20 years, but Pannier said today, many younger people need joint replacements due to sports injuries; she knows of people in their 40s who undergo these surgeries. However, given the 20-year lifetime of implants, those individuals may need new implants in their 60s. But given the invasiveness of the procedure, those patients may not have enough tissue left for a second artificial joint to be placed. Engineered cartilage could alleviate these problems and be a lifelong solution.

PROCESS

The research process of growing growth plate cartilage in the lab begins with mice, Pannier said. Growth plates are removed from the mice and the researchers get the growth plates to live in a laboratory dish. "Growth plate cartilage has four main zones. Our goal is to be able to design a scaffold to mimic these four different zones," she said. "If I could build four of them and stack them together, I think that would be amazing. Our goal for that is two or three years." Pannier hopes that within five years the tissue can be placed into animals. If it still behaves like a growth plate, it can be matured quickly.

"This project is so challenging," she said. "We make the cartilage in circular beads and we put 80,000 cells in there to try and grow a little, tiny growth plate. We have learned a lot of what not to do," she added.

"I think it is very important for the public to keep hearing that science takes a while, but have faith in it. We have already made so many advancements that nobody can even believe," she said. "We have so many more to make, but be patient." +

This project between Pannier and Dudley was funded by a joint UNMC-UNL Bioengineering for Human Health Grant Initiative.

"AGRO-ECOSYSTEMS ENTOMOLOGY IS LOOKING AT THE WHOLE SYSTEM, NOT JUST FOCUSING ON INDIVIDUAL PARTS

JULIE PETERSON, Ph.D.

Assistant Professor of Entomology and Extension Specialist, UNL West Central Research and Extension Center, North Platte, Nebraska

AGRO-ECOSYSTEMS AND MICROBIOMES THROUGH THE LENS OF INTEGRATED PEST MANAGEMENT

by JEANNA JENKINS *and* JULIE PETERSON

Not all bugs are bad.

Using the concept of Integrated Pest Management (IPM), producers and researchers look for ways to use the natural interactions of plants and insects, or biological control, to maintain the health of their crops. Through her work with agro-ecosystems entomology, Julie Peterson uses the IPM perspective to study insect activity in crop fields.

Peterson, an assistant professor of entomology at the University of Nebraska–Lincoln, works out of the West Central Research and Extension Center (WCREC) in North Platte, Neb. "Agro-ecosystems entomology is the idea of using ecology in agriculture; looking at the whole system, not just focusing on individual parts," Peterson explained. "It is looking at how, in agricultural systems, we have ecological processes like nutrient cycling and food webs that are going on; those things don't just happen in natural areas, they happen in our crop fields too. So it is a holistic approach to looking at 'how can we use what we know about ecological processes to help us with agricultural systems too?'" she said.

INTEGRATED PEST MANAGEMENT

"Integrated pest management is something that a lot of farmers have been doing for generations. It is the use of multiple different control tactics. You have cultural controls, which might be things like tilling or rotating your crops. You have biological controls, which would be using the natural enemies, the predators, the parasitoids, the pathogens, like fungal and bacterial infection – using those natural enemies that will attack your pests to control it. There is also chemical control, which would be more of our traditional insecticides, and then host plant resistance, so maybe, breeding the crop so that it has some resistance to the insect. Within that host plant resistance we can consider genetically modified crops as well," Peterson said.

ECONOMIC THRESHOLDS

"IPM uses economic thresholds," Peterson said. "Just because you have one aphid on a plant doesn't mean that one aphid is going to be doing that much damage, so we calculate how many aphids have to be on that plant before the damage they're doing is equal to how much it would cost the grower to treat those aphids," Peterson explained.

INSECT INTERACTION AND BIOLOGICAL CONTROL

Peterson and her team actively are searching for new methods of biological control and have been using laboratory procedures to do that research.

"If you're studying predator/prey interaction with say, a lion and a gazelle, you can see it. If you're studying something that has bones, you can look inside the stomach or look in the feces and say 'okay this is the bone of whatever.' With these tiny little insects, you're not going to stand there and actually see the predation happen. A lot of them are liquid feeders too, where they have the piercing, sucking mouthpart so there's no 'bits' of the insect that you could find inside. And they are tiny; you can't dissect it open," Peterson explained.

Peterson uses gut content analysis and PCR primers to examine the genome of the prey that is being studied, isolate a sequence of DNA specific to that prey, and then do a DNA extraction from the predator and run the tests. When there is a positive result, it means the predator ate the prey.

GENETICALLY MODIFIED CROPS IN THE MICROBIOME

Peterson does research with genetically modified crops. "Bt crops are genetically modified. The Bt stands for *Bacillus thuringiensis,* which is just the scientific name of the bacteria that the genes come from," Peterson said.

"These Bt proteins are expressed in the plant, and these proteins have been chosen because they are specific to certain insects that we want to kill," she said. "The protein binds to the receptors in their gut, and each protein has its own range of effectiveness for which specific species of insects it will or will not harm," she explained.

"The receptors and the proteins are kind of this lock-and-key mechanism; you really have to have those match up in order to cause the negative effects of the proteins," Peterson added.

NON-TARGET SPECIES

Peterson explained that researchers measure the risk to non-target species by comparing the harm and the exposure. Harm is determined by whether or not the ingestion of the protein by that species actually causes it a negative effect. This is then compared to the exposure, or how likely it is for the non-target species to come into contact with the protein in question.

"We've really seen very few negative impacts on non-targets, and for the most part, the adoption of Bt crops is very compatible with things like biological control," Peterson said. "There have been some really good things about the adoption of Bt crops and in a lot of systems it has lowered the need for insecticides that have broader toxicity," she said.

Peterson cautioned against the overuse of management methods, since completely removing an organism from a field's ecosystem can open up a niche for another pest.

"There are practices that farmers are adopting, like cover crops or grazing cattle on their cornstalks during the winter, and they're making those decisions not thinking about insect pests at all. They're using cover crops because they're thinking about soil health or something like that. But those decisions can have an impact on the insects as well. So the all-inclusive health of one thing, whether it is us or the plants or the animals, affects the other parts," Peterson explained.

INTERDISCIPLINARY TEAMS

Peterson is working in conjunction with WCREC plant pathologist Tony Adesemoye and a graduate student, Camila Oliveira Hofman, to study nematodes, fungi and bacteria that will attack pests, like western corn rootworm, in the soil.

"We can't really work in our own little bubbles anymore; if we're really going to answer questions and find out new information that's going to help people to grow a more sustainable crop, and to feed the world, we need to look at this from all sides and try to work together," Peterson said. +

"EXTENSION IS TO TAKE THE INFORMATION DEVELOPED THROUGH EFFORTS AT ACADEMIC INSTITUTIONS AND EXTEND THAT TO THE PUBLIC

RICHARD RANDLE, D.V.M., M.S.

Professor and Extension Beef Cattle Veterinarian, UNL School of Veterinary Medicine and Biomedical Sciences

EXTENSION CONNECTS RESEARCH, PRODUCERS, CONSUMERS

by KELLY SCHNOOR *and* RICHARD RANDLE

The care and management of animals is important to both livestock producers and veterinarians. According to Dr. Richard Randle, professor and Extension beef cattle veterinarian in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln, the people who work with livestock do everything in their power to ensure that animals are provided with good, adequate, wholesome care. There may be winter weather and sub-zero temperatures with blowing snow, but producers will still be out trying to take care of their cattle and make sure they have shelter, he added. "It's a hard job. It's difficult. And most of these people would not be doing that if they didn't have a passion for it."

Making sure that consumers receive a quality end product is a driving force in livestock agriculture.

"We have extremely high standards that, from a safety standpoint, we have to follow in order to ensure we provide a safe and wholesome product. But we also understand that keeping that animal healthy throughout its life, keeping it stress-free throughout its life and providing welfare for that animal up until the point that it reaches the consumer makes it the highest quality product that we have available in the world," Randle said.

TECHNOLOGY BRINGS CHANGES

Improvements in technology and research have enabled producers and veterinarians to do a better job rearing and managing livestock. "We do things so tremendously different today than we did even five years ago, and that creates challenges," Randle said. "Our continual challenge is actually to be able to provide a good quality but inexpensive product, and we are world leaders in that. Doing that while at the same time addressing other needs that cost money, it creates a pretty good juggling act that we need to continually work with. As a result, we are constantly looking at ways to reintroduce the concepts that people are used to in a fashion that addresses the current fervor of what's taking place in the public."

Crop technology is an area that has been rapidly changing and is also important to animal health. "When we think about crops, technology that we've put forth in terms of

production and on a limited amount of acres that provide the good, healthy and nutritious food, both for humans and for livestock, is an extremely important concept. So as we produce drought-tolerant species of plants, heat-tolerant species, pesticide-resistant species of plants, all of those things go toward providing a good healthy plant that's available both for our consumption and livestock consumption," Randle said.

Before new practices can be implemented, however, research and studies are conducted. "Many of the things that we do today as academicians are heavily reliant upon what we call sound science," he said. That means there is a good basis behind which suggestions or recommendations are made. An example of sound science would be evidence-based medicine, he explained.

But science alone isn't enough.

EDUCATING THE PUBLIC

As an Extension veterinarian who works with both producers and the public, Randle oversees a project at the Nebraska State Fair aimed at being transparent and educating consumers about what happens on a farm. It is a birthing pavilion where visitors to the fair can walk through and see live births of cattle, pigs and goats and see chickens hatch from eggs.

"We have about 20,000-30,000 people from the public coming through, and it gives us an opportunity not only for them to see firsthand live births that are taking place but how we handle those animals, how we provide for the welfare of those animals. And we answer their questions about agriculture in general," Randle said.

While the animals are in the birthing pavilion, they are housed just as they would be on the farm. Even the swine are housed in farrowing crates, or confining pens, when they give birth. The sows, or mother pigs, are in the crates for five to six days. "Most of these sows weigh somewhere in the neighborhood of 400-600 pounds. The baby piglets that they give birth to weigh about three pounds, on average. So people can see how the design of that crate alleviates a lot of the problems with those sows laying down on those baby piglets and smothering them, causing injury and death," Randle said.

Teaching the value of agriculture and livestock production is part of Randle's work as an Extension veterinarian. "There is a lot of agricultural ground out there that is not suitable for anything else but growing grass. And the animals such as cattle and other livestock that can utilize that grass make it an important concept as we think about food supply," Randle said. The production of healthy crops and grass fed to healthy livestock is what leads to a secure and safe food supply, he added. And all of those living organisms are intertwined and under the care of livestock producers and farmers as stewards of the land.

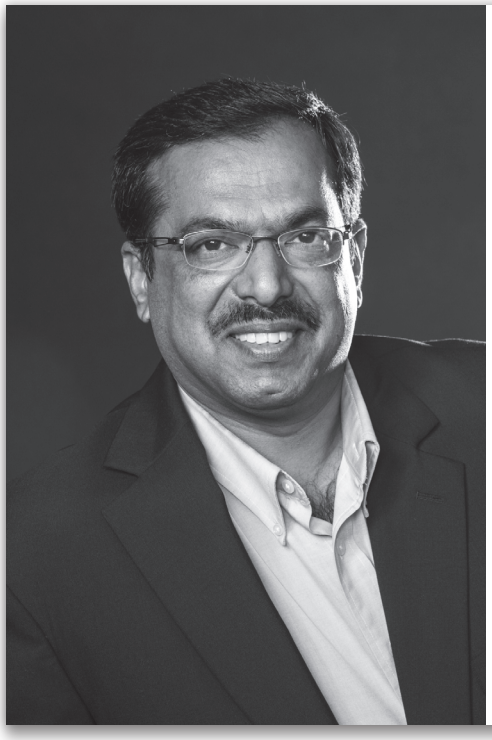
THE VALUE OF EXTENSION

Extension work is important to agriculture through research and through outreach to producers and consumers. Collaborative efforts that assist in implementing research and new practices between livestock producers and veterinarians are made possible through Extension programs in each state, such as Nebraska Extension, which provides and distributes information throughout the state of Nebraska.

"The value of Extension is simply that our job is to take the information that is derived and developed through efforts at academic institutions and extend that to the public. It has to get into the public's hands and become implemented and work to have value," Randle said. "We have to recognize that agriculture is so extremely important, not only for our state, but for the nation and for the world. And yet, the percentage of the population devoted to agriculture is extremely small."

Technology is not only used on the farm but also used to spread the word about what practices and innovations are implemented on farms. According to Randle, "The use of social media today, the use of the Internet today gives us both challenges and opportunities to get our information out to a broader audience and actually create more value because we can get information into the hands of people quicker and to a larger group of people."

As an Extension veterinarian, Randle is a vehicle for delivering that information. "Talking to producers themselves in terms of making that change that we talk about and the need and necessity for that, helping them through it, that's where I get my most enjoyment. They are interested in doing something, I help them through it, and it comes to fruition and it works for them. Then that's a great joy for everyone," he said. +



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IMMUNOLOGISTS ARE ALWAYS LOOKING FOR WAYS TO KEEP OURSELVES HEALTHY THROUGH VACCINATIONS

JAY REDDY, D.V.M., Ph.D.

Professor and Immunologist, UNL School of Veterinary Medicine and Biomedical Sciences

IMMUNOLOGY – ASKING QUESTIONS, FINDING ANSWERS:

multiple sclerosis, cardiomyopathy two of Reddy's targets

by SIENNA CIPRIANO *and* JAY REDDY

Immunology is the study of the immune system, and Dr. Jay Reddy, professor in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln, studies not only the immune system, but what triggers diseases like multiple sclerosis and cardiomyopathy, both of which have genetic elements that predict susceptibility.

There are five main concepts when referring to immunology:

- How do we defend the pathogens as we get exposed to them?
- If the first line of defense fails, how do we fight off infection?
- If the immune system reacts excessively, what price do we pay?
- What if a good immune system is misdirected against our own tissues?
- How do we prevent pathogens from attacking us by vaccination?

"Immunologists are constantly looking for answers for previously unanswered questions, and we are always looking for ways to keep ourselves healthy through vaccination," Reddy said.

MULTIPLE SCLEROSIS RESEARCH

Multiple sclerosis (MS) is an immune system disease that causes scarring in the brain. In multiple sclerosis the myelin sheath is damaged, called demyelination. "We don't know what triggers it," Reddy said, although there seems to be a genetic predisposition to the disease. Additionally, Caucasians, females, smokers and people who are more frequently exposed to disease may be more susceptible to multiple sclerosis.

"Therapeutically, we use only the disease-modifying agents, as the causes that induce MS are unknown," he said. Still, the symptoms of multiple sclerosis will not be the same in any two patients. Treatments are largely developed based on animal experiments with mice, rats and nonhuman primates using the disease model called experimental autoimmune

encephalomyelitis (EAE). "Although not perfect, we have learned a lot on various aspects of MS pathology from the EAE models, and importantly, they serve as useful tools in drug-discovery research," Reddy said.

HUMANS AND ANIMALS, SIMILARITIES

"If you think physiologically, everyone is expected to live and survive," Reddy said. The immune system of both humans and animals is built to provide protection, but there are some differences. Reddy compares immune cells with police; they travel around watching for infiltrators and catch them. Using the same analogy, lymph nodes can be called border check posts; they exist throughout the body so if there is exposure to an infection, the action of recognizing the infiltrators takes place in the regional lymph nodes.

"For example, when we get exposed to some infection through the respiratory tract, there are cells that grab the infiltrators like garbage trucks and dump them to the regional (tracheobronchial) lymph nodes," Reddy said. The lymph nodes become enlarged, which indicates the body is reacting, and that is good, he added. When the cells see the antigen, they will park, he said, and after a time the immune cells by themselves, or their products, will go to the infection sites.

MYOCARDITIS RESEARCH

Reddy also conducts research on myocarditis, which is inflammation of the heart muscle layer, called myocardium. His mother and sister both died young of heart attacks, and both were healthy. "If I accomplish anything in my life, I would like to prevent such occurrences, or at least identify the triggers of heart attacks," Reddy said.

Learning about the heart to reach that goal of preventing heart attacks requires knowledge of infection, genetics and immunology.

Most people are exposed to viruses, such as the coxsackievirus, in their lifetimes, but certain individuals develop chronic myocarditis, he said. "Some of these individuals develop larger hearts, called dilated cardiomyopathy (DCM)," he said. Once these patients develop enlarged hearts, about half of them are likely to have a heart transplant, which is the only available treatment option. Clinical evidence suggests an association between enteroviral infections like coxsackievirus and patients with DCM, but the direct cause and effect relationship remains tenuous, Reddy said.

Reddy's research studies how the virus infection can lead to cardiomyopathy. The virus that infects humans also can induce the exact same response in animals, he said. "We recently proved that if animals are infected with the coxsackievirus, the immune cells that can recognize heart tissue as foreign can be produced, leading to myocardial damage," Reddy said. By extrapolating these events to humans, it may be possible to put forth an argument that human exposure to viruses that primarily cause damage to the heart tissue can lead to the induction of self (heart)-destructive immune cells as a secondary event. This may be an underlying mechanism for development of DCM in those exposed to infections like coxsackievirus. These events fit a "hit and run" hypothesis, Reddy said. Proving this hypothesis may possibly create avenues to target autoimmune response as one therapeutic option.

MESSAGE TO THE PUBLIC

Viruses mutate; they change. That makes it difficult to develop vaccines for viruses that exist, such as HIV, Reddy said. Also, no two individuals are alike; some respond with immunity to a virus while others respond less well.

"Think about smallpox, it was a dreadful disease, but the disease was eradicated," Reddy said. He added that if the vaccine had not been developed, perhaps the world would still be living with smallpox. Development of vaccines requires evaluations by an expert panel that includes vaccinologists, he said, as well as other scientists from different areas. "We have to be accepting of an expert panel," he said.

"We should not tinker with nature too much," Reddy said. "For instance, we should continue to wash our hands during flu season; this is a good protective measure," he added. But at the same time, some people are inquisitively getting provoked by a thought process about whether enhanced living standards and good hygiene practices in the western world have made people vulnerable to some diseases like allergies or autoimmune diseases. "This paradigm is popularly described as 'hygiene hypothesis', and there is some truth to it, although debatable," Reddy said.

"We are researchers, we should have a passion for research," Reddy said. "We need to accept both positive and negative data, and both are equally powerful," he said.

"Practice with the highest degree of ethics."

Finally, he believes there is a responsibility to mentor the next generation of scientists. "If we can mentor one individual who is forever better, then my job is done," Reddy said.

Motivation is one thing, but changing the attitude of a learner in the learning environment/process is another thing. "Both mentor and mentee must actively participate in the learning process to achieve a common goal, similar to the need to clap with two hands to produce a sound," he said. ✚

"ONE HEALTH IS THE INTEGRATIVE EFFORT OF MULTIPLE DISCIPLINES WORKING LOCALLY, NATIONALLY AND GLOBALLY TO ATTAIN OPTIMAL HEALTH FOR PEOPLE, ANIMALS AND THE ENVIRONMENT

DONALD REYNOLDS, D.V.M., Ph.D.

Professor and Director, UNL School of Veterinary Medicine and Biomedical Sciences and Associate Dean, College of Agricultural Sciences and Natural Resources

UNL SCHOOL OF VETERINARY MEDICINE AND BIOMEDICAL SCIENCES:

leading-edge, innovative

by VALERIE KESTERSON *and* DONALD REYNOLDS

Agriculture is the primary industry in Nebraska, contributing more than $23 billion annually to Nebraska's economy. Animal agriculture has a significant role in that total, requiring a system of education and services to support livestock production. The School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln provides education to present and future animal health professionals and services to the animal health industry.

NEW DIAGNOSTICS CENTER – SAFEGUARDING ANIMALS AND PEOPLE

The School of Veterinary Medicine and Biomedical Sciences is leading the way in animal health at the University of Nebraska–Lincoln (UNL) with a new veterinary diagnostics center to be completed in 2017, as well as expanded majors for undergraduate students. "I see my role as being an advocate to enhance, to further develop, to grow, all aspects of our school," Dr. Don Reynolds said. Reynolds is the director of the School of Veterinary Medicine and Biomedical Sciences and associate dean of the UNL College of Agricultural Sciences and Natural Resources. The new Nebraska Veterinary Diagnostics Center, accredited by the American Association of Veterinary Laboratory Diagnosticians, will function as a multispecies lab for the state and region and will remain the only full-service laboratory in the state. According to Reynolds, the new facility will bring more diagnostic capacity, new technology and a design that will ensure safety.

NEW EDUCATIONAL OPPORTUNITIES

A new collaboration with the Nebraska College of Technical Agriculture (NCTA), a two-year college within the University of Nebraska, would allow School of Veterinary Medicine and Biomedical Sciences students to earn the same two-year veterinary technician degree as students at NCTA. Additional goals are to add a practice management option and a research

animal management option to the veterinary science degree. These would provide new career paths for students who want to be part of a veterinary practice or a similar setting but don't necessarily want to be veterinarians, Reynolds explained. The practice management option would prepare program graduates to manage a veterinary office — which is an increasingly valuable skill, Reynolds said — but also may qualify them to manage other types of health-related practices.

Reynolds said another goal is to strengthen and enhance the existing Professional Program in Veterinary Medicine by expanding experiential learning opportunities. Veterinary students take the first two years of veterinary education at UNL and the last two at the Iowa State University College of Veterinary Medicine. The veterinary degree is issued by Iowa State University, with the diploma conferred by ISU.

REPURPOSING THE OLD DIAGNOSTICS CENTER

When the new facility is completed, the current Veterinary Diagnostic Center building will be repurposed. Reynolds hopes to add classrooms, laboratory space and an experiential learning environment for undergraduate, graduate and veterinary students.

IMPACT ON THE STATE

Nebraska leads the United States in beef cattle production, and the Nebraska Veterinary Diagnostics Center serves a crucial role through diagnosing potentially harmful diseases that, if undetected, could affect the state's economy. The Veterinary Diagnostic Center functions as a safeguard, "protecting our interest in animal agriculture," Reynolds said. "We have a lot at stake here in Nebraska." Issues such as animal disease outbreaks (avian influenza is an example) and food safety directly tie the diagnostics center to producers and consumers. The Veterinary Diagnostic Center provides surveillance and diagnoses of specific animal diseases, functions that mean a safer food supply in the United States and worldwide.

Through Extension outreach, School of Veterinary Medicine and Biomedical Sciences faculty provide veterinarians and producers across the state with information related to animal disease and well-being.

INTERRELATED HEALTH GOALS

The role of veterinarians, scientists and researchers in the School of Veterinary Medicine and Biomedical Sciences goes beyond animal and human health. It extends to environmental health and the interrelatedness of all three, Reynolds said. This aligns with the American Veterinary Medical Association's definition of One Health: "One Health is the integrative effort of multiple disciplines working locally, nationally and globally to attain optimal health for people, animals and the environment."

"We hope to promote and develop and have programs that lead to good careers and good job opportunities in the real world. We're trying to have our veterinarians, veterinary technicians, veterinary students and graduate students ready to tackle real-world problems though experiential learning." +

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THE PROTECTION OF BOTH ANIMAL HEALTH AND HUMAN HEALTH ARE ONE AND THE SAME

KELLY SCRIBNER, Ph.D.

UNL Alumnus and Toxicologist, Center for Toxicology and Environmental Health (CTEH®)

'THE DOSE MAKES THE IMPACT':

UNL grad makes a difference with career in toxicology

by MARY GARBACZ *and* KELLY SCRIBNER, *based on an interview by* JAMES ANDERSON

Kelly Scribner, Ph.D., transferred to the University of Nebraska–Lincoln as an undergraduate to study veterinary science. Her intended career goal took a turn, however, when she took a Pharmacology and Toxicology course taught by Michael Carlson, an assistant professor of practice in the School of Veterinary Medicine and Biomedical Sciences and a toxicologist.

Scribner was hooked.

Two weeks before the end of the semester, she told Carlson she wanted to go to graduate school in toxicology. She took the graduate entrance exam during finals week and spent her last UNL semester working in Carlson's lab and preparing for her new trajectory. That new trajectory resulted in Scribner earning a Ph.D. in toxicology from Texas A&M University and her career as a responding toxicologist for the Center for Toxicology and Environmental Health (CTEH®). "The training I received here in Nebraska was amazing," she said. "It prepared me so well for grad school that I was doing thesis-level research within six months. It was because I gained such a good education here."

Her job with CTEH® takes her to emergency situations across the U.S. and around the world to make sure the air, water and environment are safe for people and animals.

The situations can be natural disasters, such as tornadoes or hurricanes, or manmade, such as derailments or fertilizer plant explosions. Any time a chemical has been released, it has the potential to impact a community, worker safety or the environment, Scribner said. It's the toxicologist's job to conduct the tests and communicate with the public about potential risks.

"We try to make sure people understand the context of what's going on at the site, what's being done to remediate the situation and how the community can protect itself," she said. "I get to make a real-life impact."

THE JOB

Toxicologists have a saying, Scribner said: "the dose makes the poison." Scribner and other toxicologists determine what level – or dose – is safe.

"Everybody who works in our field – the protection of both animal health and human health are one and the same. We don't look at one without looking at the other. We want both populations protected," Scribner said.

In the case of a fertilizer plant explosion, for instance, a team drives to surrounding communities to take air readings for toxicologists to help determine if the air is safe. Teams go with the workers to extinguish the fire and clean up the chemicals. They also do air monitoring to help protect workers from exposure to harmful levels. If the situation warrants, toxicologists make sure workers are wearing proper protective equipment.

People

Part of Scribner's job as a toxicologist is to take the accumulated data and communicate it to the public. She explains what happened and why, as well as explaining the potential risks. "We do a lot of that in crisis situations, especially in small communities," she said. "It's a scary time. You hear a lot of scientific words that people don't necessarily understand. You're talking to people on probably one of the worst days of their lives."

In emergency situations, people will search the Internet to understand symptoms they may be experiencing. "The Internet is a wonderful tool, but it can be a frightening tool, depending on what you're looking for," she said. Scribner, her fellow toxicologists and government agencies are on-site to visit with individuals and explain what is going on, what is being done and how people can protect themselves. "We want to be over-protective of our children and our other sensitive populations," she said. In addition to children, sensitive populations include pregnant women, elderly and immune-suppressed individuals, she added. The role of the Environmental Protection Agency (EPA) includes protection of people, animals and the environment, but also communication to people about the safety of their food, air and water.

"I can go talk to a woman who is pregnant and worried about what this will mean to her child. I can talk to her about it and give her peace," Scribner said. "I love being able to do that. I love being able to have some real-world impact."

The environment

"We are constantly in contact with the environment," Scribner said. "The foods we eat, the things we use and come into contact with, our yards, our homes." She added that there are two ways the environment should be protected: knowing the harmful things naturally present in the environment and how to identify and avoid them.

The ecosystem is fragile, Scribner said, and preventing things from entering the environment that can adversely impact it, such as things that can hurt fish, wildlife or crops, is essential.

"Toxins and poisons are naturally occurring in nature," Scribner said. For example, many of the vegetables people eat every day, such as tomatoes and potatoes, produce toxins in their growing cycle as a way of preventing animals from eating them before they are ripe, she said. Drought, another natural phenomenon, changes the dynamic of the environment. Plants aren't receiving water at the right time, forcing animals to eat fruit, vegetables or other plants they might not normally eat, which can have negative effects on them.

Animals

"Animals are just as much in the environment as we are, if not more," Scribner said. "They have such a raw interaction with the plants and water in the environment." When there is an environmental impact, toxicologists have a priority list. At the top of the list is human health and safety; right after that is animal safety. "We make sure that while we are protected, so are the animals that are living in that vicinity," Scribner said, including wildlife, aquatic life, sensitive populations and endangered populations. "When we are there doing the work, we make sure we aren't destroying habitat or stressing them out unnecessarily, which could bring them harm," she explained.

Among the toxins that can harm animals is crude oil. Scribner said animals are more resilient than people in many ways, but anything that reaches too high a level can be harmful. Salt can be harmful if it gets too high in a freshwater river; a change in temperature or level of oxygen can affect fish in a body of water. Water itself can be lethal if someone drinks too much of it. "It's all about the dose and the relationship with the compounds when you interact with them in the environment," she said.

SCRIBNER'S MESSAGE

"When you read about some of the things that are going on and going into the environment, it's scary, but the government and a lot of other people are working very hard to keep everybody safe and to be responsible," she said. Continuing to be accountable and responsive depends on a future of young people interested in science.

"Our country needs scientists, our world needs scientists," Scribner said. "Every day, we are producing more new things and inventing new things. As a scientist, part of the job is creating those things, but also learning more about them as we start introducing them into the communities and into our environment," she said. There are many career options in science, she said.

"Let your passions and the things you enjoy lead you where you want to go." ✚

(See the story about Michael Carlson in this publication.)

"THE COMPLEXITY OF THE SOIL MICROBIOME COMPARES TO AN ASTRONOMER STUDYING THE STARS IN THE UNIVERSE; IT IS A NEW FRONTIER IN SCIENCE

DANIEL SCHACHTMAN, Ph.D.

Professor and Plant Molecular Physiologist, UNL Department of Agronomy and Horticulture and Director, UNL Center for Biotechnology

DNA PLANT RESEARCH GOAL:
find microbes that can develop drought-tolerant plants

by HOPE HEMME *and* DANIEL SCHACHTMAN

"Agriculture feeds people," said Daniel Schachtman, professor of agronomy and horticulture at the University of Nebraska–Lincoln. He uses his passion of feeding people to discover how plants interact with microbes, the unseen organisms below the surface of the soil.

Schachtman also is director of the UNL Center for Biotechnology. Though his roles do not overlap, both are providing new research opportunities at UNL.

Schachtman works with soils and plant roots to discover how plants tolerate stressful soil conditions, such as drought and low nutrients. "We are working to fully understand the diverse array of microbes in soils that interact with plant roots. The complexity of the soil microbiome compares to an astronomer studying the stars in the universe – it is a new frontier in science that is on earth and just below our feet," he said. Schachtman is working to answer questions such as: How do plants shape microbes that live in and around the root microbiome and how does the root microbiome enhance plant growth? In the long term, he aims to discover new microbes that will contribute to the increased productivity of agricultural ecosystems.

"Right now we're working on surveying the associations that plants have with microbes in the soils and in their roots," he says. This research is trying to discover how the less-well-studied soil microbes affect root function and plant growth.

NEBRASKA'S SOILS

"One of the things we've got going for us is our extensive, diverse and well-developed network of field facilities," Schachtman said about UNL. Nebraska's fields are well-known as high producers. The soils and climate across the state will help Schachtman discover the diversity of microbes in many different environmental situations and could provide important clues to which microbes are important for high yield or which microbes help plants in stressful situations.

Schachtman and his team will remove plant root samples from UNL field plots in Mead, North Platte and Scottsbluff. The roots will be taken to UNL laboratories, where they will be cleaned and the DNA studied to determine which

microorganisms are in them and how the community structure changes across environments. The goal, Schachtman said, is to find microbes that impart desirable traits, such as drought tolerance, that can be used in plant breeding in the future.

Recently, Schachtman and a team of 14 scientists received a grant that was awarded by the Department of Energy (DOE) to study the root microbiome of energy sorghum. The team includes Schachtman and two other UNL scientists; researchers from Clemson University; Colorado State University; Boyce Thompson Institute at Cornell University; University of Washington; Iowa State University; Donald Danforth Plant Science Center; the DOE - Joint Genome Institute; and the University of North Carolina-Chapel Hill. This project will use multiple interdisciplinary approaches in varied settings – including the laboratory, controlled environments and the field – to identify plant genes and sorghum-associated microbes that will enhance the sustainable production of sorghum as a biofuel feedstock. Most of the fieldwork will center on Nebraska and will capitalize on the moisture gradient that exists across the state from Lincoln, where it is relatively wet, to Scottsbluff, where it is relatively dry.

"The $14 million, five-year grant provides an opportunity for UNL to move ahead in research on root microbiomes and to contribute to enhancing the sustainability of bioenergy crops," Schachtman said. To be economically viable and to avoid competition with existing food production systems, these biofuel crops will need to be grown on marginal lands with few inputs such as irrigation or fertilization. Microbes potentially offer unique solutions to enhancing the ability of crops to produce their own nitrogen fertilizer as well as tolerate drought.

This research is important because it will uncover "natural ways to improve yields to enhance stress resistance and then to protect plants against insects and diseases," Schachtman said. This is one way to help farmers understand the soil their crops live in. Knowing what goes on underneath the soil surface can help farmers tailor new treatments to the needs of the crops.

CENTER FOR BIOTECHNOLOGY

In his role as director of the UNL Center for Biotechnology, Schachtman oversees a group of core facilities that help faculty, students and other researchers answer their research questions. Each core facility has a director and lab technicians. These core facilities focus on various areas of research in biology. This space houses expensive equipment that is shared for economic efficiency and also has many expert scientists who will assist faculty. The facilities include:

- Proteomics and metabolomics
- Bioinformatics
- Plant transformation
- Microscopy

Schachtman believes the Center for Biotechnology is a vital part of UNL research and will bring new capabilities to UNL researchers and make the center financially sustainable over the long term.

Schachtman said the research being conducted will affect all of agriculture, from producers to consumers. +

"WE TAKE VERY SERIOUSLY THE INFLUENCE OUR WORK HAS ON FEEDING A GROWING WORLD POPULATION

AMY MILLMIER SCHMIDT, Ph.D.

Assistant Professor and Livestock Bioenvironmental Engineer, UNL Departments of Biological Systems Engineering and Animal Science

THE IMPACT OF MANURE MANAGEMENT:

finding the right balance

by KELLI GREEN *and* AMY MILLMIER SCHMIDT

The same nutrients that make manure a beneficial soil amendment and fertilizer for crops can also cause water-quality issues if they reach water through runoff or leaching. Balancing the use of manure to improve soil fertility with careful management to maintain water quality is the goal of Amy Millmier Schmidt, an assistant professor in the Departments of Biological Systems Engineering and Animal Science at the University of Nebraska–Lincoln. Millmier Schmidt, a livestock bioenvironmental engineer, works to determine the best methods for applying manure to cropland and managing the fate and transport of manure constituents in the environment.

"Our role is figuring out the right balance, how much to put on so that the crops are getting what they need, but there's not so much that we're losing it (manure) through leaching of nitrogen into groundwater or the runoff of those nutrients and their contaminants into the surface water," she said. Leaching is the loss or extraction of certain materials from a carrier into a liquid.

Manure is a plant nutrient source and the most natural fertilizer for crops, according to Millmier Schmidt. "When you apply the manure, you're not only providing nutrients for your crops, you're also improving the soil quality. The microorganisms, organic matter, and nutrients in the manure help improve the soil fertility. We use the term 'soil health'; that refers to the chemical, biological and physical properties of the soil," she said. These properties include, among others, water-holding capacity, soil aggregate stability, the ability to cultivate the soil and the ability of plant roots to pull water from the soil.

Manure also can negatively impact the environment when not properly managed. The same things that make manure great for fertilizing cropland, such as nitrogen, phosphorus and organic matter, can feed aquatic plants and reduce the oxygen content of fresh water, Millmier Schmidt said. If manure is over-applied to land to fertilize crops and lost by runoff or erosion, those nutrients could make their way into water and fertilize the aquatic plants, potentially causing algae

blooms that compete for oxygen with fish and other aquatic organisms. This competition for oxygen could kill fish and impair water quality.

THE RIGHT BALANCE

To help achieve balance, farmers use nutrient management plans that are typically written by environmental consultants or other technical service providers, Millmier Schmidt said. Many farmers rely on these environmental experts to help determine the appropriate rate, method and timing of application of each source of manure on a farm, she added. "The work that myself and other manure and nutrient management specialists at UNL do is focused on getting a better understanding of how to apply manure to cropland – injection beneath the soil surface or surface application, whether it's treated in some way before being land-applied, and how all of those factors would impact losses of nutrients and other contaminants to the environment," Millmier Schmidt said.

Manure management is part of a larger and diverse effort to ensure that livestock production remains sustainable, Millmier Schmidt added. "By doing this type of research we are focusing our efforts on increasing crop production through more efficient use of manure nutrients and improved soil fertility, and at the same time trying to minimize our impact on the environment and help livestock and crop producers remain sustainable. We take very seriously the influence our work has on feeding a growing world population with fewer inputs at a lower cost and with an ultimate goal of making high-quality, nutrient-dense animal proteins and other food products available to those who don't have adequate access now," she said.

MANURE: INTIMATELY CONNECTED

At first glance, manure management doesn't sound that exciting, Millmier Schmidt admits, but it is connected to many important issues that people are concerned about. All animals, including humans, naturally excrete hormones in their feces and urine, so all animal and human wastes can contain potential environmental and human health contaminants like pathogenic organisms, hormones and pharmaceutical compounds.

Pathogenic organisms are agents that cause infection, and antimicrobials are medications or pharmaceutical compounds taken to prevent or treat a bacterial infection. Knowing that animal manure can contain these potential contaminants, researchers and manure managers need to understand manure's connection to One Health. One Health is the concept that all of the world's kingdoms are interconnected, including plants, animals, people and the natural environment.

"Manure can impact more than just the crops that we're growing," Millmier Schmidt said. "It can impact ground and surface water that can, in turn, impact human health, and it can impact humans directly through food safety issues. I think that manure can be intimately connected to all of those different areas based on how it's used and how it's managed. Ideally, we want to manage the manure so that we're optimizing soil fertility to maximize crop production and optimizing the quality of those crops that are fed back to the animals that are being raised to produce high-quality, energy-dense proteins for human consumption." +

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SCIENCE IS THIS THING YOU CAN FIND OUT; IT'S NOT A BELIEF

PATRICIA SOLLARS, Ph.D.

Associate Professor of Neuroscience, UNL School of Veterinary Medicine and Biomedical Sciences

THE SCIENCE OF SLEEP

by JOSHUA POORE *and* PATRICIA SOLLARS

All humans and other mammals sleep, according to Patricia Sollars, associate professor of neuroscience in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln, but the distribution and structure of sleep varies vastly between species. "There's a huge range in the amount of sleep that's needed by individual organisms," Sollars said. "Some animals need to sleep only three hours a day, others sleep 20," she added.

There are two types of sleep: Rapid Eye Movement (REM) sleep, and non-REM sleep. "Non-REM sleep is typically thought to be generally restorative and it goes from stage one, which is pretty light sleep, down through stage four for humans," Sollars said. After stage four, humans enter REM sleep. It is thought that memory consolidation occurs during this time, according to Sollars.

Humans and animals differ greatly in their sleep habits, she said. Humans are monophasic sleepers, meaning that the majority of sleep occurs all at once. Polyphasic sleepers, such as mice and rats, sleep in increments throughout the day and night. Crepuscular sleepers, such as trout, are active at dawn and dusk.

SLEEP ACROSS A LIFESPAN

The need for sleep differs across the lifespan of humans, Sollars said. "Babies need a lot of sleep, but they also sleep, as all parents know, fragmentally," Sollars said. "So it takes a while for that sleep to consolidate," she added.

Younger children need eight hours of sleep and a nap during the day, she said. After some time, the child stops taking a nap, and a turning point is reached in the sleep cycle. "As you enter adolescence, you want to stay up later," Sollars said, "and it's not just a social phenomenon; it is, in fact, a physiological phenomenon." The need for sleep remains the same, but it is shifted to a later time of the day. Adolescents suffer severe sleep deprivation because, in part, society has not made an adjustment for this shift, according to Sollars. After adolescence, the human biological clock shifts back.

The elderly experience two key differences in sleep: they tend to go to sleep earlier and they experience less deep sleep. The problem is that the elderly still have the same need for sleep, but spend more time in the shallow phases of sleep and less time in REM, according to Sollars. Health concerns, such as coughing and illness, also influence the quality of sleep. "As you get older your sleep quality diminishes

because you're much more susceptible to these sorts of physiological constraints," Sollars said.

EFFECTS OF SLEEP LOSS

Humans and animals experience different effects from sleep loss, depending on the level of sleep deprivation, Sollars said. At low levels of sleep loss, people become irritated and concentration becomes difficult. One theory is that REM sleep allows people to consolidate their memories. If this is the case, sleep deprivation will reduce the ability to learn, according to Sollars. At high levels of sleep deprivation, animals and humans begin to forget entirely the things that are going on around them.

People who have changing work shifts tend to experience the effects of sleep deprivation regularly. Minor shifts in a work schedule will physiologically cause less harm than major shifts over time.

A NEED FOR SCIENCE LITERACY

"I think it's less important for people to know about my work than it is for the public to have greater science literacy," Sollars said. Internet research is easy to do and some people will trust that, she said, but it would be so much better if people understood the research on a deeper level, asking critical questions to determine whether the information is legitimate.

"Science is this thing you can find out; it's not a belief, it's 'did these scientists who have said this base their conclusions on something legitimate?'" she said. "Make your conclusions about life based on evidence," she said, not on a position someone takes who is not an authority.

"There's more than enough human talent out there for all of the goals that might have to be addressed," Sollars said. "Whether or not there's sufficient funding to enable that to proceed into the future is a very serious question right now," she added.

"We aren't at a place where we can say we know enough," Sollars said. +

"WE'RE NOT WINNING THE WAR ON BACTERIAL DISEASE; ANTIBIOTIC RESISTANCE IS RAMPANT ALL OVER THE WORLD

GREG SOMERVILLE, Ph.D.

Associate Professor, UNL School of Veterinary Medicine and Biomedical Sciences; Expertise: bacterial physiology and metabolism

'WASH YOUR HANDS. ALWAYS.'

Hand-washing is first line of defense against 'devastating infections'

by SIENNA CIPRIANO *and* GREG SOMERVILLE

Floor burns, cuts, scrapes, tattoos and piercings all are examples of places antibiotic-resistant *Staphylococcus aureus* can enter a body and cause skin and soft tissue infections that are difficult to cure. Add to that, personal hygiene is lacking: people aren't washing their hands after they use the bathroom, and in medical situations, health,care workers may transmit bacteria between patients when proper antiseptic procedures are not followed.

And people don't understand the risks or consequences. "*Staphylococcus* causes devastating infections in hospitals and in the community," said Greg Somerville, associate professor in the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln. Somerville studies *Staphylococcus aureus* and its effects on both humans and animals. On the agricultural side of things, bovine mastitis is a very serious disease in the dairy industry and also is caused by the staph bacterium.

As a scientist, Somerville hopes his work will lead to better treatments and better therapies so fewer people die from staph infections.

"We're not winning the war on bacterial disease; antibiotic resistance is really rampant all over the world and is creating a lot of problems," he said.

HOW STAPH SPREADS

Sports teams also are susceptible to staph infections, he added; football and basketball players often get floor burns or scrapes. "You've just opened up the skin to a potential infection and so anything that lets bacteria in gets past the first layer of defense – the skin."

After the bacteria gets past the skin, the body's immune system starts to track down the bacteria and kill them, he said. The white blood cells migrate toward the site of the injury and if things go right, the white blood cells consume and kill the bacteria and immune cells develop an antibiotic-based response.

"The whole idea is that the white blood cells will clear that infection," he said.

If an infection is not cleared by the immune system, "it can explode, and cause life-threatening infection," Somerville said

But it doesn't work that way for people whose immune systems are compromised – such as the very young, the elderly

and those who have had organ transplants.

Somerville said hospital-acquired infections cost the United States somewhere around $50 billion annually. Everybody thinks that operating rooms are sterile, but there are bacteria in air vents and on equipment, as well as bacteria from inadequate hand-washing, he said. "If you're in the hospital for more than seven days, you have a 50 percent chance of coming down with an infection that you did not come in there with," he said.

Some bacteria are very good at evading the immune system, he said. "Those are the ones we're more worried about right now, because they often are also very antibiotic-resistant. We're running out of ways to kill some of the bacteria."

THE RESTROOM SURVEY: *the 'ick' factor*

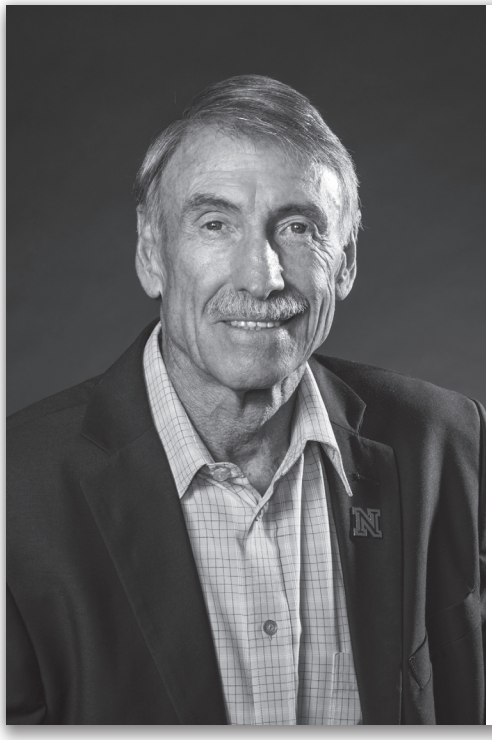
Somerville is a member of the American Society of Microbiology. Every few years the organization does a study of how many people wash their hands after using the restroom. Ninety five percent of people report that they wash their hands after using the restroom; however, only 60 to 70 percent of people are observed washing their hands, meaning 30-40 percent do not.

"Personally, there is an 'ick' factor to that, but from a bacterial pathogenicity standpoint, what you're doing is contaminating the door. You just transmitted whatever bacteria that you had on your hands to the door handle. Wash your hands. Always."

LEARNING MORE

When it comes to knowledge about disease, it is safe to say that the communication to the public is not very good, Somerville said. "There is a need for people who can go out and teach the public at large about these issues," Somerville said. Scientists have not been trained to communicate to the public. Considering the communication gap about antibiotic-resistance and the disease process itself, the problems that have been going on for decades are getting worse instead of better.

"There is no way that you ever entirely protect yourself. Unless you put yourself in a sterile bubble, you're always going to be at risk. You can't worry about it too much. Washing your hands is the best thing you can do," Somerville said. +



"EVERY TIME THERE'S AN ADVANCE MADE IN HUMAN DISEASE, THERE MAY BE A BENEFIT TO PLANTS AND ANIMALS

JAMES STEADMAN, Ph.D.

Professor and Department Head, UNL Department of Plant Pathology

DRY BEANS:
nutrition for the world

by KELLI GREEN *and* JAMES STEADMAN

Dry edible beans are one of the most nutritious foods you can eat, according to James Steadman, head of the Department of Plant Pathology at the University of Nebraska–Lincoln Institute of Agriculture and Natural Resources. High in fiber and protein, with a low glycemic index, dry beans are nutritionally competent, contain antioxidants and can be produced throughout much of the world.

Nearly 165,000 acres of dry edible beans were produced in Nebraska in 2014, mostly in the western part of the state. Nebraska ranks first nationally in production of great northern beans; second in production of pinto beans; and third for production of all classes of dry edible beans, according to the Nebraska Department of Agriculture's 2015 production statistics.

The University of Nebraska–Lincoln partners with 12 other land-grant universities across the United States and the United States Department of Agriculture in a multistate dry and snap bean project funded by USDA grants. For this project, Steadman teams with Carlos Urrea, UNL dry bean plant breeder, to address resistance to biotic and abiotic stresses, sustainable production and cooking aspects of beans.

Eating one cup of beans a day can help reduce the risk of colon cancer, breast cancer and prostate cancer, Steadman said. Beans also are accessible and adaptable to different kinds of environments. "Beans can be grown everywhere: throughout the Americas, east and southern Africa and Asia. India grows up to 20 different kinds of beans that we don't know much about," Steadman said.

Steadman has conducted research in many countries around the world and his current projects, in Mozambique and Zambia, focus on root rot and rust in dry beans. Root rot is a disease that hinders the growth of plant roots, which are critical for plant production, Steadman said. New molecular technologies help determine the causal agents of root rot through analyzing the DNA sequences of potential pathogens. Use of DNA sequences aims to reduce the amount of time it takes to identify the fungi that cause root rot to reduce or eliminate this problem. This can improve production in beans in these and other African countries, Steadman said. Rust

also is caused by a fungal pathogen that is highly variable and affects leaves and pods. Races of the pathogen must be identified through mobile bean nurseries to enable resistance genes to be deployed, similar to flu virus strains that are identified for deployment of vaccination in humans.

Epidemiology, the study of disease patterns and pathogen population distributions, is the core of Steadman's research. "I have a close relationship with breeders, and our perspective is that the most long-lasting and environmentally compatible approach to controlling or managing disease is to use disease resistance," he said. In order to reduce epidemics, plant breeders search for genes that reduce or eliminate pathogens that cause diseases. Through epidemiology and the use of plant disease resistance, researchers use similar tools for the One Health concept of the interconnectedness of plants, animals and humans. Use of chemicals and cultural and health practices also are interventions in One Health.

ONE HEALTH: A CYCLE

Plant, animal and human health share a lot of the same principles, Steadman said. For example, stress biologists look for the commonalities in metabolic cycles that would affect biotic and abiotic stress in plants, animals, humans, or all three. When scientists come together and look at similarities and differences between microbes and host diseases, One Health becomes mechanistic and allows scientists to work on biotic stress together. "Every time there's an advance made in managing cancer or some other human disease, there may be a benefit to plants and animals because the technology becomes available to make research more efficient and an end product more likely in the future," he said.

Steadman cited an example of One Health in plant pathogenic fungus in West Africa. "When moisture is available in West Africa during the corn growing season, a fungus infects the kernels, and when families consume the corn, they are consuming low levels of carcinogens that are especially problematic in children over time. There are very high rates of cancer in West Africa because of the continual consumption of low levels of carcinogens; it's affecting the children's education and the next generation of families," he said. This circumstance illustrates the interconnectedness of the health of plants and people and also where education of families about fungal disease management options can reduce a human health problem.

OPEN MINDS FOR ONE HEALTH

Steadman advocates educating the public about One Health and plant, animal and human disease control through the dissemination of information, especially now on mobile devices and websites. A concern for many scientists is the interplay between organic production, genetically modified organisms (GMOs) and producing more with less water and land. "Particularly, it's a problem in Africa where there have been ministers of agriculture and human health who have said they will never use any of those new techniques; 'we will grow crops the way we always have,'" Steadman said. While research on the safety of new technologies is ongoing, no documented human problems have been found; for example, cheese has been made with GMO fungi for many years, he added.

Steadman encourages the public to learn more about the benefits of genetic modification. "Today, most city dwellers know very little about food production and management of that process relative to human health," he said. Scientists are constantly finding new technologies, such as silencing a gene's action, which can provide resistance to multiple viruses in one plant species. Making relevant information readily accessible about food production, technology and disease management will help the global society better understand One Health. +

"THE SPREAD OF ANIMAL DISEASE HAS A HUGE IMPACT ON FOOD SECURITY, BUT IT ALSO IMPACTS A FARMER'S ECONOMIC VIABILITY

DAVID STEFFEN, D.V.M., Ph.D.

Professor, UNL School of Veterinary Medicine and Biomedical Sciences and Veterinary Pathologist, Veterinary Diagnostic Center

DISEASE TRANSMISSION:

exposure or inherited?

by COLLEENE MARRIOTT *and* DAVID STEFFEN

Animal diseases can be transmitted by exposure to pathogens if infectious – or they can be inherited. Dr. David Steffen works to understand both types of diseases, with the goal of understanding the causes of diseases and congenital birth defects, in particular.

Steffen is a veterinary pathologist and researcher at the Nebraska Veterinary Diagnostic Center at the University of Nebraska–Lincoln; his specialization in perinatal and developmental cattle diseases results in referrals from all over the country, he said.

"The spread of animal disease has a huge impact on food security, but it also impacts an individual farmer's economic viability," he said. Some disease outbreaks, such as the Porcine Epidemic Diarrhea Virus (PEDV), wiped out 40 percent of the baby pigs in the six months it took to go through the herds, Steffen said. Not only was it a devastating illness to the farmers, it decreased the supply of pork to the consumer, causing higher prices.

Steffen's work as a pathologist with the Nebraska Veterinary Diagnostic Center involves finding the cause of disease or death in animals throughout the region, including food animals, pets and zoo animals, whether for food, companionship or animal conservation. Those findings are reported to veterinarians and animal owners so that disease can be effectively treated and controlled.

DISEASE CHARACTERISTICS

The spread of disease depends on the behavior and condition of the animals or people transmitting infectious agents, Steffen said. Disease agents must be infective and be able to maintain themselves in the host by evading the immune system to cause animal or human disease.

Any bacteria that is an effective pathogen – a disease-causing bacteria – has to evade the immune system. "Most of the organisms that are on our skin or in our bodies live in a symbiotic relationship with us," Steffen said. Some bacteria are beneficial; they may help a human or animal digest food, or colonize a surface at attachment sites, thus keeping pathogens from attaching and causing disease. "If an organism is going to be pathogenic, it has to attach to our bodies or to the animals'

bodies to maintain its position," he said. The structure of some bacteria may inhibit the white blood cells from destroying it, he said. For example, the anthrax bacillus has a thick capsule that helps it evade the white blood cells, he explained. Some viruses, like the AIDS virus or the bovine leukosis virus, mutate frequently, allowing them to evade the immune system. The body just forms an immune response to one mutant – and another develops.

"There has to be some way for the organism to evade the immune system," he said. In cattle, one of the main respiratory pathogens is *Mannheimia haemolytica.* This bacterium produces a toxin that kills white blood cells, enabling it to cause severe lung damage.

ZOONOTIC DISEASES, PUBLIC HEALTH

"The minority of diseases are actually what we call zoonotic pathogens – that go from animals to man, or man to animals," Steffen said. In the 1800s, these were important disease risks, but thanks to today's good public health system, those concerns are much less important.

"In the 1800s, a lot of people in the United States contracted tuberculosis and a big source of tuberculosis was *Mycobacterium bovis*, which is the cattle form. This cattle form could be shed in the milk and people would get tuberculosis from drinking milk," Steffen said. A similar situation occurred with brucellosis, he said. "We don't want brucellosis causing abortion in our cattle, but the big reason we continue control programs is because it causes human illness and is a very serious disease," he explained.

Veterinarians and research scientists work to prevent animal diseases and stop epidemics before they start. Today's public and animal health systems have implemented barriers to disease transmission. Procedures such as pasteurization of milk significantly decrease the risk of zoonotic disease transmission. The pasteurization process kills not only tuberculosis and *Brucella*, but also kills more common bacteria, such as *Listeria* and *E. coli*, he said.

"One of the risks now, with the trend of people drinking unpasteurized milk or eating cheese made with unpasteurized milk – is that some of these zoonotic diseases are re-emerging as clinical problems for people," Steffen said.

Leash laws are another example of a public health tool implemented to protect people, he said. "You have to have your pet on a leash, collared and identified – but that has nothing to do with the annoyance of having the neighbor's dog run and jump on you; it's about rabies control." Rabies is a zoonotic disease; it can pass from animals to humans through exposure to the saliva of an infected animal, often through a bite.

ONE HEALTH AND LOUIS PASTEUR

The One Health concept reflects the interconnectedness of the health of all: environment, animals, plants and humans.

"If you go back to Louis Pasteur and some of the original scientists, some of the fundamental medical research and microbiology were done by people who were working on animal diseases," Steffen said. "It's all basic biology and biology of disease," he added. Dr. Louis Pasteur (1822-1895) developed the food preparation process called pasteurization, which is the basis for germ theory. He also developed vaccines for anthrax and for rabies.

Having a human component to disease research sometimes attracts additional research funding, but the real benefit is in solving medical problems, such as in Steffen's own research into genetic diseases in cattle.

"In some of the genetic diseases, we find there are comparable diseases in human children. Steffen uses the research into the human forms of the diseases to understand the cattle form. "And sometimes it works the other way around – when we find something that emerges in animals, we can use it to better understand a human disease problem," he said.

GLOBALIZATION, TECHNOLOGY AND DISEASE TRANSMISSION

Globalization and technology have impacted disease transmission, Steffen said. The rapid movement of people, animals and even shipping containers from one part of the world to another has made disease a global issue.

"Those sealed shipping containers have had a huge impact," Steffen said. "Mosquitoes that are able to spread pathogens – some fairly aggressive – have come over from Asia in sealed containers with used tires. They arrive here rapidly and get opened up while mosquitoes are still alive. They establish breeding colonies in the United States and things like that are a big risk for disease spread," he explained. Historically, when the U.S. was first settled, it took months to get across the ocean in a boat; too long for most pests or disease-infected persons or animals to survive. People move from one part of the world to another often in a matter of hours. Ebola, Steffen said, was spread through transportation from one community to another and then, from one country to another rapidly during incubation periods and before symptoms appeared.

West Nile Virus, Steffen said, is spread by mosquitoes but the disease is relatively new to North America; the first case in North America was in 1999 in New York state. West Nile Virus originated in Africa and the Middle East. Since its arrival in North America, West Nile Virus has spread through resident birds and mosquitoes through bites across the continent. "And now infection risk is part of the reality of living in North America," Steffen said. ✚

"CHLOROVIRUSES ARE PRESENT IN FRESH WATER ON EVERY CONTINENT ON EARTH THAT WE HAVE SAMPLED

JAMES VAN ETTEN, Ph.D.

Professor and Virologist,
UNL Department of Plant Pathology

UNL CHLOROVIRUS RESEARCH PROVIDES MANY SURPRISES

by CHELSEA TAYLOR *and* JAMES VAN ETTEN

A 1981 evening discussion with a colleague at the University of Nebraska–Lincoln led to an experiment, which ultimately led to the discovery of a new family of viruses that affect algae, now called chloroviruses. In 2010, an email on a Sunday afternoon invited James Van Etten to collaborate with a large research team that studies schizophrenia, bipolar disorder and major depression because the team had discovered some chlorovirus-like RNA sequences in brain tissue from people who had died and had been afflicted with these mental illnesses.

He initially thought the email was a hoax by one his friends.

The next morning, Van Etten did some checking. The Sunday email was from a scientist, Dr. Bob Yolken, at Johns Hopkins Medical School (JHMS) in Baltimore, Maryland and he was serious. Van Etten agreed to collaborate.

"Three days later, two researchers from JHMS were in our laboratory. That was the start of a now five-year research collaboration," Van Etten said.

Van Etten is the William Allington Distinguished Professor of Plant Pathology at UNL. Van Etten said the JHMS team had always been convinced that something in addition to genetics might be involved in these diseases, such as a viral or environmental component, and that is why they had conducted the big sequencing project.

"There is no question that these mental health diseases have a genetic component," Van Etten said. However, there may be another unknown factor or factors that contribute to these diseases. Scientists from both the Van Etten and JHMC laboratories wrote a paper on some of their research that was published October 27, 2014, in the Proceedings of the National Academy of Science. The paper described a possible correlation between the chloroviruses and cognitive behavior in humans and mice. Mice were subjected to various behavior tests 6 to 22 weeks after being fed virus-infected algae. Compared to mice that had only been fed uninfected algae, the mice exhibited some differences in cognitive behavior, according to the article. The changes in behavior were statistically significant, even after repeated experiments, Van Etten said. The research focused on the hippocampus part of the brain, which is responsible for memory and navigation.

THE CHLOROVIRUSES

"Chloroviruses are present in fresh water on every continent on Earth that we have sampled," Van Etten said. "However, we have not checked any samples from Antarctica." There is a seasonality to the presence of the viruses; typically, there is a higher number of infectious particles in the spring and in the late fall, he said. The scientists have learned there are many, slightly different species of the chloroviruses, as well. "However, it is clear we know very little about the natural history of these viruses," Van Etten said. "We're probably just at the tip of a large iceberg."

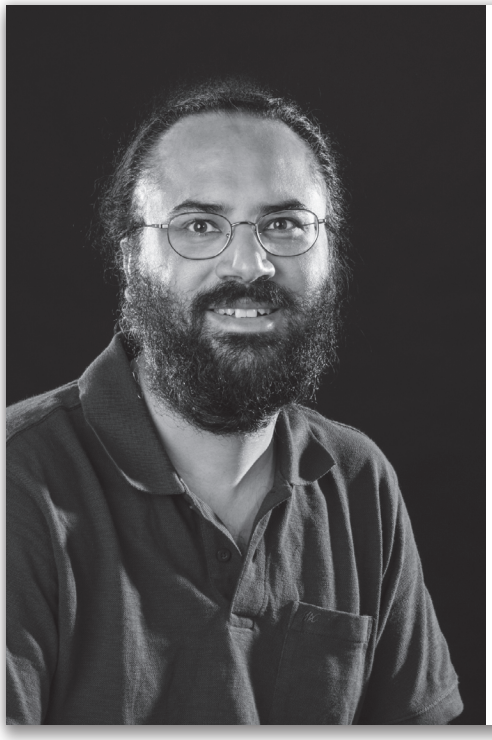
Massive algal blooms in the oceans, often called red tides and brown tides, may cover hundreds of square miles. Often, the rapid disappearance of these blooms is caused by viruses that are evolutionarily related to the chloroviruses. Viruses, in general, can replicate very rapidly, e.g., going from one infectious virus to 1,000 or more infectious particles in a few hours, and each of these can infect additional cells. Thus, the chloroviruses and other viruses are playing a major role in the ecology of aqueous environments.

One of the interesting properties that the Van Etten lab has discovered about the chloroviruses is that they have as many as 400 genes. For comparison, HIV, the AIDS virus, has about 12 genes. At the time of their discovery, the chloroviruses encoded more genes than any other known virus. "Furthermore, many of these genes had never been found in a virus and some of the genes code for really interesting proteins," he said. Consequently, these viruses have taken the Van Etten research in many unexpected directions over the last 35 years and led to numerous productive research collaborations with research scientists around the world, including the group at JHMS.

As one example, the chloroviruses were the first viruses discovered to encode a protein that forms a functional potassium ion channel; furthermore, the virus-encoded protein is the smallest protein to form an active channel. Potassium ion channels are important in almost all physiological events that occur in living organisms, including human sight, heart rate, signaling and cognitive behaviors, he said. Consequently, there is a huge research effort worldwide to understand how potassium ion channels work. Because of their simplicity, research on the chlorovirus channels has resulted in more than 50 scientific publications.

As far as the scientists can tell, the chloroviruses do not have any effect on higher plants. "We have tested them against a number of plants," he said. However, he thinks it's possible that the chloroviruses might also infect another microorganism. If so, that might be the link to humans and animals. "However, currently we have no direct evidence to support this possibility," Van Etten said.

Van Etten also serves as the co-director of the Nebraska Center for Virology. The Nebraska Center for Virology is a biomedical research facility located at UNL. Founded in 2000 with a $10.5 million grant from the National Institutes of Health, the center's researchers focus on viral diseases of humans, including HIV-1, as well as viruses of plants and animals. The Nebraska Center for Virology includes virologists from UNL, the University of Nebraska Medical Center, and Creighton University Medical Center. ✚



"PUBLIC SUPPORT GREATLY IMPACTS OUR EFFORTS TO MEET THE FOOD, FUEL AND FIBER NEEDS OF AN INCREASING POPULATION

HARKAMAL WALIA, Ph.D.

Associate Professor and Plant Molecular Physiologist, UNL Department of Agronomy and Horticulture

GROWING PLANTS FOR TOMORROW'S CLIMATE:

scientists now using Nebraska Innovation Campus greenhouse for global experiments

by JEANNA JENKINS *and* HARKAMAL WALIA

Agriculture has experienced significant scientific advancement in the last few decades, and Harkamal Walia is optimistic about technology that is revolutionizing and industrializing the way agricultural research is conducted. Walia is an associate professor of agronomy at the University of Nebraska–Lincoln.

"In the last five years the genomics has really 'arrived' for crop plants – the plants that make food and fiber and fuel for us," he said, "so that has really revolutionized the kind of questions we can ask, and the extent and the scale." Genomics is the field of utilizing technology to study one or more aspects of a large number of genes in parallel.

Another developing area of technology is phenomics, or the ability to use imaging and other sensor systems to measure plant phenotypes, such as plant height and growth rate. "Rather than looking at one or two varieties, we can look at hundreds of varieties within the same experiment without having to manually go and measure everything, or destroy and weigh everything, because we can use camera systems and conveyer belts to do plant measurements," Walia explained. "You could think of this as an industrialization of plant measurements," he said.

He added that with the investments UNL has made in faculty expertise as well as infrastructure, UNL is poised to be among the best institutes in the world for utilizing crop phenomics for important agronomic traits.

FUTURE RESEARCH

Walia currently is involved in a research project funded by the National Science Foundation to study salt stress in rice. The research team is working with 400 different rice varieties grown in 80 different countries. This research has been conducted at the University of Nebraska–Lincoln and at the University of Adelaide Plant Phenomics Facility in Australia,

allowing year-round research. The three-year project will move to the Nebraska Innovation Campus greenhouse facility in 2015.

MENTORING STUDENTS

Walia mentors graduate students and teaches an undergraduate course at UNL. "I try to relay the importance of food production and how it is linked to societal issues," he said. He encourages his students to develop a more scientific attitude toward understanding and responding to emerging agricultural technologies and science in general. "Scientifically sound opinions on agriculture among the citizens are essential for continued public support of research efforts at the university. Public support greatly impacts our efforts to meet the food, fuel and fiber needs of an increasing population." +

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WE'RE HOPING THAT WE CAN BUILD BETTER VACCINES AND HAVE MORE TARGETED THERAPEUTICS THAT ONLY ACTIVATE THE CORRECT ARM OF OUR IMMUNE RESPONSES

MATTHEW WIEBE, Ph.D.

Associate Professor and Virologist, UNL School of Veterinary Medicine and Biomedical Sciences

LEARNING HOW OUR BODIES PROTECT THEMSELVES AGAINST INVADING DNA:

lessons from a virus

by BROOKE JINDRA *and* MATTHEW WIEBE

Early prevention of viral infection that can otherwise lead to cancer, autoimmune disorders or other diseases is the research goal of Matthew Wiebe, an associate professor and virologist in the University of Nebraska–Lincoln School of Veterinary Medicine and Biomedical Sciences.

Understanding a cell's defensive mechanisms and ensuring it has the proper amount of DNA is relevant in understanding virology and other diseases such as cancer, Wiebe said. If there are errors in how DNA is maintained and expressed, these diseases can develop, he said.

"Even though our bodies have DNA and viruses have DNA, there are various machines within our cells that can recognize DNA that's foreign – that's other than our own," Wiebe said. These sensors act as detection mechanisms to interrupt an infection caused by the foreign DNA, he said. If a body does not have these sensors, a virus is much more effective at infection, Wiebe added.

Once a virus gets past these DNA sensors, cells are unable to distinguish which DNA are its own, Wiebe said. In some cases, cells can specifically prevent foreign viral DNA from reaching this step, he said.

THE BAF PROTEIN

This defensive process, a key focus of Wiebe's research, uses the barrier-to-autointegration factor protein, commonly called BAF. The BAF protein, found in all multicellular organisms, has the ability to protect a body's DNA from the invading DNA in a virus by preventing its replication, Wiebe said.

"We're hoping that by understanding these processes, that we can build better vaccines and that we can have more targeted therapeutics that will only activate the correct arm of our immune responses," Wiebe said.

Every living thing on earth has DNA in its cells, meaning that Wiebe's research has the potential to impact animals, plants and humans. Understanding how any organism

guards its own DNA and itself from infection will lead to new vaccines, Wiebe said.

While treatments are not currently available, future therapeutics could consist of activating specific DNA sensors that would trigger an earlier immune response, Wiebe said. The longer a viral infection lasts, the more pathogens spread throughout the body. By stopping the infection early on, the virus is defeated more efficiently, he said.

EXAMINING POXVIRUSES

In addition to the BAF protein, Wiebe studies the family of viruses called poxviruses, particularly the vaccinia virus. Poxviruses are very skilled in their ability to inactivate the human immune system, Wiebe said. "They have all the 'keys to the castle' in many ways," he added.

"We can learn from this virus about how our immune system works and how to potentially tweak it," Wiebe said. By learning where the virus targets the cell, it will be possible to prevent infection, he said. Poxviruses are specific to the species they infect. Among this family of viruses is variola, the virus that causes smallpox, he said. While smallpox has been eradicated, it still has value in research such as this.

Smallpox was declared eradicated in 1980 upon completion of a global immunization campaign led by the World Health Organization, Wiebe said. Eradication was successful partly because smallpox can only be transmitted from human to human, and because those who survived a smallpox infection became immune.

Wiebe, a UNL assistant professor, conducts his research at the Nebraska Center for Virology, a biomedical research facility located at UNL. Other researchers in the center focus on viral diseases of humans, including HIV-1, Kaposi's sarcoma and herpes, as well as viruses within plants and animals. Key collaborators with Wiebe's research include UNL Professor of Veterinary and Biomedical Sciences Clinton Jones and UNL Professor of Biological Sciences Luwen Zhang. Jones researches bovine and human herpes viruses, while Zhang's research is on Epstein-Barr virus. Both contribute with their own focuses on these specific viruses. +

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THE HIV VIRUS IS ALWAYS CHANGING AND IT INCREASES THE CHALLENGE OF DEVELOPING A VACCINE

CHARLES WOOD, Ph.D.

Director, Nebraska Center for Virology and Professor, UNL School of Biological Sciences

HIV/AIDS RESEARCH CHANGING LIVES WORLDWIDE

by VALERIE KESTERSON *and* CHARLES WOOD

Worldwide collaborations and research facilities such as the Nebraska Center for Virology at the University of Nebraska–Lincoln make it possible for biochemist Charles Wood to change lives.

Wood, the director of the Nebraska Center for Virology and the Lewis L. Lehr professor in the School of Biological Sciences, isn't alone in the fight to find preventive vaccines for viruses that take lives, like the Human Immunodeficiency Virus (HIV).

The Nebraska Center for Virology, formed in 2000, includes 12 faculty members from four UNL entities: the School of Veterinary Medicine and Biomedical Sciences, Plant Pathology, School of Biological Sciences and Department of Biochemistry. "We are bringing together a team of scientists. People from different areas and different departments," Wood said.

ONE OF A KIND

The Nebraska Center for Virology is a Center of Biomedical Research Excellence (COBRE) and was formed under the Institutional Development Award (IDeA) program of the National Institutes of Health. The Nebraska Center for Virology partners with the University of Nebraska Medical Center and Creighton University, making it a center for the entire state, Wood said.

The center functions in a dual role. It provides a learning atmosphere for students and faculty at the university and for students from across the world, but is also instrumental in discovering and preventing viruses and diseases. "It's important for the well-being of our food crops, well-being of our animals, and for our own well-being. It's really important, to say the least," Wood said.

Wood is involved in research projects with other scientists and students, many of them coming to Nebraska from Africa, China and South America to learn at the Nebraska Center for Virology.

VIRUSES – WHAT ARE THEY?

A virus is smaller than a bacterium and visible only under an electronic microscope, Wood said. The biggest distinction

between a virus and a bacterium is that a virus has to survive inside a host, Wood said, but a bacterium can grow anywhere else, independent of a living organism. Virologists study viruses.

Wood studies the immune system and human viruses. This is what led him to his current field of study, which involves looking at the Human Immunodeficiency Virus (HIV) and other viruses found in Acquired Immunodeficiency Syndrome (AIDS) patients, and ways they can be prevented.

The human body can fight off common viruses like colds or influenza by producing antibodies and building up immunity. This helps defend the body from contracting the same strain again. Some viruses, such as polio and measles, now can be prevented by vaccines. But not all viruses respond as well to vaccines.

"HIV is a virus that hides in the body and comes out periodically, making it difficult to treat," Wood said. "Because the virus is always changing, and we can only vaccinate for the strain that we know, it increases the challenge of developing a vaccine that will be effective."

TWO DECADES OF WORK IN ZAMBIA

Wood and his research colleagues have spent more than 20 years traveling to Africa – mostly to Zambia – to research HIV/AIDS and set up clinics to treat those who have HIV and AIDS.

HIV/AIDS is sexually transmitted, in addition to being transmitted through blood and body fluids, Wood said. "We know that if you use a condom 100 percent of the time, you can prevent 99 percent of the infections," Wood said, "but change in behavior is extremely difficult."

Residents of Zambia focus first on survival, Wood said. After that, they consider how the research of viruses, such as HIV/AIDS, impacts their communities, he added. That is slowly changing with the work and research that Wood and his team are doing through clinics and education.

Wood's work in Zambia started with one collaborator and an office. Next came a telephone line, next hiring people to work on the project, then building a clinic and a laboratory. It was a slow process, Wood said, but now there are research laboratories to study the virus and clinics to treat patients. The lab/clinic combination is essential because of the patient-based research they are doing. "We need the clinics, the patients and the samples," Wood said. "Our research is geared toward helping patients; those things go hand in hand." The type of research that they are conducting affects public health by learning more about how viruses spread and how to build better vaccines, Wood said.

"It's a very complicated issue. It's not only science, but it's behavior, sociology, social study, social structure," Wood said, "but we have a very successful treatment right now."

The treatment regimen targets specific parts of the life cycle of the virus, Wood said. By using a combination of drugs and targeting the virus at different stages of its life cycle, the virus doesn't have time to mutate and become resistant. "This has made it a more manageable, chronic disease," Wood said, "but we have to be careful because we cannot treat our way out of an epidemic. Prevention is still key."

Sustaining the clinics and laboratories in Zambia is necessary to see continued improvement. Funding for projects like these as well as the center on campus is important, but that funding is difficult to obtain, Wood said.

IMPACT ON NEBRASKA

The study of viruses and disease not only impacts people; it also impacts the world food supply. Nebraska and many other parts of the world rely on disease-free crops and animals for safe food and for the economy. The One Health concept is about the interconnectedness of plants, animals, humans and the environment. Keeping all parts of the system healthy helps ensure longevity, Wood said.

STUDENTS

Wood and his colleagues are encouraged by young students who wish to pursue similar paths that aid in the prevention and management of viruses and diseases. "The fulfillment of our profession is to be able to teach students, to be able to have students all over the world and to excite students to go into research to try and follow your footsteps and become a researcher," Wood said. "This is what really excites us; to be able to leave something behind for people to learn. To influence the next generation of young people who want to go into research." +

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HIV IS A PANDEMIC AND HAS BEEN FOR MANY YEARS

SHI-HUA XIANG, Ph.D.

Assistant Professor and Virologist, UNL School of Veterinary Medicine and Biomedical Sciences

HIV/AIDS: *vaccine development*

by JESSIE HORN *and* SHI-HUA XIANG

"HIV is a pandemic, and has been for many years," said Shi-hua Xiang, assistant professor in the Nebraska Center for Virology and the School of Veterinary Medicine and Biomedical Sciences at the University of Nebraska–Lincoln. Xiang is one of many scientists working to find a cure or a vaccination for AIDS. "It causes such an impact, especially an economic impact on our society, so it's a very important project we're working on here," he added.

The human immunodeficiency virus (HIV) can only infect humans, Xiang said. The virus takes over the immune system of the human body, destroying immune cells, and weakening the body's ability to combat many diseases and illnesses. HIV spreads by reproducing through cells in the body.

Over time, HIV completely destroys the human body's immune system, until the person is completely unable to combat disease and infection. When this happens, HIV often leads to acquired immune deficiency syndrome (AIDS). AIDS is the final stage of the infection; without treatment, it will lead to death in a few years.

"There are about 35 million people worldwide still living with the virus, and most of them are in Africa," Xiang said.

Researchers at UNL have been working toward a vaccine or a cure for the virus since the virus was discovered in the 1980s. The main focus of the research conducted at UNL is to develop an effective vaccine or a long-term preventative strategy to counter HIV/AIDS.

Xiang focuses his research on the envelope structure and viral entry of the HIV virus. Xiang studies the interactions between the viral envelope glycoproteins and cellular receptors that are required for HIV entry into the target cells.

Xiang also studies ways to improve the immunogenicity of the envelope structure of the HIV virus. The virus has evolved into an immunosuppressive state, meaning that it suppresses an immune response from the individual infected. Therefore, by improving its immunogenicity, it can evoke a trigger for the body's production of neutralizing antibodies to fight the virus.

Xiang also studies transmission and contraction of the virus and hopes to develop a method of control. Mucosal surfaces in the gastrointestinal tract and the female genital tract in

humans are the main sites for contracting HIV. These places in the human body house large quantities of commensal bacteria, which are in a mutual relationship with the body. Xiang's research aims to use these bacteria as a shield to combat HIV contraction and transmission. This could be a long-term strategy for prevention of HIV, Xiang explained.

Xiang believes his work, as well as the work of his colleagues and collaborators, has the potential to change the world. "The satisfaction in my work comes from being able to say we've made progress and created new strategies," Xiang said. +


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