Center of Excellence in Livestock Diseases and Human Health

2009 Annual Report
We are pleased to present the 2009 annual report for the Center of Excellence in Livestock Diseases and Human Health. Along with benchmark data for fiscal years 2005-2009, this report includes highlights of faculty research projects funded by the center in fiscal year 2009.

The center is adapting to the changing extramural funding environment. With the precipitous increase in competition for decreasing federal research funds, the center has concentrated on maintaining competitiveness of active research programs, providing bridging funds to keep important research programs viable, and promoting the start-up of new College of Veterinary Medicine (UTCVM) investigators. In addition, the center is investing in initiatives that promote translational research, the coordinated movement of bench-level research to the clinic. Thus, even though the number of center faculty has decreased, the areas of active research in the UTCVM impacted by the center have increased.

During 2009, the center supported the efforts of 15 faculty members. These faculty have made significant advancements in cancer biology, molecular pathophysiology, host defense, and disease transmission. Center faculty also made significant advancements in the prevention and treatment of infectious and non-infectious livestock diseases that affect agricultural productivity. Research funding remained stable even with fewer center faculty. In addition, the return on investment, as the ratio of research expenditures to the state appropriation for the center, was a slightly improved 5.8:1. Key performance indicators predict a very strong upsurge in extramural funding for fiscal year 2010.

Center faculty continue to garner national and international recognition for their research and scholarship. During calendar year 2009, center faculty published 59 peer-reviewed articles and gave 26 invited presentations at regional, national, and international meetings.

We are proud of the progress made by center faculty, and we hope you enjoy this summary presentation of center activities and accomplishments.

Jim Thompson, Dean
Robert N. Moore, Director
Misty R. Bailey, Editor
Center of Excellence in Livestock Diseases and Human Health
2009 ANNUAL REPORT

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Comparative Summary of Accomplishments

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<tr>
<td>Return on investment</td>
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* Based on calendar year through publication date of this report.
† Based on fiscal year.
**Dissemination of Research**

The UTCVM distributes two publications to the public—the magazine *Veterinary Vision* and the newsletter *Volunteer Vet*—and one in-house newsletter, *Discovery*. In addition, Center of Excellence faculty share their research with a worldwide audience through scientific conferences. The map showcases where their research has been presented in 2009.

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The quarterly, in-house newsletter *Discovery* keeps UTCVM researchers informed about each other’s work and research-related policies and resources. [www.vet.utk.edu/research/newsletters/](http://www.vet.utk.edu/research/newsletters/)

The quarterly newsletter *Volunteer Vet* features research activities and results and is distributed to donors and employees.

The annual magazine *Veterinary Vision* carries features concerning ongoing research activities and the results of concluded research studies. It is written for a general audience.
The Center of Excellence was a major sponsor of the Comparative & Experimental Medicine and Public Health Research Symposium, which brought together researchers from 20 different departments across three UT-Knoxville campuses for a 2-day-long event that included special seminars on omega-3 fatty acids, polyamines, energy homeostasis, and public health. Featured was the center’s own Dr. Hildegard Schuller, who presented her research on nicotine addiction and cancer. The symposium culminated with an awards banquet and guest speaker Bill Landry, known locally for narrating the lives of East Tennesseans through “The Heartland Series” television feature.

Fifty researchers from the Institute of Agriculture presented talks at the symposium, including heavy participation by members of the Department of Animal Science. These 50 representatives were among 85 new scientists to present, and at the end of the day, the institute was able to boast 12 winners of travel awards. The center sponsored ten of the 2008 award winners to present at scientific meetings during FY 2009, including four international and seven national conferences.

The symposium was designed to allow sharing of research results, promote collaboration, and provide new investigators meeting-format experience via 10-minute presentations.

http://www.vet.utk.edu/research/symposium/
Introduction

The center was created in 1984 to promote interdisciplinary activities designed to improve the quality of human life through better animal health; expand livestock disease research capabilities in the College of Veterinary Medicine (UTCVM) and the Institute of Agriculture; identify and characterize animal diseases that are similar to human diseases; and develop new strategies for the diagnosis, treatment, and prevention of disease.

Since 1984, the center has developed successful programs that affect the understanding, treatment, and prevention of livestock and human diseases. These programs predominately focus on molecular and cellular approaches to research in infectious diseases, toxicology, host defense, molecular genetics, and carcinogenesis.

The center has developed investigative strengths along innovative, sophisticated, and contemporary lines in two general areas:

1) Animal Models and Comparative Medicine
2) Mechanisms of Disease, Pathogenesis, and Immunity

These areas are each highly interrelated, and the center plays a critical role in developing these focused areas of strength in both the UTCVM and the Institute of Agriculture.

Personnel

Dr. Robert N. Moore, Professor and Associate Dean for Research and Graduate Studies, continues as director of the center. In October 2008, Dr. Jim Thompson began as dean following Dr. Leon Potgieter as interim dean after Dr. Michael Blackwell retired.

Collaborations

Center faculty pursuing collaborative research between laboratories include Dr. Mei-Zhen Cui and Dr. Xuemin Xu, who are doing their part in the worldwide animal research effort known as “Replace, Reduce, Refine” by sharing specific strains of laboratory mice.

Accomplishments

Despite the persisting, dismal funding environment, center faculty continue to make excellent progress in ongoing projects, gaining national and international recognition for their expertise and accomplishments. Details of current faculty research are provided in the Faculty Reports section (pp. 12–26) and are excellent in terms of benchmarks for 2009. Center faculty have successfully adapted to the increased competition for federal and corporate funds. To balance the loss of federal funds, center faculty aggressively and successfully sought more awards from foundations and other private sources. Figure 1 shows the percentage breakdown of external funding by source.

External Funding:
$3,030,150
New Grants:
$415,381
The 15 center faculty also averaged 4 peer-reviewed publications (67 total) and 2 invited presentations (26 total) at prestigious national and international meetings. See Publications and Presentations (pp. 27–35) for details.

The return on the state’s investment in the center was 5.8:1, calculated as ratio of expenditures from extramural funding to center appropriation. Extramural funding totaled $3,030,150 this year, while expenditures for the year were $3,167,426. The total funding includes new, multi-year awards for Drs. Wang and Xu, totaling $293,421; and new, one-year awards for Drs. Frank, Kania, and Oliver, totaling $121,960. Research expenditures continued to stabilize at $3,167,426. See “Research Funded Externally” and “Research Expenditures” on p. 3 for the fiscal year 2009 data summary.

Fig. 1. FY 09 external funding by type.
Total = $3,030,150
### Research Funded Externally FY 2009

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<tr>
<th>INVESTIGATOR</th>
<th>FEDERAL</th>
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<th>FOUNDATION/PRIVATE</th>
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*Represents FY 2009 receipts for active grants
†Award was granted a no-cost extension

### Research Expenditures FY 2009

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<th>INVESTIGATOR</th>
<th>FEDERAL</th>
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Allocation of Funding

The Center of Excellence in Livestock Diseases and Human Health supports investigators and promotes research through a variety of mechanisms. Although it is not a primary source of research funding, the center facilitates established investigators’ efforts to maintain and expand their research programs and promotes new investigators’ potential to develop competitive research programs.

Center faculty consist of senior members who have research interests in line with center objectives and a strong history of securing external funding using center funds. Junior members are those who have received seed money or bridge funding or are new faculty who have received start-up funds. Junior members are expected to secure external funding within 2 years; members who fail to secure such funding will be placed on probation for 1 year. If, at the end of the probationary period, external funding has not been secured, the member will be dismissed from the center.

Start-Up Funds

The center provided start-up funds for one faculty member to secure additional external funding. Dr. Brian Whitlock was awarded $25,000 to jump-start his research, which involves studying concentrations of kisspeptin, a hormone that is released from placenta during pregnancy in sheep, cattle, horses, and dogs. In humans, kisspeptin stimulates puberty in males and seems to induce ovulation in females. Dr. Whitlock used some of his start-up funds to purchase an ultrasound machine for use in future ovulation experiments. In the long-run, his studies could affect farm animal production.

Graduate Student Support

The center supported four stipends for Comparative and Experimental Medicine graduate students of center faculty. These stipends allow the students to work half-time in faculty laboratories to perform research for their theses or dissertations.

Infrastructure

The center promotes the research infrastructure of both the UTCVM and the Institute of Agriculture through the purchase and maintenance of essential research equipment. The Research and Graduate Programs Advisory Committee reviews equipment requests based on three criteria: justification of need, current availability of equipment, and number of investigators who may benefit. During fiscal year 2009, the committee authorized $1,608 toward the purchase of one piece of equipment; this H₂O water purification system and its accompanying reservoir benefited the center’s animal science faculty.
In support of the UTCVM’s research enterprise, the center funded service contracts for several pieces of equipment purchased previously with COE funds. Service for an ultracentrifuge, two cell sorters, and miscellaneous laboratory instruments totaled $38,199. The ultracentrifuge, laboratory instruments, and one cell sorter are college-wide resources and benefit nearly every investigator in the college, including clinicians. The second cell sorter is shared by center faculty members Dr. Barry Rouse and Dr. Mark Sangster and is used almost daily.

Seminars and Sponsored Lectures

COMPARATIVE AND EXPERIMENTAL MEDICINE SEMINAR COURSE—Fall 2008 & Spring 2009

The COE provided sponsorship for this course, which focuses on topics relevant to comparative and experimental medicine and emphasis areas of the COE. The following guest lectures were incorporated into the course:

Mark Smith, “The Two-Hit Hypothesis of Alzheimer’s Disease”
Professor, Department of Pathology, Case Western Reserve University

Kumar Sambamurti, “Common Mechanisms of Neurodegeneration in the Eye and the Brain Places APP in the Middle”
Associate Professor, The Neuroscience Institute, Medical University of South Carolina

Steven C. Zicker, “Cognitive Aging in Dogs and Nutritional Intervention”
Principle Scientist and Veterinary Clinical Nutritionist, Hill’s Science and Technology Center

Melissa A. de la Garza, “Non-human Primate Biosafety and Biosecurity in Biomedical Research”
Assistant Veterinarian & ABSL3 Laboratory Scientific Manager, Southwest National Primate Research Center

Yasmine Belkaid, “Role of T Regulatory Cells During Pathogenesis of Infectious Disease”
Mucosal Immunology Unit, National Institute of Allergy and Infectious Diseases, NIH

Tony Kong, “Genomics and Cancer Chemoprevention by Dietary Food Factors”
Professor & Director, Graduate Program in Pharmaceutical Sciences, Ernest Mario School of Pharmacy, Rutgers University

James C. Fleet, “Vitamin D and Calcium Metabolism: A Critical Role for Intestinal Calcium Absorption”
Professor, Department of Foods and Nutrition, Purdue University

Kirstin Barnhart, “A Novel Therapeutic for Metastatic Prostate Cancer: From Bench to Investigational New Drug”
Assistant Professor, Department of Veterinary Sciences, University of Texas M.D. Anderson Cancer Center

Yeonhwa Park, “Application of Conjugated Fatty Acids for Prevention of Obesity and Osteoporosis”
Assistant Professor, Department of Food Science, University of Massachusetts
Nigel Mackman, “**Atherosclerosis and Thrombosis**”  
Distinguished Professor & Co-Director, Thrombosis and Hemostasis Program, University of North Carolina

David W. Horohov, “**Age and Immunity to Influenza in Horses**”  
Chair & Professor, Department of Veterinary Science, Maxwell H. Gluck Equine Research Center, University of Kentucky

**Dissemination of Research**

Faculty are encouraged to share their research by speaking to professional groups, community groups, and civic groups. The center partially supported travel expenses for two faculty and one graduate student to be able to attend national scientific meetings (total $2,332) in Charlotte, NC, and Chicago, IL, also paying the printing charge for a scientific poster for one of these meetings ($168). A complete list of faculty publications and presentations for the 2009 calendar year can be found in the Publications and Presentations section (pp. 27-35).

Travel awards totaling $5,487 for 10 new investigators involved in the 2008 Comparative and Experimental Medicine Research Symposium allowed them to disseminate their research at 12 different local, national, and international meetings.

In addition, the UTCVM issues press releases to state, regional, and national media, resulting in numerous television and print features, many of which relate directly to research conducted through the center. The three UTCVM news publications described on p. ii are available on the UTCVM Web site (http://www.vet.utk.edu/), which also provides an overview of the types of research conducted by UTCVM and COE faculty.
In an effort to foster interest in careers in biomedical research, the center helped provide opportunities for 23 veterinary students to perform research within the UTCVM during the summer.

In addition to laboratory and field research, students attended weekly professional development seminars, during which guest speakers addressed topics such as career opportunities in research, compliance issues in lab animal care, scientific writing, and the grant proposal process. They also participated in the Comparative & Experimental Medicine and Public Health Research Symposium.

Near the end of the 10-week program, the students presented their research findings to their colleagues and to UTCVM faculty.

To maximize student participation, the program is open to both center and non-center faculty. During fiscal year 2009, four COE faculty participated in the program. The center will continue to encourage participation of its faculty.

The students involved in the summer research program and a brief description of their activities follow:

**Katherine Barber**, a 2nd-year student who majored in biology at Middle Tennessee State University, assisted Dr. Kim Newkirk and Dr. Robert Donnell in examining the prevalence and role of mast cells in cutaneous hemangiosarcomas and hemangiomas. Barber is from Nashville and is interested in an academic career in anatomic pathology.

Spencer, TN, native **Kate Carpenter**’s interest in large animal medicine led her to seek the mentorship of Dr. Robert Donnell, who oversaw her project in locating caprine herpesvirus 2 (a viral agent of Malignant Catarrhal Fever) in goats, cattle, camels, cervids, and sheep. Carpenter holds animal science and wildlife and fisheries bachelor’s degrees from the University of Tennessee.

Third-year student **Cristina Catasus** is from Gainesville, FL, but earned a bachelor of science degree in biology from Jacksonville University. She worked with Dr. James Schumacher analyzing the effect of
Program Report

hyperbaric oxygen therapy on joint inflammation in horses.

**Lissette Cepero** assisted Dr. Al Legendre with data collection for an oncology clinical trial. Her goal for the summer was to become more familiar with the process of scientific writing, and thus she helped compose the results of the study. Cepero holds a bachelor of science degree in biology from the University of Miami, in her hometown.

Third-year student **Tamara Chamberlin** learned molecular and genetic techniques from Dr. Jeff Phillips to measure the immune response in horses and dogs that received a specific melanoma vaccine. Chamberlain calls Kingsport, TN, her hometown and earned a degree in biochemistry and cellular and molecular biology from the University of Tennessee.

**Laura Eberlein** worked in Dr. Stephen Kania’s laboratory sequencing the staphylococcus genome. This 3rd-year student from Columbia, TN, is interested in a career in research and/or animal behavior. She studied biology and ecology at the University of Tennessee.

Because of her interest in veterinary ophthalmology, **Joci Forkner** chose to work with Dr. Dan Ward determining the mechanism of action of a topical drug used to reduced intraocular pressure in dogs with glaucoma. Forkner is a native of Blacksburg, VA, and earned her biochemistry degree from Virginia Tech.

Hailing from Conway, MA, is **Sarah Gorman**, who worked under the supervision of Dr. Madhu Dhar looking for the expression of the ATP10C gene in lean versus obese dogs. Obese dogs had a higher rate of expression, a finding that may help in understanding diabetes mellitus. Gorman attended Skidmore College in Saratoga Springs, NY, where she studied neuroscience and chemistry. She is interested in a career in equine surgery.

**Katherine Hamon** earned her bachelor of science degree from North Carolina State University but also studied abroad at Australia’s University of the Sunshine Coast in Queensland. Her faculty mentors were Dr. Kim Newkirk and Dr. Andrea Matthews, and her project looked at variation of feline kidney sizes in an attempt to determine whether abnormal size correlated to a higher incidence of renal disease.

Second-year student **Mary Hes** worked with Dr. Brian Whitlock to induce a surge in the levels of two specific hormones in sheep. Hes holds bachelor of science degrees in cellular and molecular biology and in French from the University of North Carolina at Asheville. She calls Hillsborough, NC, home.

Dr. Claudia Kirk and Dr. Joseph Bartges served as mentors for **Caroline Horner** to study the influence of saline treatment on urinary supersaturation of calcium-containing substances in cats. Horner is from Brentwood, TN, and has a bachelor of science degree in biology from the University of Tennessee.

**Amanda Lutzy** is a 2nd-year student from Knoxville, TN, who earned a biology bachelor of science degree from Rhodes College in Memphis. During her work with Dr. Barton Rohrbach and Dr. Sharon Patton this summer, she helped develop and process a follow-up survey to dog owners across the country regarding their current heart worm prevention practices in order to better understand the public’s general knowledge of heart worm prevention and determine areas in which there may be room for further education.

Dr. Jacqui Whittemore oversaw the work of **Blake Marcum**, a 3rd-year student from Centralia, IL. Marcum, who majored in biological science at the University of Illinois-Edwardsville, assisted Whittemore in measuring survival time associated with microalbuminuria in critically ill dogs.
University of Tennessee at Chattanooga graduate **Ashley Miller** worked with Dr. Amy LeBlanc collecting specimens for a canine cancer biospecimen repository. Miller is a 3rd-year student from Chattanooga, TN, and is interested in small animal internal medicine, oncology, and clinical pathology.

Working with Dr. Linda Frank was **Rebekah Mullins**, a 3rd-year student from Kingsport, TN. Mullins holds a bachelor of science degree in biology from East Tennessee State University and spent the summer studying the fluctuation of estradiol levels in normal dogs. Her career interests lie in veterinary dermatology.

Second-year student **Cristina Noltenius** worked with Dr. Jeff Phillips to evaluate the expression of tyrosinase from canine and equine melanomas. Noltenius has a bachelor of science degree in biological sciences from the University of Tennessee. Although she is still uncertain about her career, she sees herself heading toward large animal medicine in the future.

Brentwood, TN, native **Eve O’Neil** earned biology and German bachelors degrees from Boston College. Dr. Linden Craig mentored O’Neil in an investigation of the incidence of malignant mammary masses in cats. She is interested in anatomic pathology or large animal medicine as a career.

**Erica Pounds** spent her summer working with Dr. Margo Holland transforming bovine mammary stem cells via chemicals, irradiation, and xenotransplantation. Originally from Clarksville, TN, Pounds attended Mississippi State University, earning a bachelor of science in biochemistry and molecular biology. She is a 3rd-year student.

Hailing from Germantown, TN, is **Kate Purple**. This 3rd-year student holds a bachelor of science degree in natural resources and environmental studies from the University of Illinois, Champaign. Dr. Linden Craig was Purple’s mentor and directed her in studying the pathology of megaesophagus in llamas. They plan to submit a paper on their findings. Purple’s ultimate plans are to enter rural, mixed-animal practice, but she is also interested in pathology and research.

A native of Knoxville, TN, **Lisa Reynolds** earned her bachelor of science degree in agriculture from Austin Peay State University. Her faculty mentor was Dr. Linda Frank, with whom she performed a hypothyroid study. Reynolds is a 3rd-year student and is interested in a career in veterinary internal medicine.

**Leslie Sadeghi** spent the summer in Dr. Stephen Kania’s and Dr. David Bemis’s laboratory, where she learned to genetically identify bacterial isolates in order to determine regional similarities and differences between *Staphylococcus pseudintermedius* isolates. Sadeghi is from Nashville, TN, and majored in animal science at the University of Tennessee. Her career interests lie in veterinary public health.

Originally from Charlotte, NC, **Amy Schuver** earned a bachelor of science degree in biology from North Carolina State University. Because of her interest in equine medicine, she chose to work with Dr. Nicholas Frank in performing glucose tolerance tests on horses to determine the validity of an oral versus intravenous test.

Second-year student **Baye Williamson** worked with Dr. Karen Tobias studying storage and processing conditions of canine protein C. She is from Kingsport, TN, and holds a bachelor of science degree in biology from Converse College in South Carolina.
Five-Year Benchmark Data

Productivity among center faculty has been outstanding during the last 5-year period. From 2005-2009, center faculty published 352 articles in peer-reviewed journals and gave 176 invited presentations at national and international meetings.

Total research funding was up from $2.9 million in 2008 to $3.03 million in 2009, with funding from foundations and other private sources increasing dramatically from $101,325 in 2005 to $992,895 in 2009. This shift in funding dynamics reflects the faculty’s aggressive and successful search for support in response to the increased competition for diminished federal funds beginning in 2006.

It is important to note that research awards are reported differently in this Annual Report than in previous reports for the center. Previous years’ reports gave award amounts based on total years’ funding for active grants and contracts. Beginning with this report, awards data are being presented as yearly receipts, allowing for more meaningful comparisons with expenditures data and projections for future spending.

Over the past 5 years, grant and contract expenditures per center faculty member have reflected the economic downturn with a steady decrease that fell to a nadir of $155,000 for FY2008 (Table 1). Expenditures per faculty member, however, increased to $213,000 in FY2009, approaching the FY2005 pre-downturn level of $222,000. Coupled with at least three new NIH R01 grants coming online in 2010, these indicators promote confident projections that the center is recovering vigorously.

Table 1. Average expenditures per faculty member by fiscal year.

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<th>Fiscal Year</th>
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<tr>
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The 5-year average return on the state’s investment in the center is 6.6:1, the ratio of research expenditures to the state’s appropriation. For comparison, benchmark data from 2005-2009 are summarized in Figs. 2-4.
The center has successfully endured 3 years of diminished federal and corporate funding and is poised to advance with an even greater commitment to livestock and human health. This year (FY10) the center will expend approximately $418,000 to fund 16 projects. In addition, the center will continue to support core facilities for flow cytometry/cell sorting and tissue culture and has committed $40,000 for purchasing essential research software and research equipment, including real-time PCR instrumentation.

The center will again be a major contributor to the Comparative and Experimental Medicine (CEM) Research Symposium. The CEM Symposium provides a venue for new investigators (graduate students, postdocs, and research assistant professors) to gain experience presenting their research as oral presentations in scientific meeting format. The symposium grew from 15 student presentations at the initial 2007 event to 85 presentations at the 2009 symposium with participants representing 20 UT departments and programs. More than 300 people attended the 2-day event that also included a small number of poster presentations. An additional goal of the symposium is to promote and facilitate the development of research collaborations among biomedical scientists from the different Knoxville campuses of the university, a goal that closely parallels important objectives of the center.

The center will continue to increase its involvement in research training of veterinary students and graduate students by providing increased opportunities for summer internships, matching travel grants, and stipend upgrades to help recruit and retain superior graduate students. The center will continue to offer “invited speaker” courses to increase national and international exposure of the center’s faculty, students, and programs and at the same time enhance the potential for developing external collaborations for our faculty and postdoctoral opportunities for our students. During FY10, the center will again co-sponsor, along with the UTCVM, the CEM Seminar Course, supporting the visits of up to 10 noted speakers.

The UTCVM is aggressively pursuing initiatives in several different areas of research pertinent to the center. A primary goal of these initiatives is rapid movement of bench-level science to the clinic or farm, i.e., translational research. Established initiatives include investigations of equine and canine stem cells and regulatory and stimulatory interactions involving gamma aminobutyric acid (GABA) and norepinephrine receptors in lung and pancreatic cancers. Developing interactions include early stage interactions with biomedical investigators at Vanderbilt University in the general areas of pathology and laboratory animal medicine, oncology, and obesity and diabetes. The center is funding the stem cell and GABA initiatives and is providing early funding for developing interactions with Vanderbilt investigators. The oncology initiative is enhanced by earlier center investment in a developing collaboration between UTCVM oncologists and the pre-clinical imaging group at the Knoxville branch of the UT Health Sciences Center. That earlier initiative has resulted in the UTCVM participating in the National Cancer Institute Comparative Oncology Trial Consortium as well as having developed a mature collaboration involving PET/CT scanning of client-owned animals, one of the few such interactions in the country.

The center will continue to participate conceptually and materially in strategic planning to develop areas of investigative strength in the UTCVM and the Institute of Agriculture.
Taking Aim at Cancer Cells

The American Cancer Society estimates that over 10 million people in the United States are living with cancer. The traditional theory of cancer prevention and therapy is to reduce the occurrence of it by slowing, blocking, or reversing cancer development via drugs or herbs.

Dr. Baek hopes to expand that theory to include the small amounts of energy present in plasma. Scientists have found that the same substance used in televisions and fluorescent light bulbs (cold plasma) have promising biomedical application. Dr. Baek seeks to determine whether plasma exposure affects the growth of specific types of colorectal, breast, prostate, lung, and bone cancer cells. He is shown at left aiming a plasma gun at a cell-filled petri dish.

Plasma technology is an exciting new field of treatment that has already proven to be useful in promoting wound healing. Its ability to attack cancer cells while leaving minimal damage to healthy cells is part of its allure.

The results of Dr. Baek’s research will help clinical scientists direct and narrow their studies of plasma therapy to specific cancer types.
The Secret Life of Cholesterol

When low-density lipoproteins (LDL, also known as “bad” cholesterol) enter the bloodstream, they can adhere to the walls of the arteries that lead to the heart and brain. Thus, LDL contributes to the formation of plaques that can build up to form a blockage, causing a stroke or heart attack.

When LDL is combined with oxygen in the blood, one of its byproducts is lysophosphatidic acid (LPA), which has been found to accumulate in arterial plaques and to induce proliferation and migration of vascular smooth muscle cells. The movement of smooth muscle cells from one part of the cell wall to another, in addition to their proliferation, contributes to narrowing the passage for blood flow.

In Dr. Cui’s laboratory, researchers have discovered that a specific sequence of cellular events, known as the MAPK pathway, is responsible for LPA-induced migration of smooth muscle cells, and they have been able to reproduce this phenomenon in a mouse model they created. In the future, clinical investigators will be able to use these discoveries in the development of strategies to prevent the formation of arterial plaques.

Mei-Zhen Cui
Associate Professor
Pathobiology Department
PhD, Tokyo Institute of Technology, Japan
2 refereed publications in 2009

In addition to center funds, Dr. Cui’s research is supported by the National Institutes of Health.
Dissecting the Nature vs Nurture Effect in Diabetes and Obesity

Both our genetics and our lifestyles contribute to whether we may develop certain diseases, including type II diabetes and obesity. Furthermore, this complex combination of factors makes it difficult to study ways to prevent and treat such diseases. Dr. Dhar’s research group is developing a cellular model that accurately reflects that human complexity.

Dr. Dhar hypothesizes that a protein known as ATP10C influences the flow of molecules in and out of the cell. Hence, certain alterations in this protein could lead to serious change in cell function, including glucose uptake and fat deposition, which could ultimately lead to diabetes and/or obesity.

This research indicates that the ATP10C gene is a strong candidate to target for obesity-related diabetes prevention and treatment, and Dr. Dhar’s research can be used for future in vivo studies of ATP10C gene expression.

MADHU DHAR
Research Associate Professor
Large Animal Clinical Sciences Department
PhD, University of Poona, India
2 refereed publications in 2009

In addition to center funds, Dr. Dhar’s research is supported by the American Kennel Club’s Canine Health Foundation.
When most people hear “MRSA” (methicillin-resistant *Staphylococcus aureus*), they may also imagine the familiar, dreadful music from the movie *JAWS*. However, MRSP (methicillin-resistant *Staphylococcus pseudintermedius*) does not evoke quite the same fear, and for good reason: until recently, methicillin resistance in *S. pseudintermedius*, the most common canine bacterial skin pathogen, was extremely rare.

Methicillin resistance includes resistance to all members of a specific class of antibiotics, including cephalosporin and a type of amoxicillin, and MRSP in dogs is a potential source for the transfer of resistance to humans. The transfer of the methicillin resistance gene *mecA* via the SCCmec chromosome cassette is the focus of Dr. Kania’s research. His investigative group has found a specific type of *S. pseudintermedius*, agrD III, in East Tennessee that was not thought to exist in the United States. This specific type has been associated with multidrug resistance. Now, Dr. Kania’s focus is applying genetic fingerprinting to determine the relationships between the MRSP isolates found in East Tennessee and to detect whether a pattern of disease emergence exists.

Epidemiological studies such as this one will allow public health officials to focus on potentially at-risk areas and help them determine the steps to take to intervene, if necessary.

**STEPHEN KANIA**

Associate Professor  
Comparative Medicine Department

PhD, University of Florida

8 refereed publications in 2009

In addition to center funds, Dr. Kania’s research is supported by Morris Animal Foundation, Sci-Tec, East Tennessee Clinical Research Foundation, Winn Feline Foundation, and other private industry.
Regulatory Mechanisms in Lung Cancer

East Tennessee has one of the highest lung cancer death rates in the country. In an attempt to help combat that problem, Dr. Schuller is focusing on the effects of nitrosamines on the lungs.

Nitrosamines are cancer-causing substances found in nicotine, food, beverages, cosmetics, and drugs. The tobacco-specific nitrosamine NNK reacts with nicotinic acetylcholine receptors (nAChRs) on cells, resulting in hyperstimulation of these receptors, a reaction that causes toxic effects. In her laboratory, Dr. Schuller has determined that many of nicotine’s biological effects may be caused by the interaction of nitrosamines (like NNK) with nAChRs. Likewise, other factors in the human environment, such as diet and use of certain cosmetics and medicines, may also heighten the sensitivity of nAChRs, thus increasing the possibility of lung cancer.

Still, a host of factors in the human environment affects the sensitivity of these receptors, making it important to develop tools to identify hyperstimulation in individual patients. Dr. Schuller’s research can be used to help design lung cancer prevention and treatment strategies based on that hyperstimulation.
Finding Pre-cancerous Markers for Prevention

One in four deaths in the United States is attributed to cancer, which is a multi-year, multi-step, and multi-path disease process. The complexity of cancer is outdone only by the complexity in finding a cure for it. Dr. Wang’s part in this pursuit is to locate pre-cancerous markers and target them with dietary compounds to prevent cancerous cells from forming.

His research team has discovered that bladder cancer cell death is affected by reactive oxygen species (ROS), which are natural byproducts of the body’s oxygen metabolism. ROS also play an important role in cell signaling, and Dr. Wang believes that ROS help activate a specific pathway affected by histone deactylase (HDAC) inhibitors, which are compounds being tested to treat cancer. He is determining the precise molecular target of FK228, an HDAC inhibitor that may be used in the future as a cancer treatment.

Likewise, catechins found in green tea appear to target a gene overexpressed in breast cells exposed to environmental carcinogens. Dr. Wang found that expression of the HSD11B2 gene was reduced in the presence of green tea catechins, making green tea a promising focus as a natural mode of cancer prevention.

HWA-CHAIN ROBERT WANG

Associate Professor
Comparative Medicine Department
PhD, University of Virginia
BVM, National Chung-Hsing University, Taiwan

1 refereed publication in 2009

In addition to center funds, Dr. Wang’s research is supported by the National Science Foundation and the National Institutes of Health.
Determining the Cause of Alzheimer’s Disease

Abnormal accumulation of beta-amyloid peptide in the brain is believed to be a primary cause of Alzheimer’s disease, but scientists have been unable to determine whether this accumulation is due to overproduction of the peptide or the brain’s failure to clear it.

Dr. Xu’s research has shown that a cellular system involving a specific, undetermined enzyme is responsible for the clearance of beta-amyloid peptide. This enzyme is sensitive to inhibitors of calpain, a protease responsible for calcium regulation, and Dr. Xu’s goal is to identify this enzyme in order to better understand the mechanism underlying the beta-amyloid peptide’s abnormal accumulation.

The information obtained from these studies will be important for the development of methods for prevention and cure of Alzheimer’s disease.

XUEMIN XU
Professor
Pathobiology Department
PhD, Tokyo Institute of Technology, Japan
2 refereed publications in 2009

In addition to center funds, Dr. Xu’s research is supported by the National Institutes of Health, the Alzheimer’s Association, and the American Health Assistance Foundation.
Drugs that interfere with specific protein-genome interactions are now being tested for several viral pathogens, including HIV, hepatitis B and C, and influenza viruses. Once developed, they can be used in combination with other virus-specific drugs for antiviral therapy.

In Dr. Brian’s laboratory, coronavirus and its 2’-O-methyltransferase protein are the focus. This protein was found to bind to a specific replication element in the bovine coronavirus genome. This past year, Dr. Brian mapped interaction sites and tested the effects of certain viral mutations on virus replication.

His studies will pinpoint potential targets for inhibiting virus replication of both bovine coronavirus and its close relative that causes severe acute respiratory syndrome, better known as SARS, in humans.

**David Brian**

Professor  
Pathobiology Department  
DVM, PhD, Michigan State University  
2 refereed publications in 2009

In addition to center funds, Dr. Brian’s research is supported by the National Institutes of Health.
Dr. Donnell continues to survey the prevalence of malignant catarrhal fever in Tennessee. The virus threatens the state’s livestock industry through goats and deer, two common Tennessee species known to harbor the disease. This threat has already become a reality to some cattle and sheep farms.

Clinical signs of the infection are nasal and corneal discharge, fever, skin lesions, and diarrhea, and although outbreaks are rare, the mortality rate for diseased animals is as high as 90%.

Dr. Donnell has worked to develop and import reliable diagnostic capabilities to test relevant species. The prevalence discovered from the results of diagnostic testing are being used to determine which producers, wildlife managers, and diagnosticians should be educated and advised regarding the incidence and risk for the disease and how to combat it.
In horses, diagnosing insulin resistance is important because this resistance predisposes the animal to laminitis, a condition that causes the hoof to separate from the bone, potentially resulting in permanent lameness, forced retirement, or euthanasia.

Insulin resistance is often diagnosed by measuring glucose and insulin concentrations within a single blood sample. Reference ranges are available for these variables, but the limits of variability have not been determined for horses.

Dr. Frank hypothesizes that blood insulin concentrations are affected by factors other than insulin resistance, and these must be identified and quantified. He focused this past year on measuring hour-to-hour, day-to-day, and month-to-month variability in blood glucose and insulin levels in healthy and insulin-resistant horses. In addition, he assessed the effects of diet by collecting and analyzing pasture grass and hay samples.

His ultimate goal is to improve the accuracy of diagnostic testing for insulin resistance in horses.

Nicholas Frank
Associate Professor
Large Animal Clinical Sciences Department
DVM, PhD, Purdue University

13 refereed publications in 2009

In addition to center funds, Dr. Frank’s research is supported by Lloyd, the American Quarter Horse Association, Grayson-Jockey Club Research Foundation, SmartPak Equine, and the American College of Veterinary Internal Medicine.
Curing Mastitis by Manipulating the Cause

Mastitis is an inflammatory condition in cows that can last for months or even years, negatively affecting milk production by causing abnormal milk or lowering production quantity. A specific type of mastitis—Streptococcus uberis mastitis—has been the focus of Dr. Oliver’s research for over a decade.

His research resulted in the discovery of a novel bacterial protein, the S. uberis Adhesion Molecule (SUAM), which is a factor in the development of S. uberis mastitis. Collectively, experiments from his laboratory have proven that SUAM facilitates the adhesion of S. uberis to mammary cells.

This year, Dr. Oliver continued to focus on the role of S. uberis adhesion to and entry into specific bovine mammary cells. He believes that both adherence and internalization are important in the early stages of intramammary infection. The long-term goal of this study is to develop a genetic system for S. uberis chromosomal manipulation in order to control this bacterial infection.

His research could positively affect Tennessee’s dairy industry by giving dairy owners treatment options and ensuring continued high quality of Tennessee’s milk.
Stress negatively affects the body’s ability to defend itself, thereby increasing the number and severity of infections. Norepinephrine, a stress hormone, may modify the body’s response to infection, and Dr. Pighetti hypothesizes that it does so by providing an environment primed for exaggerated inflammatory responses.

Dr. Pighetti’s research team plans to identify genes regulated by norepinephrine in two bacteria commonly isolated from cattle. These two bacteria, *Klebsiella pneumoniae* and *Mannheimia hemolytica*, are associated with pneumonia and mastitis, respectively, both economically devastating conditions for the cattle industry.

She also seeks to identify how norepinephrine influences the expression of interleukin-6, a protein that supports inflammatory response to infection. Identifying the influence of norepinephrine on these mechanisms will also identify critical control points that can be targeted for therapeutic intervention.

Outcomes of these studies could directly contribute to providing solutions for improving cattle health and productivity.

Gina M. Pighetti

Associate Professor
Animal Science Department

PhD, Pennsylvania State University
1 refereed publication in 2009
Efficiency of Killer T Cell Response to HSV-1 Eye Infections

The Tyrannosaurus Rex thrived by adapting to its environment and evolving into the largest carnivore of its time. Like the T-Rex, killer T cells expand and adapt in response to viral pathogens in order to help the body fight infection. Eye infections caused by herpes simplex virus-1 (HSV-1) are particularly affected by CD8 T cells, which are induced and maintained by a number of cytokines. Much like the T-Rex roar, cytokines are signaling molecules used in cellular communication. The IL-21 cytokine plays a pivotal role in efficient CD8 T cell response, but its exact mechanism of action is not well understood.

Dr. Rouse’s research group has been working toward determining how IL-21 promotes CD8 T cell response in HSV-1. They hypothesize that IL-21 works by dominating cells that suppress the immune system: regulatory T cells (cells that keep the immune system in check and prevent it from attacking healthy cells in the body).

Research on how IL-21 supports killer T cell response could lead to treatments and new medications that boost the body’s immune response to HSV-1 eye infections.
Common knowledge dictates that once a person has had chicken pox, that person will never get chicken pox again. The reasons chicken pox is a one-time infection are memory B and T cells, which play a key role in long-term resistance to previously-encountered infection. These memory cells disperse throughout the body, creating long-lasting cell populations.

Dr. Sangster, seen at right with graduate student Hye Mee Joo, is interested in how memory B cells ($B_{mem}$) protect us from specific forms of the influenza virus. He found recently that a relatively high amount of virus-specific $B_{mem}$ cells are established and maintained in the lung after influenza infection, thereby providing resistance to future respiratory infections.

Future studies in this area may have important implications for influenza vaccine development, which has become even more in demand in the last two decades with the increasing aging population. In 2005, 62,000 people were hospitalized because of influenza, and 58% of those people were over the age of 65. The development of better vaccines would lower the physical and financial strain of influenza on all populations, but particularly the elderly.

MARK SANGSTER

Assistant Professor
Microbiology Department

PhD, University of Western Australia

2 refereed publications in 2009

In addition to center funds, Dr. Sangster’s research is supported by POM Wonderful and the University of Rochester.
In addition to center funds, Dr. Schrick’s research is supported by a private foundation.

**Tightening the Belt on E+ Fescue**

Geographically, Tennessee is considered to be in the center of a lot of things: the Bible Belt, the Mason-Dixon boundaries, and—the fescue belt? That’s correct. Tall fescue is the predominant forage grass in Tennessee, but many pastures are infected with fungal endophytes. These E+ grasses decrease fertility in female beef cattle and affect the fertilization potential of sperm in males, making E+ fescue a serious concern on Tennessee farms.

Although much research exists on how E+ fescue affects female cattle, most male-focused research has been limited to observation until now. Dr. Schrick’s investigation of E+ fescue concentrates on differing gene expression between bulls consuming E+ fescue and those consuming E-. Just recently, his research group has learned that poor embryo quality and lower pregnancy rates are associated with the lower-quality semen resulting from grazing on E+ fescue.

Once the differences between normal and abnormal sperm are discerned, Dr. Schrick plans to pursue development of techniques to separate the normal sperm from the abnormal sperm in an attempt to provide Tennessee producers with a practical and economical way to improve pregnancy rates and/or embryo quality in their herds.
Publications and Presentations

Seung Joon Baek (p. 12)


Baek SJ. Special seminar. Presented at: University of Alabama at Birmingham, Division of Hematology/Oncology; April 14, 2009.

Baek SJ. Proapoptotic protein NAG-1 suppresses inflammation. Presented at: 2nd World Cancer Congress; June 22, 2009; Beijing China.

Sukhthankar M, Cekanova M, Baek SJ. Green tea catechins: Suppression of a novel potential cell proliferator, NUDT6, in human colorectal cancer. Poster presented at: American Association for Cancer Research 100th Annual Meeting; April 18, 2009; Denver, CO.


David Brian (p. 19)

Raman S, Guan B-J, Brian DA. Cis-replication element stem-loop III in the bovine coronavirus 5’ UTR is a binding target for viral nucleocapsid protein in the positive strand and cellular proteins in the negative strand. *Journal of Virology*. In press.

Mei-Zhen Cui (p. 13)


Madhu Dhar (p. 14)


Hurst S, Peretich A, Minkin S, Dunlap J, Biggerstaff J, Dhar M. In vitro silencing of a putative phospholipid translocase results in an increase in glucose uptake in 3T3 L1 adipocytes. Presented at: Experimental Biology meeting; April 17-22, 2009; New Orleans, LA.


Robert Donnell (p. 20)

Cekanova M, Lee S-H, Donnell RL, Sukhthankar M, Eling TE, Fischer SM, Baek SJ. Non-steroidal anti-


Nicholas Frank (p. 21)


Chameroy K, **Frank N**, Elliott SB, Tadros L. Effects of levothyroxine sodium on body condition, blood measures of metabolic status, and glucose dynamics in horses with Equine Metabolic Syndrome (EMS). Presented at: Comparative & Experimental Medicine and Public Health Research Symposium; June 2009; Knoxville, TN.

Tóth F, **Frank N**, Elliott SB, Perdue K, Geor RJ, Boston RC. Optimization of the frequently sampled intravenous glucose tolerance test to reduce urine glucose spilling in horses. Presented at: Comparative and Experimental Medicine & Public Health Research Symposium; June 2009; Knoxville, TN.


Chumbler NS, Tóth F, Elliott SB, **N Frank**. Effects of sampling time and hay feeding on blood glucose, insulin, and adrenocorticotropic hormone (ACTH) concentrations in horses. Presented at: American College of Veterinary Internal Medicine 27th Annual Forum; June 2009; Montréal, Canada.


**Frank N**. Feeding considerations for the laminitic horse. Presented at: 7th Annual Mid-Atlantic Nutrition Conference; March 2009; Timonium, MD.


**Frank N**. Obesity, insulin resistance, and laminitis in horses. Presented at: Southern States Advanced Equine Feedmaster Program; January 2009; Raleigh, NC.

**Frank N**. Colic: recent advances in causes and prevention of gastric and colonic ulcers. Presented at: Southern States Advanced Equine Feedmaster Program; January 2009; Raleigh, NC.

**Frank N**. Risk factors and causes of laminitis in horses. Presented at: Purina Mills 4th Annual Equine Science University Horse Owner’s Workshop; January 2009; Murfreesboro, TN.

**Stephen Kania** (p. 15)


Wilkes RP, **Kania SA**. Use of interfering RNAs targeted against feline herpesvirus 1 glycoprotein D for


**Stephen Oliver** (p. 22)


Patel DA, Almeida RA, Dunlap JR, **Oliver SP**. Bovine lactoferrin serves as a molecular bridge for internalization of *Streptococcus uberis* into bovine mammary epithelial cells. *Veterinary Microbiology.* 2009;137:297–301.

**Oliver SP**, Boor KJ, Murphy S, Murinda SE. Food safety hazards associated with consumption of raw milk. *Foodborne Pathogens & Disease.* In press.

Stenske KA, Bemis DA, Gillespie BE, D’Souza DH, **Oliver SP**, Draughon FA, Matteson KJ, Bartges JW. Comparison of clonal relatedness and antimicrobial susceptibility of fecal *Escherichia coli* from healthy dogs and their owners. *American Journal of Veterinary Research.* In press.


Callaway TR, **Oliver SP**. On-farm strategies to reduce foodborne pathogen contamination. *Foodborne Pathogens & Disease.* In press.

**Oliver S.** Raw milk vs. pasteurized milk: the debate continues…factors in emerging infectious diseases in the Southeast. Invited seminar presented at: Southeast Center for Emerging Biologic Threats Annual Meeting; June 2009; Atlanta, GA.

**Oliver S.** Assessing milk quality: implications to dairy producers. Invited seminar presented at: 2009 National
Oliver S. Milk quality and sustainability of the dairy industry in the Southeast. Presented at: Southern Dairy Conference; January 2009; Atlanta, GA.

Oliver S. Foodborne pathogens in milk: public health implications. Presented at: Southern Dairy Conference; January 2009; Atlanta, GA.

Prado ME, Oliver SP. SUAM: An important Streptococcus uberis virulence factor. Presented at: American College of Veterinary Internal Medicine Forum & Canadian Veterinary Medical Association Convention; June 2009; Montreal, Canada.


**Pighetti GM.** New horizons for boosting immune competence. Invited presentation at: National Mastitis Council Annual Meeting; January 2009; Charlotte, NC.

**Pighetti GM.** Immune functions and effects on somatic cell counts and milk. Presented at: American Dairy Science Association-Midwest Regional Meeting; March 2009; Des Moines, IO.


**Rouse BT.** Immunopathology versus immunity in viral infections. Invited presentation at: The 5th International Veterinary Vaccines and Diagnostics Conference; July 2009; Madison, WI.


**Rouse BT.** Point/counterpoint: A review of the conference. Presented at: Immunology of Influenza Virus Infection meeting; July 2009; Athens, GA.


Joo HM, He Y, Sangster MY. The state of B cell memory in the lung is profoundly influenced by the nature of immunization. Presented at: Keystone Symposia on Molecular and Cellular Biology: B Cells in Context; March 2009; Taos, NM.

Sundararajan A, Joo HM, Sangster MY. Deficient virus-specific IgA production and mucosal B cell memory following murine gammaherpesvirus 68 infection of the respiratory tract. Poster presented at: Keystone Symposia on Molecular and Cellular Biology: Immunologic Memory and Host Defense; February 2009; Keystone, CO.
F. Neal Schrick (p. 26)


Hildegard Schuller (p. 16)


Hwa-Chain Robert Wang (p. 17)


Choudhary S, Rathore K, Song S, Wang H-CR. Reactive oxygen species in the ability of pro-apoptotic
H-Ras to enhance apoptosis induced by histone deacetylase inhibitors [abstract]. In: *Proceedings of the American Association for Cancer Research Annual Meeting*; April 19, 2009; Denver, CO. Abstract 878.


*Wang H-CR*. US veterinary education, Northern American veterinarian licensing, and UTCVM. Invited presentation at: Northwest Agricultural and Forestry University; May 26, 2009; Yanglin City, China.

*Wang H-CR*. Northern American veterinarian licensing and UTCVM. Invited presentation at: Jilin University College of Animal Science and Veterinary Medicine; May 28, 2009; Chungchun City, China.

*Wang H-CR*. US veterinary education and licensing. Invited presentation at: China Agricultural University College of Veterinary Medicine; June 2, 2009; Beijing, China.


**Xuemin Xu** (p. 18)


*Publications and presentations listed are for the 2009 calendar year to the publication date of this report. Some items may be duplicated between individual investigators.*
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<td>Improved diagnosis and monitoring of equine endocrine disorders</td>
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<td>Effects of clinical endotoxemia on glucose metabolism in horses</td>
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<td>Molecular pathways that mediate genetic susceptibility to low dose ionizing</td>
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<td>Kania, Stephen</td>
<td>Prevalence of tapeworm infection among horses in 4 geoclimatic regions of Western Coast States</td>
<td>East Tennessee Clinical Research</td>
<td>06/01/08-05/31/09</td>
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<td>Genomic sequencing of methicillin-resistant <em>Staphylococcus pseudintermedius</em> from canine pyoderma</td>
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<td>Oliver, Stephen</td>
<td>Efficacy of two experimental post-milking teat disinfectants as evaluated in a positive control natural exposure study in dairy cows</td>
<td>DeLaval</td>
<td>02/09/09-08/31/09</td>
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<td>Efficacy and field safety of Spectramast LC for intramammary treatment of clinical mastitis due to <em>Staphylococcus aureus</em> or <em>Streptococcus uberis</em></td>
<td>Pfizer Animal Health</td>
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<td>Immunogenicity and efficacy of <em>Escherichia coli</em> bacterial extract</td>
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<td>Effectiveness of Mast Out as an intramammary treatment of subclinical bovine mastitis</td>
<td>ImmuCell</td>
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<td>Continued development of SUAM as a vaccine for the prevention and control of <em>Streptococcus uberis</em> mastitis in dairy cows</td>
<td>University of Tennessee Research Foundation</td>
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<td>Efficacy and safety of Draxxin (tulathromycin) in the treatment of clinical mastitis associated with <em>Streptococcus uberis</em> in lactating dairy cattle</td>
<td>Pfizer Animal Health</td>
<td>09/27/07 - 09/23/08</td>
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<td>Molecular mechanisms associated with <em>Streptococcus uberis</em> mastitis in dairy cows</td>
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<td>Sangster, Mark</td>
<td>In vitro analysis of the anti-influenza virus activity of pomegranate juice</td>
<td>POM Wonderful</td>
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<td>University of Rochester Center of Excellence in Influenza Research</td>
<td>University of Rochester</td>
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<td>Schuller, Hildegard</td>
<td>Estrogen enhances the carcinogenic effects of the nicotine derivative NNK</td>
<td>National Lung Cancer Partnership</td>
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<td>Identification of unique biomarkers to manipulate semen for altering sex ratio in cattle</td>
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<td>Wang, Hwa-Chain Robert</td>
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<td>Xu, Xuemin</td>
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<td>Determine the role of the long Abeta-46 in Alzheimer’s disease development</td>
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<td>Vascular risk factors in Alzheimer’s disease</td>
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**Total**                                                      | **$3,030,150** | **$3,167,426**

*No-cost extension granted, resulting in no new funds in the current year. Expenditure amounts are from carry-over from the previous year.*
### College of Veterinary Medicine Center of Excellence in Livestock Diseases and Human Health

<table>
<thead>
<tr>
<th>Expenditures</th>
<th>FY 2008-09 Actual</th>
<th>FY 2009-10 Proposed</th>
<th>FY 2010-11 Requested</th>
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<tr>
<td></td>
<td>Matching</td>
<td>Appropr.</td>
<td>Total</td>
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<td>Expenditures</td>
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<td>559,242</td>
<td>838,863</td>
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<tr>
<td>Salaries</td>
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<td>Non-Personnel</td>
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<td>GRAND TOTAL</td>
<td>279,621</td>
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### Revenue

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<tr>
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<th>FY 2008-09 Actual</th>
<th>FY 2009-10 Proposed</th>
<th>FY 2010-11 Requested</th>
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<td>49,198</td>
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<td>639,995</td>
<td>959,993</td>
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