ANIMAL PRODUCTION PORTFOLIO

Knowledge Area 305: Animal Physiological Processes

Highlights of FY2006 CSREES Investments ($8.381 million)

USDA Goal 2:
Enhance the Competitiveness and Sustainability of Rural and Farm Economies

CSREES Objective 2.2:
Provide Research, Education, and Extension to Increase the Efficiency of Agricultural Production and Marketing Systems






Inhibition of Melanocortin Receptors as a Mechanism for Increasing Food Intake in Ruminants: Researchers at **Auburn University** showed that agouti related protein (AGRP) is a potent regulator of food intake in sheep. Endotoxin activates neurons that contain AGRP and increases expression of the AGRP gene. In the endotoxin model, treatment with AGRP prevented the inhibition of food intake that usually occurs in sick animals. The melanocortin 4 receptor is a key player in this disease model in sheep and may be modulated to prevent or recover food intake in sick animals. Thus, melanocortin 4 receptor agonists may be useful in increasing food intake in sick animals or in the recovery of animals from disease. (NRI Grant; CRIS Accession Number 0198081)

Development of New Nanospheres for Delivery of DNA, RNA, or Proteins: Investigators at **Cornell University** developed an efficient, long-term, and low-cost gene delivery system that is based on RNA-encapsulated biocompatible and biodegradable polymeric nanospheres. They used charge-reversal amphiphiles that transform from a cationic to an anionic amphiphile intracellularly for both DNA and RNA delivery. Enhanced gene transfection and gene knockdown were observed with these vectors compared to current cationic amphiphiles. The investigators also fabricated, for the first time, a hydrogel that is made entirely from branched DNA as a biocompatible and biodegradable sustained delivery system. The hydrogel has been used to successfully deliver insulin or somatropin to pigs. (Hatch; CRIS Accession Numbers 0191129 and 0197897)

Molecular Analysis of Contributory Factors of Osteoarthritis in Equine Degenerative Joint Disease: Equine osteoarthritis develops as a result of the degradation of collagen and proteoglycans in the extracellular matrix component of articular cartilage leading to massive joint tissue damage. Highly specific cellular proteases such as matrix metalloproteinases (MMPs) are responsible for degradation of matrix proteins. Researchers at the **University of Missouri** showed that MMP13 is overexpressed in osteoarthritic chondrocyte cells isolated from equine cartilage. They also identified specific DNA sequences in the proximal promoter of the equine MMP13 gene that bind SAF-1, an inflammation-responsive transcription factor. Parathyroid hormone (a stimulator of bone formation) stimulates binding of the CIZ transcription factor to the MMP13 promoter in chondrocyte cells. The response of chondrocytes to parathyroid hormone may be responsible for the onset of ossification. This new knowledge will be used to design new treatments for the progressive degeneration of the joint tissue during equine osteoarthritis. (Animal Health; CRIS Accession Number 0201811)

Osteoarthritis and Septic Arthritis in Equine: Results of research on septic arthritis in horses at the **University of Illinois** demonstrated that articular chondrocytes can directly respond to bacterial ligands without requiring inflammatory mediators from adjacent cell populations. Bacterial ligands elicit a substantial upregulation of intrinsic inflammatory mediators and degradative enzymes along with a suppression of normal matrix synthetic processes. The use of glucosamine at high concentrations may have limited effects on equine articular cells. Low concentrations of glucosamine may have potentially beneficial anti-inflammatory effects. In addition, corticosteroid administration in combination with hyaluronic acid can have protective effects on inflamed cartilage cells. (Animal Health; CRIS Accession Numbers 0205792 and 0205915; Hatch; CRIS Accession Number 0205508)

A New Model for Olfactory Imprinting in Salmon: Scientists at the **University of California, Davis** have shown that salmonids raised in the wild tend to have bigger brains than salmonids raised in hatcheries. The most significant differences occur in the olfactory bulbs (critical for imprinting to the home stream) and the telencephalon. Effects on brain growth and development occur within a single generation. Profound changes in brain growth and development can be observed as early as the alevin (yolk-fry) stage. Thus, salmon raised in hatcheries have a plastic central nervous system that can become optimized for a relatively unenriched environment rather than for living in the wild. Because such environmental influences on phenotype are not generally considered in conservation management, these findings have important implications for the restoration of declining salmonid populations worldwide. (Hatch; CRIS Accession Number 0172569)

Leptin and Mammary Development: Researchers at the **University of Wisconsin** showed that leptin and the leptin receptor are expressed in the epithelial and stromal cells of the mammary glands of cattle and mice. Expression of leptin and leptin receptor are developmentally regulated in epithelium but not in stroma. Greatest expression of leptin and the leptin receptor occurs during mid-pregnancy. Insulin and insulin-like growth factor-1 increase expression of leptin in cultured mammary epithelial cells. In mice that lack the leptin recptor, leptin appears to be essential for normal alveolar development. However, growth of a wild-type epithelium in leptin receptor deficient stroma leads to abnormal and greatly reduced ductal growth. This suggests that the responses to leptin during puberty are due to actions on the stromal while responses to leptin during pregnancy are due to actions on the epithelium. Since mammary growth and lactation are strongly affected by nutrition, these results provide new mechanistic information on how nutrition influences mammary development and future milk production. (NRI Grant; CRIS Accession Number 0193692; Hatch; CRIS Accession Number 0193921)

Epithelial Sodium Transport Mechanisms and Associated Regulatory Pathways that Affect Bovine Mammary Development, Function, and Involution: Scientists at **Kansas State University** used an *in vitro* bovine mammary epithelial system to show that changes in the ratio of electrolytes to carbohydrates in the apical (milk side) medium caused a rapid and profound effect on the epithelial barrier. Protein links that hold the cells tightly together became reduced or absent in high electrolyte medium, whereas low electrolyte medium promoted the enhancement of these cell-cell interactions and sealing of the cell layer. Cortisol (a hormone that increases at the time of birth) causes a rapid and dramatic increase in the ability of these cells to remove electrolytes from the apical compartment. Thus, a new mechanistic process was discovered by which hormones modulate the integrity and function of the mammary system. (NRI Grant; CRIS Accession Number 0198408)

Luteinizing Hormone Regulation of Circadian Clock Genes in the Avian Ovary: Investigators at the **University of Illinois** identified transcripts for novel circadian clock genes associated with the near 24 hour periodicity of the chicken reproductive cycle. They demonstrated for the first time that an ovarian clock is present in the chicken ovary. Luteinizing hormone altered expression of two clock genes in the ovary, suggesting that endocrine regulatory elements are important in regulating the synchrony of the ovarian clock with the primary clock in the brain. Alterations of the clockwork mechanisms, through changing amounts of light, may provide new methods to increase the efficiency of producing fertilizable ova in hens. (Hatch; CRIS Accession Number 0205709)

Improving Reproductive Performance in Broiler and Turkey Breeders Using Sperm Penetration Values: Scientists at the **University of Arkansas** developed a sperm penetration assay to evaluate breeder flock performance. Flock criteria identified as causative to poor fertility from this project are: insufficient male/female ratio, poor physical conditioning as the male or female birds age, poor physiological development of males, and poor hen conditioning. The investigators also developed new methods for storing eggs during hatching which requires little to no capital expense and results in a 1-4% increase in hatch. These methods are being implemented by the two largest poultry integrators in the U.S. and nearly half of all broilers produced in the U.S. have been produced utilizing this egg storage program. A 1-2% increase in hatch in all broiler breeder flocks in the U.S. results in an increase of 2.5-5 million more chicks hatched per week. With the cost of chicks at nearly $0.25 per chick, this results in a potential net increase of $1.25 million additional revenue. (Animal Health; CRIS Accession Number 0189950)