441 Dam/grand-dam nutrition during pregnancy affects milk supply in offspring and reproductive performance in grand-offspring. H. T. Blair*, D. S. van der Linden, L. C. Davenport, P. R. Kenyon, C. M. C. Jenkinson, S. W. Peterson, D. D. S. Mackenzie, S. T. Morris, and E. C. Firth, *National Research Centre for Growth & Development, Massey University*, *Palmerston North, New Zealand*.

In temperate climates the cost of providing feed is higher in winter than other seasons, causing ewes to be fed restricted rations during some periods of pregnancy. Epidemiological information suggests that undernutrition of the fetus may affect its health and performance in later life; these effects may be passed between generations (fetal programming). In 2005 510 ewes (G0) carrying either singleton or twin fetuses had either ad lib (H) or restricted (L) access to pasture between d21 and d140 of pregnancy. In 2006 onset of puberty in ewe offspring (G1) was assessed and in 2007 220 G1 ewes were mated and a subset milked. In 2008 growth and puberty of G2 offspring were monitored. At d140 of pregnancy H G0 ewes were heavier than L ewes (78.4 vs 65.0±0.36kg). G1 twin-born lambs from L dams were lighter than contemporaries from H dams (4.52 vs 5.23±0.06kg). Lambs reared by H G0 dams were heavier than L lambs at weaning (32.8 vs 31.0±0.37kg), but by 6 months of age there was no weight difference between H and L G1 ewe lambs. No differences were found in onset of puberty or reproductive traits at 18 months of age between H and L G1 ewes. Weights of H and L G1 ewes throughout their first pregnancy were similar. Birth weights of L G2 offspring were heavier than their H contemporaries (4.74 vs 4.53±0.08kg). L G1 ewes tended to produce more milk ($P<0.10$) with higher predicted lactose yield (6.97 vs 6.60±0.14kg) than did their H contemporaries over a 50-day lactation. This was reflected in higher weights of G2 L lambs at weaning (28.5 vs 25.5±1.36kg) and a greater proportion of L G2 ewe lambs reaching puberty at c.8 months of age. These results indicate that dam nutrition can affect the yield and composition of milk in their offspring and the weight and reproductive capability of their grand-offspring. Molecular and physiological mechanisms for these changes are being sought.

Key Words: fetal programming, milk supply, reproduction

442 Fetal programming of skeletal muscle development in ruminant animals. M. Du* and M. J. Zhu, *University of Wyoming*, *Laramie*.

Enhancing skeletal muscle growth is crucial for the profitability of animal agriculture and meat industry. Effective enhancement of skeletal muscle growth is dependent on our understanding of mechanisms controlling skeletal muscle growth and development. Fetal stage is of particular importance for skeletal muscle development because there is no net increase in the number of muscle fibers after birth. The lower priority in nutrient partitioning renders skeletal muscle development venerable to the fluctuation of maternal nutrition. In ruminant animals, skeletal muscle matures at late gestation, when skeletal muscle possesses well developed muscle fibers, intramuscular adipocytes and connective tissues formed by fibroblasts. All these cells are derived from mesenchymal stem cells. Maternal nutrition during fetal stage, especially the mid to late gestation, directly affects the proliferation and differentiation of mesenchymal stem cells and, thus, alters the muscle fiber number and size, intramuscular adipocyte number and collagen content in offspring muscle — a process called fetal programming. Available studies provide several major mechanisms linking maternal nutrition and fetal muscle development, including Wnt/β-catenin signaling, insulin like growth factor signaling, inflammatory signaling and AMP-activated protein kinase, and epigenetic modifications. Future studies should focus on the identification of underlying mechanisms associated with fetal programming of skeletal muscle development, such as analyzing signaling pathways and the subsequent epigenetic modifications in crucial genes regulating myogenesis, adipogenesis and fibrogenesis from mesenchymal stem cells, and the resulting skeletal muscle growth and development and meat quality.

Key Words: fetal programming, skeletal muscle, growth

443 Programming of fetal fat and muscle: Natural and genetic fetal restriction and exogenous nutritional influences. G. J. Hausman*, *USDA-ARS*, *Athens, GA*.

Naturally restricted growth (runts) and genetically reduced birthweights, as in lean and obese pigs, can have a long lasting or permanent influence on postnatal performance. The degree of restriction or reduction in birth weight dictates the influence on postnatal growth and development. Small birth weights increase fat cell development and muscle fiber size but decrease fiber number. Maternal nutrition can reduce fetal growth depending on species and severity of either protein or energy restriction. However, maternal nutrition can influence progeny development without influencing birth weights. Restricted fetal growth and low birth weight influences growth and development in many species. Maternal under nutrition and even over nutrition may restrict fetal development and subsequent postnatal development. The considerable literature including several recent long term studies warrants a review of these topics in regards to pigs, sheep and cattle.

Key Words: fetal, restriction, progranmming

444 Epigenetic programming of behavior and physiology. M. Meaney*, *McGill University*, *Montreal, Quebec, Canada*.

Maternal care alters adaptive behavioral and endocrine responses to stress in the rat. The mechanisms for these 'maternal effects' involve stable changes in gene expression. Thus, the adult offspring of mothers that exhibit increased pup licking/grooming (LG) show increased hippocampal glucocorticoid receptor (GR) mRNA expression. The differences in GR expression associate with effects at the level of both negative feedback inhibition and HPA responses to stress.. Studies of the mechanisms for maternal effects on GR expression focus on DNA methylation within a brain-specific GR gene promoter. These studies reveal sustained effects of maternal behavior on the cytosine methylation of the consensus binding sequences for specific transcription factors that regulate GR gene expression. Pharmacological manipulations that reverse the maternal effect on cytosine methylation of the GR promoter also eliminate the effect at the level of both GR expression and HPA responses to stress. The maternal effect on DNA methylation involves an active demethylation at specific CpG dinucleotides targeted by intracellular signals driven by pup LG. Such processes reveal experience-dependent plasticity in the chemistry of the DNA and chromatin structure.

445 Large animal models of developmental programming. L. P. Reynolds*, J. S. Caton, K. A. Vonnahme, J. S. Luther, C. J. Hammer, K. R. Maddock Carlin, A. T. Grazul-Bilska, and D. A. Redmer, *Center for Nutrition and Pregnancy, and Animal Sciences Department, North Dakota State University*, *Fargo*.

Developmental programming refers to the long-term effects of various `stressors' (e.g., maternal nutrient excess or limitation) on fetal or neonatal development; that is, `programming' of organ systems during a discrete developmental period resulting in compromised function even in adulthood. This concept was first hypothesized based on the results of epidemiological studies in humans and has been subsequently confirmed with controlled animal studies. In addition to its effects in humans, developmental programming likely has profound implications for the efficiency of livestock production. The various large animal models of developmental programming will be described along with the effects that have been observed in various organ systems. The models to be presented include those using cattle, sheep, and swine, and also will include models of maternal and neonatal nutrition (including energy, protein, and specific nutrients such as selenium), maternal age, maternal and fetal genotype, maternal environmental stress, and multiple fetuses. The critical importance of large animal models of developmental programming in solving socioeconomic and health-related issues also will be discussed. Moreover, the consequences of developmental programming for livestock production will be discussed, along with potential therapeutic approaches to minimize or at least manage these deleterious effects. *Supported by NIH grants HL64141 and HD45784, and USDA-NRI grants 2005-35206-15281 and 2007-012. We thank the many colleagues and students who have contributed to our research efforts over the years.*

Key Words: animal models, developmental program, socioeconomic impliations

Meat Science and Muscle Biology: Pork and Beef Quality

446 Effects of dietary oxidative stress on postmortem events and tenderness of fresh pork. D. D. Boler*, L. W. Kutzler, A. C. Dilger, D. M. Fernandez-Duenas, S. F. Holmer, F. K. McKeith, and J. Killefer, *University of Illinois*, *Urbana*.

Extreme postmortem oxidation treatments have been shown to reduce proteolysis of beef steaks; which led to reduced protein degradation and delayed tenderization. The objective of this experiment was to determine if dietary oxidative stress from feeding finishing barrows highly oxidized oils reduced postmortem tenderization and delayed myofibrillar protein degradation. One hundred twenty barrows were allotted to a 2 × 2 factorial in a complete randomized block design with 3 blocks of 40 barrows each. Factors included oil type (fresh or oxidized) and dietary antioxidant (inclusion or exclusion). Fresh or oxidized corn oil was included in the diet at 5%, with or without 132 ppm antioxidant (ethoxyquin + tertiary butyl hydroquinone). Treatment diets were fed for the last 56 d of finishing prior to harvest. Barrows (n=24) whose live weights were closest to their respective pen means were selected for meat quality analysis and humanely slaughtered. Samples were collected to determine the overall effect of diet on oxidation in the carcass. Longissimus muscle was dissected between the 6th and 11th rib of the right side of the carcass at 24 h postmortem. Four pairs of chops were cut from the longissimus muscle beginning at the 6th rib. Pairs of chops were randomly assigned to aging durations of 1 d, 3 d, 7 d, or 14 d postmortem. Tenderness was analyzed on one chop using Warner-Bratzler shear force. Proteolysis of myofibrillar proteins was determined on the paired chop by Western blotting. No differences ($P > 0.05$) were detected in shear force values at any time points. No differences ($P > 0.05$) were detected in Troponin-T degradation between fresh and oxidized oil treatment groups; however, the presence of antioxidant appeared to accelerate ($P < 0.05$) myofibrillar protein degradation. The addition of highly oxidized oils in finisher pig diets does not appear to affect postmortem tenderization or myofibrillar proteolysis. Lack of differences in tenderness may be due to the level of oxidation in the oxidized oil treatment group being inadequate to illicit a response.

Key Words: pork, proteolysis, myofibrillar proteins

447 Effects of oxidized corn oil and synthetic antioxidant blend on pork quality and shelf-life. D. M. Fernández-Dueñas*[1], L. W. Kutzler[1], D. D. Boler[1], S. F. Holmer[1], J. Zhao[2], R. J. Harrell[2], J. Andrews[2], M. Vazquez-Añon[2], M. Ellis[1], F. K. McKeith[1], and J. Killefer[1], [1]*University of Illinois*, *Urbana*, [2]*Novus International Inc.*, *St. Charles, MO*.

The objective of this experiment was to evaluate the effect of oxidized oil and a blend of synthetic antioxidant (AOX, ethoxyquin and tertiary butyl hydroquinone; Novus International Inc.) on meat quality traits and shelf-life. The trial was a 2×2 factorial arrangement, with fresh vs. oxidized corn oil with or without AOX. A total of 32 barrows were selected for meat quality and shelf-life evaluation. Subjective color, marbling, and firmness, as well as objective color, pH and backfat depth (BD) were collected. Drip loss (loin chops) and percent moisture and fat were determined (loin chops and ground pork). Pigs fed oxidized oil had lower carcass yield (P=0.01) and pigs fed AOX had higher carcass yield (P=0.05) when fed either fresh or oxidized oil. Pigs fed AOX had 39% higher loin fat (P=0.07) and higher loin marbling score when fed fresh oil but not oxidized oil (AOX P=0.08, interaction P=0.08). Pigs fed oxidized oil had 13% lower Boston butt fat and less back fat depth at the 10th and last rib ($P<0.05$). Pork chops from pigs fed AOX were more juicy (P=0.08) and tender (P=0.03) and chops from pigs fed oxidized oil were less tender (P=0.06) after 14 days of storage. Shelf–life was measured as thiobarbituric acid reactive substances (TBARS) and discoloration score after stored in display cases for 0, 7, 14, and 21 days. After 14 and 21 days of storage, loin chops from pigs fed fresh oil with AOX had the lowest TBARS values and those fed oxidized oil without AOX had the highest. Chops from fresh oil without AOX and oxidized oil with AOX were intermediate (treatment effect P=0.02). Loin chops from pigs fed fresh oil with AOX had lower discoloration scores after 21 days of storage compared to those fed fresh oil alone (P=0.008). Results indicated pork quality was improved with dietary AOX supplementation by having lower TBARS and lower discoloration score. Pork chops from pigs fed AOX were more juicy and tender compared to the control.

Key Words: antioxidant, pork quality, TBARS