575 Enhancing neonatal intestinal growth, development and repair following injury. J. Odle* and R.J. Harrell, *North Carolina State University, Raleigh*.

Early postnatal morbidity and mortality of mammalian neonates represent significant challenges to the agricultural and medical sciences. While many stressors come to bear on the neonate soon after birth, it is convincingly clear that gastrointestinal maladies are among the most prominent. This is not surprising given the relatively quiescent state of the intestine in utero and the rapid ontogeny required following birth. Furthermore, the intestinal mucosa, initially sterile, must be protected from viral and bacterial pathogens that are ubiquitous in the postnatal environment. Because the intestine is a "supply organ", the overall systemic health and vitality of the neonate hinges on its development and function. Therefore, understanding the role of various nutritional, hormonal and pharmacologic agents in ushering the growth, development and function of the intestine is seminal. Our studies have specifically examined rotaviral gastroenteritis, a leading cause of neonatal intestinal injury and diarrhea, with the ultimate goal of improving the rate and extent of recovery. Using rotaviral infection within a neonatal piglet model, we have shown that the level of enteral nutrition delivered post-infection can starkly affect the clinical, biochemical and immunological response during recovery. While a brief period of "gut rest" may be beneficial, if prolonged, it can significantly delay recovery. We also have documented a modest mitogenic response of damaged intestine to supplemental epidermal growth factor, and have shown attenuation of rotaviral damage to the intestine of pigs fed milk replacer formulated with plasma proteins compared with soy-protein-based formulas. However, we have been unable to measure beneficial effects of enteral glutamine or alanyl-glutamine. Our collective findings suggest several positive (but modest) effects of various enteral-treatment regimens/agents on intestinal recovery. Further research is needed to understand better the complex interplay between nutrients, growth factors, immunological, and bacterial determinants which impact intestinal health and ultimately neonatal vitality.

Key Words: intestine, growth, rotavirus

576 Effects of dietary energy and protein on the immunological performance of milk replacer-fed Holstein bull calves. B. J. Nonnecke*[1], M. E. VanAmburgh[2], M. R. Foote[2], J. M. Smith[2], and T. H. Elsasser[3], [1]*National Animal Disease Center, USDA, ARS, Ames, IA,* [2]*Cornell University, Ithaca, NY,* [3]*BARC-East, USDA, ARS, Beltsville, MD*.

Nutrient requirements of preruminant dairy calves are not well described. Current practices, often favoring a least cost approach, may compromise growth performance and health. The present study evaluated and compared immune function in neonatal calves on a higher nutritional plane with that of calves fed a diet meeting current industry standards. Colostrum-fed, Holstein bull calves (n=19) were assigned randomly at ∼4 d of age to one of two treatment groups. Treatment (TRT) 1 calves were fed a 20% crude protein (CP): 20% fat milk replacer (MP) at a rate of 1.4% BW of dry matter (DM)/d for 8 wk. Calves assigned to TRT 2 were fed a 30% CP: 20% fat MR at a rate of 2.4% BW of DM/d. The functional capacity of mononuclear (MNL) populations from peripheral blood collected at 0, 4, 6, and 8 wk during the study period was estimated using a battery of in vitro tests. Nitric oxide (NO) and interferon-γ production by mitogen-stimulated MNL were influenced ($P \leq .05$) by nutritional plane, whereas mitogen-induced DNA-synthesis and secretion of tumor necrosis factor-α and polyclonal immunoglobulin were unaffected ($P \geq .05$). The total number of peripheral blood leukocytes was also unaffected by nutritional plane. These results suggest that increased dietary energy and protein can modulate specific aspects of the neonatal immune system. Additional research is necessary to determine if these changes reflect increased immunocompetency (i.e. infectious disease resistance). Leukocytes from all calves demonstrated age-related changes in their capacity to produce IgM, both cytokines, and NO and to synthesize DNA, possibly reflecting the maturation of the calf's immune system.

Key Words: Nutrition, Preruminant calf, Immune function

577 Regulation of leptin and leptin receptor (LR) expression with chronic inflammatory challenge in the growing pig. K.L. Houseknecht[1], C.P. Portocarrero[1], M.E. Johnston[2], R.D. Boyd[2], M.E. Spurlock[3], M.T. Leininger*[1], C.A. Bidwell[1], M.A. Mellencamp[2], and M.E. White[4], [1]*Purdue University,* [2]*PIC USA, Inc.,* [3]*Purina Mills, Inc.,* [4]*University of Minnesota*.

Leptin is an adipocyte-derived protein that regulates appetite and energy homeostasis. Leptin acts via binding and activation of LR; long-form LR predominate in the hypothalamus and are credited with the regulation of appetite control. Short form LR are found in most tissues, and in vitro studies implicate them in the regulation of peripheral tissue metabolism. In rodents, leptin has been implicated in regulating anorexia associated with acute inflammation. As it is not known how the expression of leptin and its receptors are regulated with chronic inflammation in swine, our aim was to determine the effect of serial inflammatory challenges on leptin and LR gene expression in adipose tissue and circulating leptin concentrations. Gilts and barrows (initial body weight ∼ 65 kg) were assigned to Control (saline; gilts n=14, barrows n=12) or lipopolysaccharide (LPS; gilts n=11, barrows n=13) treatments. Animals were injected IM every 7 d for a total of 5 injections. The initial LPS dose was 15 μg/kg BW; dosage was increased 50% each 7d. Blood samples were collected at -24 and +6 hr relative to the 5th LPS injection and at slaughter. Animals were slaughtered ∼60 hr following the final injection. LPS reduced feed intake in barrows and gilts acutely (24 hr post-injection; $P<0.01$) and chronically (28 days; $P<0.05$). Leptin mRNA abundance in adipose tissue and serum leptin were not affected by LPS in either sex ($P>0.05$). However, chronic LPS treatment caused a dramatic reduction in LR expression in adipose tissue of gilts (70%, $P<0.002$) and barrows (81%, $P< 0.01$) compared to controls. As leptin is thought to regulate its own expression in adipose tissue as well as to regulate insulin action in the adipocyte, down-regulation of LR with chronic inflammation may have important implications for adipose tissue metabolism and whole-body energy homeostasis.

Key Words: leptin, inflammation, swine

578 Effect of endotoxin (LPS) challenge on pituitary-thyroid axis and extrathyroidal thyroid hormone metabolism in cattle. S. Kahl*, T.H. Elsasser, and T.S. Rumsey, *USDA, Agricultural Research Service, Beltsville, MD*.

Thyroid status is compromised in a variety of acute and chronic infections and contributes to the impaired growth performance observed during disease states. To simulate and assess the impact of low level disease stress on the coordinated response of the thyroid regulatory/response axis, graded levels of LPS challenge (0, .2, 1.0, 3.0 μg/kg BW, i.v. bolus, E. coli 055:B5) were administered to experimental animals. Two heifers and 14 steers (Angus x Hereford, 243 ± 4 kg) were assigned to control or one of the three levels of LPS treatment (n = 4) and were limit-fed an all-concentrate diet (15% CP, 3.08 Mcal/kg DM) for 5 wk to gain 1.25 kg BW/d. Saline or LPS were injected through the jugular vein and blood samples were collected at 0, 3, 6, 12, 24, and 48 h relative to injection. Liver biopsy samples were obtained 8 h after LPS injection. LPS did not affect plasma concentrations of thyrotropin (TSH) within 12 h after the challenge. After 24 h, TSH was higher, compared to controls, only in animals injected with 3 μg LPS/kg ($P < .05$). All LPS doses decreased ($P < .01$) plasma thyroxine (T_4) and triiodothyronine (T_3) at 6, 12, and 24 h. Negative response of T_3, measured as area under the time x concentration curve (AUC), increased linearly with the log of LPS dose ($r^2 = .998$, $P < .05$). Plasma reverse-T_3 (rT_3) increased after all LPS doses at 6 and 12 h ($P < .01$) and after 1 and 3 μg dose at 24 h; the response in plasma rT_3 (AUC) increased linearly with the log of LPS dose ($r^2 = .999$, $P < .05$). Hepatic type-I 5'-deiodinase (5'D) activity was not affected 8 h after LPS challenge (1.36 ± .13 nmol I^- x h^{-1} x mg $protein^{-1}$). Results indicate that the reduction in plasma concentration of T_4 and T_3 in the early phase of acute response to LPS in cattle is related to reduced activity of the thyroid gland rather than to altered pituitary secretion of TSH. The data (rT_3 and 5'D) also suggest that LPS challenge may affect peripheral metabolism of thyroid hormones outside the liver and(or) by other types of deiodinases.

Key Words: Thyrotropin, Thyroid hormone, Endotoxin

579 Effects of endotoxin (LPS) challenge on plasma adrenomedullin responses in cattle: correlation with maintenance of insulin-like growth factor-I (IGF-I) status. T.H. Elsasser*[1], S. Kahl[1], T.S. Rumsey[1], E.E. Connor[1], and J.L. Sartin[2], [1]*USDA, Agricultural Research Service, Beltsville, MD,* [2]*Auburn University, Auburn, AL.*

Accompanying the acute phase response (APR) to infection, blood shunting and regional tissue hypoxia contribute to free radical accumulation and disruption of tissue function. Tissue expression and circulating plasma concentrations of adrenomedullin (AM), a potent vasodilating peptide, increase with hypoxia and after in vivo challenge with bacterial toxins like LPS. The objective of the present study was to correlate the relative magnitude of AM response to LPS challenge with the capacity for steers to maintain normal plasma concentrations of IGF-I. Twenty-two Angus Hereford steers (mean BW 318 kg) fed to gain 1.25 kg/d were challenged with a single bolus of LPS (E. coli 055B5, iv; 0.2 μg/kg BW). Blood samples for plasma were collected at 0, 1, 2, 3, 6, 8, 12, 24, and 48 h relative to LPS; liver and kidney biopsy samples were collected at 8 h into Bouin's fixative for immuno-histochemical determination of nitrated proteins (a measure of aberrant nitric oxide-superoxide anion reactions), AM, and inducible nitric oxide synthase. Plasma IGF-I and AM were measured by RIA; plasma NO_2 and NO_3 (NOx) were measured by the Griess reaction. Animals were grouped by AM response, group 1 (G1) having responses < 100 pg/mL over baseline (22 pg/mL) and group 2 (G2) having AM responses > 150 pg/mL over baseline ($P < .002$). Decreases in plasma IGF-I in G1 were 11 and 27% lower at 8 and 48 h, respectively, after LPS than those in G2 ($P < .02$). Increases in plasma NOx (area under the curve) were 63% greater in G1 than G2 ($P < .05$). Cells with nitrated proteins were more frequent in G1 steers than G2 steers. IGF-I concentrations at 8 and 48 h were positively ($P < .05$) and NOx responses negatively ($P < .05$) correlated with AM response. In conclusion, steers with greater AM responses experienced fewer effects of the APR as reflected in lesser decline in circulating IGF-I concentrations.

Key Words: Endotoxin, Adrenomedullin, Insulin-like Growth Factors

580 Biological markers of neonatal calf performance: relationships among serum IGF-1, zinc and copper to poor growth in Holstein calves. T. W. Graham*[1], J. E. Breher[1], A. M. Oberbauer[2], J. S. Cullor[2], T. B. Farver[2], and M. E. Kehrli[3], [1]*Veterinary Consulting Services, Davis, Ca,* [2]*University of California, Davis,* [3]*USDA, National Animal Disease Center, Ames, IA.*

The principle objective of this study was to examine for relationships between serum IGF-I and growth during the first 90 days of life in Holstein calves. Potentially explanatory or confounding variables included in these models were serum IgG, total protein (TP) or packed cell volume (PCV) at birth, gender, twin status, bovine leukocyte adhesion deficiency (BLAD), serum Zn and Cu. Holstein calves (n = 421) were fed colostrum and brought to a calf facility where measurements of weight, length, and height were recorded at birth, 30, 60, and 90 days. Jugular blood was drawn from calves on day 1 to determine PCV, TP, IgG, Zn, Cu, IGF-I, and BLAD genotype (homozygous negative for the D128G CD18 allele compared to the heterozygous condition). Jugular blood was also drawn on days 2 through 10, 30, 60, and 90 days to determine serum Zn, Cu, and IGF-I (predictor variables). Serum IGF-1 approximately doubled from birth (15 ng/ml) to 90 days (30 ng/ml) in bulls and heifers, with bulls having approximately 20% more circulating IGF-1 than heifers by 90 days of age. Consistently, twins had less circulating IGF-1 than singletons. Serum Zn decreased and Cu increased from birth to 90 days (1.2 to 1.0 ppm Zn and 0.5 to 0.7 ppm Cu). Stepwise multiple regression and logistic regression were used to examine the relationships between predictor variables and weight, height, and length at 30, 60, and 90 days of life. Higher birth weight, single male calves, higher serum IGF-I and Zn, and lower serum Cu and Cu to Zn ratio were positively associated with weight, length, and height ($P<0.05$). Birth weight was the most important predictor of calf growth. BLAD status did not significantly affect growth in this study. These results suggest that low birth weight, lower serum IGF-I, and inflammation are significantly associated with poor growth (birth to day 90) in neonatal Holstein dairy calves.

Key Words: IGF-1, Zinc/Copper, Inflammation

581 Infection of weaned pigs with *Salmonella typhimurium* alters plasma insulin-like growth factor binding proteins. J. E. Minton[1], S. K. Durham*[2], R. Balaji[1], and S. S. Dritz[1], [1]*Kansas State University, Manhattan,* [2]*Diagnostic Systems Laboratories, Inc., Webster, TX.*

We demonstrated previously that infection of weaned pigs with *S. typhimurium* resulted in a suppression of circulating insulin-like growth factor-I (IGF-I). Plasma IGF-I was decreased by 24 h, and was maximally suppressed by 48 h following infectious challenge. Normally, IGF-I circulates primarily as a part of a ternary complex bound to IGF binding protein-3 (IGFBP-3) and the acid labile subunit. Thus, the fall in plasma IGF-I we have observed in diseased pigs may be associated with alterations in circulating concentrations of IGFBPs. The objective of the current investigation was to evaluate concentrations of the IGFBPs, primarily IGFBP-3, in plasma of pigs infected orally with *S. typhimurium* (S). Pigs were penned individually with ad libitium access to feed and water. After an acclimation period, venous catheters were placed in all animals. Pigs were given sterile broth (C; n = 4) or 3 X 10^9 cfu S (n = 6) in 5 ml broth. Plasma was collected at 24 and 48 h after disease challenge. Plasma was subjected to western ligand blotting (WLB) utilizing ^{125}I-IGF-I and IGF-II. Images were evaluated for total IGFBPs by densitometric analysis. In addition, plasma samples were analyzed for content of IGFBP-3 utilizing an immunoradiometric assay (IRMA) developed for human IGFBPs. Total IGFBPs were similar between C and S treatments at 24 h, but were reduced ($P < .01$) in infected pigs at 48 h. Concentrations of IGFBP-3, as estimated by the IRMA, were similar between S and C treatments at 24 h, but tended to be reduced ($P < .08$) at 48 h in S (217 + 45.8 vs 365.5 + 56.2 ng/mL). The data suggest that reduced circulating IGF-I provoked by enteric disease is accompanied by changes in peripheral IGFBPs, including IGFBP-3.

Key Words: Disease, Insulin-like growth factor binding proteins, Pigs

582 Effects of endophyte-infected fescue seed on calf performance and physiological indices. C. Golden*, M. Nihsen, S. Wright, M. Poole, T. Denard, E. Piper, and C. Rosenkrans, Jr., *University of Arkansas, Fayetteville.*

Cattle consuming endophyte-infected tall fescue (EIF) have reduced productivity. That production loss is reportedly exacerbated by heat stress and bacterial challenge. Our objective was to investigate the interactions between EIF seed on calf feed consumption, weight gain and hematology. Dairy crossbred calves (n = 20; 91 SE 14 kg) were assigned to dietary treatments within a 2x2 factorial design. Treatments were inclusion of non-EIF or EIF seed at 10% of total feed ration. On day 14, five calves were randomly selected from each dietary treatment to undergo stress (intraperitoneal injection of lipopolysaccaride Salmonella typhimurium (.7 microgram/kg BW) immediately followed by four hours of transportation). Individual calf weights were taken weekly and feed consumption recorded. Blood samples were taken at 0, 8, and 22 hours postinjection. Inclusion of EIF seed decreased ($P < .05$) calf weight gain (17 vs. 10 SE 1 kg), average daily gain (.76 vs. .37 SE .1 kg/d), and overall feed intake (4.8 vs. 4.0 SE .2 kg/d). Blood characteristics were not affected ($P > .5$) by an interaction between main effects. However, stress increased ($P < .07$) blood concentrations of white blood cells 22 hours after injection (10,500 vs. 18,450 SE 2380 cells/microliter), hemoglobin (109 vs. 119 SE 2.4 mg/ml), hematocrit (30.3 vs. 32.4 SE .8 %), and prolactin (6.6 vs. 14.9 SE 1.6 ng/ml). These data indicate that EIF seed and stress decrease animal performance. However, we did not detect an interaction between bacterial and transportation stress and ingestion of endophyte-infected fescue seed.

Key Words: Fescue, Stress, Blood

583 Effects of ivermectin and immune challenge on steers consuming endophyte-infected fescue hay. M. Nihsen*, T. Bedingfield, T. Denard, M. Poole, S. Wright, Z. Johnson, E. Piper, and C. Rosenkrans, Jr., *University of Arkansas, Fayetteville.*

Fescue toxicosis has been studied for many years with limited success in producing an effective and efficient treatment. Our objective was to determine effects of ivermectin, and an immune challenge on steer physiological responses and performance while consuming endophyte-infected tall fescue hay. Crossbred steers (n = 64; 308 SE 9 kg BW) were allotted to treatment by a complete randomized block design with a 2x2 factorial arrangement of treatments. Main effects were: ivermectin

slow-release bolus (yes or no) and a lipopolysaccharide (Salmonella typhimurium .7 microgram/kg BW) immune challenge (yes or no). Four steers were placed in each of 16 pens and fed a dietary supplement (.45 kg/d per steer; coccidiastat and mineral supplement in a corn carrier) and ad libitium endophyteinfected tall fescue hay. Steer weights, feed consumption, and hematology were collected weekly. Data were analyzed with pen as the experimental unit. Average daily gain and feed intake were decreased ($P < .1$) for steers receiving both an ivermectin bolus and immune challenge when compared with steers receiving no bolus and immune challenge, and no bolus no immune challenge. Treating steers with an ivermectin slow-release bolus increased ($P < .05$) red blood cell counts (9,369 vs. 8,702 SE 2223 cells/microliter), hematocrit (32.5 vs. 31.0 SE .8 %), and hemoglobin (121 vs. 115 SE 3 mg/ml). Prolactin (8.3 SE 1.5 ng/ml) and leptin (2.6 SE .13 ng/ml) were not ($P > .6$) altered by either treatment. Serum alkaline phosphatase and cholesterol were not ($P > .6$) altered by either treatment; however, lactate dehydrogenase and triglycerides were altered ($P < .05$) by ivermectin bolus and immune challenge. These data suggest that ivermectin bolus may improve performance of cattle grazing endophyte-infected fescue by altering blood cell function.

Key Words: Fescue, Ivermectin, Stress

584 The effect of composition of liquid milk replacer at a low energy level on the small intestinal permeability of piglets after weaning. M.A.M. Spreeuwenberg*[1], J.M.A.J. Verdonk[2], and M.W.A. Verstegen[3], [1]*Nutreco,* [2]*ID-TNO,* [3]*University of Wageningen, The Netherlands.*

A total of 36 pigs (25,8 ñ 2.0 days, 7.8 ñ 1.0 kg) were used to determine the effect of composition of liquid milk replacer at a low energy level on the small intestinal permeability after weaning. Pigs were allocated to three treatments with 12 piglets per treatment. The difference in three milk replacers is the ratio of lactose and protein, a high protein content is accompanied with a low lactose content (and vice versa). In the high protein diet, the control diet and the high lactose diet, the protein content was respectively 448.6, 299.5 and 150,3 g/kg of liquid milk replacer. The lactose content was respectively 73.5, 235.0 and 400.5 g/kg. The percentage of fat was in all compositions the same: 300 g/kg. The piglets were fed restricted to simulate the low feed intake after weaning. The average energy intake at day 1 till 4 was respectively 137.3, 350.0, 416.0 and 414.0 kJ DE/kg$^{0.75}$ (std: 76.3, 105.8, 78.3, 97.7). No creep feed was provided during the suckling period. The piglets were housed individually in transparent plastic cages, so they had visible contact. At 1, 2 or 4 days after weaning the pigs were sampled at 3,5 m distal of the Ligament of Treitz, under general anaesthesia. Permeability coefficient (10^{-6} cm/s) was measured by Ussing chambre. Transcellular transport was measured by Gly-Sar, paracellular transport was measured by Mannitol. At a low energy level, the milk replacer with a high ratio of lactose / protein had a tendency to have less paracellular transport then the control diet ($P<0.10$). Compared to day 1, day 2 and 4 had significant increased paracellular transport ($P<0.05$). The ratio between trans- and paracellular transport was significantly increased for the milk replacer with the high ratio lactose / protein compared to the control ($P<0.05$). In conclusion, the ratio between lactose / protein can influence the transepithelial transport.

Key Words: Weaned pigs, Milk replacer, Permeability

585 In Utero Dietary Conjugated Linoleic Acid (CLA) Alters Body Composition and Growth Rate in Newborn Pigs. S.P. Poulos*[1], M.J. Azain[1], and G.J. Hausman[1,2], [1]*University of Georgia, Athens,* [2]*USDA-ARS, Athens, GA.*

CLA alters body composition when fed to growing animals. This study investigated effects of CLA fed during gestation and lactation on the growth and development of piglets. Sows were fed a control diet containing corn and soybean meal with 0.83% soy oil (n=8) or a 0.5% CLA diet containing corn and soybean meal supplemented with 0.83% CLA-60, Conlinco (n=6) from day 40 of gestation through weaning (day 28). Within 24 hours of birth (day 0), one male and one female piglet per litter were sacrificed. Body and organ weights recorded and tissue samples were frozen. Weights of remaining pigs were recorded on day 0, 7, 14, 21 and 28. Blood was collected on day 0 and 28. Two barrows and two gilts per litter were weaned onto a corn and soybean meal based diet until market weight. Animals were weighed 69 days post-weaning, and loin eye area and backfat thickness were determined 133 days post-weaning. Sow's milk samples were collected on day 21 of lactation and fatty acid composition was determined using gas chromatography. Leptin concentrations of pigs' serum (days 0, 28) and sow's milk (day 21) were determined via RIA (Linco). CLA did not alter sow's feed intake, body weight, backfat thickness, or litter size and weight at birth ($P>0.05$). CLA resulted in significant decreases in newborn pig heart, kidney, and lung weights, but not backfat weight relative to their body weights (day 0). Body weight and gain were decreased on day 7, 14 ($P<0.05$) however, this effect was not significant at weaning ($P>0.05$). There was no difference in either weight or weight gain post-weaning. There were no differences in serum leptin on day 0 and day 28 or in sows' milk on day 21 ($P>0.05$). CLA decreased total milk fat by 17% ($P<0.01$) and caused significant changes in the amounts of specific fatty acids resulting in an increase in % saturated fatty acids and a decrease in % unsaturated fatty acids in milk from day 21 of lactation ($P<0.05$). In Utero Dietary CLA alters body composition in newborn pigs by altering organ weight, not backfat. Changes in subsequent growth rates until day 14 may be due to changes in the sow's milk composition since growth rate and body weight did not differ post-weaning. This effect may be of significance when feeding CLA and in helping to determine CLA's mechanisms of action.

Key Words: Conjugated Linoleic Acid (CLA), Swine, Body Composition

586 Adipose tissue characteristics of weanling pigs fed conjugated linoleic acid. V. L. Adams*[1], C. D. Gilbert[1], H. J. Mersmann[2], and S. B. Smith[1], [1]*Texas A&M University,* [2]*Children's Nutrition Research Center, USDA/ARS.*

The purpose of the study was to determine if feeding conjugated linoleic acid (CLA) to weanling pigs depressed lipogenesis and preadipocyte proliferation in s.c. adipose tissue. Eighteen weanling pigs (17 d of age; 4.9 kg BW) were allotted randomly to sorghum-based diets supplemented with 1.5% tallow, corn oil, or CLA. The diets provide equal amounts of total lipid (4.5%), crude protein (20%) and cholesterol (0.2%). The piglets were fed a basal diet for 7 d and their respective diets for 35 d before slaughter. Body weights were not different (25.6 kg; $P = 0.66$) at slaughter. Subcutaneous adipose tissue explants were incubated with 10 mM [U-^{14}C]glucose + 0.1 mU/mL insulin. Glucose incorporation into total lipids was 72.4, 76.0, and 109.7 nmol/(100 mg per h) for s.c. adipose tissue from tallow, corn oil, and CLA-fed piglets, respectively, and was unaffected by diet ($P = 0.20$). Tritiated thymidine incorporation into DNA in preadipocytes was 8,254, 9,295, and 7,415 dpm/(100 mg per h) for s.c. adipose tissue from tallow, corn oil, and CLA-fed piglets, respectively, and also was unaffected (($P = 0.61$) by diet. The CLA diet increased the concentration of 16:0, 18:0, and decreased 16:1, 17:1, and 18:1 (the last to 21%; ($P < 0.05$), suggesting depression of stearoyl coenzyme A desaturase activity in the CLA-fed pigs. The concentration of CLA isomers was raised only slightly in s.c. adipose tissue by the CLA diet (from undetectable to 3% of total fatty acids) even though the CLA oil contained 44.5% CLA isomers. The data indicate that practical levels of supplementary CLA have little effect on the growth of weanling pigs or s.c. adipose tissue growth and development. However, CLA caused a more saturated fatty acid composition.

Key Words: Pigs, Lipogenesis, Fatty acid

587 Effects of conjugated linoleic acid on milk composition and baby pig growth in lactating sows. R.J. Harrell*[1], O. Phillips[1], D.L. Jerome[2], R.D. Boyd[3], D.A. Dwyer[4], and D.E. Bauman[4], [1]*North Carolina State University, Raleigh,* [2]*Conlinco Inc., Detroit Lakes, MN,* [3]*Pig Improvement Company USA, Franklin, KY,* [4]*Cornell University, Ithaca, NY.*

The lactating sow limits the growth potential of the neonatal pig by limiting the supply of nutrients and/or not providing the optimum balance of nutrients to maximize growth. Therefore, alterations in sow milk composition could improve piglet weight gains. Fifty-five mixed parity lactating sows (Landrace x Chester White) were blocked by parity and randomly assigned to receive either a corn-soybean meal diet (control) or a diet with 1% CLA-60 (conjugated linoleic acid, ConLinCo Inc. Detroit Lakes, MN). Diets were formulated to meet the nutrient requirements of a high producing lactating sow (NRC, 1998) and sows were fed to appetite. Treatments were initiated at approximately 4 d postfarrowing and continued until weaning at 22 d of lactation. Sow weights and backfat measurements were taken initially and again at weaning. Pig

weights and sow milk samples were collected initially, 7 d post treatment, and again at weaning. The inclusion of CLA did not alter sow ADFI, ending litter weights (average 60.9±1.0 kg) or litter size (average 10.3±.1 pigs/litter), sow weight or backfat losses (P > .20). Milk samples from sows fed the CLA had a lower percentage of total solids (P < .05), fat (P < .01), and tended to have lower gross energy content (P < .10), but were not different in protein or ash content (P > .20). Milk samples from sows fed CLA had greater C12:0, C14:0, C16:0 (P < .01), and tended to have greater C18:0 concentrations (P < .10). However, sows that received CLA had milk with lower concentrations of C18:1 (P < .05), C18:2 (P < .01), and tended to have lower concentrations of C14:1 (P < .10), but were not different in C16:1 (P > .10) or C18:3 (P > .20) concentrations. These results suggest that sow milk fat content can be reduced with the dietary addition of CLA, but this did not result in any differences in piglet growth rate.

Key Words: Swine, Lactation, Conjugated linoleic acid

588 An immunocastration vaccine (Improvac®) increases growth in individually and group-housed boars. I. McCauley[1], G.M. Cronin[1], J.L. Barnett[1], K.L. Butler[1], D.P. Hennessy[2], R.G. Campbell[3], B. Luxford[3], R.J Smits[3], A.J Tillbrook[4], and F.R Dunshea*[1], [1]*Agriculture Victoria, Victorian Instituite of Animal Science, Werribee, Vic 3030, Australia,* [2]*CSL Limited, Parkville, Australia,* [3]*Bunge Meat Industries, Corowa, Australia,* [4]*Monash University, Clayton, Australia.*

A total of 120 entire boars (EB), 120 immunocastrate boars (IB) and 60 barrows (BA) were used in a study to investigate the interactions between sex (S) and housing (H) (group (G) vs individual (I) pens). The study consisted of 4 pens of 15 each of EB, IB and BA and 4 blocks of 15 each of individually housed EB and IB. IB were treated with Improvac® (2 ml) at 14 and 18 wks. Pigs were fed *ad libitum* and measures made between 18 and 23 wks. Data were analysed by an appropriate ANOVA with block/pens of 15 pigs as the experimental unit. The main effect of H was deliberately confounded with block effects in the design and thus cannot be legitimately reported. Also, the sed's relate only to comparing S within H. There were no SxH interactions for any variable. ADG was highest in IB (908, 1079, 944, 1098, 1225 g/d for GEB, GIB, GBA, IEB and IIB, respectively, sed=35.3 g/d) and since there were no differences in initial weight, final weight was also highest in IB (102, 109, 104, 113, 118 kg, sed=2.3 kg). Feed intake was highest in IB and lowest in EB (2518, 3050, 2871, 2881 and 3463 g/d, sed=112.1 g/d). FCR was highest in BA and similar for IB and EB (2.80, 2.88, 3.05, 2.64 and 2.83 g/d, sed=.112 g/d). P2 back fat was highest in BA and lowest in EB with IB intermediate (13.5, 15.3, 17.4, 13.5 and 16.0 mm, sed=.63 mm). Within boars, testes weight was higher in EB than in IB (475 vs 206 g, sed=24.0 g). Within the G pigs, EB had the most bouts of agonistic behaviour (27.9, 9.5 and 9.5 bouts/pig/d for GEB, GIB and GBA, respectively, sed=4.66 bouts/pig/d) at 21 wks of age. Improvac® treatment, used to eliminate boar taint, also improves growth performance. In group pens at least, this is associated with decreased sexual and aggressive behaviours. *Supported by the Pig Research and Development Corporation*

Key Words: Immunocastration, Vaccine, Boar

589 Vaccination of entire boars with Improvac® eliminates boar taint and increases growth performance. F.R. Dunshea*[1], C. Colantoni[2], K. Howard[2], P. Jackson[1], K.A. Long[1], S. Lopaticki[1], E.A. Nugent[1], J.A. Simons[1], J. Walker[2], and D.P. Hennessy[2], [1]*Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia,* [2]*CSL Limited, Parkville, Australia.*

Three hundred (200 entire boars, 100 barrows) pigs were used in a 2x3 factorial design to assess the efficacy of a gonadotrophin releasing hormone (GnRH) vaccine, Improvac®, in eliminating boar taint. The respective factors were sex (barrows (BA), boars treated with placebo (EB) or boars treated with Improvac (IB)) and slaughter age (23 (E) or 26 wks (L)). Vaccines (2 ml) were administered 8 and 4 wks before slaughter. All IB exhibited anti-GnRH titres. Testes (467 vs 219 g) and bulbourethral gland (142 vs 64 g) weights were reduced (P<.001) and serum testosterone were below 2 nM in the majority of IB (94% and 92% at 2 and 4 wks post secondary vaccination, respectively). Boar taint, as assessed by the concentration of androstenone (1.21, .16 and .11 μg/g for EEB, EIB and EBA and 1.05, .13 and .10 μg/g for LEB, LIB and LBA, respectively) and skatole (.133, .068 and .048 μg/g and .095, .056 and .046 μg/g) in subcutaneous fat, was suppressed (P<.001) to low or non-detectable levels in 100% of IB with the concentrations of taint compounds not significantly different to BA. No IB had high concentrations of both androstenone (>1.0 μg/g) and skatole (>.2 μg/g). In contrast, 49.5% of EB had high androstenone and 10.8% had high skatole, resulting in 10% of the EB with high concentrations of both compounds. IB grew more rapidly (786 vs 868 g/d, P=.051 and 858 vs 1119 g/d, <.001, for E and L) than EB with a similar FCR (3.03 vs 3.05 and 3.30 vs 3.10 for E and L) over the 4 wks after the secondary vaccination. Compared to BA, IB were leaner (P<.001) and more feed efficient (P<.05). The vaccine was well tolerated by the pigs, and no observable site reactions could be detected at slaughter. Vaccination of boars with Improvac® allows the production of heavy entire boars with improved meat quality through the prevention and control of boar taint.

Key Words: Immunocastration, Boar taint, Growth

590 An immunocastration vaccine (Improvac®) and porcine somatotropin (Reporcin®) have synergistic effects upon growth performance in boars. I. McCauley*[1], M. Kolek[1], D. Suster[1], W.T. Oliver[2], R.J. Harrell[2], and F.R. Dunshea[1], [1]*Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia,* [2]*North Carolina State University, Raleigh.*

Sixteen individually-penned entire male pigs were used in study to investigate the interactions between commercial immunocastration vaccine (Improvac®) and porcine somatotropin (pST, Reporcin®) regimes. The study was a 2x2 factorial design with the respective factors being immunocastration vaccine (unvaccinated or 2 ml of Improvac® at 14 and 18 weeks of age) and pST (0 or 5 mg/d from 18 weeks of age until slaughter). Pigs were individually-penned and fed *ad libitum* until slaughter at 22 weeks of age. Chemical indicators of boar taint, androstenone (AEN) and skatole (SKA) were measured in fat samples by HPLC. As shown in the table below, while neither Improvac® or Reporcin® alone had any effect upon daily gain, the combined treatment increased daily gain by 25%. Feed intake was decreased by pST treatment but simultaneous treatment with Improvac® ameliorated the reduction in feed intake. FCR was not affected by Improvac®, but was reduced by pST treatment. Improvac® dramatically decreased testes size and the level of both boar taint compounds in fat whereas pST had no effect upon testes weight or fat SKA but reduced fat AEN. For fat AEN, the effects of pST and Improvac® were additive. In conclusion, Improvac® and Reporcin® have synergistic effects upon growth rate in individually-penned boars.

Vaccine (V) pST(P) mg/d	UV 0	UV 5	Improvac 0	Improvac 5	sed	Significance V	P	VxP
Gain, g/d	1345	1396	1288	1677	98	.15	.015	.044
Feed intake, g/d	3630	3057	3751	3512	136	.02	.004	.13
FCR, g/g	2.77	2.29	3.10	2.09	.18	.64	<.001	.079
Testes, g	592	449	206	311	144	.030	.86	.25
SKA, μg/g fat	.16	.30	.02	.03	.09	.02	.29	.34
AEN, μg/g fat	2.75	1.50	.10	.01	.26	<.001	.011	.020

Key Words: Immunocastration, Porcine somatotropin, Boar

591 Effect of Paylean™ (ractopamine hydrochloride) on swine growth performance and carcass leanness as determined by 20- and 13-trial pooled summaries, respectively. D. J. Jones*[1], D. H. Mowrey[1], D. B. Anderson[1], A. L. Schroeder[1], E. E. Thomas[1], L. E. Watkins[1], R. E. Karnak[1], D. M. Roth[1], and J. R. Wagner[1], [1]*Elanco Animal Health, Greenfield, IN.*

The effect of Paylean on swine growth performance was evaluated from 1983 to 1993 in 20 dose titration trials involving 1,922 pigs. Barrows and gilts were fed 16% crude protein diets containing 0, 5, 10, or 20 ppm Paylean from approximately 67 kg to approximately 105 kg body weight. All growth performance data were taken after a 0-d Paylean withdrawal. Results showed that Paylean increased rate of weight gain (P<0.01) and improved feed to gain ratio (P<0.01) at all doses evaluated. In 13 of the 20 dose trials, carcass data were taken after either

a 0-d, 4-d, or 5-d withdrawal period. Dressing percent was increased at 5 ppm ($P<0.05$), and at 10 and 20 ppm ($P<0.01$). Loin eye area was increased ($P<0.01$) for all doses and fat-depth at the tenth rib was decreased ($P<0.01$) for the 10 and 20 ppm doses. Color, firmness, and marbling of the longissimus dorsi were not affected ($P>0.05$) by any Paylean dose. Percentage dissected lean from the pork carcass was increased at the 5 ppm dose ($P<0.05$) and at the 10 and 20 ppm doses ($P<0.01$). Percent lean cuts (trimmed, boneless), determined only for the 20 ppm dose, were increased ($P<0.01$). In conclusion, Paylean fed at 5, 10, or 20 ppm improves swine growth performance and increases carcass leanness without affecting meat quality factors.

	Paylean, ppm				
Variable	0	5	10	20	SE
Average Daily Weight Gain[1], kg	0.834	0.893	0.902	0.916	0.050
Average Daily Feed Intake[1], kg	2.99	2.95	2.91	2.88	0.02
Feed to Gain Ratio[1]	3.62	3.33	3.25	3.16	0.02
Dressing Percent[2]	73.3	73.7	74.1	74.4	0.1
Loin Eye Area at Tenth Rib[2], cm^2	32.77	35.54	36.64	37.41	0.32
Fat Depth at Tenth Rib[2], cm	2.74	2.69	2.51	2.41	0.05
Dissected Lean[3], %	51.8	53.9	55.6	57.5	0.7
Trimmed, Boneless Lean Cuts[4], %	45.4	–	–	48.0	0.8

[1] 20-trial summary; [2] 13-trial summary; [3] 6-trial summary; [4] 3-trial summary

Key Words: Paylean, swine growth, carcass leanness

592 Recombinant bovine somatotropin enhances growth rates in two species of ornamental fish; Giant Danios (*Danio aequipinnatus*) and Zebra Fish (*Brachydanio rerio*). P. R. Simpson*[1], B. C. Peterson[1], N. J. Hughes[1], and G. T. Schelling[1], [1]*Department of Animal and Veterinary Science, University of Idaho, Moscow.*

Zebra Fish (*Brachydanio rerio*) and other tropical fish, such as Giant Danios (*Danio aequipinnatus*), are often used as a model for growth development, molecular genetics, and immunology. Their small size is often a limitation in these studies. To address this, a 14-week growth study was initiated to determine the effects of recombinant bovine somatotropin (rbST; 5.0% dilution of Posilac) on growth performance and size; where Giant Danios (mean weight 2.87 ± 0.20 g) were allotted to two treatment groups with five replicates. Treatments were sham-injected controls (C) and 120 mg/g BW rbST (T). Fish were reared in 10 gal aquariums with individual filter systems at 27°C, and were hand fed twice daily to satiation. A high fishmeal commercial trout diet (55% crude protein) was used to provide for maximum growth. The fish received one intraperitoneal injection every 21 days starting on d 0. Fish were weighed weekly for 98 days. Resulting weights for d 28, 63, and 98 were 3.14, 3.50, and 3.86 g for C and 4.90, 7.41, and 8.86 g for T. Recombinant bST treatment increased ($P < 0.0001$) growth rates 538% throughout d 98, where total gain for C was 1.11 g and T was 5.99 g. The final weight of group T (8.86 g) was 129% greater ($P < 0.0001$) than group C (3.86 g). A similar study was conducted with Zebra Fish (mean weight 0.435 ± 0.05 g), using the same treatment groups. The resulting weights for d 14, 28, 42, and 56 were 0.479, 0.508, 0.568, and 0.575 g for C and 0.573, 0.569, 0.630, and 0.610 g for T. The initial 2 week growth response to rbST was maintained throughout d 56, with the lack of continued response possibly due to higher maturity level of the fish at the time of the trial. Administration of rbST can greatly increase the growth rates of Giant Danios, and was shown to have a short-term effect on adult Zebra Fish.

Key Words: Somatotropin, Giant Danio, Zebra Fish

593 Effects of replacing fish meal protein with meat and bone meal protein as a major dietary ingredient on growth performance in rainbow trout *(Oncorhynchus mykiss)*. G.T. Schelling*, M.T. Casten, N.J. Hughes, R.A. Roeder, and R.W. Hardy, *University of Idaho, Moscow.*

Feeding experiments were conducted to examine the potential of replacing fish meal protein (FM) with a standard, good quality meat and bone meal protein (MBM) in 25% increments for growing rainbow trout. With the objective of making an overall evaluation of growth performance and carcass composition, semi-purified diets were used to provide FM protein:MBM protein of 100:0, 75:25, 50:50, 25:75, and 0:100 as the sole dietary protein in isonitrogenous and isocaloric diets. Two hundred and twenty five rainbow trout (mean weight 120 g) were alloted to five treatments with three replicates in a randomized block design. The tanks were five cubic feet; water flow = 20.51 L/min; temperature = 15°C. The fish were hand fed to satiation twice daily and were weighed on d 0, 21, 42, and 63. Daily gain, daily feed intake, and feed/gain ratios were determined for growth performance. A sub-population of fish were sacrificed on d 63 for body composition determination by whole carcass proximate analysis. In the 100:0 diet, fish gained 3.8 g/d and the relative percentage gains for the series of diets with increasing MBM protein were 100, 90, 83, 85, and 59% (59 lower, $P < .05$). The feed/gain ratios were .94, .98, 1.04, 1.09 and 1.46 (1.46 less efficient, $P < .05$), respectively. There were no marked differences ($P > .05$) in dry matter and protein content of the whole body carcass fed the dietary treatments. The 0:100 diet resulted in reduced growth ($P < .05$) and therefore, had somewhat more carcass fat ($P < .05$). This work indicates that FM protein in semi-purified diets for rainbow trout can be replaced with 25 and 50% MBM protein with only 5 and 10% loss in F/G, and even up to 75% with a 15% loss in F/G.

Key Words: Meat and bone meal protein, Fish protein nutrition, Rainbow trout

594 Growth response of white sturgeon to bovine somatotropin dosage levels and administration patterns. G.T. Schelling*, M.T. Casten, R.A. Roeder, and R.W. Hardy, *University of Idaho, Moscow.*

The slow growth of white sturgeon (Acipenser transmontanus) results in low production and propagation, and we previously reported a considerable growth increase when they were administered 80 μg bST/g body weight of bovine somatotropin (bST). It is the objective of this work to determine growth responses with 0 (C), 40 (L), 80 (M), and 120 (H) μg bST/g body weight (Posilac) administered intraperitoneally at 3 wk and 15 wk intervals. The sturgeon (initial wt. 1100 g) were grown in raceways that held 16°C water, and were fed a commercial trout diet. At the end of the 272 d trial, the C,L,M, and H treated fish weighed 2752, 4735, 5599, and 5706 g. The table shows the 6 wk period gains for the treatments that were administered at the first eight 3 wk intervals (first four 6 wk periods) and then terminated. The table reveals a considerable growth response (262%) average) for the L, M, and H treatments at 3 wk intervals. The last column in the table demonstrates that during the last 6 wks of the 15 wk injection, the L period response dropped to that of C. However, both the M and H treatments were still producing a significant ($P <.05$) growth response. This work demonstrates the tremendous growth response that occurs when white sturgeon are administered bST. The low bST level provided for maximal gain when administered at 3 wk intervals, but higher dosage levels were required to maintain high gains over the 15 wk administration interval.

Table of Period Gains (g/d/fish)

Injections	1 2	3 4	5 6	7 8	- -	- -
Control, gain	203	295	258	423	345	117
Low bST, gain	545	646	833	896	602	127
Med bST, gain	547	789	924	1133	705	340
High bST, gain	552	719	866	821	1139	502
Six-Week Periods	1	2	3	4	5	6

Key Words: Fish Growth, Somatotropin, Sturgeon

595 Growth response of rainbow trout to bovine somatotropin dosage levels and administration patterns. G.T. Schelling*, N.J. Hughes, P.R. Simpson, and B.C. Peterson, *University of Idaho, Moscow, ID / USA*.

A five-week growth study with juvenile rainbow trout administered a sustained-release bovine somatotropin (bST as Posilac®) was conducted to determine the effect of administration level and frequency on growth performance. The study was designed to evaluate the efficacy and efficiency of the sustained deliver system for fish. The treatments were: (C) control, (10/W)10 μg bST/g BW/weekly, (20/W) 20 μg bST/g BW/weekly, and (120/3W) 120 μg bST/g BW/3 wks. Each treatment consisted of 3 replicate tanks of 5 fish having an initial weight of 16 g. The fish were grown in 15° C water and were hand-fed daily to satiety. A commercial high-fishmeal trout diet was used that contained 57% protein and met the recognized nutrient requirements. The fish were handled weekly for weighing and treatment, and all non-injected fish received a weekly needle puncture. The 5-wk gains for the fish were: 17.4, 32.1 30.3 and 29.3 g/fish for the C, 10/W, 20/W and 120/3W treatments. All of the bST treatments resulted in increased gains ($P < .01$) of similar magnitude ($P > .05$). The average bST gain response over the controls was 75.9%. The F:G for the 4 treatments were 4.57, 3.11, 2.98 and 3.20, respectively. The average F:G improvement ($P < .05$) was 32.3%. The feed intake for the 4 treatments was 3.0, 4.2, 3.6 and 3.9 g/fish/week respectively, and was increased ($P < .05$) by all bST treatments by 30.0%. Previous work in this laboratory demonstrated that 120 μg/g BW at 3 wk injection intervals was needed for maximal gain. Since the 10 μg bST/g BW/wk treatment resulted in the same growth performance as the 120 μg bST/g BW/3-wk period, there is at least approximately a 4-fold increase for bST by using the 3-wk injection frequency. The current work indicates that while the delivery system is efficacious for at least 3 wks, the efficiency is decreased relative to weekly administrations.

Key Words: Fish growth, Somatotropin, Rainbow trout

596 Differential expression of insulin-like growth factor binding proteins (IGFBP) -3 and -5 mRNA by primary porcine satellite cells. M.E. White*[1], H.R. Hathaway[1], and W.R. Dayton[1], [1]*University of Minnesota, St. Paul, MN*.

Muscle satellite cells are myogenic cells, which are critically important for postnatal muscle growth. The insulin-like growth factors (IGFs) are believed to play an important role in satellite cell growth and development and the biological activity of the IGFs is regulated by a family of IGFBPs. Other growth factors, which affect satellite cell growth, may work in part through the IGF-IGFBP system. We have reported previously that IGFBP-3 and -5 are produced specifically by porcine satellite cells (PSC) but not by muscle derived fibroblasts isolated from these primary cultures. The objective of this study was to determine the basal expression levels of IGFBP-3 and -5 steady-state mRNA levels in PSC cultures. IGFBP-3 and -5 mRNA were measured using ribonuclease protection assays (RPAs) using procine-specific IGFBP-3 and -5 probes. PSC were isolated from the hind limb muscle of 7 wk old crossbred pigs, plated on reduced growth factor matigel 1:100 v/v)-coated plates. Proliferating cultures of PSC in control media or exposed to growth factors for 18 hr were harvested and total RNA was extracted. Both IGFBP-3 and -5 mRNA are expressed by primary PSC cultures. IGFBP-5 mRNA expression level is significantly higher in these cultures than IGFBP-3 mRNA. These data indicate that PSC produce IGFBP-3 and -5 mRNA and that steady-state IGFBP-5 mRNA levels are higher than those of IGFBP-3 in these cultures.

Key Words: Satellite Cells, Porcine, IGFBP

597 Satellite cell activation, IGF-I mRNA, myostatin mRNA and hepatocyte growth factor (HGF) mRNA levels in the semimembranosus muscles of anabolic steroid implanted and nonimplanted feedlot steers. W. R. Dayton*[1], B. J. Johnson[2], M. E. White[1], and M. R. Hathaway[1], [1]*University of Minnesota, St. Paul,* [2]*South Dakota State University, Brookings*.

Ribonuclease protection assays were used to measure the steady-state level of IGF-I mRNA in the semimembranosus muscles and livers of steers implanted from 32 to 38 d with Revalor-S, a combined trenbolone acetate and estradiol implant. Steady-state IGF-I mRNA levels were 73% higher ($P<.01$, n=7) in the livers of implanted steers than in the livers of nonimplanted, control steers. Similarly, steady-state IGF-I mRNA levels were 47% higher ($P<.01$, n=7) in the semimembranosus muscles of implanted steers than in the same muscles from nonimplanted, control steers. Steady-state hepatocyte growth factor and myostatin mRNA levels were not different in the semimembranosus muscles of implanted and nonimplanted steers. Circulating IGF-I concentration was 40% higher ($P<.01$, n=7) in implanted steers than in nonimplanted, control steers. Additionally, the number of actively proliferating satellite cells that could be isolated from the semimembranosus muscle was 45% higher ($P<.01$, n=7) in implanted steers than for nonimplanted steers. Viewed together these data suggest that elevated muscle IGF-I levels stimulate increased satellite cell proliferation that may contribute to the increased muscle growth observed in Revalor-S- implanted steers.

Key Words: Anabolic steroid, satellite cells, IGF-I

598 Fatty acid attachment to human growth hormone-releasing factors (1-29) and (1-44)NH2 increases the release of GH and IGF-1 in growing pigs. P. Dubreuil*[1], T. Abribat[2], and P. Brazeau[3], [1]*College of Veterinary Medicine, University of Montreal, QC, Canada,* [2]*Asana Laboratories, Longueil, QC, Canada,* [3]*Notre-Dame Hospital, University of Montreal, QC, Canada*.

This study evaluated the effect of a fatty acid (hexenoyl trans-3 (A)) attachment to the Tyr-1 of the human (h)GRF(1-29)NH2 and (1-44)NH2 on GH or IGF-1 release. Male growing pigs between 35 and 45 kg BW were used. Human GRF(1-29)NH2 was compared to AGRF(1-29)NH2 following sc injection at doses of 1.25, 5.0 and 20 μg/kg on GH profile. GH AUCs obtained were 3336, 3647, 3814 and 3948, 5979, 6323 ng/min/mL (SEM:425) for h and AGRF(1-29)NH2, respectively. Greater GH AUCs were observed ($P<0.05$) at doses of 5 and 20 μg/kg of AGRF compared to hGRF suggesting a higher potency of AGRF. In order to extend the concept to hGRF(1-44)NH2, 5 groups of 8 pigs were injected sc BID for 5 consecutive days with 1) saline (3 mL), 2) hGRF(1-44)NH2 (30 μg/kg), 3-5 AGRF (1-44) NH2 at doses of 7.5, 15 and 30 μg/kg. After 5 days of treatment, IGF-1 concentrations were 204, 221, 358, 306 and 401 ng/mL (SEM:25) for groups 1-5, respectively. IGF-1 concentrations were significantly higher($P<0.05$) in groups 3 and 5 than in the saline group indicating also a higher potency of this molecule. These data show that adding an hexenoyl chain to the Tyr-1 of the hGRF molecules increases the GH-releasing potency of both molecules. The mechanism by which these effects are achieved are unknown and under study.Study supported by Theratechnologies, Montreal,Canada

Key Words: GRF, GH, Pig

599 Induction of growth hormone (GH) messenger RNA (mRNA) by corticosterone (CORT) in cultures of chicken embryonic pituitary cells. I. Bossis* and T. E. Porter, *University of Maryland, College Park*.

We have reported that glucocorticoids can induce premature differentiation of GH-secreting cells both *in vitro* and *in vivo* during chicken embryonic development. In the present study, the mechanism of glucocorticoid-induced GH gene expression was assessed using quantitative *in situ* hybridization analysis for GH mRNA directly in cell culture plates. Values presented below are in counts per minute (cpm) from ^{32}P labeled GH riboprobe recovered after posthybridization washes. Embryonic day twelve (e12) pituitary cells were cultured for 48 hours in the presence of vehicle (VEH), GH-releasing hormone (GHRH) at 100 nM, CORT at 1 nM and GHRH plus CORT in combination. Steady state levels of GH mRNA were significantly affected by treatment (60 $\pm$ 6, 218 $\pm$ 13, 1720 $\pm$ 35 and 10499 $\pm$ 371 cpm for VEH, GHRH, CORT and GHRH plus CORT, respectively; $P<.0001$). In a second experiment, e12 cells were cultured in plates and treated for 0, 8, 16, 24 and 48 h with CORT at 1 nM. Duration of treatment with CORT significantly affected levels of GH mRNA (73 $\pm$ 6, 465 $\pm$ 16, 1224 $\pm$ 29, 2144 $\pm$ 42 and 1785 $\pm$ 35 cpm for 0, 8, 16, 24 and 48 h, respectively; $P<.0001$). In a third set of experiments, e12 cells were cultured for 12 h in the presence of VEH, CORT at 1 nM , CORT at 1 nM plus cycloheximide (CHX) at 5 μM and CHX at 5 μM. Treatment with CHX significantly blocked the induction of GH mRNA by CORT (173 $\pm$ 18, 1500 $\pm$ 60, 242 $\pm$ 32 and 68 $\pm$ 12 cpm for VEH, CORT, CORT plus CHX and CHX, respectively; $P<.0001$). Culture of e12 cells in the presence of CHX at 5 μM for 12 h followed by new medium with CORT at 1nM for 12h resulted in a substantial increase in GH mRNA, indicating that the substantial

reduction in responsiveness to CORT in the presence of CHX observed was not due to non-specific toxic effects. We conclude that induction of GH mRNA by corticosterone in chicken fetal pituitary cells is mediated by a protein(s) synthesized in response to corticosterone.

Key Words: Somatotroph, Corticosterone, Pituitary

600 Identifying differentially expressed genes in C2C12 myogenic cells using Differential Display PCR. J.B. Edeal*, C.D. Gladney, M.F. Allan, D. Pomp, and S.J. Jones, *University of Nebraska, Lincoln*.

To gain insight into the molecular mechanisms of skeletal muscle development, we searched for genes regulated by the differentiation of C2C12 myogenic cells. The differentiation of skeletal muscle starts when mononucleated myoblasts (MB) withdraw from the cell division cycle, align, elongate, and fuse into multinucleated myotubes (MT). Using Differential Display PCR (dd-PCR) in C2C12 myogenic cells, we tested the hypothesis that the differentiation of MB to form MT is accompanied by significant changes in gene expression. C2C12 cells were grown to 80-90% confluency in DMEM +10% fetal bovine serum. Differentiation was induced by the addition of DMEM + 2% horse serum + 10 uM cytosine arabinoside. Total RNA was extracted from 6 culture plates (3 containing MB, 3 containing MT). cDNA from these samples was used as template for dd-PCR, providing three replicates within treatment. Bands were excised based on the consistency of banding within replicates (cell state) versus differences across cell type. To date, 100 primer combinations (5 anchor (3) x 20 arbitrary (5)) have been used to identify over 100 putative differentially expressed bands. Preliminary sequencing results from four of these bands yielded homologies to Myosin Light Chain-2, AMP deaminase 3, and Glutathione Peroxidase 1. Northern hybridization will be used to confirm differences observed in gene expression from the dd-PCR results. In the past it has been impossible to examine a large array of changes during this critical step in muscle growth. Differential Display PCR has allowed us to observe many differences in gene expression between two treatments (differentiated (MT), undifferentiated (MB)) in C2C12 myogenic cells.

601 The effect of LXRα activators on adipocyte differentiation. T.D. Brandebourg*[1], V.A. Manning[1], A.E. Brodie[1], and C.Y. Hu[2], [1]*Oregon State University, Corvallis,* [2]*Oregon State University and Sultan Qaboos University*.

The objective of this study was to investigate a potential role for LXRα, a ligand-activated orphan receptor expressed in adipose tissue, in regulating adipocyte differentiation. 3T3-L1 preadipocytes were used to examine the effect of treatment with known activators of LXRα [22(R)-hydroxycholesterol (22R), 20(S)-hydroxycholesterol (20S)] on adipocyte differentiation. Cells were seeded at a density of 3×10^4 cells/cm^3 on six-well (35-mm) tissue culture plates in 2 mL of DMEM medium plus 10% fetal bovine serum and were maintained at 37°C in a 5% CO_2-humidified environment. Cells were grown to confluence (d 2). On d 0, differentiation was induced by treatment with insulin (10 μg/mL), dexamethasome (1 mM), and IBMX (.5 mM). Cells were treated with either ligand or carrier (ETOH) from d 0 to d 7. In separate experiments, 22R or 20S was administered at concentrations of 2.5, 5, 10, or 20 μM. Cholesterol (Chol), which does not appreciably activate LXRα, was administered at concentrations of 2.5, 10 or 20 μM. Differentiation was evaluated by measuring sn-glycerol-3-phosphate dehydrogenase (GPDH; EC 1.1.1.8) activity on d 7. Independent experiments were performed on duplicate wells where n=3 for 22R and n=2 for both 20S and Chol. Protein content was determined by the Bradford method using bovine serum albumin as a standard. Compared to controls, 22R reduced GPDH activity (nmol/(min*mg protein) by 20% at 5 μM ($p<.05$) and 40% at both 10 and 20 μM ($p<.01$). Administration of 20S did not affect GPDH activity at 5 μM ($p<.08$) and 10 μM ($p<.19$) while significantly decreasing GPDH at 20 μM (89%, $p<.01$). However, 20S appeared to affect cell viability at 20 μM. Cholesterol administration did not have any effect on GPDH activity at any concentration examined. These data suggest the LXRα receptor may play an important role in inhibition of adipocyte differentiation.

Key Words: Adipose Tissue, Differentiation, LXR

602 Analysis of Adipocyte Gene Expression During Marbling in Angus X Hereford Steers. K. D. Childs*[1], M. Allan[2], D. Pomp[2], J. R. Malayer[1], R. D. Geisert[1], D. W. Goad[1], and J. B. Morgan[1], [1]*Oklahoma State University, Stillwater,* [2]*University of Nebraska, Lincoln*.

Identifying genetic markers pertaining to specific traits for growth and carcass quality would be a substantial benefit to the beef industry. The present study was undertaken to test for differential gene expression in intramuscular adipocytes during fat deposition of feedlot steers. Angus X Hereford steers (n=50) that were fed a high-energy concentrate ration *ad libitum* for 20 (n=5), 86 (n=15), 121 (n=15) and 146 (n=15) d to obtain various developmental stages of marbling. Subcutaneous fat measurements at slaughter averaged 0.18", 0.29", 0.43" and 0.53" ($P<.05$), respectively. Carcass traits were statistically different ($P<.05$) between days on feed. Intramuscular adipose was excised from the *longissimus dorsi*, snap frozen in liquid nitrogen and stored at -80°C. Total cellular RNA was extracted with TRIzol and Dnased. RNA concentrations were normalized and pooled. Pooled samples of total RNA (2 μg) representing each day on feed were then analyzed by differential-display polyamide chain reaction (DD-PCR), using 200 primer combinations comprised of 20 arbitrary (5') and 10 anchor (3') oligonucleotides. Band differences among treatment groups were scored and 70 bands of interest were harvested. Excised bands were reamplified by PCR, sequenced and submitted to GenBank for homology identification. From the 70 reamplified products, 35 did not sequence, 15 did not have homolgy in GenBank and 25 contained significant homology to known genes. Sequences encoding regions for the translational repressor of NAT1 (cytidine deaminase) and myopodin were evaluated in adipose from individual animals by Northern hybridization to confirm differential gene expression among treatment groups. Northern results suggest that both the repressor of NAT1 and myopodin are differentially expressed in younger/leaner animals versus older/fatter animals. Gene expression is altered during adipocyte differentiation in intramuscular adipose of fattening steers. (Research funded by Oklahoma Beef Industry Council)

Key Words: Adipose, Cattle, DD-PCR

603 Growth control of mouse mammary epithelial cells by keratin antibody-targeted liposomes containing oligonucleotides antisense to epidermal growth factor receptor. I.-S. Yuh*, S.-Y. Lee, and B.-J. Hong, *College of Animal Resources Sciences, Kangwon Natl. University, Chuncheon, Korea*.

Mouse mammary epithelial cells(NMuMG cells) were incubated by the addition of 17β-estradiol(1nM, E)+progesterone(10nM, P) or E+P+EGF with or without various types of oligomers(21-mer) to EGF receptor activity domain(cDNA:+711-+731). Sense or antisense oligomers were encapsulated in protein A-bearing liposome. Uncoupled protein A and unencapsulated sense or antisense oligomers were separated from liposomes on Sepharose 4B columns(encapsulation efficiency of oligomers in liposome-protein A; 0.8%). Addition of E+P into various concentration of EGF showed the interaction in DNA synthesis between EGF and E+P($P\leq0.05$). Antisense oligomers 1μM decreased DNA synthesis induced by E+P or E+P+EGF(53.4 or 65.6% inhibition to control, $P\leq0.05$). Sense oligomers(1μM) also inhibited DNA synthesis induced by E+P or E+P+EGF($P\leq0.05$). However, random-sequenced oligomers(21-mer, 1μM) did not inhibit EGF-induced DNA synthesis. The inhibitory effect of sense oligomers should be due to the unexpected match to functional gene product in growth. Cells were bound with keratin monoclonal antibody(5μg/ml) and then incubated with dilution of protein A-bearing liposomes containing sense or antisense oligomers in the presence of E+P or E+P+EGF. Dose dependent inhibition of DNA synthesis was observed. In the presence of E+P+EGF, 10 or 100nM encapsulated antisense oligomers in liposome-protein A inhibited DNA synthesis by 71.2 or 78.9% to control, respectively($P\leq0.05$). The encapsulated oligomers in liposome-protein A inhibited DNA synthesis at 100 fold lower concentration than the unencapsulated oligomers. Incubation with keratin monoclonal antibody increased uptake of oligomers by mammary epithelial cells for 6 hour incubation compared to those without keratin monoclonal antibody, however keratin monoclonal antibody effect was moderate in inhibition of DNA synthesis.

Key Words: Mammary, EGF receptor gene, Liposome

604 The effect of glucagon and insulin on β-oxidation of 1-^{14}C-palmitate by piglet hepatocytes in primary culture. G. Matsey*, X. Lin, and J. Odle, *North Carolina State University, Raleigh*.

Two experiments were conducted to study the effects of glucagon and insulin on β-oxidation of 1-^{14}C-palmitate by newborn piglet hepatocytes in primary culture. Hepatocytes were isolated from piglets chosen randomly after birth and prior to 12 h of age. Hepatocytes were plated into 25 cm^3 culture flasks and allowed a 4 h pre-incubation phase at 37°C in basal culture media. Basal media was replaced with incubation media containing palmitate (0.5 mM) and hormones at 4, 22, 46, and 70 h from initial plating. The accumulation of ^{14}C from 1-^{14}C-palmitate in CO_2 and acid soluble products (ASP) was determined in duplicate using treatment media containing 1-^{14}C-palmitate. Treatments for Exp. 1 (n=5) consisted of the application of two insulin/glucagon ratios (I 10^{-11} M/G 10^{-6} M and I 10^{-8} M/G 10^{-10} M) in the presence or absence of palmitate (0.5 mM). Treatments for Exp. 2 (n=4) consisted of increasing glucagon concentrations (G $10^{-11,-9,-7,-5}$ M) against a fixed insulin concentration (I 10^{-11} M) in the presence of palmitate (0.5 mM). DNA content for both experiments was unaffected by treatment but declined progressively ($p < .001$) with time by an average of 60% from 200 ± 59 to 80 ± 16 ug/flask. Results from Exp.1 and 2 revealed no effect ($p>0.1$) of treatment on the accumulation of ^{14}C in CO_2 or ASP. However, in Exp. 2 there was a significant decline with time ($p<.001$) in the accumulation of ^{14}C from 1-^{14}C-palmitate in both CO_2 and ASP levels where accumulation dropped 50% (155 ± 10 to 78 ± 12 nmol/h/mg DNA) and 63% (282 ± 20 to 105 ± 23) respectively. These results indicate that chronic exposure of newborn piglet hepatocytes to widely divergent hormonal concentrations of insulin and glucagon resulted in no detectable alterations in β-oxidation of 1-^{14}C-palmitate by newborn piglet hepatocytes in primary culture.

Key Words: fatty acid oxidation, hepatocyte, neonatal swine

605 Association of Endocrine Factors (Insulin-like Growth Factor-I and Binding Protein-3) with Litter Size in Yolkshire Breed. S.H. Yang[1], D.S. Seo[1], J.S. Yun*[1], W.J. Kang[1], K.C. Hong[1], S.S. Park[2], and Y. Ko[1], [1]*Department of Animal Science*, [2]*Graduate School of Biotechnology, Korea University*.

The litter size has been one of important economic traits in pig reproduction. Insulin-like growth factor-I (IGF-I) has been shown to mediate actions of steroid hormone or synergize with other endocrine factors so that it consequently plays roles in reproductive processes, including ovulation, implantation, maintenance of pregnancy, and fetal development. But, the effect of serum IGF-I on porcine litter size has not been studied much. Therefore, this study was conducted to relate serum estradiol (E2), progesterone (P4), IGF-I concentration, and IGF binding protein (IGFBP)-3 expression with porcine litter size. Moreover, the possible association with estrogen receptor (ER) as a candidate gene for the litter size was investigate. Sera from estrous cycle to postnatal growth were colleceted from pigs in two groups showing high and low litter sizes. Serum E2,, P4, and IGF-I concentration were measured by RIA and IGFBP-3 expression was detected by ligand blotting. DNA extracted from blood was utilized for PCR-RFLP to analyze ER genotypes of pigs in each group, which produced three polymorphic patterns. During estrous cycle, IGF-I and P4 concentration in both groups decreased from metestrus to estrus, but IGFBP-3 and E2 showed opposite expressions. Also, IGF-I and IGFBP-3 concentration decreased gradually as pregnancy proceeded. Unlike E2 and P4, IGF-I and IGFBP-3 decreased moderately as new born pigs grew. Significant differences in IGF-I amount between two groups were partially detected at metesterus ($P<0.001$), day 40 ($P<0.05$) of pregnancy, and day 30 ($P<0.05$) of postnatal growth. Furthermore, based on the ER genotype analyzed, low litter size group showed higher IGF-I concentration than high litter size group during the pregnancy and postnatal growth. Taken together, the results indicate that the serum IGF-I was correlated with steroid hormones system but not intimately with litter size in pigs. But, if the expression of IGF-I and IGFBP-3 were examined together with ER genotype, it is possible to utilize IGF-I as a probe for predicting the litter size in pigs. Thus, this study implies that porcine litter size might be affected by IGF-I through a mechanism acting locally at the ovary.

Key Words: Pig, IGF-I(Insulin-like Growth Factor-I), Litter Size

606 Quantification of bovine liver pyruvte carboxylase and phosphoenolpyruvate carboxykinase mRNA by Northern blot analysis. C. Agca* and S.S. Donkin, *Purdue University, West Lafayette, IN*.

Pyruvate carboxylase (PC; EC 6.4.1.1) and phosphoenolpyruvate carboxykinase (PEPCK; EC 4.1.1.32) are two rate limiting enzymes for gluconeogenesis. These enzymes are regulated, at least in part for bovine, through changes in mRNA abundance. Northern blot analysis provides data for relative differences between samples for a specific mRNA, but fails to provide quantative information between two different mRNA species. In order to overcome this limitation, 1050 bases of bovine PC and 1150 bases of bovine cytosolic PEPCK were cloned into transcription vectors. Plasmids containing PEPCK and PC inserts were linearized, and sense cRNA strands were synthesized and quantified. Total RNA (20 μg) from liver biopsy samples from 7 cows on -28 and +1 day relative to calving were separated by agarose gel electrophoresis. The electrophoresis was interrupted and 12, 25, 50, 100, 200, and 400 pg of PEPCK cRNA and 1.5, 3, 6, 12, 25, 50, and 100 pg of PC cRNA were added to the sample wells and the electrophoresis was continued. The RNA was transferred to Genescreen membrane, which was hybridized sequentially with ^{32}P labeled PEPCK and PC cDNAs. The abundance of mRNA (pg/μg total RNA) between samples taken on -28 and +1 days relative to calving is similar for PEPCK (17.3 ± 6.6 and 15.5 ± 6.7). However PC mRNA abundance is higher ($P < 0.05$) on +1 day (1.9 ± 1.1) compared to -28 day relative to calving (0.5 ± 0.2). The PEPCK to PC mRNA (pg/pg) ratio is diminished ($P < 0.05$) between -28 and +1 days relative to calving (35.2 ± 18.4 vs. 8.8 ± 3.8). This method provides quantitative information combined with the simplicity of Northern blot analysis to enable a direct comparison of changes in expression of PC and PEPCK mRNA. Results point to large differences between absolute quantities of PEPCK and PC mRNA. The relative quantities of these mRNA, assuming similar translational efficiencies, indicate that an increase in PC can contribute to increased gluconeogenesis from pyruvate at calving despite a lack of change in PEPCK.

Key Words: Pyruvate carboxylase, Phosphoenolpyruvate carboxykinase, Gene expression

607 Cloning of bovine hepatic cytosolic and mitochondrial phosphoenolpyruvate carboxykinase mRNA and expression in bovine liver. C. Agca*, R.B. Greenfield, and S.S. Donkin, *Purdue University, West Lafayette, IN*.

Phoshoenolpyruvate carboxykinase (PEPCK; EC 4.1.1.32) is compartmentalized in the cytosol and mitochondria and these forms are encoded by two different genes. Ruminant liver contains approximately equal activities of mitochondrial PEPCK (PEPCK-M) and cytosolic PEPCK (PEPCK-C). Our objective was to clone the two forms of bovine PEPCK cDNA and determine their expression in liver before and after calving. Regions of identity for human, rat, and mouse PEPCK-C and mouse and human PEPCK-M mRNA were used to design primers for reverse transcriptase-PCR. The 5' and 3' rapid amplification of cDNA ends protocol was used to clone the 5' and 3' ends of PEPCK-C and 3' end of PEPCK-M mRNA. The PCR products of PEPCK-C and PEPCK-M were ligated to pGEM 3Z plasmid and sequenced. Bovine PEPCK-C mRNA contains 2592 nucleotides, and encodes 622 amino acid. The cDNA coding sequence of bovine and human PEPCK-C show 84% identity. A partial clone of the 3' end of PEPCK-M contains 460 bases. The PEPCK-M clone is 76% identical to the corresponding human sequence. The coding sequence of bovine PEPCK-C is 54% identical to bovine PEPCK-M with negligible identities of 3' untranslated region. The 3' end clones were chosen as cDNA probes due to sequence differences. Total RNA from liver biopsy samples obtained from 10 cows at -28, -14, +1, +14, and +56 relative to calving were used for Northern blot analysis of PEPCK-C and PEPCK-M. Northern blot analysis shows that both PEPCK-C and PEPCK-M mRNA are approximately 2.5 kb. The correlation coefficient of PEPCK-C and PEPCK-M is 0.54. The mRNA PEPCK-C is increased ($P<0.05$) at 28 days after calving yet the abundance of PEPCK-M is unchanged during this period. The ratio of PEPCK-C to PEPCK-M is increased ($P<0.05$) during this interval. Because PEPCK-M provides 50% of the total PEPCK activity in ruminants, it may play an important role in gluconeogenesis yet PEPCK-M mRNA does not appear to be specifically regulated during the transition to calving.

Key Words: Gene expression, Compartmentalization, Phoshoenolpyruvate carboxykinase

608 The somatotropic axis of young calves can be modulated by nutrition and bST. A.L. Bork*, J.M. Smith, M.R. Foote, and M.E. Van Amburgh, *Cornell University, Ithaca, NY.*

Our objective was to investigate the responsiveness of the somatotropic axis in young calves. We hypothesized that young calves provided a higher plane of nutrition would express improved growth rates, higher insulin-like growth factor-I (IGF-I) levels, and a greater response to bST treatment. Nineteen neonatal Holstein bull calves were randomly assigned to one of two treatment groups at an average age of 4.2 d (week one) and fed milk replacer (MR) until nine weeks of age. Treatment (TRT) 1 calves were fed MR containing 20% crude protein (CP), 20% fat at a rate of 1.4% body weight (BW) dry matter (DM) per day. Calves assigned to TRT 2 were fed a 30% CP, 20% fat MR at a rate of 2.4% BW DM per day. Calves were weighed weekly on two consecutive days and DM intake was adjusted accordingly. At five weeks of age, on three consecutive days, all calves were given a daily injection of bST (120 μg/kg BW). Blood samples were obtained every Tuesday and immediately prior to first bST injection and 14 and 24 hours after the third injection. Plasma samples were later analyzed for IGF-I by radioimmunoassay after glycyl-glycine extraction. Average growth rates for calves assigned to TRT 1 and TRT 2 were 0.44 and 1.10 kg/day ($P< 0.001$), respectively. From week two to week nine of life, calves assigned to TRT 2 had higher circulating IGF-I levels compared to TRT 1, (128.5ng/ml vs. 73.3 ng/ml for TRT 2 and 1, respectively ($P < 0.001$)), consistent with the higher energy and protein intake. Calves on both treatments responded similarly to the bST challenge (40% increase in circulating IGF-I levels). Surprisingly, however, calves assigned to TRT 2 exhibited a 460 g/d increase in growth rate for the seven day period following bST challenge with no change in intake. Calves assigned to TRT 1 did not exhibit a change in growth rate. We conclude that the somatotropic axis is functioning in young calves, and that calves on a high plane of nutrition are not only able to respond to a bST challenge with higher IGF-I, but also exhibit a growth response at five weeks of age.

Key Words: Calves, Nutrition, IGF-I

609 Thyroid hormones regulate somatotroph abundance during chicken embryonic development. L. Liu* and T. E. Porter, *University of Maryland, College Park.*

We reported previously that corticosterone can induce somatotroph differentiation *in vitro* and *in vivo* and that triiodothyronine (T_3) can act synergistically with corticosterone to further augment the abundance of somatotrophs *in vitro*. The objective of the present study was to test our hypothesis that thyroid hormones regulate the abundance of somatotrophs during chick embryonic development. First, we tested if administration of T_3 to developing chick embryos could increase somatotroph proportions prematurely *in vivo*. Somatotroph differentiation normally occurs between embryonic day 12 (e12) and e16. The albumen of fertile eggs was injected on e11 with T_3 (12 pg, 120 pg, 1.2 ng). The embryos were then allowed to continue developing until e13, when pituitary cells were isolated and subjected to reverse hemolytic plaque assays and immunocytochemistry to detect GH-secreting and GH-containing cells, respectively. Injection of T_3 increased GH-secreting cells to 7.6±0.7% (12 pg of T_3) and 8.4±0.6% (120 pg of T_3) of all pituitary cells ($P<0.05$), compared to 3.8±0.6% for basal levels. The 1.2 ng dose of T_3 was ineffective. The percentage of GH-containing cells was increased from the control level of 4.6±0.9% to 7.4±0.9%, 9.4±0.9% and 12.6±0.9% by 12 pg, 120 pg and 1.2ng of T_3, respectively ($P<0.05$). Next, we evaluated the effects of the thyroid hormone synthesis inhibitor methimazole on somatotroph differentiation during development. Injection of 5 μg of methimazole on e9 decreased the abundance of GH-containing cells on e14 from 13.7±0.5% for vehicle treated embryos to 7.8±0.5% ($P<0.05$). Taken together, these results indicate that treatment with exogenous thyroid hormones can modulate somatotroph differentiation and that endogenous thyroid hormone synthesis may contribute to normal somatotroph differentiation. Since we reported that T_3 alone was ineffective *in vitro*, we interpret these findings to indicate that effects of treatments *in vivo* were due to interactions with endogenous glucocorticoids.

Key Words: Somatotroph, Triiodothyronine, Methimazole

610 Effects of recombinant bovine somatotropin (rbST) and nutrition on growth and muscle fiber profiles in early-weaned beef steers. K. E. Moulton*[1], T. G. Althen[1], A. R. Williams[1], L. R. Jefcoat[1], A. B. Moore[1], M. B. Solomon[2], and J. S. Eastridge[2], [1]*Mississippi State University, Mississippi State,* [2]*Beltsville Agricultrural Research Center, USDA, Beltsville, MD.*

Our objective was to determine effects of rbST and nutrition on growth and fiber profiles in beef calves. At 100 d of age, 48 crossbred steers were trained on the Calan Feeding System. At 155 d of age, steers were assigned to treatments in a 2x2 factorial design testing the effects of protein fed at levels according to NRC (NP), vs high protein diet (125% of NRC, HP) and rbST (Posilac, 2.2 mg/kg/14 d s.c., ST) vs no rbST (C). Blood samples were taken every 14 d for IGF-1 analysis. Treatments continued until 255 d of age and semitendinous muscle biopsy samples were collected to determine myofiber morphology. Every 28 d steers were evaluated via ultrasound for backfat (BF) and REA. The C-NP, C-HP, and ST-NP steers consumed more feed than the ST-HP steers (850, 878, 847 vs 724 kg, $P<0.05$). The ST steers had improved feed efficiency (FE) when compared to C (0.17 vs 0.15 G/F, $P<0.05$). Treatment with ST reduced BF (.59 vs .51 cm, $P<0.05$) and tended to increase REA (54 vs 51 cm2, $P=0.07$) at 255 d when compared to C steers. Steers fed the NP diet had more BF than steers fed the HP diet (.58 vs .52 cm, $P<0.05$). IGF-1 concentrations, cross-sectional areas for fiber types, and percentage distribution of SO fibers were not different between treatments ($P>0.10$). The ST treatment resulted in a decrease in percentage FOG (26 vs 31%, $P<0.05$) and increase in percentage FG (58 vs 53%, $P=.05$) fibers when compared to C steers. Steers treated with ST gained more efficiently, have less BF and tend to have larger REA than controls. Although concentrations of IGF-1 in blood serum and fiber cross-sectional areas were unaffected by ST, percentage distribution of FG fibers increased and percentage distribution of FOG fibers decreased in ST steers. These data substantiate earlier findings by our lab and demonstrate that ST treatment alters myofiber morphology in beef calves.

Key Words: rbST, Beef Cattle, Muscle Fiber Types

611 Location and ontogeny of thyrotrophs during chicken embryonic development. M. Muchow*, I. Bossis, and T. E. Porter, *Department of Animal and Avian Sciences, University of Maryland, College Park.*

We demonstrated previously that messenger RNA levels for the beta subunit of thyroid stimulating hormone (TSHβ) are maximal on embryonic day (e) 19 in chickens. However, little is known about the production of TSHβ protein in this species. The present study used a heterologous antiserum to rat TSHβ to determine the location and abundance of TSHβ producing cells during embryonic development. Western blot analysis was performed to determine the specificity of the rat TSHβ antiserum against the chicken protein. Rat TSH (10 ng), affinity purified chicken LH and FSH (1 μg each), and homogenates of chicken pituitary, liver, heart, and spleen (5 μg of protein each) were separated on a 16% SDS-PAGE gel and transferred to a nitrocellulose membrane, which was probed with the rat TSHβ antiserum. Identical peptide bands (about 17 and 30 kDa) were detected in both the rat TSH and the chicken pituitary samples. No bands were seen in the LH, FSH, or other tissue extract samples, supporting the specificity of the antiserum for chicken TSHβ. Thyrotrophs were localized in whole mount preparations of e19 pituitaries both by immunocytochemistry (ICC) using the rat TSHβ antiserum and by *in situ* hybridization (ISH) using a digoxigenin-labeled antisense riboprobe to chicken TSHβ. Both ICC and ISH localized thyrotrophs to the cephalic lobe of the anterior pituitary. Next, ICC was performed on dissociated pituitary cells to define the ontogeny of thyrotrophs during development. Pituitaries from e11-19 embryos and day 1 posthatch chickens were isolated, dispersed by trypsin digestion, and subjected to TSHβ ICC. TSHβ cells comprised 0.7 ± 0.1%, 4.0 ± 0.4%, 5.3 ± 0.4%, 7.0 ± 0.8%, 6.7 ± 0.7%, and 3.9 ± 0.4% of all pituitary cells on e11, e13, e15, e17, e19, and d1, respectively. Thus, thyrotrophs were rare on e11, and their abundance was maximal on e17 ($P<0.01$, $n=4$ separate trials). We conclude that TSHβ-producing cells are located in the cephalic lobe of the anterior pituitary and that the size of the thyrotroph population increases prior to hatching.

Key Words: Thyrotroph, Chicken Embryo, Development

612 Partial feed restriction induces pyruvate carboxylase mRNA but not phosphoenolpyruvate carboxykinase mRNA in liver of lactating dairy cattle. J.C. Velez* and S.S. Donkin, *Purdue University, West Lafayette, IN.*

The ability of dairy cattle to adapt to changes in nutrient intake requires appropriate changes in expression of several key genes in liver. We determined effects of partial feed restriction on expression of pyruvate carboxylase (PC), phosphoenolpyruvate carboxykinase (PEPCK), growth hormone receptor (GHR), and insulin-like growth factor-I (IGF-I) mRNA. Six mid-lactation Holstein cows were fed a total mixed diet for ad libitum intake during a 6-day period. Liver biopsy and blood samples were obtained at the end of the period and cows were then restricted to 50% of ad libitum intake for 5 days. Liver biopsy and blood samples were obtained at the end of the second 5-d period and cows were readjusted to ad libitum intake. Liver biopsy samples were also obtained after 12-d of realimentation. Plasma non-esterified fatty acids (μM) were unchanged (235 vs. 252; ad libitum vs. feed restriction) by feed restriction. Northern blot analysis of total RNA revealed a tendency (P<.15) for increased expression of PC mRNA during feed restriction. Expression of PEPCK, GHR and IGF-I remained unchanged during this period. Expression of PC and IGF-I were elevated (P<.05) by 68% and 356% respectively during realimentation compared with the ad libitum feeding period but there were no differences for PEPCK or GHR mRNA. The lack of coordinated changes in PC and PEPCK mRNA suggests expression of these enzymes that is mediated by separate signals in bovine liver. The data also demonstrates compensatory overexpression of PC and IGF-I mRNA as a consequence of feed restriction and realimentation.

Key Words: Feed restriction, Gene expression, Gluconeogenesis

613 Production responses to different porcine somatotropin injection regimes. F.R. Dunshea*[1], [1]*Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia.*

Thirty-two female crossbred pigs (initial weight 75 kg) were utilised in this experiment to investigate the effect of differing porcine somatotropin (pST) regimes on growth performance. Pigs were kept in individual pens and fed *ad libitum* a wheat-based diet formulated to contain 14.4 MJ DE/kg and 180 g ideal protein/kg. Treatments were daily injection with saline (Sal), daily injection with pST (5 mg) (D), bidaily injection of pST (10 mg) (2D) and injection of pST (12 mg) every Monday, Wednesday and Friday (MWF) for 3 weeks. On the days that pigs were not receiving pST they were injected with saline (0.5 ml). pST treatment had no significant effect upon ADG, despite being 100 g/d greater in the 2D and MWF pigs. All pST regimes caused a reduction in feed intake and FCR. Feed intake decreased after the first injection and for the D group remained low and constant. Feed intake for the 2D group was also reduced but not to as great an extent as in the D group. Feed intake in the MWF group showed a clear temporal response with feed intake being low during the week but increasing over the latter part of the weekend. Thus, feed intake on Sunday through Monday was 400 g greater (P<.001) that on Saturday through Sunday. Therefore, it appears that the effects of pST may be reduced when a 3d interval is used between injections. P2 back fat was significantly reduced with all pST injection regimes. Alternative pST injection regimes can improve growth performance in finisher pigs.

	Sal	D	2D	MWF	sed	P-value
ADG, g/d	769	773	874	871	79.1	.369
Feed intake, g/d	2894	2000	2378	2512	154	<.001
FCR, g/g	3.88	2.66	2.76	2.89	.20	<.001
P2 backfat, mm	19.8	14.8	16.3	15.9	1.2	.003
Change in P2, mm	6.5	.3	2.2	1.8	1.4	.001
Dressing, %	71.8	71.1	71.3	71.0	.7	.618

Key Words: Porcine somatotropin, Swine, Growth

614 Response to repeated bST challenges around weaning in Holstein heifer and bull calves. J.M. Smith*, M.E. Van Amburgh, A.L. Bork, and M.R. Foote, *Cornell University, Ithaca, NY.*

Our objectives in the current study were (1) to compare the responses to repeated ST challenges during the weaning period, and (2) to compare the response to ST challenge between heifer and bull calves. Calves received 4 L colostrum initially, then were fed a 30% CP: 20% fat milk replacer (MR) twice daily (MR DM at 2% of BW per d) and free choice water. Calves were weighed weekly and feed amounts adjusted accordingly. Calves were first offered starter (26.5% CP, 1.07 Mcal NEg/kg, DM basis) after reaching 100 kg BW. When starter was introduced, MR DM was offered at 1% BW per d for one week, then at 0.5% BW per d for one week before being discontinued. Blood was collected from three heifer and three bull calves during three 24-hr periods following bST challenges. The challenge protocol consisted of injecting 120μg/kg BW bST once daily for three days. The first bST challenge was performed when calves weighed about 105 kg. Two wk later, which was 10d after starter was first offered and MR restricted, the second bST challenge was performed. The third bST challenge took place two wk after the second challenge and 10 d after calves had been totally weaned off milk replacer. Blood was collected prior to the first bST injection (-72 hr) and at 0, 4, 8, 12, 14, 16, 18, 20, 22, and 24 hr after the third injection. Plasma aliquots were stored at -20°C until analyzed for IGF-1 by RIA. Growth rates for the heifers and bulls during the period encompassing the challenges were not significantly different (P = .18), averaging 0.97 and 1.11 kg/d, respectively. Circulating IGF-1 at -72 hr was not different (P = .61) between heifer and bull calves. For all calves the response to challenge, calculated as the difference between the 14-hr post-challenge value and the -72-hr value, was not different (P = .902) among the three periods before, during, and after weaning, but was greater in heifers than bulls (P = .038). We conclude that weaning does not necessarily lead to uncoupling of the somatotropic axis and that it is reasonable to apply data derived from milk replacer-fed bull calves to heifers.

Key Words: calves, somatotropin, insulin-like growth factor

615 Accuracy of volume measurements by magnetic resonance imaging. A.M. Scholz*[1], A.D. Mitchell[2], P.C. Wang[3], and H Song[3], [1]*University Munich, Experimental Station Oberschleissheim, Germany,* [2]*USDA, ARS, Growth Biology Lab, Beltsville, MD,* [3]*Howard University, Washington, DC.*

Volume measurements of body regions were accomplished within three different magnetic resonance imaging (MRI) experiments on totally 96 pigs from 10 to 60 kg (MRI_I: n=28, MRI_II: n=22) and from 30 to 90 kg (MRI_III: n=46). The purpose was to evaluate the accuracy of MRI for predicting the chemical carcass composition (MRI_II, MRI_III), and the dissected weights of separate muscles or fat tissues (MRI_I). The MRI was performed on a Picker Vista 1.5 Tesla whole body magnet generating successive axial images with a slice thickness of 1 cm. The images were processed by means of a digitizing tablet using the Sigma Plot PC3D program for MRI_I and MRI_II, and by means of the 'Analyze' software (Mayo Foundation) for MRI_III. The whole volumes of both longissimus dorsi muscles (MLD), the overlying fat (BF), and ham muscles were quantified in MRI_I and MRI_II. In experiment MRI_III, the volume of both MLD and of the overlying fat was measured in a defined 10 cm section and the volume of the ham with overlying fat in a defined 15 cm section. A stepwise regression analysis was performed, estimating carcass lipid % (CLipid%) and carcass lean % (CLean%, sum of carcass protein % and water %) from volumes of MRI_II and MRI_III. A higher accuracy in estimating body composition resulted from a body weight range of 30 - 90 kg compared to 10 - 60 kg due to a very low variation in the pigs < 20 kg. However, the correlations (r) between the dissected weights and MRI volumes of specific tissue groups are very high in the weight range of 10-60 kg, e.g., with r=0.967 for MLD and r=0.973 for BF in MRI_I.

CLipid%	R^2	$\sqrt{MSE}$	C.V.	d.f.	Variables in the Equation
MRI_II	0.765	1.802	10.764	2	BF Volume, Total Fat-Muscle Ratio
MRI_III	0.898	1.500	6.945	2	Fat Volume LD, Fat-Lean Ratio HAM
CLean%					
MRI_II	0.702	2.174	3.056	2	Total Fat-Muscle Ratio, BF Volume
MRI_III	0.857	1.625	2.181	2	Fat Volume LD, Fat-Lean Ratio HAM

Key Words: Body Composition, Magnetic Resonance Imaging

616 Changes in total body and regional bone mineral content and bone density in pigs from 4 to 137-kilograms body weight. A. D. Mitchell*[1], A. M. Scholz[2], and V. G. Pursel[1], [1]*USDA, Agricultural Research Service, Beltsville, MD,* [2]*Ludwig Maximillians University-Munich, Oberschleissheim, Germany.*

Traditional methods of assessing bone mineral deposition in pigs involve slaughter followed by dissection, ashing, and/or chemical analysis. By the use of dual energy X-ray absorptiometry (DXA) it is now possible to perform many of these measurements on the live animal. The purpose of this study was to quantify the changes in total body and regional bone mineral content (BMC, g) and bone mineral density (BMD, g/cm^2) in pigs between 4 and 137-kg body weight (BWT). A total of 992 DXA scans were performed on anesthetized pigs, using a Lunar DPXL densitometer. Linear and polynomial regression analysis was performed using SigmaPlot 5.0 procedures. Relative to BWT, the BMC for total body, front legs, back legs, and trunk were described by 2nd order polynomial regression with R^2 values of 0.965, 0.931, 0.952, and 0.820, respectively. Relative to total body BMC, the BMC of the front legs, back legs, and trunk was described by linear regression with growth coefficients (b = slope) of 0.274, 0.298, and 0.213 and R^2 values of 0.97, 0.98, and 0.91, respectively. Likewise, the increase in BMD relative to BWT was described by 2nd order polynomial regression with R^2 values of 0.943, 0.905, 0.929, and 0.888, for total body, front legs, back legs and trunk, respectively. Relative to total body BMD, the BMD of the various regions was described by linear regression with growth coefficients (b = slope) of 1.75, 1.01, 0.99, 0.97, 0.93, 0.75, and 0.37 for the head, front legs, back legs, spine, pelvis, trunk, and ribs. Thus, during the growth of pigs from 4 to 137 kg, the largest increase in bone mineral deposition was observed in the back legs while the largest increase in bone mineral density was observed in the head.

Key Words: Bone Mineral Content, Bone Mineral Density, Swine

617 Dual energy X-ray absorptiometry accurately predicts whole body and carcass composition in pigs. D. Suster*[1], B.J. Leury[2], J.D. Wark[3], D.J. Kerton[1], E. Ostrowska[1], and F.R. Dunshea[1], [1]*Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Victoria, Australia,* [2]*Dept. of Animal Production, University of Melbourne, Victoria, Australia,* [3]*Dept. of Medicine, Royal Melbourne Hospital, Victoria, Australia.*

An Hologic QDR4500 Dual energy X-ray absorptiometer (DXA) was used to determine body composition in 150 pigs ranging from 10 to 130 kg live weight. Pigs were slaughtered commercially after the final scan, eviscerated and the empty carcass scanned before chemical analysis. Values predicted by DXA for fat, lean and bone mineral (BM) mass, for live animal and carcass were compared with chemically determined values for empty body and empty carcass, respectively. Fat depth at P2 was measured directly. A linear regression model y=ax+b, where y is chemical composition and x is the DXA predicted value was used. Scan repeatability in the live animal was also examined by scanning 15 pigs (35-45 kg live weight) in triplicate. Lean tissue predicted by DXA (live animal, y=.83x+1.98, rsd=1.79 kg, r^2=.99; carcass, y=.95x-.85, rsd=1.51 kg, r^2=.99) was highly correlated with chemical measurements. While DXA slightly underestimated lean content of the carcass, it overestimated lean content of the live animal. At least some degree of overestimation in vivo presumably arose from water in the gut lumen being included as lean tissue. DXA predictions of fat (live animal, y=1.33x-1.43, rsd=1.69 kg, r^2=.96; carcass, y=1.21x-.91, rsd=1.24 kg, r^2=.97) were highly correlated with proximate analyses, although the in-built algorithms underestimated fat. A positive correlation was also observed between P2 fat depth and chemical fat but the correlation was not as strong as the DXA prediction (rsd=2.89 %, r^2=.78). Bone mineral predicted by DXA (live animal, y=1.19+.22, rsd=.19 kg, r^2=.93; carcass y=1.07x+.09, rsd=.15 kg, r^2=.92) also correlated well with chemical ash. Coefficient of variation for repeated scans are low for lean (CV=.32%), fat (CV=2.03%) and BMC (CV=1.72%). These data demonstrate the potential of DXA to determine body composition in the live animal and carcass, and to improve on current routinely used methods. *Supported by the Pig Research and Development Corporation*

Key Words: DXA, Swine, Body Composition

618 Body composition changes of Angus females from breeding through second parturition determined by real-time ultrasound. G. H. Rouse*[1], D. E. Wilson[1], C. L. Hays[1], and A. Hassen[1], [1]*Iowa State University, Ames.*

The objective of this research was to measure changes in muscle, subcutaneous fat, midintramuscular fat as 255 Angus females developed from initial breeding through second parturition. Real-time ultrasound scans and weights (WT) were collected serially 5 times on the females: before breeding (BB), before first parturition (P-1), at weaning (W-1), before second parturition (P-2) and at weaning (W-2). Ultrasound scans collected included fat thickness at the 12th rib (FTK), ribeye area at the same location (REA) and percent intramuscular fat (PF). Least squares means of these live animal measures are shown below. Weight and fat thickness increase in linearly except for a loss in weight and condition between first parturition and weaning. Ribeye area increased at each of the 5 scans, while change in % intramuscular fat were small, one percent. Heifers were divided into 3 frame sizes based on adjusted yearling hip height, less than 5, 5-6, and above 6. Smaller heifers had less PF P<.05 than large heifers at initial breeding and after their second calf P<.10. While these same smaller heifers had less FTK initially and more FTK after their second calf than the large heifers, the differences were not significant. These results indicate changes in FTK are much greater than changes in PF, while REA continued to develop even during weight and condition losses following first calving.

	FTK,cm	PFAT,%	Wt.kg	REA.cm2
BB	$0.21\pm.20^{a,b}$	$4.95\pm.91^{a,b}$	$411.18\pm26.64^{a,c}$	43.19 ± 6.65^{a}
P-1	$0.41\pm.07^{a,b}$	$5.13\pm.34^{a,b}$	457.49 ± 9.23^{b}	51.75 ± 2.47^{b}
W-1	$.36\pm.03^{a}$	$4.53\pm.11^{a,b}$	419.67 ± 11.05^{a}	$59.34\pm.8\ 4^{c}$
P-2	$.61\pm.08^{b}$	$4.11\pm.35^{a}$	$500.34\pm21.70^{b,c}$	$63.91\pm2.\ 59^{d}$
W-2	$.74\pm.18^{b}$	$5.11\pm.81^{b}$	572.63 ± 45.27^{d}	$77.12\pm5.91\ ^{e}$

Least squares means within a column with a different superscript are statistically significant (P<.05)

Key Words: Beef heifers, Composition, Parturition ultrasound

619 Assessment of alternative linear statistical models for studying growth in crossbred lambs. G.J.M. Rosa*[1,2], M. A. Neres[1,3], C. Costa[1], and D. Gianola[2], [1]*FMVZ-UNESP, Botucatu, SP, Brazil,* [2]*Animal Sci. Department, University of Wisconsin, Madison,* [3]*FCA-UNIMAR, Marilia, SP, Brazil.*

Data were body weights of 32 Suffolk backcross lambs in a 2 × 4 factorial experiment (2 sexes; 4 rations). Each lamb was weighed at 24, 35, 46 and 57 days of age, creating a longitudinal series. The data were analyzed by likelihood-based and Bayesian linear methods under normality assumption. A first model was a split-plot in time, assuming constant residual variance and intra-lamb correlation. An alternative model was multivariate, allowing for heterogeneous variance and correlations, but at the expense of a less parsimonious parameterization. Additional models fitted different structures to the residual covariance matrix. These included a model with first-order auto-regressive, AR(1), residuals, as well as Toeplitz and compound-symmetry covariance structures. On the basis of Akaike's and Schwarz' criteria for model assessment, a linear regression on time with different coefficients for each ration and an AR(1) residual error term was found to have the better fit. A Bayesian version of this model, using flat priors and Gibbs sampling, led to estimates that were similar to those based on likelihood.

Key Words: Longitudinal data, Multivariate models, Lamb growth

620 A random regression model for analysis of lamb growth. G.J.M Rosa*[1,2], M. A. Neres[1,3], C. Costa[1], and D. Gianola[2], [1]*FMVZ-UNESP, Botucatu, SP, Brazil,* [2]*Animal Sci. Department, UW-Madison, WI,* [3]*FCA-UNIMAR, Marilia, SP, Brazil.*

A 2 × 3 factorial experiment was conducted to evaluate effects of sex of lamb and of dietary levels of hay (0, 15 and 30% in diet) on growth of Suffolk backcrosses. Data were from 12 animals of each sex. Body weights were recorded at 61, 75, 85 and 99 days of life, or until they reached 30kg (culling weight), producing longitudinal unbalancedness. The data were analyzed in 3 ways. First, a two-stage procedure fitted linear regressions on age to each lamb at the first stage. Subsequently, the least-squares estimates (intercept and slope) were described with a

bivariate linear model having effects of sex of lamb and ration; least-squares estimates were assumed bivariate normal, and independent between lambs, but with a 2 × 2 covariance structure within animals. The second analysis fitted a longitudinal mixed effects linear model, with fixed effects of sex and ration and random effects of lamb. The variance-covariance matrix of lamb-specific regression coefficients was estimated by REML; effects of sex and ration were estimated using empirical best linear unbiased estimation. A Bayesian linear mixed-effects model (as in the second analysis) using Gibbs sampling and flat priors for all parameters was undertaken as well. The last two procedures are more efficient, since the two-stage method introduces extra variability in parameter estimation. Likelihood-based and the Bayesian method gave similar results, except for (co)variance components. The Bayesian procedure takes into account uncertainty about all parameters in the model, producing more satisfactory finite-sample inference.

Key Words: Longitudinal data, Mixed model, Lamb growth

621 Dietary betaine does not effect whole body palmitate oxidation. D. Wray-Cahen*[1], T.J. Caperna[2], E. Virtanen[3], and N.C. Steele[2], [1]*FDA/CDRH, Rockville, MD,* [2]*USDA/ARS, Beltsville, MD,* [3]*Finnfeeds Intl., Wiltshire, UK.*

Dietary trimethylglycine (betaine, BET) is associated with reduced carcass fat in the growing pig. We explored potential effects of BET on fatty acid oxidation and metabolism during intravenous infusion of 1-^{13}C-palmitate (PA). Pigs (55 kg BW, n=6) were fed one of three diets containing 0% BET (control), 0.125% BET or 0.5% BET at 80% of *ad libitum* energy intake. Diets were corn-soybean meal-based and contained 17.6% crude protein and 3.27 Mcal ME/kg; experimental diets were fed for one week before initiation of infusion studies. Animals were catheterized to allow for simultaneous sampling and infusion. PA was complexed to methyl-β-cyclodextrin (MBC) for intravenous infusion. After priming the pigs with ^{13}C-bicarbonate, the PA/MBC complex was infused into pigs under steady-state fed conditions for 4 h at 0.7 μmol/kg/h. The control and 0.5% BET pigs were also studied under fasted conditions (n=5). Metabolism and oxidation of infused PA were determined by breath or blood $^{13}CO_2$-enrichments. CO_2 (IRMS) and palmitate (GCMS) isotopic enrichments were determined by mass spectrometry. Under steady-state fed conditions, palmitate oxidation was 0.163±0.14, 0.144±0.030, 0.163±0.034 μmol/kg/min for control, 0.125% BET, and 0.5% BET pigs, respectively; dietary treatment had no effect on oxidation (P>0.1). Fasting increased overall oxidation rates by 7-8 fold in both the control and 0.5% BET groups (P<0.01), but fasting oxidation rates were similar (P>0.1) between these dietary treatment groups. Under these experimental conditions, dietary BET had no apparent effect on whole body fatty acid oxidation either in the fed or fasted state and therefore the reduction in adipose accretion must be via another mechanism. Supported in part by Finnfeeds Intl.

Key Words: Betaine, Palmitate oxidation, Lipid metabolism

622 Effects of betaine on nutrient partitioning in feed-restricted pigs. I. Fernandez-Figares*[1], D. Wray-Cahen[2], N.C. Steele[1], R.G. Campbell[3], D.D. Hall[4], E. Virtanen[5], and T.J. Caperna[1], [1]*USDA/ARS, Beltsville, MD,* [2]*FDA/CDRH, Rockville, MD,* [3]*BMI, Gridley, IL ,* [4]*United Feeds, Sheridan, IN,* [5]*Finnfeeds Intl., Wiltshire, UK.*

Dietary betaine (BET) is associated with decreased lipid deposition and altered protein utilization in pigs. Recent reports have suggested that substantial positive effects of BET on feed efficiency are greater in energy-restricted pigs. The purpose of this study was to examine the effects of BET on growth and body composition in young feed-restricted pigs. Thirty-two Landrace x York barrows (36 kg, n=8 pigs per group) were fed one of four corn-soybean meal-skim milk based diets containing 0, 1.25, 2.5 or 5g/kg BET. Pigs were fed at 73% *ad libitum* (ARC) and feed allotment was adjusted weekly according to body wt. At 64 kg, pigs were electro-stunned, exsanguinated and organs were removed and weighed. Carcasses were chilled for 24 h at 4C to obtain carcass measurements. Fat depths along the midline and at P1, P2, P3 sites at 10 th rib were determined. One half of each carcass and total viscera (VIS) were ground for chemical analysis (H_2O, fat, protein, and ash). ADG was 475, 472, 501 and 499 g/d (PSE=23) for pigs consuming 0, 1.25, 2.5 or 5g/kg BET, respectively. Compared to controls, pigs consuming .5% BET had 9.8% less carcass fat, (481 vs 434 g/kg DW, PSE=20, P<0.05); fat depth at P3 was 26% lower in .5% BET pigs (P<0.08). Carcass protein: fat ratio was 0.96 for controls and 1.13 for .5% BET pigs (PSE=.09, P<0.10) and carcass protein deposition rate was enhanced by 17% (P<0.10) in .5%BET pigs, compared to controls. Linear regression analysis indicated a positive linear association between BET level and carcass lean gain efficiency (P<0.13) while negative linear trends for small intestine wt (P<0.11) and total VIS wt (P<0.13) were noted. These data suggest that BET alters nutrient partitioning in feed-restricted pigs such that protein deposition is enhanced at the apparent expense of carcass fat and in part, VIS tissue. Supported by Finnfeeds Intl. and NATO Science Fellowship (IF-F).

Key Words: betaine, body composition, pigs

623 Effect of yeast culture in calf starters fed to Holstein heifer calves. P.C. Hoffman*[1], G.J. Swart[1], J.E. Garrett[2], and A.J. Nytes[3], [1]*University of Wisconsin, Madison,* [2]*Diamond V Mills, Cedar Rapids, IA,* [3]*Vita Plus Corp., Madison, WI.*

Eighty Holstein heifer calves (age = 1 d) were allocated to one of two dietary treatments. Calves were offered a commercial calf starter with (Yeast) or without (Control) 10 g/kg of Diamond V XP Yeast Culture ad libitum for 49 d. Calves were allocated to treatments over a 30 d period and were housed in individual calf hutches. Calves were fed 5.0 l/d of pasteurized waste milk in two equal feedings. Calf starters (Yeast and Control) were offered ad libitum starting d 2 until d 49. Calves were weaned when they consumed 900 g of calf starter for 3 consecutive days. Intake of calf starter was recorded weekly. Body weight (BW) of calves was recorded at entry, weaning, and at 49 d. Data were analyzed as a completely randomized design using ANOVA procedures of SAS. Two calves were removed from the trial due to health problems unrelated to treatment. Calves fed Control were weaned earlier (43.3 vs 45.9 d; $P < 0.05$) as compared to calves fed Yeast. Inclusion of yeast culture in calf starters reduced ($P < 0.03$) 49 d starter intake (20.9 vs 26.6 kg). There were no differences in BW at weaning, BW at 49 d, average daily gains, or feed efficiency between calves fed Control or Yeast. Data suggest yeast culture inclusion in calf starters decreased starter intake and increased weaning age. Mechanisms explaining these observations are unavailable at this time.

Item	Control	Yeast	SE	$P <$
Begin BW, kg	40.3	40.5	0.92	0.39
Weaning Age, d	43.3	45.9	1.02	0.05
Weaning BW, kg	64.2	65.5	1.07	0.67
49 d BW, kg	69.3	67.6	1.61	0.12
49 d ADG, g/d	590	554	28.6	0.22
Starter Intake, kg	26.6	20.9	2.39	0.03

Key Words: Yeast, Calves, Starter

624 Effect of Lean Growth Rate on Puberty Attainment of Gilts. J. L. Patterson*[1], R. O. Ball[1], H. J. Willis[2], F. X. Aherne[2], and G. R. Foxcroft[1], [1]*University of Alberta, Edmonton, Alberta,* [2]*Alberta Agricultre, Food and Rural Development, Edmonton, Alberta.*

The current trend in the production of market pigs places emphasis on lean tissue growth rate. However, it is unclear how high lean growth rate impacts sexual development of gilts. One hundred sixty-eight prepubertal Genex Manor hybrid F1 gilts were used to examine the effect of lean growth rate on the attainment of puberty. At approximately 96 d of age and 54 kg weight, gilts were allocated with respect to growth rate and litter origin to one of two dietary treatments: 1) a diet formulated to optimize lean growth rate (O; n=84) 2) a diet producing normal lean growth rate (N; n=84). All gilts were fed treatment diets ad libitum and housed in groups of six. Weight, backfat and loin depth, and feed intake were measured weekly. Starting at 134.7 ± .26 d (mean ± sem) of age, gilts received 20 min direct exposure to a vasectomized boar daily as a pen group for pubertal stimulation. Puberty attainment was determined as the day gilts first exhibited the standing reflex in response to contact with a boar. At pubertal estrus, body weight, backfat and loin depths were recorded. Diet affected (P≤.05) weight (O, 73.7 ± .3; N, 71.2 ± .3 kg), growth rate (O, .63 ± .002; N, .61 ± .003 kg/d), loin depth (O, 44.0 ± .3; N, 41.7 ± .3 mm), fat depth (O, 12.3 ± .2; N, 11.6 ± .2 mm) and estimated lean growth rate (O, .37 ± .003; N, .35 ± .003 kg/d) during the growth period (start to stimulation). Feed consumed over the growth period differed (P≤.10) (O, 2.5 ± .05; N, 2.6 ± .05). Of the 160 gilts completing the trial, only five did not reach puberty by 200 d. Diet did not affect age at puberty (O, 158.6 ± 2.0; N, 158.5 ± 2.0)

or days to puberty (O, 28.4 ± 2.0; N, 28.3 ± 2.0). Litter origin affected age at puberty (P=.02) and days to puberty (P=.002). Results indicate that observed differences in lean growth performance during prepubertal development had no effect on the age at puberty in O and N gilts, nor was overall lean growth rate at stimulation associated with pubertal age (r=.001 P=.75).

Key Words: Gilt, Puberty, Growth

625 The importance of a high feed intake during lactation of primiparous sows nursing large litters. J.J. Eissen[1], J.W.M. Merks*[2], M.W.A. Verstegen[1], and K.H. de Greef[3], [1]*Wageningen Institute of Animal Sciences, Wageningen University, Wageningen, The Netherlands,* [2]*IPG, Insitute for Pig Genetics B.V., Beuningen, The Netherlands,* [3]*Institute for Animal Science and Health, ID-Lelystad, Lelystad , The Netherlands.*

The objective of this study was to investigate the effects of nursing a large number of piglets on lactation and post-weaning performance of primiparous sows and whether a larger feed intake can prevent possible negative effects. Data were recorded on 307 ad libitum fed sows of three genotypes in an experiment where litter size was standardized to 8, 11 or 14 piglets during a four-week lactation. Sows were fed ad libitum from day 10 after farrowing and piglets had no access to creep feed during lactation. Daily feed of sows was not affected by litter size for two genotypes, whereas it was curve-linearly affected for the third genotype (P<.05) with a maximum at 10.8 piglets. Backfat thickness loss of the sows increased linearly with litter size (P<.05) for two genotypes. In the third genotype backfat loss increased only at large litter sizes >9.8 piglets (P<.01). Body weight loss of the sow and litter weight gain increased linearly with litter size (P<.001). Differences in responses to increasing litter size found between the three genotypes may be related to differences in feed intake pattern during lactation, upper critical temperature and body composition of sows. Sows nursing more piglets during lactation had a higher probability of a prolonged weaning-to-estrus interval. A higher feed intake during lactation reduced tissue loss of the sow, increased litter weight gain (P<.01) and reduced the probability of a prolonged weaning-to-estrus interval. At high levels of litter size, a one-kg increase in feed intake resulted in a lower output, measured as reduced body tissue loss or increased litter weight gain, compared with low levels of litter size. This may be related to higher maintenance requirements of sows due to heat stress and (or) less optimal conditions for piglet weight gain at high levels of litter size. Selection for a larger feed intake during lactation and improvement of environment and diet factors to reduce occurence of heat stress is recommended.

Key Words: Feed intake, Primiparous sows, Litter size

626 Effect of increasing nutrient intake to sows from day 28-56 of gestation on subsequent progeny performance. P.C. Penny*[1], M.A. Varley[2], and S. Tibble[3], [1]*JSR Healthbred Ltd, Southburn, UK,* [2]*SCA Nutrition Ltd, Thirsk, UK,* [3]*SCA Iberica S.A. Mequinenza, Espana.*

Utilisation of consumed feed from 40-100 kg BW and it's conversion into pig growth is a major determinant of efficient pig meat production. Targeting specific time windows during gestation can potentially influence lean tissue deposition in subsequent progeny via changes to foetal development. The objective of this study was to examine the effect of increased nutrient intake during day 28-56 of gestation on progeny growth from weaning to slaughter. Twenty four multiparous sows (JSR Genepacker 90) were randomly allocated between two treatments, Standard (ST) 2.5 kg/d or Elevated (EL) 5.0 kg/d from d 28-56 of gestation. Three boars and gilts were weaned from each sow and were housed in groups of twelve from d 58 to slaughter. All pigs received identical nutrition and were weighed on d 58, 93, 128 and 159. Quantity of feed consumed during gestation was lower (P<.01) for ST than EL sows (322 vs 383 kg). There were no differences for born alive, litter weight at birth and weaning, or average daily feed intake (ADFI) between ST and EL sows. No significant performance response was observed from weaning to d 93. ST progeny produced a significantly lower average daily gain (ADG) from d 93-128 (P<.05) compared to progeny from EL fed sows (0.697 vs 0.743 kg). Gain/Feed (G/F) for ST progeny was also substantially reduced (P<.05) during this same time window (0.38 vs 0.41). Rib lean measurement (52.3 vs 54.4 mm) showed a positive response (P<.08) towards those progeny from EL fed sows. These results suggest performance benefits are obtainable from progeny which have been derived from sows that have received increased maternal nutrients during a specific foetal development window.

Key Words: Sows, Gestation, Performance

HORSE SPECIES

627 Correlation of real-time ultrasonic measurement of longissimus muscle area of thoroughbred horses with lifetime earnings and average earnings per win. R. L. Dobec*, M. L. Borger, and D. B. Foye, *The Ohio State University Agricultural Technical Institute, Wooster.*

The primary objective of this study was to estimate the relationship of real-time sonoray measurements of fat depth and longissimus muscle area of thoroughbred horses with lifetime earnings and average earnings per win. Mares with racing records at the Keeneland 1998 November sale (n=44) were randomly selected and scanned for longissimus muscle area (LEA) and center loin fat depth (BR) posterior to the last rib (18th rib). An Aloka 500V console (Animal Ultrasound Services, Inc. Ithaca, N.Y.) with a 17.0 cm 3.0 megahertz linear probe was used for scanning. Age, earnings, average earnings per win, and total wins were obtained from catalog data. Longissimus muscle tracing and loin fat depth measurement were estimated using the Critical Vision Technology (CVT). Data were analyzed using SAS. Correlations of LEA with lifetime earnings and average/win were .18 and .13. The value of LEA as a predictor of racing success was significant (p≤.04). Mean LEA for this study was 23.4, std. dev. = 2.2. There was enough relationship to racing ability to merit further research with larger sample size.

Key Words: Racehorses, Thoroughbred, Ultrasonics

628 Tibial optical bone density is positively correlated with bone strength. K.L. Waite*, B.D. Nielsen, D.S. Rosenstein, and K.D. Roberson[1], *Michigan State University, East Lansing.*

Radiographic photodensitometry is a non-invasive method of estimating optical bone density in the horse. There is concern in the equine research community, however, that optical bone density is not correlated with bone strength. The objective of this study was to determine the correlation between optical bone density as determined by radiographic photodensitometry and bone strength. The hypothesis was that there is a significant positive correlation between optical bone density and bone strength. Tibiae, humeri and femurs were removed from turkeys euthanized as part of a separate study. Dorso-palmar radiographs were taken (57 KV, 400 mA, 4 msec, 1.6 mAs) to determine radiographic bone aluminum equivalence (RBAE). An aluminum stepwedge penetrometer was exposed with each radiograph as a standard. Radiographs were scanned at two locations on the bone and logarithmic regression was used to determine the lateral and medial RBAE using the thickness of the stepwedge and the maximum optical bone density readings of these cortices. Total RBAE was determined using the total area of the bone divided by the total area of the stepwedge. Shear tests were conducted with a double block test fixture designed to exert a shear force on a 5 mm section of the mid-diaphysis of each bone, with a load rate of 5 mm/min. Correlations between RBAE (mm ^{2}) and load (N) were calculated using the correlation procedure of SAS (6.12). There was no correlation between RBAE and strength in any of the femur and humerus measurements taken. No difference was found between tibial RBAE taken at the mid-diaphysis or the nutrient foramen, and tibial data were pooled. Total tibia RBAE was correlated with bone strength (r=.56, P=.0009), as was medial RBAE (r=.47, P=.0073) and lateral RBAE (r=.56, P=.0009). These data suggest there is a positive correlation between optical bone density and bone strength in the tibia and support radiographic photodensitometry as an effective, non-invasive means of detecting potential differences in bone strength in the live animal.

Key Words: Radiographic photdensitometry, Bone strength, Correlation