277 The effect of daily photoperiod on growth of commercial broilers. 3. Skeletal development. M. S. Lilburn*[1] and A. Mitchell[2], [1]*Ohio State University, Wooster,* [2]*Growth Biology Lab, USDA, Beltsville, MD.*

Broiler starter diets from three commercial feed mills (same company, different locations) were fed to day-old Hubbard Hi-Y broiler chicks along with a Control diet manufactured at Ohio State University. The analyzed calcium levels were as follows: Source 1, .76% ; Source 2, .97% ; Source 3, .81 % ; Control, .98%. Each of the diets was fed to 5 replicate pens of broiler chicks in Petersime battery brooders in each of two light controlled rooms. In Room A, the chicks were exposed to a 24 hr photoperiod from 0 to 4 d and 22 hr from 5 to 21 d whereas in Room B, the photoperiod was decreased to 16 hr at 5 d of age. At the end of the study, each chick was weighed and the tibia and femur were removed for length, width @ 50% of length, defatted dry weight and bone mineral content. Chicks exposed to 16 hr of light weighed significantly less than those chicks exposed to 22 hr (706 vs 747 g; $P < .0001$). The 16 hr photoperiod also resulted in a significant decrease ($P < .01$) in all bone measurements: tibia wt, 1.58 vs 1.78 g; tibia length, 6.34 vs 6.48 cm; tibia width, 5.8 vs 6.0 mm; femur length, 4.82 vs 4.93 cm; femur width, 6.7 vs 7.1 mm. Tibia and femur bone mineral content and bone mineral density were significantly greater in birds fed the Source 2 and Control diets compared with birds fed the Source 1 and Source 3 diets. These same bone mineral measurements were consistently higher in the 22 h. photoperiod though the differences were not always significant. In conclusion, variability in commercial starter diets combined with early photoperiod restriction may have a negative effect on skeletal development in broilers.

Key Words: Bone, Photoperiod, Calcium

278 Spatial disparity of ammonia flux within a broiler house at one and 21 days of age. D. M. Miles*[1], P. R. Owens[1], D. E. Rowe[1], and S. L. Branton[2], [1]*USDA-ARS, Waste Management and Forage Research Unit, Mississippi State, MS,* [2]*USDA-ARS, Poultry Research Unit, Mississippi State, MS.*

Ammonia concentrations greater than 25 ppm in broiler houses have been linked to emasculated birds. The objectives of this study were to measure ammonia and other gas fluxes in a commercial broiler house and assess any spatial variabilities. Application of these findings include the development of optimum sampling methods as well as the identification of characteristics of modern tunnel ventilated houses that contribute to gas emissions. Researchers hypothesize that litter age, moisture, pH, temperature, and airflow patterns affect gas flux values and these parameters vary spatially. Ammonia, nitrous oxide, carbon dioxide, methane, and carbon monoxide were measured using a photoacoustic multigas analyzer along with flux boxes. Samples (n=36) were collected systematically throughout the house along a set grid. Twenty-eight flocks had been grown on the litter prior to the summer flock sampling with chicks in the house at one (placement) and 21 (mid-growout) days of age. At one day of age during half-house brooding, average NH_3 flux was 498 mg/m^2-hr for the brood area and 372 mg/m^2-hr for the vacant end of the house with peak areas near the middle of the cool cell end (where airflow is not well established) and near the north side wall (an area of high litter moisture, 37%). At 21 days of age, litter temperatures were reversed from those at chick placement and were greater near the fan end of the house. Both ranged from about 25.6 to 31.9 C. Litter pH was greater in the nonbrood half of the house at placement and mid-growout. Average NH_3 flux for the mid-growout was 136 and 310 mg/m^2-hr for the brood and fan ends. A peak area for NH_3 flux in mid-growout was evident approximately 7 m past the midpoint of the house (towards the fans) and correlated to high pH (8), high litter moisture (33%), and high CO_2 flux (12500 mg/m^2-hr). The spatial variability of these parameters demonstrates that increased NH_3 flux relates to high litter moisture as well as greater litter temperatures and CO_2 flux and NH_3 flux decreases on average from placement to mid-growout.

Key Words: Ammonia, Broiler, Emissions

PSA Immunology

279 *Salmonella* vaccination programs in broiler breeders. I. Humoral and mucosal immune response. A. Rolon*[1], J. S. Bailey[2], P. S. Holt[2], C. L. Hofacre[3], J. L. Wilson[2], D. E. Cosby[2], L. J. Richardson[2], and N. A. Cox[2], [1]*Department of Poultry Science, University of Georgia, Athens,* [2]*U. S. Department of Agriculture Russell Research Center, Athens, GA,* [3]*Department of Avian Medicine, University of Georgia, Athens.*

Although vaccination against *Salmonella* has been used more frequently in broiler breeders in recent years, there is a paucity of information in the literature demonstrating the immunological response of treatments that combine live and autogenous killed cell vaccines. The present research was designed to assess the immunological response that was generated by three vaccination protocols. Treatment vaccines consisted of a live Aro-A mutant commercial *Salmonella* Typhimurium (ST) vaccine and an autogenous killed vaccine consisting of a pool of *Salmonella* serovars Berta, Heidelberg, and Kentucky prepared by a commercial company. Four groups of 250 Cobb x Cobb breeder chicks were vaccinated as follows: A) 2 live (day 1 and 21) and 2 killed (day 77 and 126); B) 3 live (day 1, 21, and 77) and 1 killed (day 126) and ; C) 2 killed (day 77 and 126); and D) untreated controls. To assess humoral and mucosal immune response, samples of serum (SER), crop lavage (CL), gut lavage (GL), hatchling serum (HSER), and egg yolk (EY) were tested to measure IgA and IgG. ELISA for IgA and IgG on *Salmonella* Enteritidis and *Salmonella* Typhimurium lypopolysaccharide (SELPS and STLPS) as capture antigen were conducted. Overall, immunological response was stronger on STLPS than SELPS. IgA of SER, CL and GL as well as IgG of CL were short-lived peaks after first killed vaccine. Strong GL IgG after first live and both killed vaccine events were measured with the killed response enduring longer. SER IgG responses were observed after killed vaccine events, and lasting throughout 40 wk of age. HSER and EY IgA were negligible, and IgG comparable among all treatments throughout time. These results show that killed antigen is vital in eliciting adequate IgG inserum and gut. Live vaccination with Aro-A mutnat ST vaccine enhances gut IgG and possibly aids in conferring adequate immunity during the breeder's first weeks of life.

Key Words: *Salmonella*, Vaccination, Immune Response

280 *Salmonella* vaccination programs in broiler breeders. II. Resistance to challenge under a multiple marker strain model. A. Rolon*[1], J. S. Bailey[2], P. S. Holt[2], C. L. Hofacre[1], J. L. Wilson[2], D. E. Cosby[2], L. J. Richardson[2], and N. A. Cox[2], [1]*University of Georgia,* [2]*U. S. Department of Agriculture.*

Resistance to *Salmonella* challenge of breeders and their chicks under three vaccination programs was assessed. Vaccine protocols combined a live Aro-A *Salmonella* Typhimurium (ST) vaccine and an autogenous 3-serovar killed vaccine. Treatments combined: 2 live and 2 killed or 3 live and 1 killed vaccines delivered at 1 d and 3, 11 and 17 wk of age; 2 killed vaccines given at d 77 and 126; and a non-vaccinated control (C). Breeders were gavaged with 10^7 cells of a 3-strain cocktail (*Salmonella* Enteritidis (nalidixic acid resistant, Nal-SE), Typhimurium (rifampicin resistant, Rif-ST) and Thompson (ampicillan resistant, Amp-STH)), at wk 3, 6, 10 18 and 22. Chicks from eggs laid at wk 29, 34 and 40 of breeder age (BA) were challenged at one day-of-age. Chicks were divided in two groups per treatment, one given a commercial competitive exclusion culture (CE), and both were challenged with 10^7 cells of a Nal-SE + Rif-ST+Amp-STH cocktail and kept in isolation units for one and two wk. Ceca and Liver-Heart-Spleen (LHS) samples were cultured for each marker strain on BGS + antibiotic (Nal, Rif, or Amp) plates and colonies counted after 24h incubation. Log_{10} data were analyzed under a factorial design. Breeder *Salmonella* counts showed significant differences between (live) vaccinates and non-vaccinates at 3 and 6 wk challenges. By 10 wk, there were no discernible difference in *Salmonella* level in challenge and control chicks, indicating protection by (1d and 3 wk) live vaccines had diminished at this time. All programs reduced breeder *Salmonella* counts compared to controls at 22 wk. Chick *Salmonella* counts showed little consistency between vaccine treatments. At 34 and

40 wk BA, no difference was observed in susceptibility of chicks from vaccinated and control breeders. Passive immunity did not show consistent decrements on challenged chicks *Salmonella* counts. These results show that live vaccination with the Aro-A ST vaccination decreases *Salmonella* counts during the first 6 wk of age of the breeder, as do all programs by 22 wk of age, and that competitive exclusion is the most effective treatment in reducing *Salmonella* counts.

Key Words: *Salmonella*, Broiler Breeders, Competitive Exclusion

281 Construction and evaluation of recombinant *Salmonella* vaccine expressing *Eimeria* sporozoite and merozoite antigen. V. Konjufca*, S.-Y. Wanda, and R. Curtiss III, *Washington University, St. Louis, MO*.

Coccidiosis is a poultry disease caused by ubiquitous protozoan parasite *Eimeria* sp. and is characterized by intestinal lesions, poor growth, morbidity and mortality. Efforts to produce an effective vaccine against this disease have been with limited success and the need for an effective vaccine is still evident. *Eimeria* is an intestinal parasite, thus a vaccine capable of inducing both mucosal and systemic immune responses would be most effective in protecting against this parasite. Our approach uses the *Salmonella* Type Three Secretion System (TTSS) to deliver an antigen directly into the cell cytoplasm of the immunized host to result in MHC class I antigen processing for induction of antigen-specific CTL responses. To accomplish this goal, *Eimeria* genes encoding antigens EASZ240 and EAMZ250 were fused to *Salmonella* effector protein gene *sptP* in the parental Asd^+ pYA3653 vector, yielding pYA3657 and pYA3658, respectively. SptP effector protein is secreted by TTSS of *Salmonella* and translocated into the cytosol of immunized host cells. The host-strain chromosomal copy of the *sptP* gene was deleted and replaced by a reporter gene *xylE*. Newly constructed pYA3657 and pYA3658 were introduced into host strain χ8879 (Δ*phoP233* Δ*sptP1033::xylE* Δ*asdA16*). This strain is an attenuated derivative of highly virulent *S. typhimurium* UK-1 strain. In vitro experiments show that EASZ240 is secreted into the culture medium by TTSS without contact with eukaryotic cells. In addition, EASZ240 is delivered into the cytoplasm of Int-407 cells by TTSS, making this protein a good model antigen for evaluation of TTSS as an antigen delivery system. Colonization of bursa, spleen and liver by all three vaccine constructs were observed in immunized day-old chicks with peak titers at 6 to 9 days post-immunization. In vivo experiments indicate that both humoral and cell-mediated immune responses were induced in vaccinated chickens.

Key Words: *Eimeria*, Vaccine, *Salmonella*

282 Rous sarcoma growth in lines congenic for major histocompatibility (*B*) complex recombinants. E. S. Schulten[1], W. E. Briles[2], and R. L. Taylor, Jr.*[1], [1]*University of New Hampshire, Durham,* [2]*Northern Illinois University, DeKalb*.

Six congenic lines of chickens with major histocompatibility (B) complex recombinant haplotypes were examined for Rous sarcoma virus (RSV) tumor growth. These lines were created by crossing a male bearing each B complex recombinant (R^1 - R^6) to highly inbred Line UCD 003 ($B^{17}B^{17}$) females, which constitute the genetic background. Backcrosses were made by crossing recombinant heterozygous males (RB^{17}) to UCD 003 females. After the tenth backcross, heterozygotes for each recombinant were mated to produce homozygous progeny for one of six different recombinants with 99.9% of their background genome from Line UCD 003. The MHC recombinant haplotypes for these lines were: R^1=*B-F/B-L*^{24}, *B-G*^{23}; R^2=*B-F/B-L*^{2}, *B-G*^{23}; R^3=*B-F/B-L*^{2}, *B-G*^{23}; R^4=*B-F/B-L*^{2}, *B-G*^{23}; R^5=*B-F/B-L*^{21}, *B-G*^{19}; and R^6=*B-F/B-L*^{21}, *B-G*^{23}. R^2, R^3, and R^4 (all *B-F/B-L*^{2}, *B-G*^{23}) are distinct recombinants because each haplotype arose from separate recombinational events. Chicks from each line were challenged with 10 pfu of subgroup A RSV. Tumors were assigned tumor size scores at 2, 3, 4, 6, 8, and 10 weeks post-inoculation. Each bird was assigned a tumor profile index (TPI) number based on the six tumor size scores. Hatch and B genotype were main effects in the statistical analysis. Least squares ANOVA was used to evaluate rank transformed TPI values and mean tumor sizes through a repeated measures design. Fisher's Protected LSD at $P < 0.05$ separated significant means. R^1R^1 and R^4R^4 chickens had greater tumor growth and significantly higher TPI than the other four recombinant lines. R^1R^1 has *B-F/B-L*^{24}, a previously characterized progressive haplotype. The higher tumor growth and TPI of R^4R^4 indicates the presence of different genes affecting RSV tumors compared to the serologically-similar R^2R^2 and R^3R^3. The similar tumor growth of R^5R^5 and R^6R^6 shows no *B-G* region effect.

Key Words: B complex, Oncogene, Tumor

283 Demonstration of Carboxypeptidase E protein and mRNA in the diffuse neuroendocrine system of the chicken thymus. X. Zhang*[2], J. J. Zhu[1], and L. R. Berghman[1], [1]*Departments of Poultry Science and Veterinary Pathobiology, Texas A&M University, College Station,* [2]*Department of Poultry Science, Texas A&M University, College Station*.

In previous studies, we have described a complex neuroendocrine cell population within the chicken thymus using a monoclonal antibody against avian chromogranin A (CgA). CgA is considered an on/off switch in neuroendocrine cells, controlling the biogenesis of large dense-core vesicles (LDCV) and essential for the regulated secretory pathway. Here, we report that most of the CgA-positive cells are also immunoreactive for carboxypeptidase E (CpE), a processing enzyme present in the Golgi and secretory granules of neural/neuroendocrine cells that is necessary for the post-translational maturation of prohormones into bioactive peptides. Our immunofluorescent dual staining experiments used antisera against the conserved C- and N-terminal portions of CpE, respectively, (kindly donated by Dr. Peng Loh, NIH) and a monoclonal antibody against avian chromogranin A on chicken thymus sections. Surprisingly, the antisera against the respective CpE termini did not produce identical staining patterns. Co-localization of C-terminal CpE immunoreactivity was observed in most, if not all, CgA positive cells. In contrast, the antiserum against N-terminal CpE clearly identified cells but also nerve fibers, and N-terminal CpE immunoreactivity was generally not co-localized with CgA. This seems to suggest the existence of different CpE isoforms in the chicken thymus. Based on chicken genome sequence data, the synthesis of both CgA- and CpE-specific mRNA in the chicken thymus was confirmed by RT-PCR. The observed neuroendocrine cells were located predominantly in the transition zone between the cortex and the medulla of the thymic lobules, which is known to be heavily innervated by the autonomic nervous system. These findings fit with our current working hypothesis that some of the locally produced neuroendocrine molecules are processed and released through the regulated neuroendocrine secretory pathway, potentially under the control of the autonomic nervous system.

Key Words: Chicken, Thymus, Carboxypeptidase E

284 Cationic amino acid transport (CAT) expression in immune tissue and the effect of lysine on lymphocyte function. B. Humphrey* and K. Klasing, *University of California, Davis*.

Lysine and arginine are transported into cells by cationic amino acid transporters (CAT). Two experiments determined the effect of the acute phase response (APR) on CAT expression and the effect of lysine levels on lymphocyte proliferation. The first experiment was designed as a 2 x 2 factorial with fasting or feeding and 2 levels of LPS (+/- LPS; 1mg/kg BW s.q.). Treatments were initiated when broiler chicks were 2 weeks of age and samples were collected 12-h later. Plasma amino acids were determined and bursa, thymus and liver CAT1-3 mRNA levels were assed by quantitative PCR. Plasma lysine and arginine levels were increased by both LPS and fasting ($P<0.05$). Bursa and thymus CAT-1 levels did not change with fasting ($P>0.05$) and increased 5-fold with LPS ($P<0.05$). Bursa and thymus CAT-2 levels did not change with fasting ($P>0.05$) and decreased below the limit of detection with LPS. Thymus CAT-3 levels in fasting chicks decreased 1.4-fold with an LPS injection ($P=0.05$). Bursa CAT-3 levels in fasting chicks decreased 2-fold with an LPS injection ($P<0.05$). Experiment two determined thymocyte proliferation in response to 4 lysine levels (no lysine, 0 μM; lysine deficient, 50 μM; lysine adequate, 500 μM; lysine APR, 1500 μM) and 2 levels of PHA (0 or 30 μg/ml). In vitro lysine levels were similar to in vivo lysine levels for each indicated physiological state. Thymocytes proliferated in response to PHA at all lysine levels except for 0 lysine ($P<0.05$). Proliferation at 500 μM lysine was greater than 50 μM ($P<0.05$) and tended to be greater than 1500 μM ($P=0.06$). During the APR, the bursa and thymus increase their transport capacity for lysine and arginine while the levels of these nutrients increase in plasma. In addition to providing increased lysine and arginine for use in nitrogen metabolism, increased transport capacity of lysine by the thymus may also serve to suppress T

lymphocyte responses since thymocyte proliferation tended to be lower with lysine concentrations at 1500 μM.

Key Words: Acute Phase Response, Lysine, Lymphocyte

285 Effect of testosterone and lead on T cell maturtion in the developing thymus. I. Hussain*, M. Piepenbrink, and R. Dietert, *Department of Microbiology and Immunology, College of Veterinary Medicine, Cornell University, Ithaca, NY.*

The developing immune system is particularly sensitive to environmental and hormonal influences. Genders can differ in this sensitivity as well. Because the heavy metal, lead, can suppress Th-1 associated function among perinatal thymocytes and cause a systemic loss of postnatal Th-1 function, we investigated the ability of in ovo administered lead and testosterone to alter thymocyte maturation. Cornell K-strain chick embryos were injected via the air sac on embryonic (E) day 8 with either testosterone (12.5 μg/egg in ethanol) or 15% ethanol in 100 μl volume. The groups then received either lead acetate (200 μg/egg) or sodium acetate (control) on E 12 of incubation by the same route. On E 20, thymuses from 4-5 female embryos per group were harvested in sterile Hanks balanced salt solution on ice, and thymocytes were separated using Ficoll. Tri-color flow cytometry was performed with fluorescent-conjugated antibodies against chicken-CD3, CD4, CD8, TCR1 and TCR2 surface molecules and data were analyzed using the MIXED procedure of SAS. Lead did not induce changes among the cell surface markers measured in this study. However, testosterone administration caused changes in both the CD4+CD8+ and CD4+CD8- cell populations (P #8804 0.05). Testosterone treatment followed either by sodium or lead acetate injection caused a statistical increase in CD4+CD8+ cells (73.23 $\pm$ 2.77 % and 79.85 $\pm$ 2.77 % with sodium or lead acetate, respectively) compared either with ethanol and sodium acetate or ethanol and lead acetate treatments (69.68 $\pm$ 2.77 % or 68.98 $\pm$ 2.77%, respectively). Additionally, testosterone treatment significantly lowered the percentage of CD4+CD8- cells from 7.61 $\pm$ 1.3 % (control) to 4.2 $\pm$ 1.3% or 4.63 $\pm$ 1.3% (for testosterone with either sodium acetate or lead acetate, respectively). Therefore, sex hormonal balance can modulate thymocyte maturation, but cellular validation of lead-induced alterations would require the use of additional Th-specific markers. Supported by USDA grant NE-60/NE-1016.

Key Words: Immune Development, Thymus, Cell Populations

286 Immunocompetence measurements of frizzle and normally feathered genotypes issued from different maternal lines of chicken. M. M. Fathi, S. A. El-Safty*, and A. Galal, *Poultry Prod. Dept, Faculty of Agric., Ain Shams University.*

An experiment was conducted on frizzled and normally feathered genotypes issued from two different maternal lines either Golden-Montazah (GM), an Egyptian local breed, or Brown Hy-Line strains during the summer season of Egypt. The immunocompetence parameters that were assessed for the offspring were lymphoid organ weights, cell-mediated immune response (PHA-P), globulin level in serum and heterophil/lymphocyte ratio. The results of CBH response showed that the frizzled genotypes had a significantly greater dermal swelling response to PHA-P compared to normally feathered sibs. The frizzled genotypes also exhibited larger bursa and thymus (as a percentage of body weight) compared to the normal genotypes in the two dam lines. A significantly genotype-dam line interaction for globulin level was observed. However, the frizzle gene increased globulin level in chickens issued from GM dams and the reverse was true in chickens issued from Hy-Line. The H/L ratio was significantly higher in both genotypes of Hy-Line dams compared to counterparts of GM ones. We concluded that under the conditions of the current study, the frizzle chickens are hyper-responders compared to normal plumage birds, especially those issued from Golden-Montazah breed.

Key Words: Frizzle Gene, Immunocompetence Parameters, Maternal Lines

PSA-Nutrition: Feed Additives and Phytase

287 *In vitro* and *in vivo* evaluation of simultaneous supplementation of α-galactosidase and citric acid on nutrient release, digestibility and growth performance of broiler chicks. T. Ao*[1], A. H. Cantor[1], A. J. Pescatore[1], M. J. Ford[1], and J. L. Pierce[2], [1]*University of Kentucky, Lexington,* [2]*Alltech Biotechnology Center, Nicholasville, KY.*

Experiments were conducted to evaluate the effects of simultaneous supplementation of α-galactosidase and citric acid on 1) *in vitro* nutrient release from soybean meal, and 2) *in vivo* nutrient digestibility and growth performance of broiler chicks fed a corn-soy diet. In Experiment 1, an *in vitro* model was used to simulate the chicken's digestive process in the crop and from the crop through the small intestine. Graded levels of α-galactosidase (0 to 13,792 units/kg) and citric acid (0 or 20 g/kg) in a factorial arrangement were added to soybean meal, which was used as the substrate. Reducing sugars were measured at the end of both phases. Increasing enzyme levels linearly ($P < 0.001$) increased release of reducing sugars in both phases. Addition of citric acid with α-galactosidase further increased enzyme activity, resulting in a significant interaction ($P < 0.001$). In Experiment 2, 144 1-d-old male broiler chicks were randomly distributed among 24 replicate cages of six chicks contained in three blocks, to provide six replicate groups for each of four treatments. Two levels of α-galactosidase (0 or 1724 units/kg) and of citric acid (0 or 20 g/kg) were added in a factorial arrangement to a low-energy (2730 Kcal ME/kg) corn-soy diet. Alpha-galactosidase ($P < 0.05$) increased body weight gain, feed intake, NDF digestibility and dietary AME_n. Citric acid increased ($P < 0.05$) the digestibility of DM, NDF and CP. Compared with the unsupplemented diet, weight gain and feed intake were depressed ($P < 0.01$) by adding citric acid alone, but not by the addition of both citric acid and α-galactosidase. Simultaneous supplementation of α-galactosidase and citric acid increased ($P < 0.05$) dietary AME_n and digestibility of DM, NDF, and CP, and improved ($P < 0.05$) feed to gain ratio. These results suggest that acidification of poultry diets may improve the effectiveness of exogenous α-galactosidase.

Key Words: Alpha-Galactosidase, Citric Acid, Broilers

288 Effect of virginiamycin in diets with adequate or reduced dietary calcium or available phosphorus for 0 to 18 d-old broilers. T. O'Connor-Dennie* and L. L. Southern, *LSU Ag Center, Department of Animal Science, Louisiana State University, Baton Rouge.*

Based on previous research in our laboratory, the addition of virginiamycin (Vm) to diets with reduced available P (aP) or Ca improved the negative effects associated with deficiencies of these minerals. To further investigate this response, two additional experiments (EXP) were conducted to evaluate the effect of Vm in diets with adequate or reduced Ca (EXP 1) or aP (EXP 1 and 2) on daily gain (ADG), daily feed intake (ADFI), gain:feed, bone breaking strength, bone ash percentage, and mg of ash in 0 to 18 d-old chicks. In EXP 1, there were six treatments with six replications of five chicks per replicate. The dietary treatments were: 1) a corn-soybean meal (C-SBM) diet with 1.00% Ca and 0.45% aP; 2) C-SBM with 0.70% Ca and 0.45% aP, 3) C-SBM with 1.00% Ca and 0.25% aP; Diets 4 to 6) as Diets 1 to 3 with 9 ppm Vm. Reducing dietary aP decreased ADG, ADFI, and BS ($P < 0.01$). Reducing dietary Ca decreased BS and gain:feed ($P < 0.06$) but had no effect on ADG or ADFI. The addition of Vm to the low aP diets tended to decrease BS (aP x Vm, $P < 0.06$) but had no effect on ADG or ADFI. The addition of Vm to the low Ca and control diets increased BS ($P < 0.03$). In EXP 2, there were twelve treatments with six replications of six chicks per replicate. The dietary treatments were: Diets 1 to 4) C-SBM with 1.00% Ca and 0.15, 0.25, 0.35, 0.45% aP; Diets 5 to 8) as Diets 1 to 4 with 11 ppm Vm; and Diets 9 to 12) as Diets 1 to 4 with 22 ppm Vm. Daily gain, ADFI, gain:feed, BS, bone ash percentage, and mg of ash per tibia were increased ($P < 0.01$) as dietary aP levels were increased. The addition of Vm, regardless of supplementation level, increased ADG and BS in chicks fed diets with 0.35% and 0.45% aP, but Vm had no effect or decreased ADG and BS at the 0.15 and 0.25% aP levels (aP x Vm, $P < 0.05$). These results indicate that Vm, added at 11 or 22 ppm, will partially overcome the negative effects associated with aP deficiency at dietary levels of 0.35% aP or greater.

Key Words: Chicks, Phosphorus, Virginiamycin