Relationships of iron and microbial growth, and ability of iron to suppress infection have been reported by many workers with iron-deficient pigs 1-3 in various attempts to explain the rapidity with which iron-deficient pigs 4-5 in the experimental 6-10 and routinely receive iron supplementation, often with dextran injections, to which we have investigated these relationships in young pigs. Previously, we have reported that anti-iron effect of sow’s milk could be recovered by the addition of iron, both in vitro and in vivo in ligated intestinal segments 2. These observations, together with unpublished work in our laboratory suggest that high-level iron supplementation may have adverse influences on colibacillary diarrhea and systemic infections in pigs, bacterial infection is shown to depress serum iron (3), thereby limiting the availability of iron to invading microbes. Therefore, we undertook experiments to determine if similar effects happen in the pig, if the level of iron supplementation affects the ability of the pig to limit iron availability, and if microbial toxins in a culture filtrate have the same effect as enteropathogenic E. coli. We further evaluated the effect of levels of iron dextran supplementation on the ability of pigg serum to support E. coli growth and on changes in glucose concentration.

In experiment 1, thirty-two pigs were used in a factorial arrangement of treatments to determine the effects of the (1) level of iron dextran supplement, (2) infusion of an E. coli 263 culture filtrate, and (3) presence of E. coli 263 in a ligated intestinal segment. The ability of the young pig to limit systemic iron availability. Iron dextran was administered IM at 3 days post partum. At 1 week of age pigs were removed from the sow and fed a milk replaces diet. Venous canulae for obtaining blood samples were fitted at 12 days. The culture filtrate was prepared from an actively growing culture of E. coli 263 in tryptic soy broth and sodium controls were infused with sterile tryptic soy broth and sodium. Pigs were laparotomized and a 40 cm ligated segment was made in the upper jejunum of each. Culture filtrate was infused IV and E. coli were injected into ligated intestines at 14 days post partum. Blood samples were obtained every 2 hours for 22 hours, following which pigs were killed and livers, spleens and kidneys were removed. Hemoglobin, heme content, serum iron and total iron binding capacity (TIBC) in blood were determined. Tissue iron content was analyzed using atomic absorption spectrophotometry.

Iron was depressed in all pigs within 6 hours, probably from the surgical incision to ligated intestinal segments. However, pigs receiving 600 mg of iron (Hfe) exhibited greater serum iron and % saturation and lower TIBC with 100 mg of iron (Le) and 200 mg. The presence of E. coli in the intestine increased TIBC in Le and not Hfe pigs, which coincided with the time of maximal fluid secretion into the intestine. Interactions with iron level were also observed for organ iron content. Whether enteric infection caused an effect similar to systemic infection was not determined conclusively. Young pigs were shown to limit iron availability in a manner similar to other animals when subjected to inflammation or infection and this was influenced by the level of iron supplementation.

In experiment 2, the rapidity with which iron appeared in, and was cleared from the serum following IM injection of 0, 100 or 200 mg of iron as iron dextran was determined. Peak serum iron concentrations of 36 and 56 ppm occurred 5 and 16 hours post injection, for the 100 and 200 mg treatments, respectively, and clearance of 90% of the peaks occurred in about 46 to 56 hours.

Experiments 3 and 4 were conducted to determine the effects of iron dextran supplementation on the ability of pigg serum to support E. coli growth (strains 263 and 026816). For each experiment, pigs were placed in separate cages at 1 week of age and fed milk replaces diets. One day before the start of each experiment pigs were fitted with venous canulae for blood sampling. Blood samples to be assayed for E. coli growth were drawn following a 14-hour fast, on days 1, 3, 5, 7, 9 and 11 in experiment 3 and 1, 3, 5, 7, 9 and 11 in experiment 4. Cultures in serum were inhibited at 56 C and serum was diluted with saline (1:10) in experiment 3 and 1:5 in experiment 4. Inoculated with E. coli and incubated, bacterial counts were determined by serial dilutions and plate counts. Serum was also analyzed for iron and glucose concentrations. The treatments were 0, 100, 200 mg and 200 mg iron as iron dextran in experiment 3, with the same treatments plus 100, 200 and 250 mg of dextran (corresponding to the amounts of dextran in the iron dextran treatments) in experiment 4.

The most notable changes in E. coli growth were the increases associated with 200 mg as compared with 100 mg of supplemental iron. In these experiments this effect was significant for E. coli 263 on day 1, when serum iron levels were greatly elevated, and for E. coli 026816 on day 3, when serum iron levels had returned to normal levels. Most treatment contrasts at other time periods showed no significant difference. Pigs receiving iron dextran had lower serum glucose values than controls in experiment 3. In experiment 4, there was a tendency for serum glucose to be lower in iron injected pigs than in dextran injected pigs, but not un.injected controls.

DISCUSSION: The shift in iron resulting in lowered serum iron concentrations associated with infection has been interpreted as a defensive mechanism by the host to inhibit microbial growth (1). This mechanism was shown here to be active in the pig, and its effectiveness to be influenced by the level of iron supplementation. High iron levels being removed from serum areas completely. The iron status of the host has been shown in several text animals to affect the growth of bacteria in the serum (4). These studies showed a similar response in the pig; however, the effect in the serum of young pigs following IM iron injection was a transitory, time-dependent one, which was most clearly observed at high iron dosages (200 mg) 1 or 3 days after supplementation. Lower levels (100 mg) of supplemental iron did not consistently cause significant increases in E. coli growth in serum. Therefore, iron supplementation levels necessary for cellular mediated immunity (5) can be maintained without apparent risk of increasing susceptibility to infection. The importance of changes in serum glucose in response to iron dextran injection is uncertain.

CONCLUSIONS: Pigs respond to inflammation and infection by lowering serum iron levels, and this effect is influenced by the level of supplemental iron. Growth of E. coli in serum of pigs is transiently increased in pigs receiving 200 mg as compared with 100 mg iron as iron dextran.