These degradation products contribute to the total radioactivity in the feces.

Total stool activity accounted for 76% of the administered Proto-^{14}C. The balance was unaccounted for. Incorporation in circulating hemoglobin was not examined but in view of the known minimal incorporation in other studies (4, 17) this may be assumed to have been insignificant.

Summary and Conclusions. Proto-^{14}C was administered through a duodenal tube in a normal subject. Serial isolations of crystalline 2-COOH porphyrin and stercobilin from the feces during the next 12 days, and radioactivity measurements provided evidence that some fraction of the administered Proto- underwent an enterohepatic circulation. A small proportion (1.5–3%) was converted to bile pigment. The data point to a continuous partial enterohepatic circulation of Proto- with loss of a constant fraction on each circulation.

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Age Changes in Body Weight and in Several Blood Componets of Conventional versus Miniature Pigs (32830)

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The utility of the pig in biomedical research has been recognized for some years (1) but its normal mature weight of 250–350 kg constitutes a disadvantage in convenience and economy. The responsiveness of the pig to selection for small size (2) has been applied to the development of several strains of "miniature" pigs for use as research animals (3–7). The safe extrapolation of physiological data obtained with the miniature pig to the conventional pig or to man rests on the assumption that important changes in biochemical and physiological parameters have not accompanied the change in mature size accomplished by selection. A considerable body of hematological and physiological data have been accumulated for the miniature pig (8–11). However, few direct comparisons have been made of the miniature and conventional pig kept under similar environmental conditions. The data reported herein were obtained to provide comparative information on

several blood parameters in miniature and conventional pigs during the period from 1 to 20 weeks of age.

Methods. Two litters of miniature pigs of the Pitman-Moore strain and 3 litters of conventional pigs of the Hampshire and the cross of Hampshire and Yorkshire breeds were used. Individual body weights of the 11 miniature (M) pigs and 26 conventional (C) pigs were recorded at 3–5 days of age (designated week 1) and subsequently at weeks 2, 3, 4, 5, 6, 8, 10, 12, 16, and 20 weeks. At each weigh period blood was drawn from the anterior vena cava of each pig for blood hemoglobin and urea and for serum alkaline phosphatase, cholesterol, and protein. Blood for hemoglobin and urea determination was added to tubes containing sodium citrate to prevent coagulation while blood for measurement of serum components was added to a separate tube not containing anticoagulant and centrifuged to remove the serum. Hemoglobin was determined by the method of Sanford and Sheard (12), urea according to Coulombe and Favreau (13), alkaline phosphatase according to Bessey *et al.* (14), cholesterol according to Mann (15) and protein according to Gornall *et al.* (16). Males were castrated at 3–4 weeks of age. Each litter was weaned at 4–5 weeks of age and fed a standard corn-soybean meal type diet until 20 weeks of age. Litters were kept in separate pens, but feeding and management was standard and similar for all pigs. Differences between the means of M and C pigs for each criterion at each time interval were tested by analysis of variance.

Results and Discussion. The means for body weight; blood hemoglobin and urea; and serum alkaline phosphatase, cholesterol, and protein for M and C pigs at weeks 1–20 are plotted in Fig. 1. The mean squares for breed (M versus C) and litter and the error mean square for each criterion at each time interval are given in Table I. Data for males and females were analyzed separately for each parameter to test sex differences.

Weight gains were similar during the early suckling period, but the curves for M and C pigs separated with time in agreement with previous reports (2, 3, 7). The failure to demonstrate a greater difference between C and M pigs in body weight is probably due to the rather slow growth rate of 1 Hampshire litter, resulting in some overlap between C and M pigs in body weight. Data for blood hemoglobin and urea showed no striking differences between M and C pigs. Blood urea tended to be higher from weeks 10 to 20 in C pigs. The early rise in hemoglobin in both groups is undoubtedly related to the intramuscular administration of iron-dextran at 3–5 days of age to prevent iron-deficiency anemia during the suckling period. Likewise, serum protein showed the same time trend for each group except that the level tended to be higher at each time interval for M pigs. A striking difference in serum cholesterol during the early suckling period in favor of C pigs may reflect a difference in milk composition between C and M sows, but no milk measurements were made to confirm this. Subsequent trends in serum cholesterol were similar for C and M pigs. The high level of serum alkaline phosphatase in pigs shortly after birth reported by others (11, 17, 18) was present in this study for both C and M pigs. However, it may be of importance that the level in M pigs declined more rapidly than in C pigs, perhaps reflecting differences in early bone growth. After 6 weeks, however, values for C and M pigs were similar.

Sex differences appeared not to be of importance in the parameters measured and the litter effect tended to be greater than the breed effect (Table I).

While caution is needed in drawing inferences from these data which are based on limited numbers of animals, the time trends for C and M pigs in each blood parameter measured indicate no serious problem in extrapolation from miniature to conventional pigs with respect to these parameters, except in the case of serum alkaline phosphatase and serum cholesterol during the first 6 and 4 weeks, respectively. The physiological bases for these apparent differences between C and M pigs in these parameters need to be determined.

Summary. Two litters (11 pigs) of Pitman-Moore miniature pigs (M) and 3 litters (26 pigs) of conventional pigs (C) of Hampshire and the cross of Hampshire and Yorkshire breeding were used to compare body weight

gain, blood hemoglobin, blood urea and serum alkaline phosphatase, cholesterol, and protein to 20 weeks of age. Body weight gain was similar during the first 6 weeks for M and C pigs, but the difference in mean weight gain between M and C pigs steadily increased at each subsequent time interval in favor of the latter. The mean weight at 20 weeks was 43 kg and 69 kg for M and C pigs, respectively. Blood parameters were similar for M and C pigs at each time interval except that serum alkaline phosphatase dropped much more rapidly in M pigs during the first 6 weeks, serum cholesterol was lower during the suckling period in M pigs and the blood urea was lower in M pigs from weeks 10 to 20 and

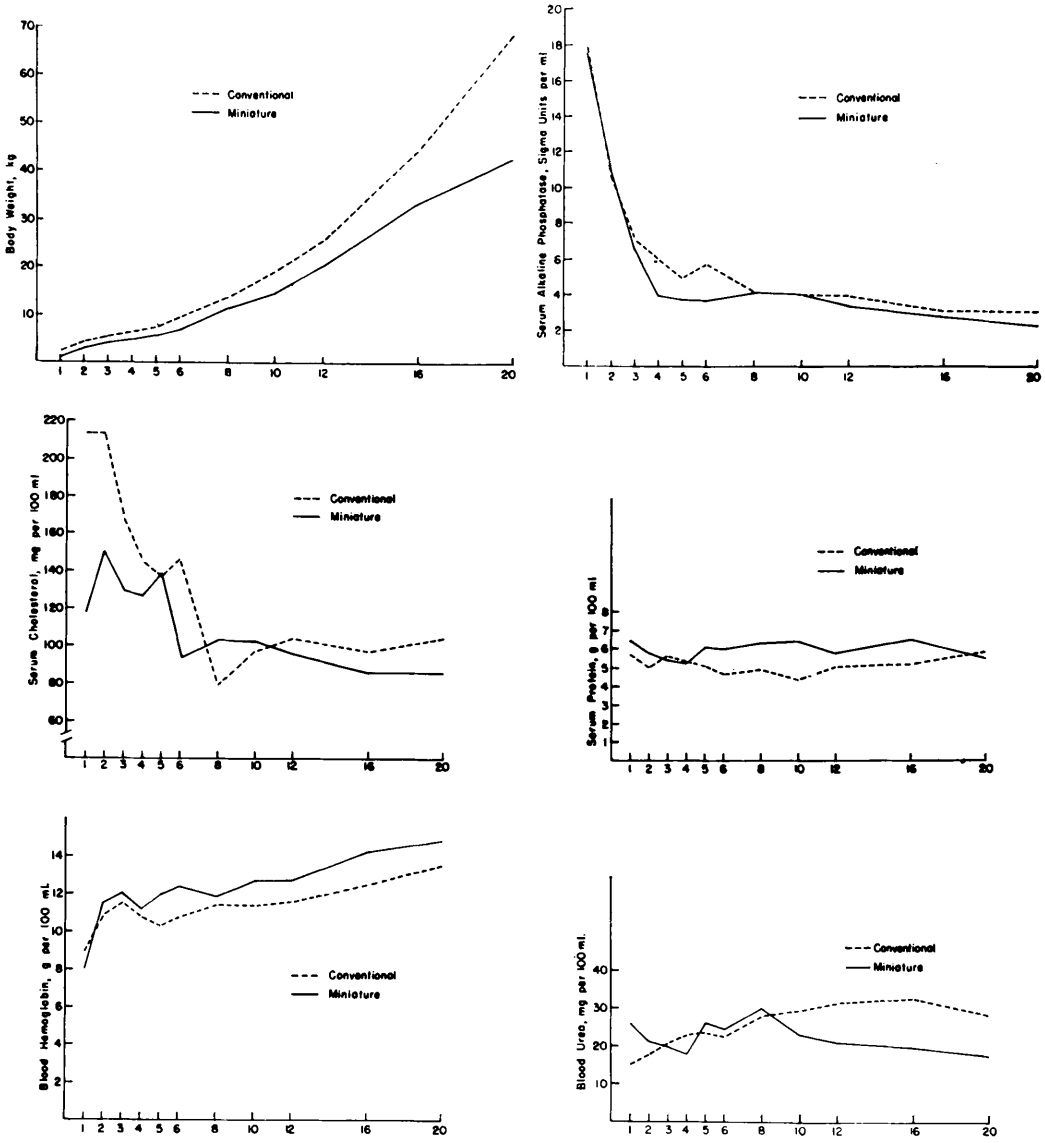

FIG. 1. Age trends in body weight and blood components of conventional versus miniature pigs.

TABLE I. Mean Squares for Body Weight, Serum Alkaline Phosphatase, Serum Cholesterol, Serum Protein, Blood Hemoglobin and Blood Urea N in Conventional Versus Miniature Pigs from 1 to 20 Weeks of Age.

Criterion	Source of variation[a]	Week 1	2	3	4	5	6	8	10	12	16	20
Body wt.	Males											
	Breed	5.50[b]	7.70[c]	8.84[c]	21.46	45.59	41.81	27.25[c]	94.18	244.08	1241.55	9787.65
	Litter	2.17	0.89	1.02	2.90	4.37	14.09	56.96[b]	287.03[c]	652.13[c]	2662.84[b]	4640.50[c]
	Error	0.63	1.23	1.56	2.69	5.00	7.32	10.94	25.63	53.13	114.74	389.54
	Females											
	Breed	16.75[c]	19.90[b]	21.09[c]	38.13[b]	85.04[c]	169.68	340.74	699.72	1211.76	2850.91	13582.81
	Litter	4.70	1.23	1.25	1.49	1.75	22.32[b]	135.20[c]	520.29[c]	1069.24[c]	4127.62[c]	5849.78[c]
	Error	0.39	1.34	1.99	2.98	3.92	6.79	20.70	31.83	81.05	174.29	225.87
Serum Alkaline Phosphatase												
	Males											
	Breed	11.30	2.34	0.07	12.67	7.06	8.06	0.12	0.01	0.83	0.91	1.53
	Litter	29.50	13.95[b]	15.77[c]	8.91[c]	1.24	7.04[c]	1.09	1.09	1.99	0.46	2.56[c]
	Error	15.26	3.20	2.41	0.78	0.51	1.25	0.38	0.43	0.67	0.30	0.54
	Females											
	Breed	11.00	1.00	5.55	25.56	16.00	18.58	0.70	0.81	2.76	0.10	2.70
	Litter	14.10	38.28[c]	22.23[c]	14.82[c]	8.42[c]	8.89[c]	0.28	2.01	2.02[c]	1.09	7.91[c]
	Error	12.19	3.44	1.41	0.71	0.68	0.66	0.67	0.68	0.35	0.36	0.37
Serum Cholesterol												
	Males											
	Breed	26412	6837[b]	1900	582	863	14945	2012	190	916	1653[b]	5678[b]
	Litter	7878[c]	518	650	1303	509	3688[b]	583[b]	446	421[c]	110	228[b]
	Error	849	705	796	502	368	686	151	169	50	73	53
	Females											
	Breed	31554	26112[b]	11988	2811	3142	9620	2927	180	219	58	62
	Litter	14433[c]	1428	1869	3489[c]	3382	5034[c]	729[c]	646[b]	806[b]	250	77
	Error	1685	3242	621	413	1829	532	67	120	169	80	67

TABLE I (continued)

Criterion	Source of variation[a]	Week 1	2	3	4	5	6	8	10	12	16	20
Serum Protein												
	Males											
	Breed	1.22	0.01	1.75	0.37	2.69	1.17	2.65	15.15[c]	0.37	3.80[c]	0.13
	Litter	4.50[c]	1.08	1.77[c]	1.66[c]	0.59[c]	0.40	0.42	0.15	2.22[c]	0.01	1.46
	Error	0.66	0.30	0.03	0.16	0.09	0.15	0.49	0.06	0.10	0.12	0.67
	Females											
	Breed	1.93	2.99[c]	0.22	0.02	6.94	6.65	10.27[c]	8.68[b]	0.25	3.28[c]	0.35
	Litter	4.61[c]	0.07	2.11[c]	2.46[c]	1.57[c]	1.52[c]	0.21	0.52	3.22[c]	0.05	2.14
	Error	0.26	0.23	0.26	0.26	0.21	0.10	0.13	0.19	0.24	0.24	0.83
Blood Hemoglobin												
	Males											
	Breed	2.59	0.01	0.02	15.90	10.25[b]	8.80	6.03	12.91	7.22	9.99	4.94
	Litter	7.53	2.88	2.30	3.68	0.69	2.00	0.67	1.62[b]	3.86[c]	2.24	2.67
	Error	2.75	2.57	2.75	3.81	4.36	1.86	1.04	0.40	0.69	1.03	0.82
	Females											
	Breed	4.04	1.68	0	0.79	7.87	5.69	0.01	2.22	2.62	20.02[c]	9.54
	Litter	8.96	4.19	10.15	9.41	2.04	1.68	1.44	0.47	5.06[c]	0.18	6.88[c]
	Error	3.52	3.80	4.61	4.82	3.93	2.51	0.55	0.66	0.18	0.37	1.04
Blood Urea												
	Males											
	Breed	201.0[c]	944.7	1.5	0.02	17.0	6.5	9.4	247.8	440.2	857.1[b]	681.1[b]
	Litter	3.9	668.3	122.7[c]	41.1[b]	193.9[c]	42.2	303.7[c]	75.7[b]	72.3[c]	73.8	11.2
	Error	16.0	297.9	20.0	8.7	15.0	42.9	19.8	17.4	9.7	34.0	23.6
	Females											
	Breed	374.4	37.86	76.8	13.5	119.9	2.8	0.01	143.9	372.4	614.6	315.6
	Litter	63.8	637.7	39.7	41.8	321.1[c]	200.7	436.6[c]	67.3	64.6	134.5	31.8
	Error	46.7	394.0	20.1	16.5	31.5	110.9	37.5	21.0	46.3	44.3	11.4

[a] Degrees of freedom for breed, litter, and error in the analysis of variance are 1, 3, and 11, respectively for males and 1, 3, and 16 for females for all criteria at week 1 and at most subsequent weeks. For some criteria during some weeks, number of degrees of freedom for error is one or more fewer due to lost or inadequate amounts of blood sample.

[b] Significant difference ($p < .05$).

[c] Significant difference ($p < .01$).

serum protein higher in M pigs throughout.

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Spleen Focus Formation by Polycythemic Strains of Friend Leukemia Virus* (32831)

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During the past 6 years a number of passage lines of Friend virus (1) have been developed and carried in this laboratory which may be distinguished by their effects on erythropoiesis. In susceptible strains of mice all of the lines induce marked hepatosplenomegaly, increased numbers of large mononuclear cells in the blood and spleen, and elevated ^{59}Fe uptakes in blood, spleen, and liver. However, some lines (FV-P) induce a hypervolemic polycythemia within 2–3 weeks of infection (2,3), while others (FV-A) cause anemia after 4–5 weeks. Because lines of the latter type in our laboratory had been obtained after passage of the former type through rats (4) or after recovery of virus from the progeny of infected pregnant mice (5), the pos-

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