COBALT POLYCYTHEMIA IN CATTLE

By

George Merrill Ward

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Dairy

1951

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation to Doctor C. F. Huffman, Research Professor of Dairying, for his counsel and timely suggestions throughout this study and for the critical reading of the manuscript; to Doctor Earl Weaver, Professor of Dairying, for the award of the Graduate Assistantship and for the provision of the facilities required for the consummation of this study.

The writer is indebted to Mr. C. W. Duncan, Research Associate in Agricultural Chemistry, and his associates for the chemical analyses used herein; and to unnamed members of the Dairy Department for their many suggestions regarding the conduct of the study and the preparation of the manuscript.

The writer wishes to extend gratitude to his wife whose never-ending encouragement has been invaluable.

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

INDEX OF TABLES - CONTINUED

INTRODUCTION

Present knowledge indicates that cobalt in trace quantities is essential for the well being of ruminants. Various "wasting diseases" occurring in localized areas of the world have been cured and subsequently prevented by providing ruminants with access to this element by any of several means, including provision of cobalt licks, feeding cobaltized salt, and increasing the cobalt content of forage by top-dressing with cobalt salts. The manner in which cobalt exerts its effect on ruminants has not been elaborated.

The essentiality of cobalt, in addition to that contained in Vitamin B_{12}, has not been demonstrated for any group of animals other than ruminants. Conversely, up to this time, it has not been shown that cobalt in quantities greater than required for their well being is able to support polycythemia in ruminants as it is in the cases of other animals. These apparent differences in the action of cobalt on the various animals raise the questions of how they occur and what physiological variation is responsible for these differences.

This investigation was initiated in an attempt to ascertain whether or not it is possible to produce a cobalt-induced polycythemia in cattle and in conjunction with that to attempt to determine the function of the rumen microorganisms in the ruminant's use of cobalt by utilizing sulfaguanidine as a bacteriostatic agent.

REVIEW OF LITERATURE

Introduction

The literature regarding the essentiality of cobalt and the effect that this element may exert on the blood of animals, with few exceptions, has been printed within the last twenty-one years. In 1935 the essentiality of cobalt for ruminant nutrition was discovered in coastal regions of Australia. In 1929 it was discovered that cobalt salts, when administered in quantities greater than normally found in rations, causes a polycythemia in rats. Since these discoveries were made many contributions have been made to the literature concerning the effects of various levels of cobalt administration to different species of animals.

The Essentiality of Cobalt

Anemia and emaciation have characterized certain "wasting diseases" which have affected cattle and sheep in many parts of the world for many years. Cobalt supplementation has been shown to cure and prevent "Bush-Sickness" and "Mortain Mains Disease" in New Zealand (4), "Mairoa Dopiness" in New Zealand (88), "Enzootic Marasmus" in Australia (130), "Nutritional Anemia" in New South Wales (59), "Nakuruitis" in Kenya (2), "Pining" in Great Britain (31), "Grand Traverse Disease" in Michigan (6), "salt sick" in Florida (92, 93), cobalt deficiency in Wisconsin (52) and New York (117), "Burton-ail" in New Hampshire (69), and deficiencies in the Hebrides (16) and Norway (47). Loss of weight and appetite, general unthriftiness,

weakness, anemia, and finally death characterize all these diseases which have been reported. The literature concerning cobalt deficiencies has been amply reviewed in recent years (11, 62, 108, 115, 128).

Cobalt supplementation has been shown to be advantageous under conditions of no obvious deficiency ailment. Klosterman et al. (75) have demonstrated that fattening swine maintained in concrete pens which were washed daily made significantly greater daily gains when cobalt chloride was added at the rate of 0.026 per cent to the ration. Noland et al. (94) obtained favorable growth results with a supplement consisting of cobalt and copper salts when added to an all-plant ration for growing pigs. Supplementation of the all-plant ration with iron, manganese, cobalt, and copper supported a much greater concentration of vitamin B_{12} in the feces than did supplementation with APF supplements or crystalline vitamin B_{12}. Kato (67) has demonstrated that cobalt is of value when used in conjunction with iron therapy in the treatment of infant anemia. Since requirement for cobalt by human beings has not been demonstrated, the action exerted by cobalt in this work may well have been that of polycythemic production.

No positive cobalt requirement in addition to vitamin B_{12} cobalt (107) has been demonstrated for animals other than sheep and cattle with the possible exceptions noted above (75, 94). The species difference in cobalt requirement is indicated by the fact that horses are not affected on cobalt-deficient pastures which do not fulfill the nutritive requirements of sheep and cattle. Underwood and Elvehjem (129) were able to maintain growth in rats on a diet consisting of milk fortified with iron and copper which supplied only 0.6 microgram of cobalt daily. Thompson and Ellis (126) found the requirement for cobalt in rabbits to be less than 0.1 microgram per day.

Mode of Action of Cobalt in Ruminants

The mode of action of cobalt in ruminants is not known although some investigators have presented suggestive data. The fact that nonruminant animals have not been shown to require cobalt tends to point to the rumen as the organ requiring cobalt for its action. Marston and Lee (83) compared the effects of subcuteneous injection and oral cobalt administration on sheep. Since only orally administered cobalt supported growth, these workers concluded that cobalt "exerts its influence on the ruminant primarily either in the lumen of the alimentary canal or when passing through its wall." Further limiting the site of cobalt action, they reasoned that, since a portion of the injected cobalt is eliminated in the feces and only appears at the intestinal level (27), the activity apparently takes place above the level of the duodenum. These investigators propose that cobalt function in ruminants may concern the activity of the symbiotic rumen flora. Verification of their deductions is partially established in that nonruminants have not yet been shown to require cobalt other than that contained in vitamin B_{12} (107). Keener et al. (68), starting with cobalt deficient lambs, were able to get slow but positive recovery using intravenous cobalt injections as compared to rapid recovery after oral cobalt administration. This study corroborated the results of an earlier study by Ray et al. (106). This slow improvement may be accounted for by the cobalt content of saliva (29). Cobalt injections in lesser quantities were not effective in alleviating cobalt deficiency in lambs (117).

In an attempt to link volume of vitamin B_{12} production in the rumen

with cobalt deficiency in sheep Hale et al. (58) demonstrated that cobalt supplemented sheep supported much greater production of the vitamin in the rumen than did cobalt-deficient sheep. The work of Becker et al. (10) essentially nullified the value of the above mentioned work as it regards the action of cobalt on ruminant animals. These investigators were unable to get any response when vitamin B_{12} was injected intramuscularly twice weekly for six weeks in cobalt-deficient lambs. Similarly oral administration of a vitamin B_{12} concentrate yielded no response. These reports seem to eliminate vitamin B_{12} production as being the important use of the cobalt required by ruminant animals.

Tosic and Mitchell (127) determined the cobalt content of rumen-microbial material from sheep on natural hay rations and found approximately 80 per cent of the total rumen cobalt contained in the microbial fraction. They were able to increase the microbial cobalt content markedly by supplementing the hay ration with one milligram cobalt daily. It is of interest in this connection that Pounden et al. (103), in a study of the fate of four types of microorganisms which are characteristically present in rumen samples taken from cattle, found that these several types of microorganisms vary in their resistance to digestion. Some pass completely intact through the alimentary canal while others disappear as early as the abomasum. Even though there is much yet to be investigated concerning the fate of cobalt in the rumen and in the microorganisms which pass from the rumen the last two quoted studies are suggestive of the fate of cobalt in ruminant animals.

Cobalt-Induced Polycythemia--Incidence

The ability of cobalt to produce polycythemia when administered in large doses has received considerable attention. Observation of this property was first made by Waltner and Waltner (135) who fed rations containing one-half and two per cent cobalt, respectively, to rats. The larger cobalt supplementation was relatively toxic while the smaller allowed normal growth but caused infertility. Since that time cobalt-induced polycythemia has been reported in rats (1, 9, 17, 21, 43, 55, 65, 78, 82, 91, 99, 119,121), rabbits (8, 54, 74, 78, 89, 111, 113, 134), chickens (114), ducks (42), salamanders (25), mice and frogs (122) guinea pigs (89, 122, 131), pigs (121), dogs (18, 36, 49, 86), and human beings (137), and possibly in sheep (66).

Factors Affecting Cobalt Polycythemia

Stanley et al. (120) have shown that it takes sixteen times the dose of cobalt administered orally to produce the same polycythemic effect in rats as when it is administered subcutaneously. The excretion of cobalt depends on its route of administration. Greenberg et al. (30, 56) found that orally administered cobalt is only partially absorbed, the remainder plus part of that contained in the bile being quickly eliminated in the feces. A portion of the absorbed cobalt is accumulated in the liver and some is eliminated in the urine. The rapid elimination (5, 27, 28) and liver storage of cobalt (27, 28) have been confirmed. Kent and McCance (71) showed that a man excreted 20 per cent of his food cobalt in the urine while injected cobalt was slowly excreted in the urine. Comar and

Davis (27) demonstrated that cobalt injected into the jugular vein was excreted in the urine and feces in the approximate ratio of two to one. Human beings excrete 60 to 80 per cent of injected cobalt in the urine (137). Houk et al. (60) showed that retention of cobalt in rats varied inversely with the dosage.

Gordon et al. (55) demonstrated the value of cobalt as a supplement for the stimulation of red blood cell and hemoglobin production in bled thyroidectomized rats. The addition of thyroxin to the supplement gave even better results. Testosterone has been shown to be necessary for hemoglobin formation (48) but an excess of this hormone is deleterious. These facts tend to show the requirement for balanced hormone production for erythropoiesis.

Liver extracts have been shown to accelerate the return to normalcy of cobalt-polycythemic rats (82, 111) and guinea pigs (111) but there was no interference with the polycythemia when both were administered together. Anderson et al. (1) reported that either whole liver powder or Wilson's liver extract aided cobalt-polycythemia production in rats. Davis (37,38) showed that liver reduces polycythemia in dogs. However, it returned four days after liver feeding was stopped. Cobalt has been shown to inhibit normal hematopoietic response to iron and copper feeding in dogs made anemic by hemorrhage whereas whole dry liver or liver extract administration overcame the inhibitory effect (50). Barron (7) found only a decreased rate of polycythemia production when cobalt and small daily injections of Lilly's liver extract were administered together.

Cobalt polycythemia in dogs has been shown to be depressed by daily administration of ascorbic acid (39) although it had no effect on low-

pressure polycythemia. Cobalt was found to reduce the blood ascorbic acid levels of cobalt-polycythemic dogs. Ascorbic acid has been used to alleviate the effects of cobalt in rabbits (7, 8) and human beings (137). Levy (78) was not able to substantiate these results with rats and rabbits but the intravenous administration of the sodium salt of ascorbic acid decreased the hemoglobin concentration in the blood of polycythemic rabbits. The sodium salt of isoascorbic acid had a similar but lesser effect and the sodium salt of glucoascorbic acid had no effect on the polycythemia.

Choline has been shown to exert no effect on cobalt polycythemia in rats (21,22). Return to normal red blood cell count was hastened by choline administration in rabbits made polycythemic with cobalt (110) and choline depressed hematopoiesis in cobalt-polycythemic dogs (38).

Burke et al. (24) found that mice could tolerate much more cobalt when it was accompanied by concurrent injections of histidine in more than equimolar quantities. Griffith et al. (57) were able essentially to prevent the inhibition of growth of young rats due to cobalt administration by supplementing the ration with methionine, cystine or cysteine, especially the latter. These workers established the relative nontoxicity of the cobalt-cysteine complex formed in vitro. Orten and Bucciero (97) concluded that cobalt polycythemia in rats was inhibited by cysteine, inhibited less by histidine and not inhibited by methionine. These workers were able to obtain some degree of polycythemia by the administration of the cobalt-histidine complex but not with the cobalt-cysteine complex. Ely et al. (45) demonstrated the ability of injected methionine to prevent the toxic symptoms due to excessive cobalt intake in cattle.

Orten and Orten (98) found that rats fed a ration low in protein became polycythemic at the same rate and to the same extent as did rats on a stock ration. Ely et al. (46) were unable to reduce the toxicity of cobalt fed to dairy calves by supplementing the grain mixture with casein, more than doubling the protein content of the grain ration.

Anderson et al. (1) were able to increase the rate of polycythemia development and intensity of toxicity as well as to depress growth due to cobalt administration by the addition of mono-sodium phosphate to a milk diet, lowering the calcium/phosphorus ratio of the milk to 0.6. Orton et al. (102) demonstrated the stabilizing influence of manganese on the increased hemoglobin, erythrocyte count, cell volume and blood volume values characteristic of cobalt polycythemia. The same workers (100) found that a diet consisting of whole milk supplemented with adequate amounts of iron and copper with cobalt added would support polycythemia in rats for nearly a year and that upon removal of the cobalt from the diet the hemoglobin, red blood cell volume, and erythrocyte count slowly returned to normal. Beard and Andes (9) obtained an increase in red blood cell count without increase in hemoglobin concentration when rats were fed milk fortified with iron and cobalt. Addition of vitamin D to the ration allowed the hemoglobin concentration to increase as well.

It has been established that cobalt polycythemia is accompanied by an increase in blood volume in rats (101, 119) and dogs (40). In each case the increased blood volume was accounted for by the increase in volume of cells. Stanley et al. (101) characterized the erythrocytes of polycythemic rats as being 41 per cent greater in volume than normal, almost entirely due to increased thickness of the cell. They found essentially the same

hemoglobin content in both normal and polycythemic cells. Valerio (132) studied the morphological changes brought about by cobalt polycythemia in guinea pigs. He found mild poikilocytosis, a tendency toward reduction in erythrocyte diameter, augmentation of lymphocytes after prolonged treatment, and moderate increase in number of platelets.

Valerio (133) determined that cobalt treatment of guinea pigs produced hyperemia and congestion of bone marrow, liver, spleen, kidney and lung in addition to a polycythemia of medullary origin and reticulohistiocytic activity with formation of hemocytes and phagocytes. Observations of macroscopically visible degeneration in the liver, kidneys, pancreas, and myocardium and inflammation in the kidneys were made. Davis et al. (42) observed early marrow hyperplasia and an increase in extramedullary erythropoietic masses in the spleen, liver, kidneys and adrenals in ducks made polycythemic by cobalt administration. Continued injection of cobaltous chloride produced evidence of marrow hypoplasia, disappearance of extramodullary erythropoietic foci, and a lowered phagocytic activity of the reticuloendothelial elements of the spleen and liver.

The literature concerning the effect of splenectomy on the development of polycythemia due to cobalt administration is controversial. Cornil et al. (32) observed parenchymatous degeneration of the livers of guinea pigs repeatedly injected with small doses of cobalt acetate. The degeneration was more intense in splenectomized animals. Perwald (14) reported that splenectomy made cobalt ineffective as an agent causing polycythemia in rats but Orten (95) found only a delay in the action of cobalt attributable to spenectomy. Perron (7) found no change in the action of cobalt on rabbits due to splenectomy.

Bucciero and Orten (23) could find no evidence of a decrease in the oxygen carrying capacity of the blood of cobalt treated polycythemic rats. The methemoglobin content of the blood did not very significantly from the concentration found in the blood of control animals. Dorrance et al. (43) observed that rats made polycythemic by cobalt administration have an increased work performance under conditions of anoxia. Immediately after withdrawal of the cobalt administration and prior to the drop in hemoglobin concentration of the blood a steady improvement in work performance was noted. Barron (7) showed that cobalt added to polycythemic blood in a Warburg apparatus decreased respiration rate of the red blood cells which may account for the results obtained by Dorrance et al. Withdrawal of the cobalt administration allowed the cobalt content of the circulating blood to fall nearly to zero. Warren et al. (136) disagree with Barron in regard to the decrease in respiration of cells in vitro due to small concentrations of cobalt.

Mechanism of Cobalt Polycythemia

Various theories have been advanced in attempts to explain the production of cobalt polycythemia. Mascherpa (86) explained the action of cobalt as a stimulation of bone marrow to produce red and white blood cells. He believed that cobalt stimulates the lymphopoietic organs and the spleen since the production of white cells was also increased. Orton (96) concluded that the hematopoietic activity of cobalt is a result of an increase in the rate of formation of hemoglobin and erythrocytes as

opposed to a passive accumulation of red cells as a result of a diminished rate of cell destruction.

The possible action of cobalt to inhibit enzymes which contain sulfhydryl groups has been postulated as a mechanism in polycythemia production (7, 57). This action would alter the oxidative mechanisms at the cellular level, leading to the inhibition of respiration of the young cells and causing them to be thrown into circulation (7). Orten and Bucciero (97) attempted to explain the action of cobalt on sulfhydryl compounds as leading to cellular anoxia and, in turn, leading to a compensatory polycythemia. Davis (41) attributed the polycythemia to the physiological effort to overcome local hypoxia produced by cobalt.

Schubmehl et al. (113) concluded that the chemical depression of bone marrow respiration and glycolysis was not the mechamism involved in cobalt polycythemia. These workers ruled out the involvement of neural mechanisms and histological changes in the marrow blood vessels as factors.

A recent contribution may shed some light on the mechanism of cobalt polycythemia. Berlin (13) has shown by the use of a tracer technique that injected cobalt rapidly reaches a saturation level in the liver, kidney, and lungs of rats, and that prolonged administration tends to a slow increase in the cobalt content of red blood cells, spleen, and bone marrow.

Cobalt Tolerance in Ruminants

Several reports have indicated the possibility of reaching a toxic level of cobalt intake for cattle and sheep. Josland (66) reported the development of a polycythemia in one of four ewes drenched daily for seven months with one milligram of cobalt as cobaltous sulfate per 200 grams of

body weight. Two ewes became mildly anemic while one was unaffected. Ely et al. (45) concluded that oral administration of excessive amounts of cobalt depressed appetite and that excessive intravenous administrations of cobalt salts produced rapid respiration, incoordination, lacrimation, salivation, defecation, and urine leakage within five minutes. These investigators (46) concluded that the toxicity of cobalt fed as the sulfate, chloride, or carbonate was of the same intensity for calves. Tolerance of cattle for cobalt has been established at the level of 50 milligrams per animal per day (52), 40 milligrams daily per 100 pounds body weight for calves (46), and 50 milligrams daily per 100 pounds body weight for "growing dairy animals" (70).

Sulfaguanidine

Marshall et al. (81) first suggested the use of sulfaguanidine as a chemotherapeutic agent to combat intestinal infections. These workers described the compound as being fairly soluble in water but poorly absorbed from the intestinal tract. Black et al. (15) were first to report that inclusion of 0.5 per cent sulfaguanidine in a synthetic ration was sufficient to cause reduction in growth rate of rats. Confirmation of this observation was made by several workers (33, 35, 79, 80, 84, 85, 118).

Black et al. (15) were able to produce a growth response when liver extract or p-aminobenzoic acid was included in the diet with sulfaguanidine. The response to these two supplements differed in that the response of liver extract was immediate while that of p-aminobenzoic acid was delayed. These workers interpreted their results as indicating that the p-aminobenzoic acid overcame the inhibition of bacterial synthesis caused by sulfaguanidine

while liver extract furnished nutritive principles ordinarily elaborated by the bacteria of the alimentary canal. MacKenzie et al. (80) reported hyperemia and hypertrophy of thryroid glands due to inclusion of one to two per cent sulfaguanidine in the rat ration in addition to confirming the results of Black et al.

Various vitamin deficiencies have been induced by the administration of sulfonamide derivatives to experimental animals. It is not the purpose of this review to cover this phase of the action of the sulfa drugs. For this coverage the reader is referred to adequate reviews (3, 34, 144).

Gant et al. (51) studied the intestinal flora of rats receiving a diet containing sulfaguanidine and found that the number of organisms remained constant in the cecum but that coliform organisms decreased in number while the enterococci increased. Kirby et al. (73) demonstrated the same shift of organisms in feces from human beings treated with sulfasuxidine. Their results indicated that Escherichia coli were the organisms responsible for some vitamin syntheses. The decrease in fecal excretion of thiamine as the result of sulfathalidine administration to dairy cows has been reported (125). This would indicate some change in the quality or quantity of the flora of the alimentary canal.

The mode of action of sulfonamide compounds has not been a controversial subject although, to date, it has not been demonstrated experimentally in its entirety. Woods and Fildes (143) postulated and Woods (140) expanded a possible mechanism of sulfonamide compounds. These workers found p-aminobenzoic acid to be a powerful antisulfonamide agent as well as an essential nutrient either synthesized by bacterial cells or obtained from the environment of the cells, according to the type of bacteria. This theory attributes

the competition between sulfonamides and p-aminobenzoic acid to their common chemical structures. The anilide portion of their molecules is common to both.

The sulfonamide derivative competes for the particular cell reaction which requires p-aminobenzoic acid and which takes place through the anilide portion of the molecule. When the sulfonamide has reacted, the chain of events within the cell is broken since the sulfonamide lacks the remaining configuration required and the cell either dies or its normal metabolism is modified.

This theory does not account for the antibacterial action of all sulfonamide derivatives (53) but sulfaguanidine is not one of the exceptions. Woods (141) has reviewed the literature and compounded a list of organisms including bacteria, fungi, and yeasts for which p-aminobenzoic acid is an essential growth factor. Many other organisms which do not require p-aminobenzoic acid have been found to be able to synthesize it or materials with the same biological activity. Wood (139) deduced that since the equimolar ratio between the concentrations of p-aminobenzoic acid and sulfonamide derivatives remain constant that these two substances compete for an enzyme. Tamura (124) showed that the antisulfonamide effect of p-aminobenzoic acid occurred with all microorganisms tested with the exception of Bact. tularense.

Woods (142) recently reviewed the biochemical significance of p-aminobenzoic acid-sulfonamide competition and the effects of this competition on the factors either elaborated or required by microorganisms.

EXPERIMENTAL PROCEDURE

Seventeen calves whose ages ranged from 12 to 191 days when started on the experiment representing the Holstein, Guernsey, Jersey, Ayrshire, and Brown Swiss breeds and eight yearling heifers of the Holstein breed in the Michigan State College Experiment Station dairy herd were used in this investigation. All animals had been used for one or more experiments previous to being assigned to this work. Criteria for the selection of these animals were normal health and appearance, appetite for the concentrate mixture, and normal blood picture. The pertinent data regarding these animals and their assignment to groups is presented in Table 1.

Calves were started on the experiment at all times of year as they became available. The calves were maintained in individual solid board pens bedded with wood shavings. All calves had access to good grade alfalfa-mixed hay for ad libitum consumption. Herd milk was fed at the rate of 5 pounds diluted with water twice daily to all calves except three animals which were used on a preliminary experiment and were more advanced in age when started on the experiment. A grain mixture consisting of 40 parts ground yellow corn, 40 parts ground oats, 26 parts linseed oil meal and 1 part salt was fed to all animals while data were being taken. The cobalt content of the hays used in this experiment ranged from 0.03 to 0.18 parts per million, of the grain mixture from 0.04 to 0.18 parts per million, and of the milk from 0.002 to 0.007 parts per million.

The yearling heifers were all started on the experiment at one time. Their ration was composed of the same type of hay and the same concentrate mixture as that fed to the calves. These heifers were kept in stanchions and were fed in mangers having tight partitions.

A preliminary experiment was set up using animals C680, C681, and C684. Cobaltous sulfate, hepta-hydrate, was mixed into the concentrate mixture at the rate of 0.5 gram per pound of mixture and fed at the daily rate of 1 pound per 105 pounds body weight. This supplementation furnished 1 milligram cobalt per pound body weight per day. It was unfortunate that the animal which was designated to be the control in this experiment died soon after cobalt administration was started on the other three animals. In the light of this development it was decided to delete cobalt from the ration of animal C681 after 136 days of supplementation. The control for this group consisted of the period before supplementation for each animal and the period subsequent to supplementation in the case of calf C681.

Four groups of calves were set up on the basis of results obtained with the preliminary group. The control group, designated Group 1, received no supplement. Group 2 was supplemented to the extent of 1 milligram cobalt daily per pound body weight by incorporating 1 gram cobaltous sulfate, hepta-hydrate, in each pound of concentrate mixture and feeding the supplemented mixture at the rate of 1 pound daily for each 210 pounds body weight. After 14 weeks of cobalt supplementation animal C741 was supplemented with 1 milligram iron daily per pound body weight supplied in the form of ferric citrate, C. P. Feeding schedules were revised weekly and the concentrate ration was mixed and bagged for that period of time. The supplementation for Group 3 differed from that of Group 2 by the addition of sulfaguanidine to the extent of 2 per cent of the estimated dry matter of the ration mixed into the cobalt-concentrate mixture for 70, 102,

and 115 days, respectively, of the time these animals were on the experiment. Subsequent to these periods the cobalt supplement was continued. The two animals in Group 4 were supplemented for periods of 39 and 125 days, respectively, with sulfaguanidine alone at the rate of 2 per cent of the estimated dry matter intake. Following these periods of time the animals were supplemented with cobalt at the same rate as were the animals in Group 2. Additional unsupplemented concentrate mixture was included in the daily concentrate ration of any animal in Groups 1 to 4, inclusive, which had not gained weight the previous week.

Groups 5 and 6 were composed of yearling heifers. Group 5 was the control for Group 6 which was supplemented with cobalt at the rate of 0.5 milligrams daily per pound body weight. The supplement was supplied by 25 grams cobaltous sulfate, hepta-hydrate, mixed into 100 pounds of concentrate mixture and fed at the rate of 1 pound daily per 105 pounds body weight. After 84 days on experiment the concentrate mixture was supplemented with 50 grams cobaltous sulfate, hepta-hydrate, per 100 pounds of concentrate mixture fed at the rate of 0.75 pound per day per 105 pounds body weight. This latter supplementation was sufficient to furnish 0.75 milligram cobalt daily per pound body weight. Group 5 received unsupplemented concentrate mixture at the same rates.

Three test tubes of jugular blood were taken weekly, one containing lithium citrate as anticoagulant, one containing potassium oxalate, and one with no anticoagulant. The citrated blood was used for determination of red blood cell count by the method of Wintrobe (138, p.211), red blood cell volume (hematocrit) by the method of Wintrobe (138 p. 201), hemoglobin by

the method of Sanford et al. (109), plasma calcium by the method of Clark and Collip (26), plasma inorganic phosphorus by Briggs' modification (19) of the Bell and Doisy method (12), and plasma magnesium by a modification devised by Duncan et al. (44) of the Briggs method (20). Plasma ascorbic acid was determined by the method of Mindlin and Butler (90) in oxalated plasma. Total serum proteins and serum albumin were determined by a micro-Kjeldahl technique. Globulin separation was accomplished by Kingsley's modification (72) of Howe's method (61).

Calculation of mean corpuscular hemoglobin, mean corpuscular volume, and mean corpuscular hemoglobin concentration values were made from the experimental data.

Each animal was weighed weekly while on the experiment. Response to supplementation was evaluated on the basis of body weight change and blood analyses.

Table 1

Composition of Experimental Groups

Group	Animal No.	Breed	Sex	Age	
				At start (days)	Suppl. Started (days)
Preliminary	C680	Guernsey	M	191	210
	C681	Guernsey	M	175	195
	C684	Holstein	M	161	181
1. Control	C718	Brown Swiss	M	45	-
	C719	Ayrshire	M	18	-
	C724	Jersey	M	32	-
	C742	Holstein	M	33	-
	C749	Guernsey	M	75	-
2. Cobalt	C715	Jersey	M	32	39
	C739	Holstein	M	35	53
	C741	Holstein	M	33	36
	C744	Holstein	M	12	29
3. Cobalt plus Sulfaguanidine--Cobalt					
	C711	Holstein	M	81	88
	C725	Holstein	M	32	50
	C730	Holstein	M	37	47
4. Sulfaguanidine--Cobalt					
	C714	Holstein	M	46	84
	C726	Holstein	F	32	57
5. Yearling Heifers--Control					
	A73	Holstein	F	371	431
	A75	Holstein	F	323	383
	A78	Holstein	F	292	352
	A80	Holstein	F	228	288
6. Yearling Heifers--Cobalt					
	A72	Holstein	F	395	455
	A76	Holstein	F	303	363
	A77	Holstein	F	294	354
	A79	Holstein	F	285	345

RESULTS

Blood Picture

The data from determinations performed on the blood from animals used in the preliminary trial are presented in Appendix Tables 1, 2, and 3 and those pertaining to whole blood in Figures 1, 2, and 3. These three animals reached the height of their increases in red blood cell counts approximately 15 weeks after cobalt supplementation was started. Animal number C681 maintained the high red blood cell count until about 4 weeks after supplementation was suspended whereas the counts spontaneously reduced in intensity in the other two cases at about 55 weeks of age. Hemoglobin and red blood cell volume values essentially paralleled those of the red blood cell counts. Little change was noted in the mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration values for the duration of the trial. Peak experimental values obtained were 16.76, 16.31, and 18.10 millions red blood cells per cubic millimeter, 19.00, 19.20, and 18.80 grams per cent hemoglobin, and 50.0, 55.5, and 48.5 per cent red blood cell volume, respectively. These values represent increases in excess of 60 per cent as compared to those obtained prior to cobalt supplementation. The experimental values for plasma calcium, plasma inorganic phosphorus, plasma magnesium, and plasma ascorbic acid were relatively constant and in no way followed the pattern of values set by the measurements concerning the red blood cells. All three of the animals gained weight in excess of 1 pound per day during

the period of experimentation as is shown in Appendix Table 26.

The detailed data obtained on Group 1, the control group, are presented in Appendix Tables 4, 5, 6, 7, and 8 and the data obtained on the whole blood and serum of this group are presented in Figures 4, 5, 6, 7, and 8. Those obtained on Group 2, the cobalt supplemented group, are presented in Appendix Tables 9, 10, 11, and 12 and in Figures 9, 10, 11, and 12. Comparison of the results obtained with Groups 1 and 2 showed essentially no difference in concentrations of constituents determined on blood plasma as well as in concentrations of total serum proteins and serum albumin.

Differences between the two groups did occur in the results obtained from determinations made on the erythrocytes and their constituents. By the time the animals in Group 2 had been supplemented with cobalt for 15 weeks their red blood cell counts had increased approximately 100 per cent over those of Group 1, to values ranging from 18.95 to 21.95 millions red blood cells per cubic millimeter. The red blood cell volume values leveled off 3 to 5 weeks after the plateau was reached in the red blood cell counts. High red blood cell volume values ranged from 46.5 to 58.5 per cent for the four animals in Group 2. The hemoglobin concentration did not level out until 10 to 15 weeks after the leveling occurred in red blood cell counts and in one case, that of C744 as shown in Figure 12, the animal was not continued on the experiment a sufficient length of time for the hemoglobin concentration to reach a plateau.

The mean corpuscular hemoglobin values essentially paralleled the mean corpuscular volume values both in Group 1 and in Group 2. However,

both decreased in Group 2 animals until such a time as the red blood cell counts reached their plateaus and thereafter these mean values tended to return to their original level, whereas both these values remained relatively constant for animals in Group 1. The mean corpuscular hemoglobin concentration remained essentially unchanged in both groups for the duration of the experiment. This condition may be described as a microcytic hypochromic polycythemia which changes to a normocytic normochromic polycythemia after the red blood cell count plateau is reached. Supplementation with iron in the ration of animal C741 apparently speeded up the return of the red blood cell size and red blood cell hemoglobin content to normal.

The detailed data for the animals in Group 3 are presented in Appendix Tables 13, 14, and 15 and the data obtained from determinations carried out on the whole blood and serum from these animals are presented in Figures 13, 14, and 15. The values for plasma and serum constituents which were determined showed no material change during the period of experimentation as was found for Groups 1 and 2. During the period of cobalt and sulfaguanidine supplementation the animals in this group showed gradual concurrent increases in red blood cell counts, red blood cell volumes and hemoglobin concentrations for periods varying from 3 to 10 weeks. Red blood cell counts ranging from 15.85 to 16.70 millions per cubic millimeter were attained in this group. In two of the three cases the red blood cell volumes and hemoglobin concentrations attained paralleled those reached in Group 2. Mean corpuscular hemoglobin values, mean corpuscular volumes and mean corpuscular hemoglobin concentrations remained essentially unchanged

during this period. In only one of the 3 cases was cobalt supplementation alone able to support the high red blood cell counts, red blood cell volumes, and hemoglobin concentrations which were attained while sulfaguanidine was included in the supplement.

The detailed data for the two animals in Group 4 are presented in Appendix Tables 16 and 17 and data obtained on whole blood and serum from these animals are presented in Figures 16 and 17. During the period of sulfaguanidine supplementation the various values for blood constituents which were determined did not very significiantly from those values obtained with Group 1 with the exception of total serum protein concentration in the case of animal number C726 which suffered an attack of pneumonia during this period. After the sulfaguanidine supplementation had been replaced with cobalt supplementation the results for both animals resembled those obtained with Group 3 during concurrent cobalt and sulfaguanidine supplementation although one animal, C726, varied in the intensity of the effects. It may be noted at this point that this animal was about 8 weeks older than the other animal, C714, when cobalt supplementation was started.

The detailed data obtained from determinations performed on the blood of yearling heifers in Group 5 are presented in Appendix Tables 18, 19, 20, and 21 and those from Group 6 in Appendix Tables 22, 23, 24, and 25. Representative animals from these two groups were selected for graphical presentation of data in Figures 18 and 19, respectively. No consistent difference could be noted in the data from these two groups of animals. One animal in the cobalt supplemented group, A72, did show evidence of some elevations of red blood cell volume and hemoglobin concentration.

Growth

The detailed data concerning body weight changes of the animals used in the experiment are presented in Appendix Table 26. Due to the variations in age, sex, and breed of animals used comparisons of the body weights were made with weights interpolated from Ragsdale's standard (105). The results of these comparisons for Groups 1, 2, 3, and 4 are presented in Figure 20 and for Groups 5 and 6 in Figure 21. Breaks in the curves on these figures represent supplement changes. Data from which the figures were constructed are presented in Appendix Tables 27 and 28, respectively. Without exception the animals in Group 1 exhibited rates of growth which were superior to those of the standard. No animal in Groups 2, 3, or 4 grew as rapidly as the standard. Animal number C714 in Group 4 most nearly approached this accomplishment but its rate of growth declined during the period of cobalt supplementation. The animals in Groups 5 and 6 exhibited very nearly the same growth picture with one exception, A80, which surpassed the standard and was in the unsupplemented group (Group 5).

Table 2

Key to Abbreviations Used on Figures

RBCC	Red blood cell count--millions per cubic millimeter.
RBCV	Volume of packed red blood cells--per cent.
HB	Hemoglobin--grams per cent.
MCV	Mean corpuscular volume--cubic microns.
MCH	Mean corpuscular hemoglobin--micromicrograms per red blood cell.
MCHC	Mean corpuscular hemoglobin concentration--per cent.
TSP	Total serum proteins--grams per cent.
S. ALB	Serum albumin--grams per cent.
BODY WT.	Body weight--hundredweight.

$$MCH^{*} = \frac{\text{Hemoglobin (grams per 1000 cubic centimeters of blood)}}{\text{Red blood cell count (millions per cubic millimeter of blood)}}$$

$$MCV^{*} = \frac{\text{Volume of packed red blood cells (per 1000 cubic centimeters of blood)}}{\text{Red blood cell count (millions per cubic millimeter of blood)}}$$

$$MCHC^{*} = \frac{\text{Hemoglobin (grams per 100 cubic centimeters of blood x 100)}}{\text{Volume packed red cells (per 100 cubic centimeters of blood)}}$$

* (138, p. 222-223)

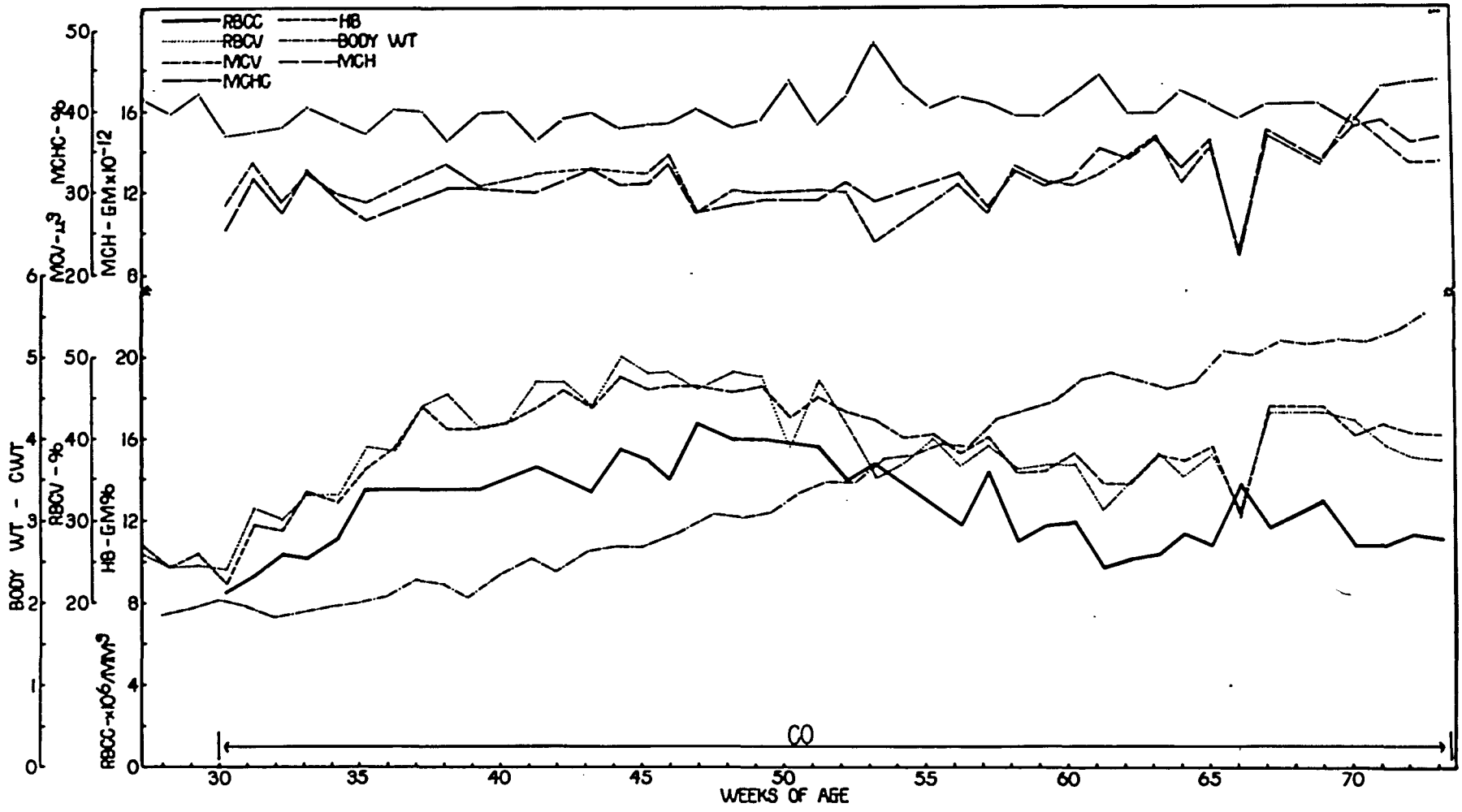

Figure 1. Blood picture and growth curve of animal number 0689 -- Preliminary Groun.

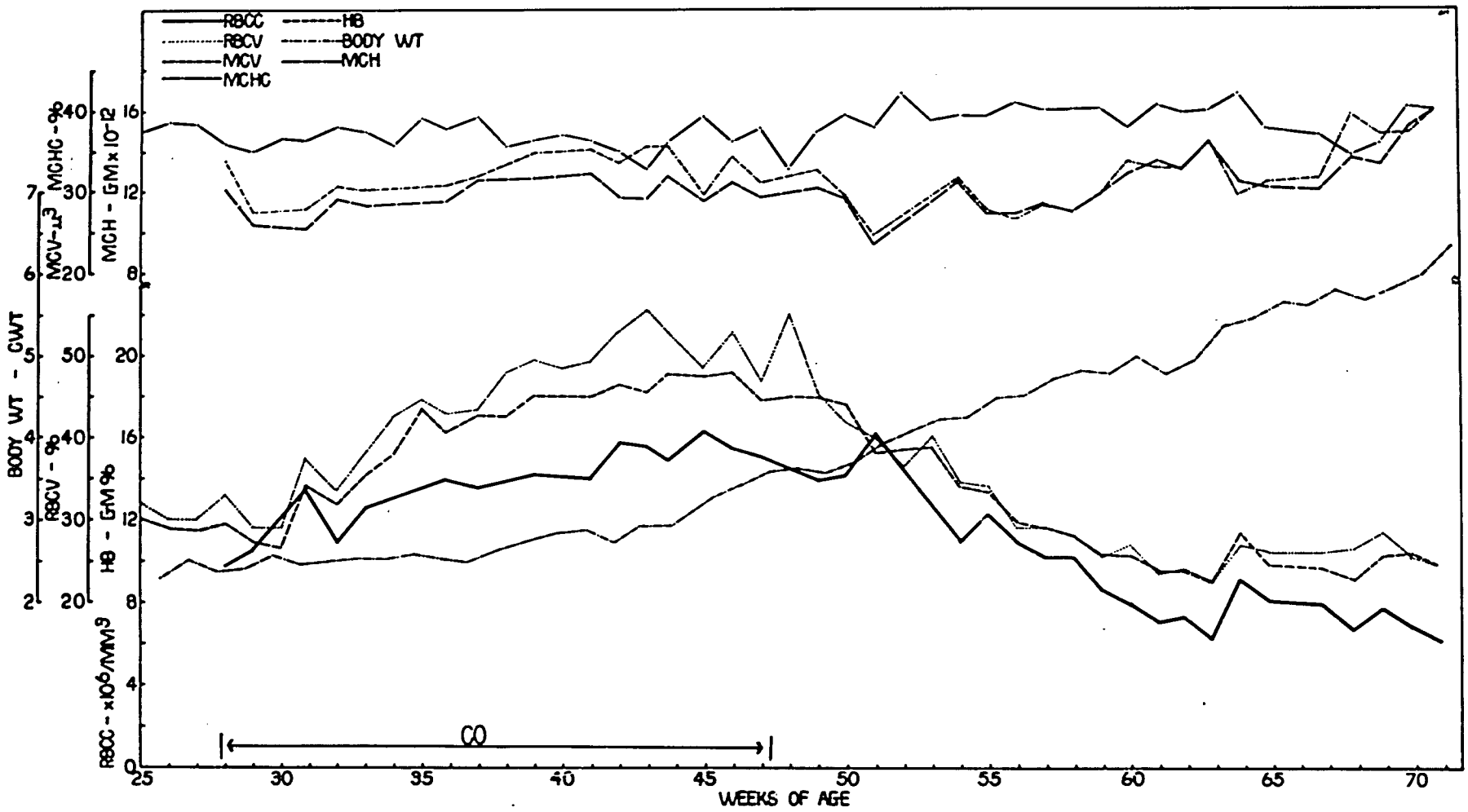

Figure 2. Blood picture and growth curve of animal number 0681--Preliminary Group.

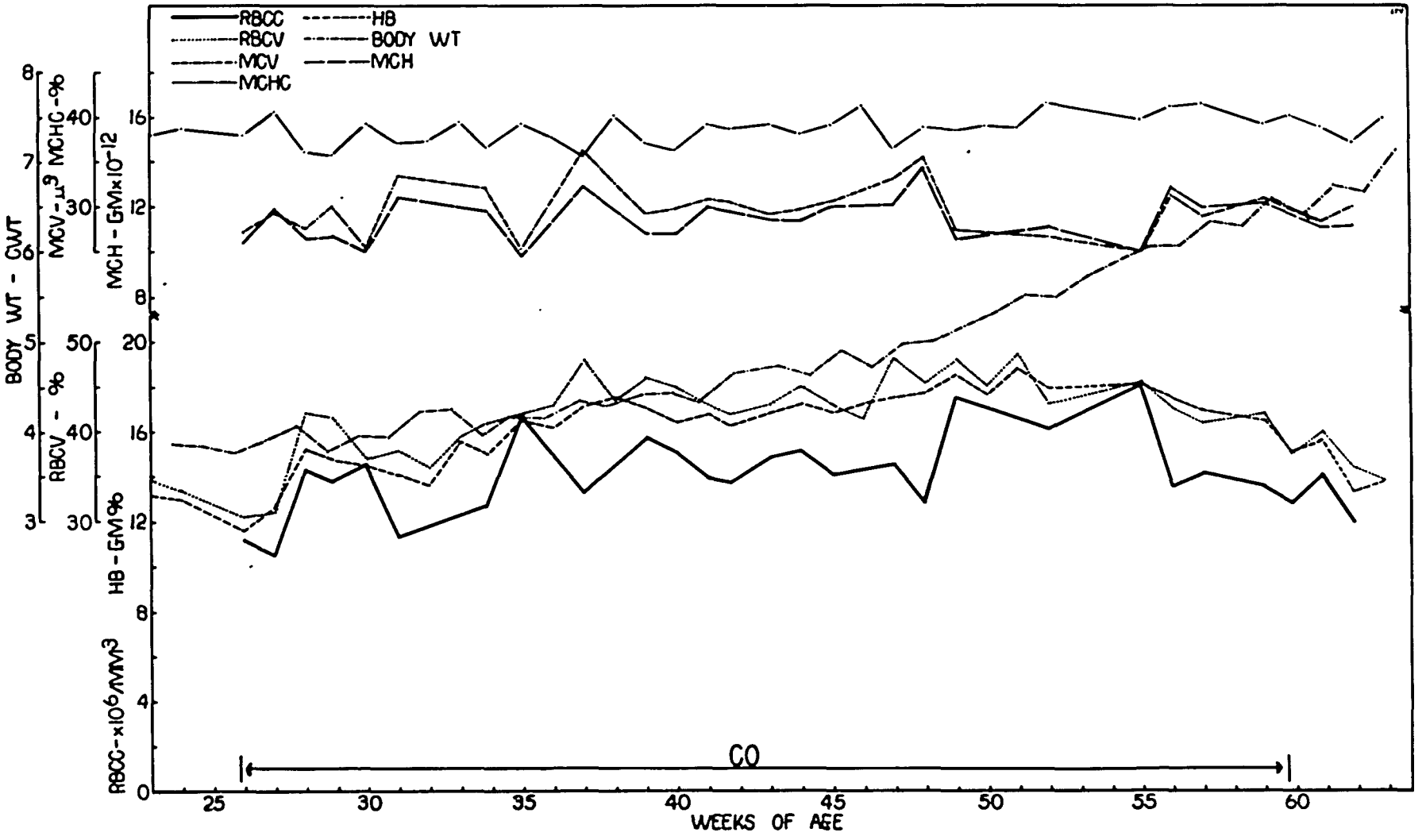

Figure 3. Blood picture and growth curve of animal number 0684--Preliminary Group.

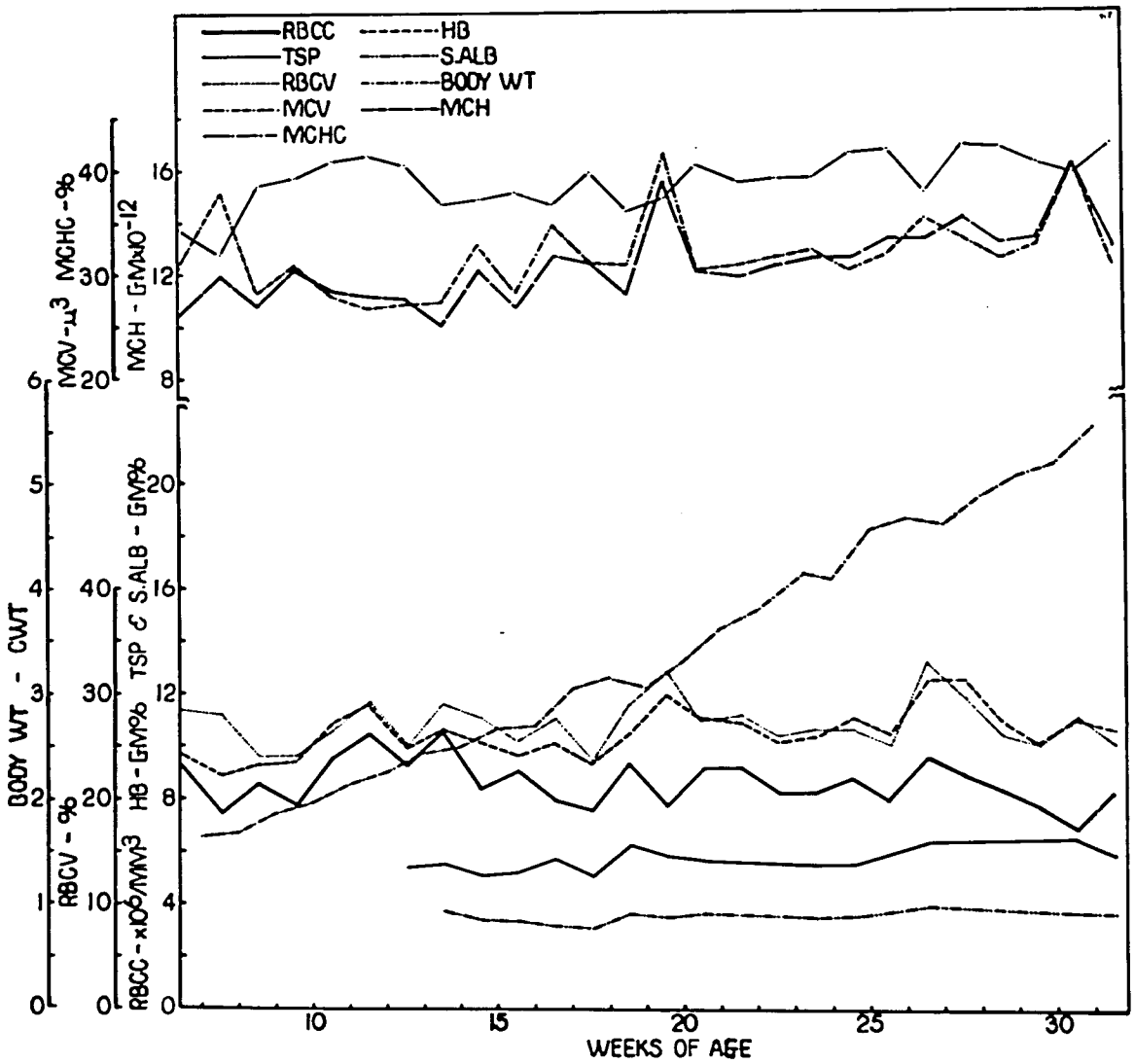

Figure 4. Blood picture and growth curve of animal number C718--Group 1.

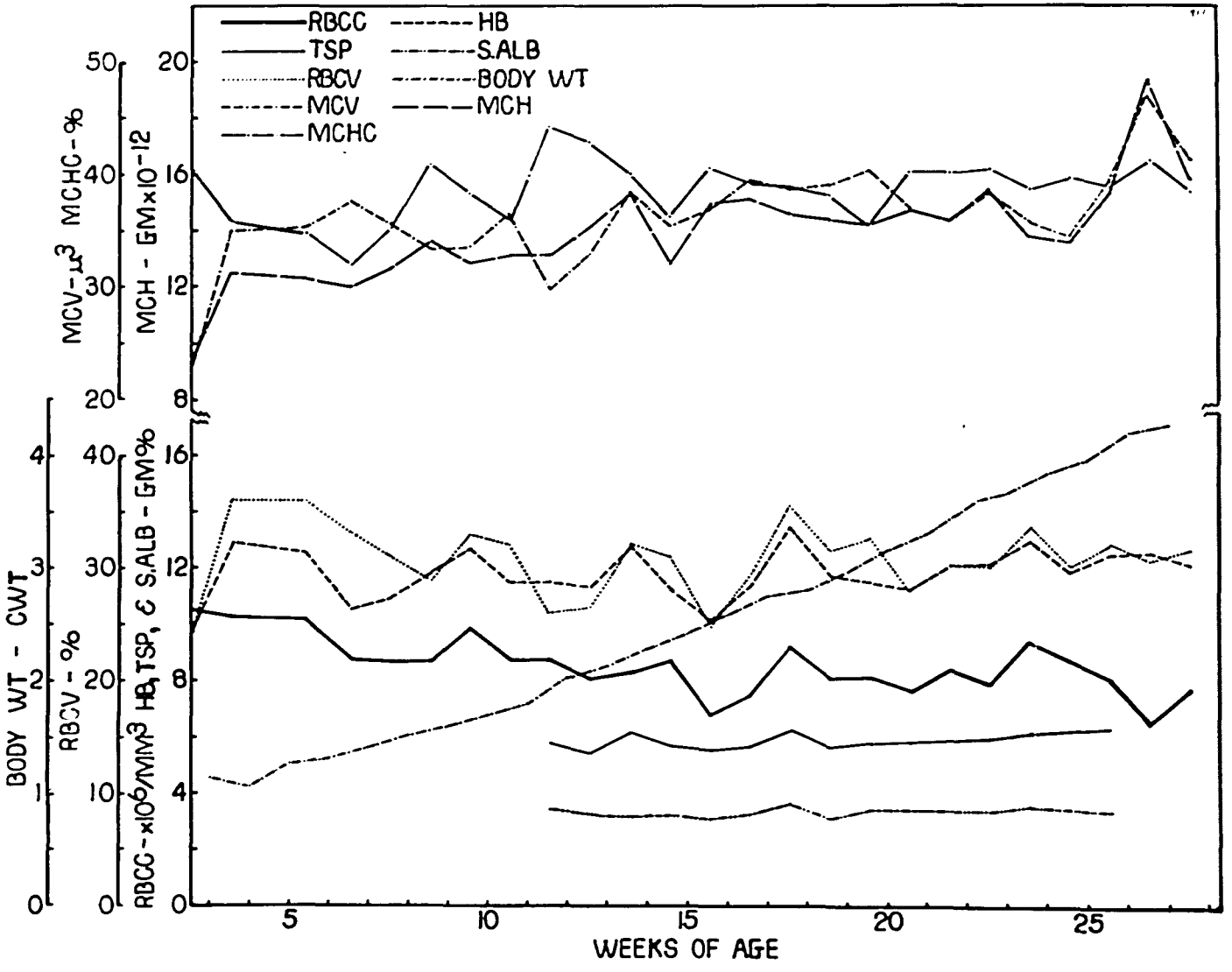

Figure 5. Blood picture and growth curve of animal number 2719--Group 1.

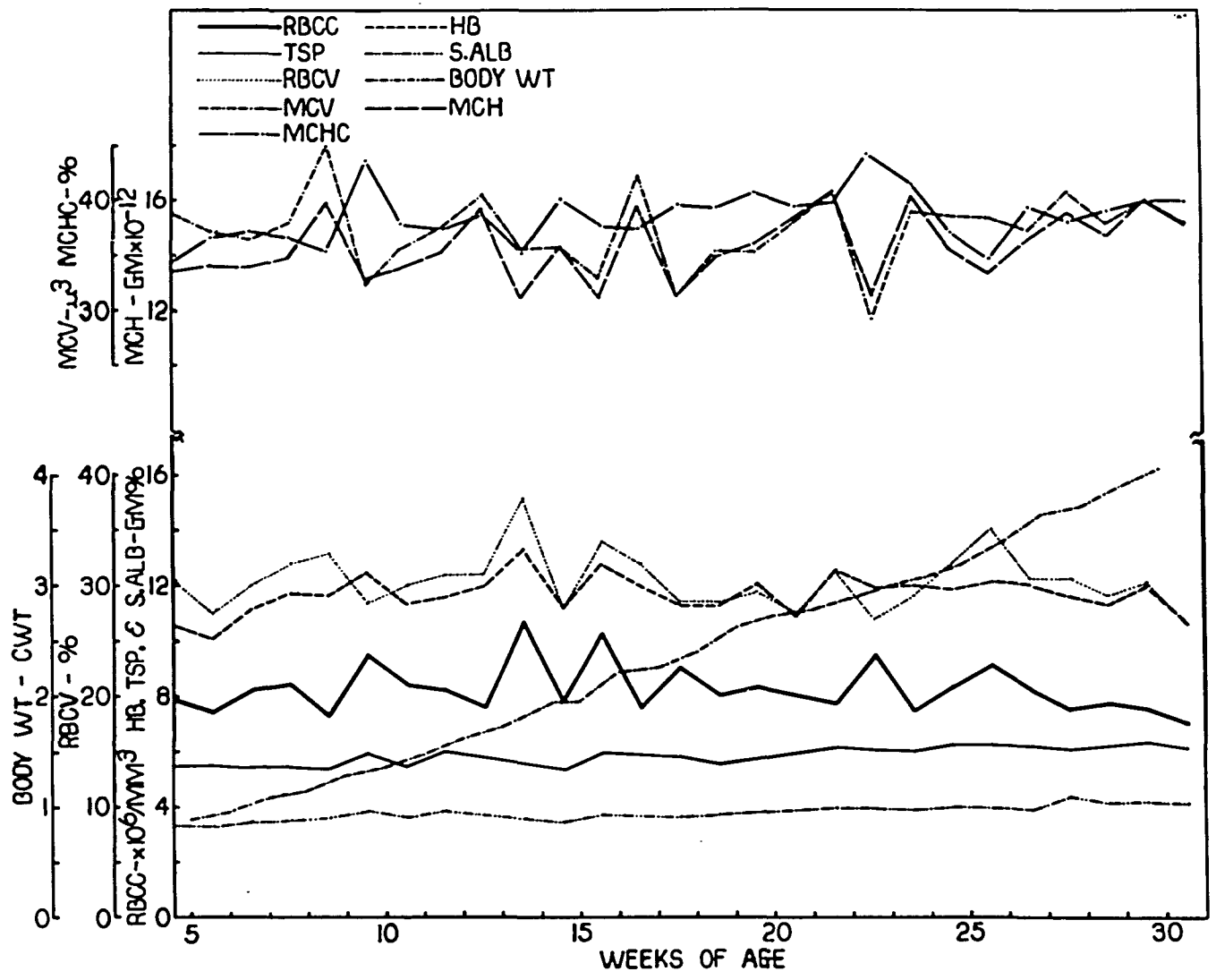

Figure 6. Blood picture and growth curve of animal number [illegible]-Group 1.

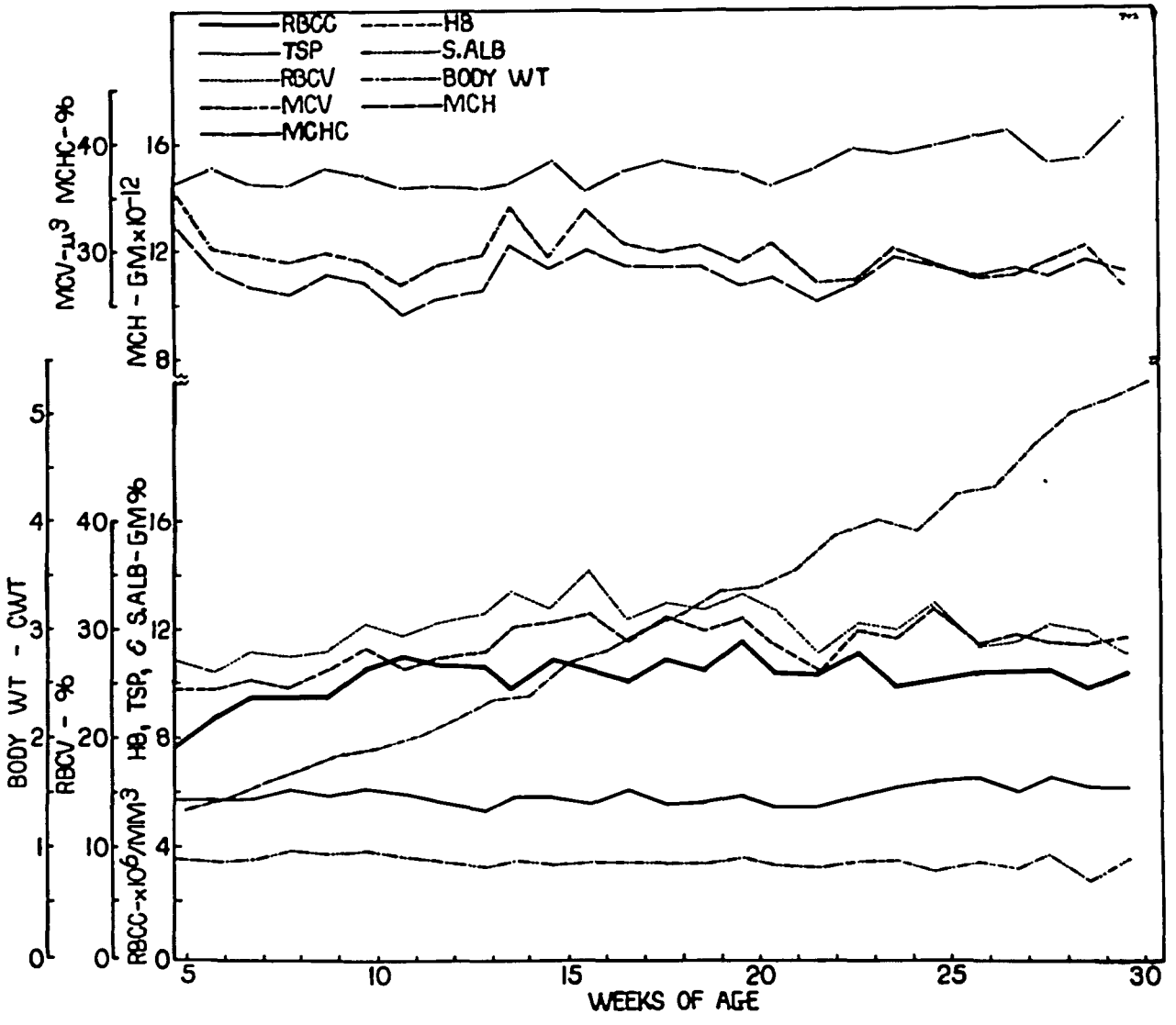

Figure 7. Blood picture and growth curve of animal number 0742--Group 1.

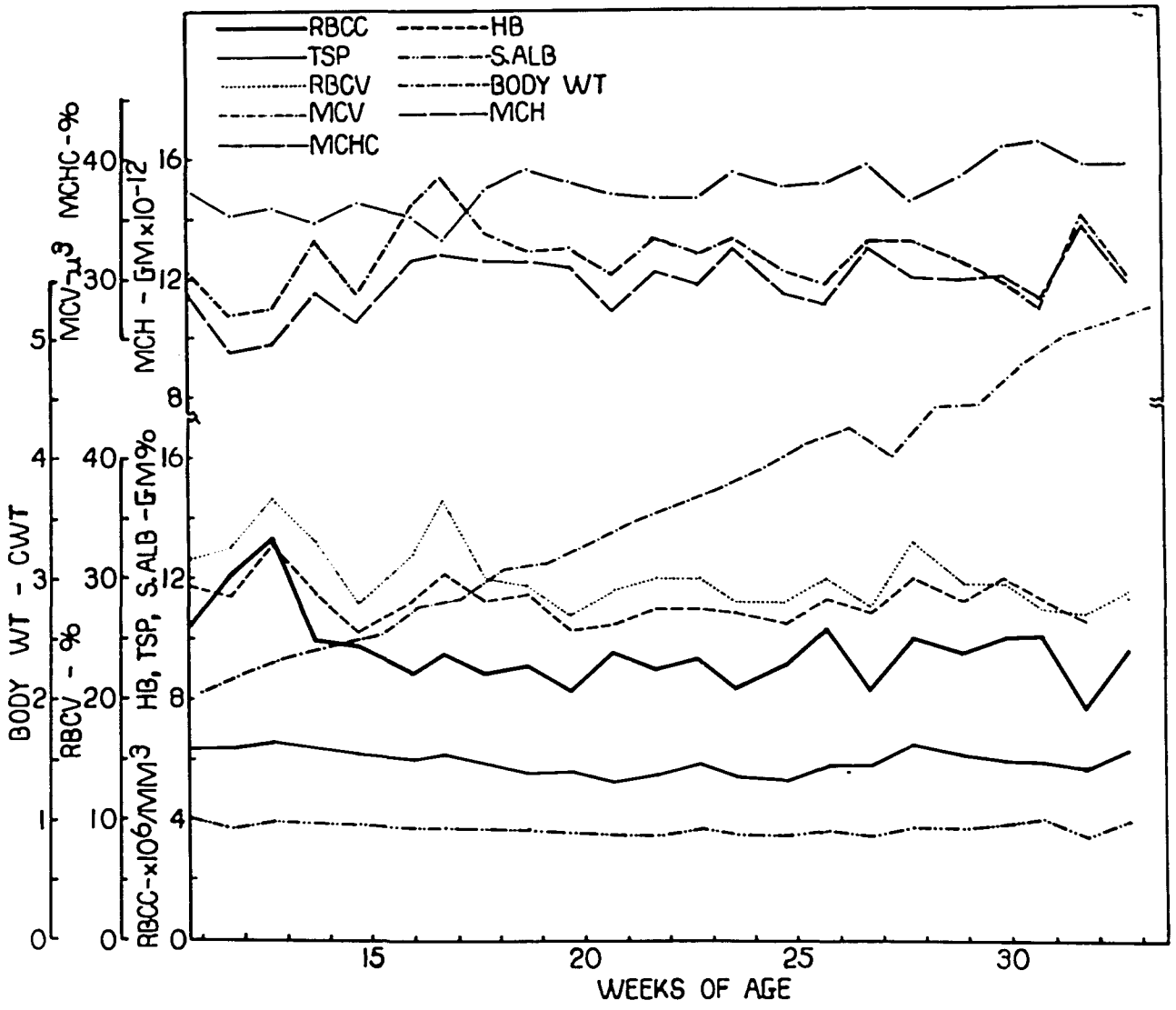

Figure 8. Blood picture and growth curve of animal number 37%--Group 1.

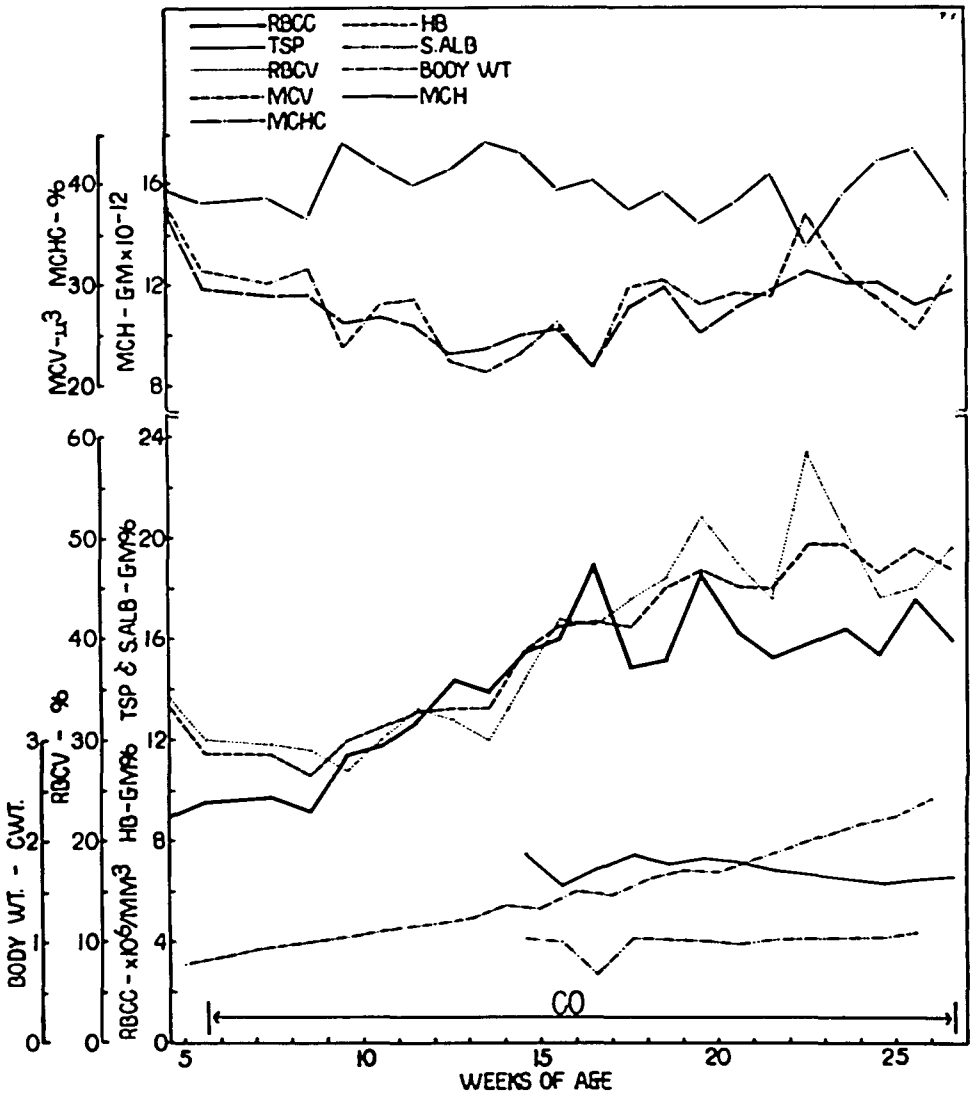

Figure 3. Blood picture and growth curve of animal number 371 - born [illegible].

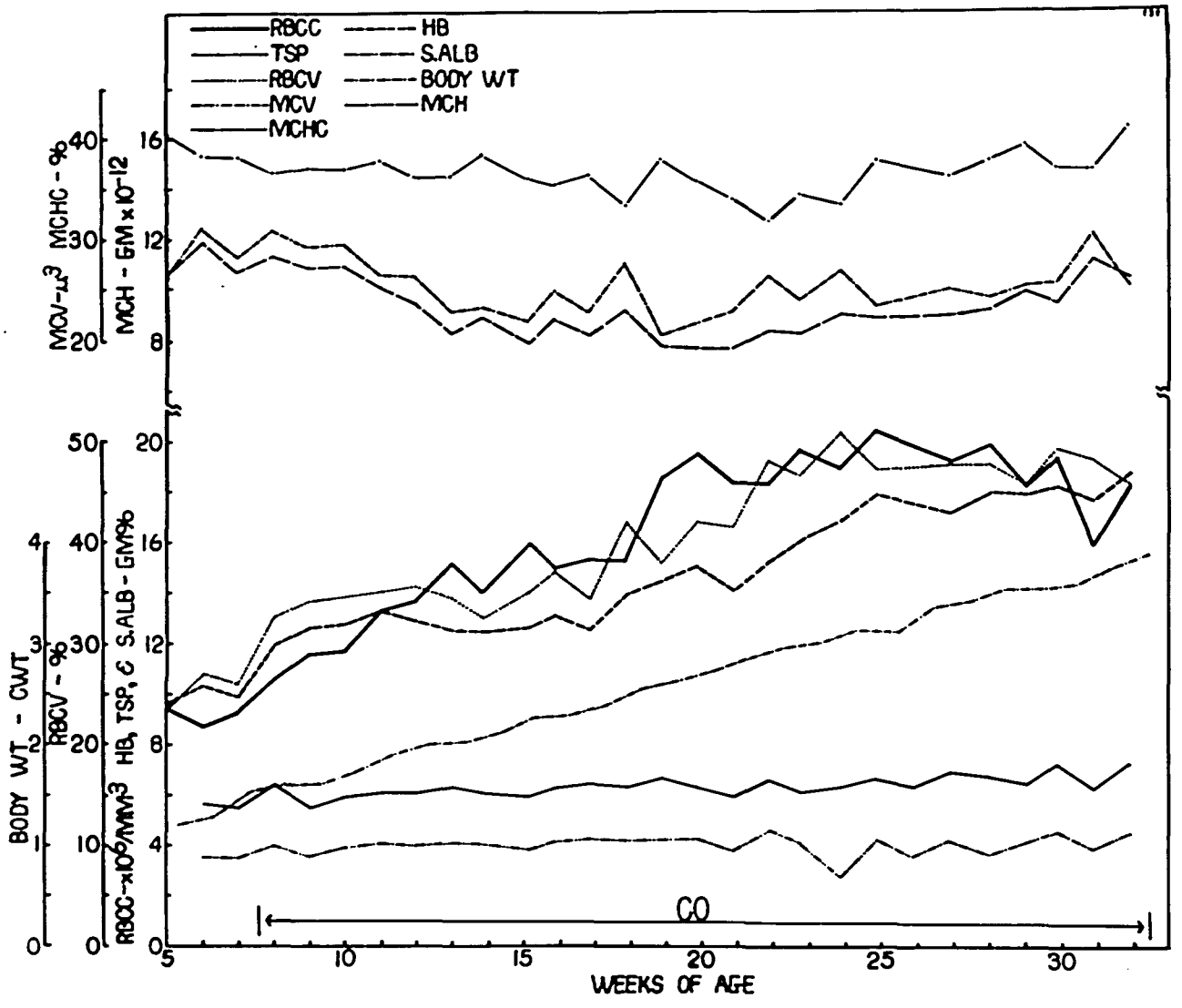

Figure 10. Blood picture and growth curve of animal number 0739--Group 2.

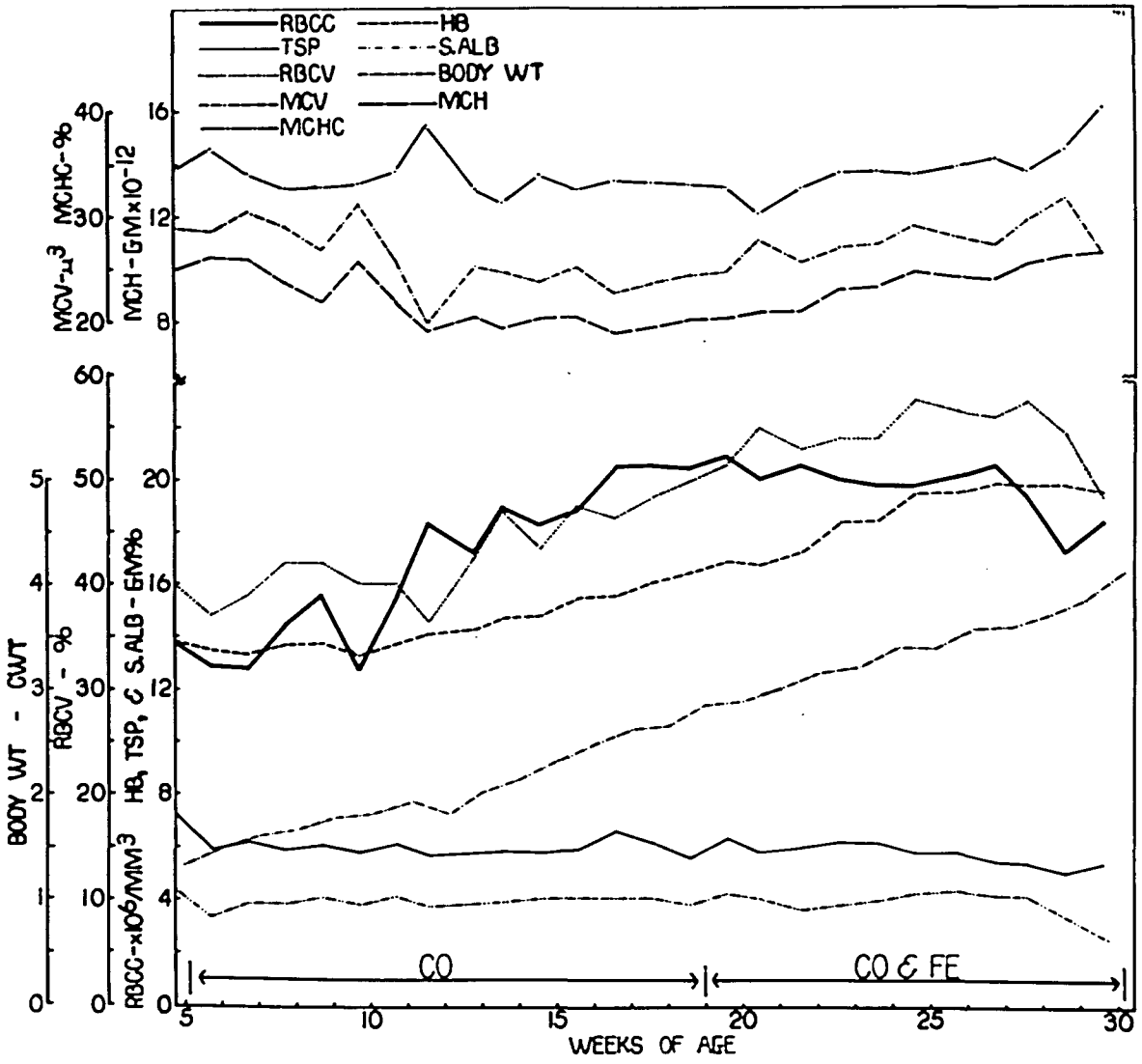

Figure 11. Blood picture and growth curve of animal number 0741--Group 2.

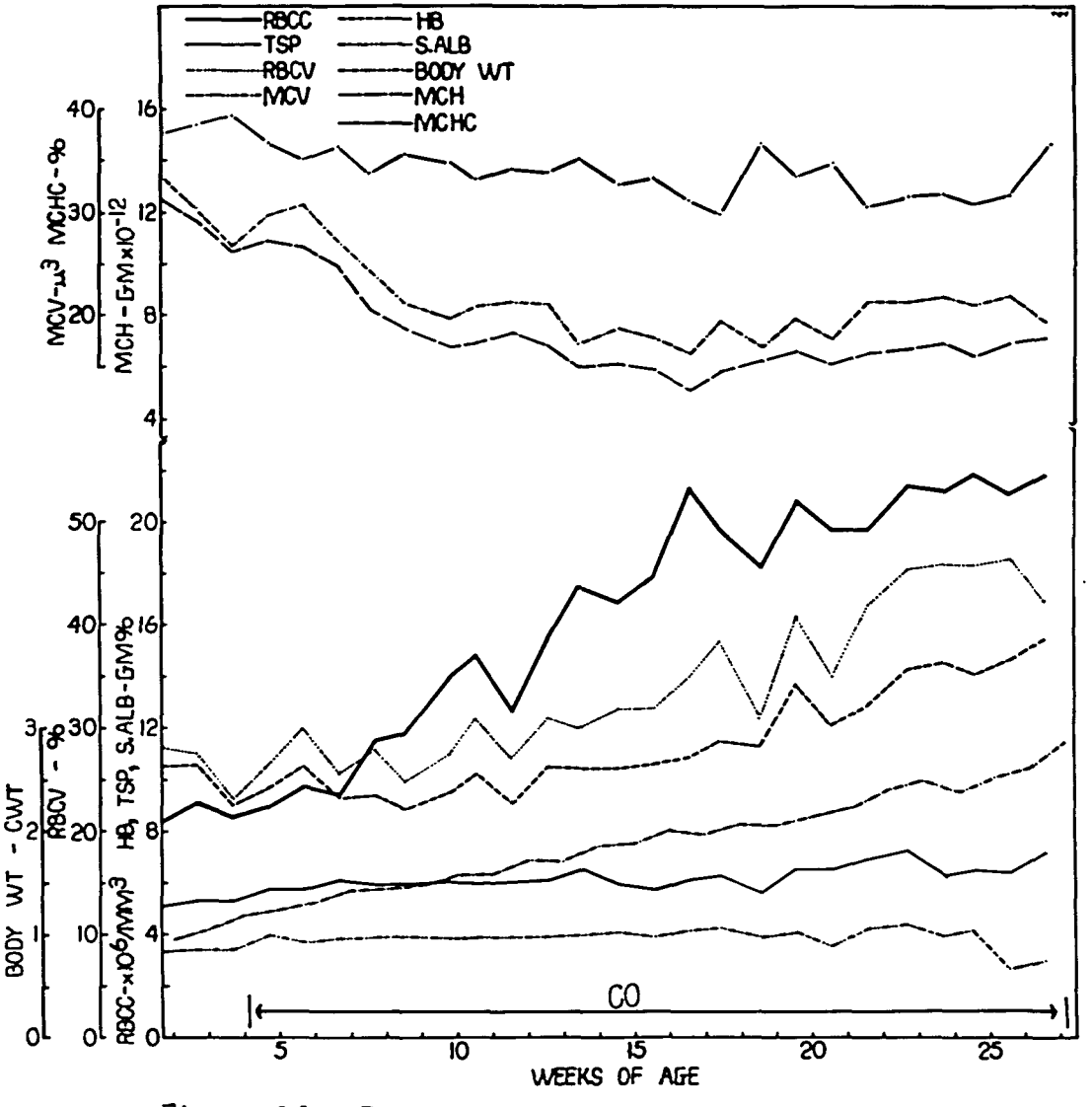

Figure 11. Blood picture and growth curve of animal number C744--Group 2.

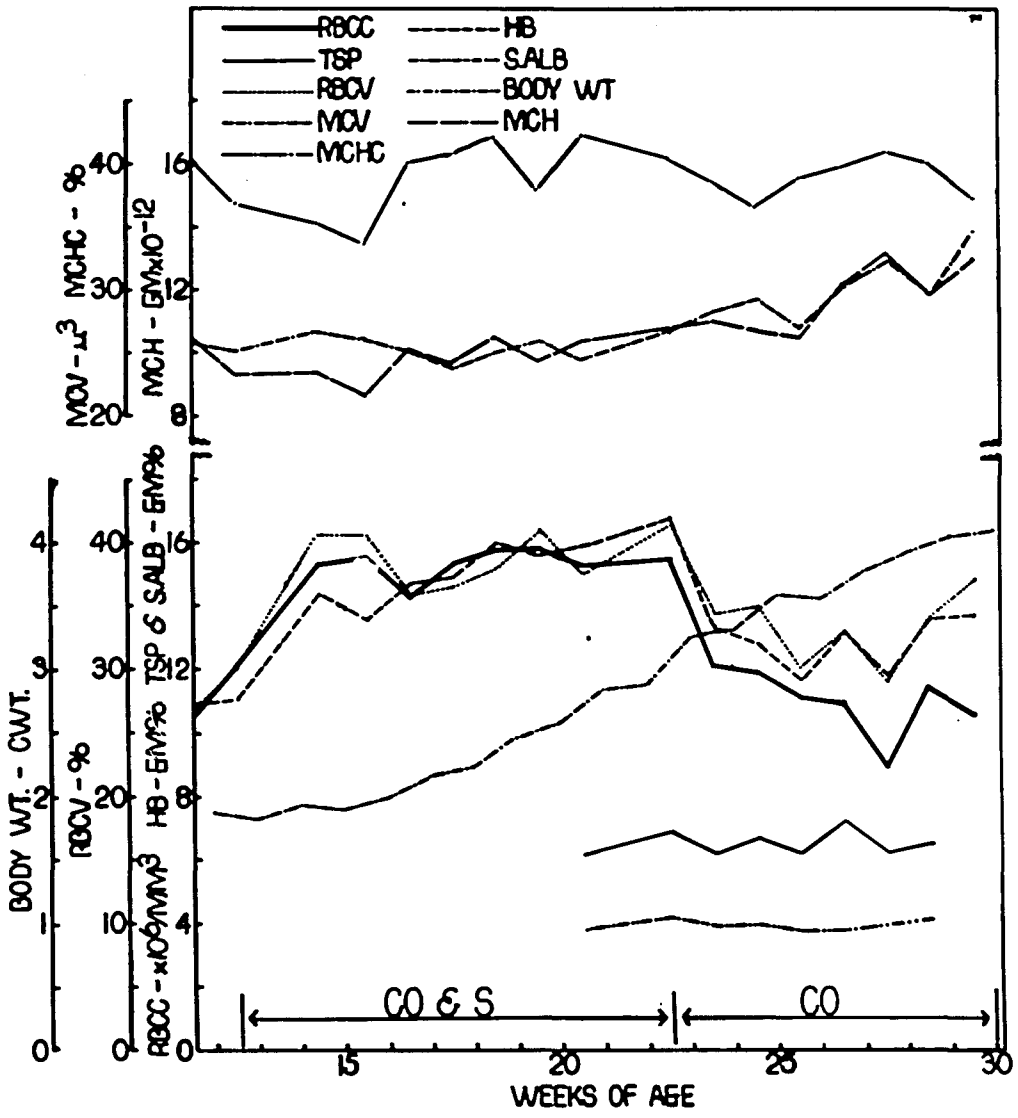

Figure 13. Blood picture and growth curve of animal number 3711--Group 3.

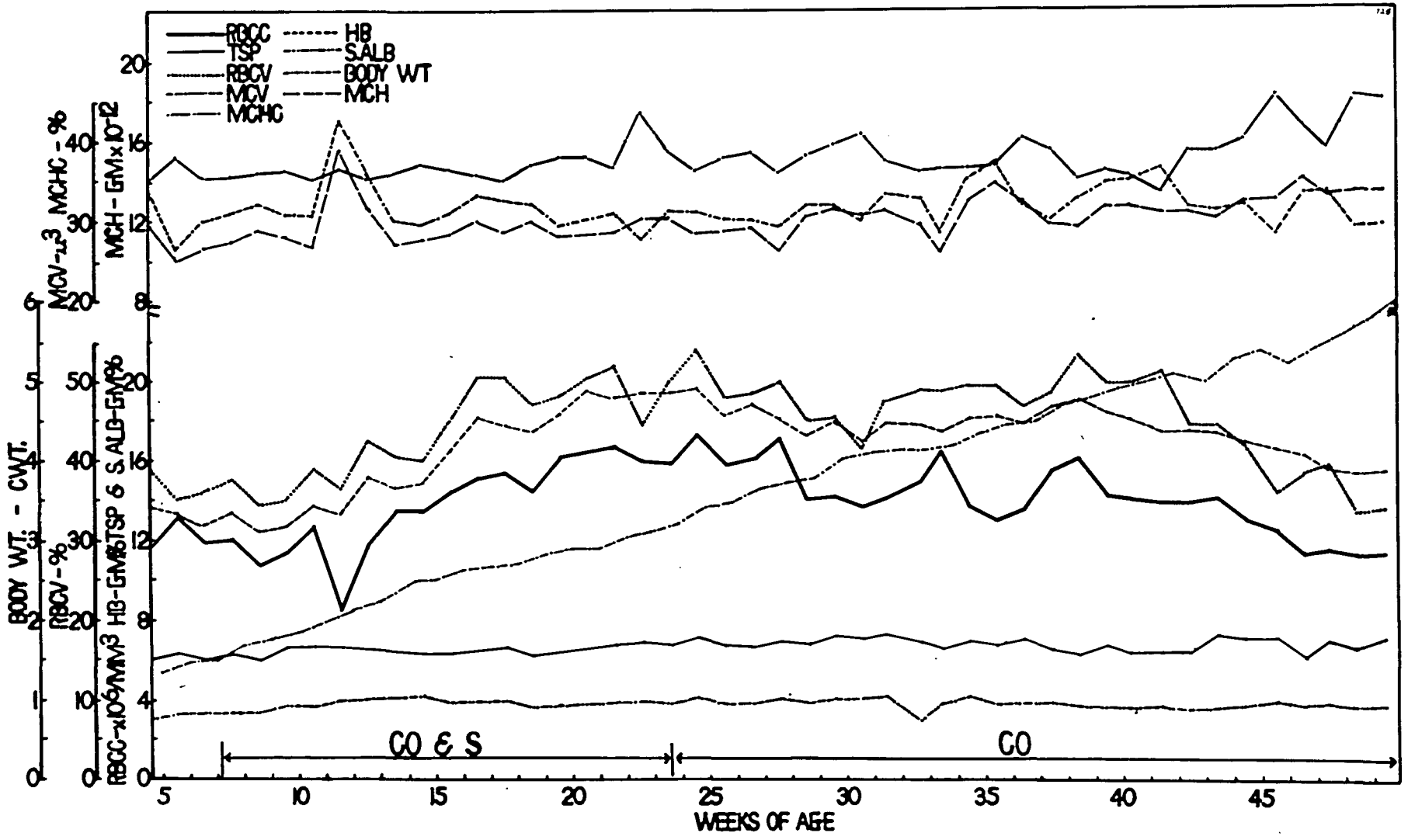

Figure 14. Blood picture and growth curve of animal number 0715--Group 3.

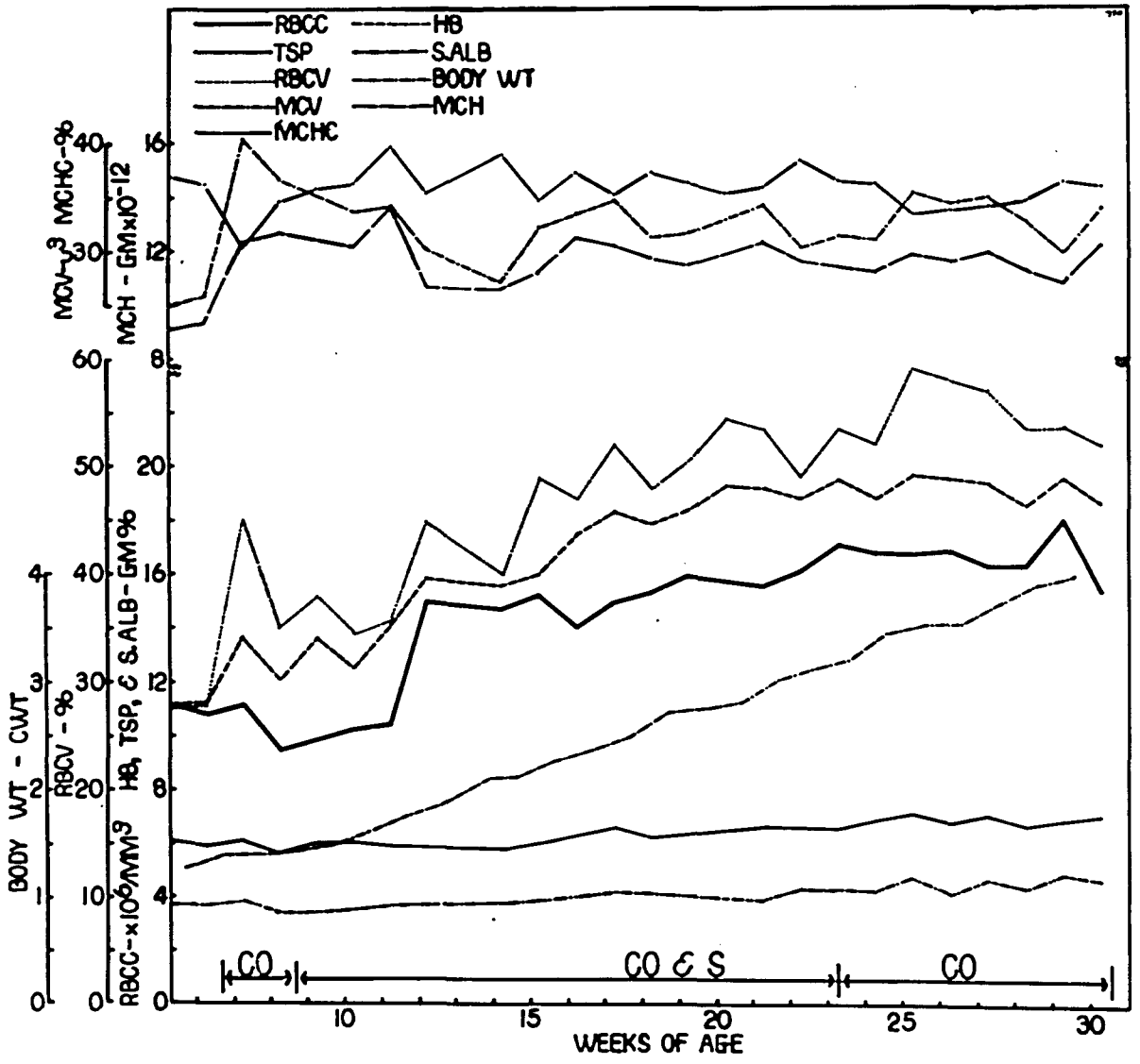

Figure 15. Blood picture and growth curve of animal number 0730--Group 3.

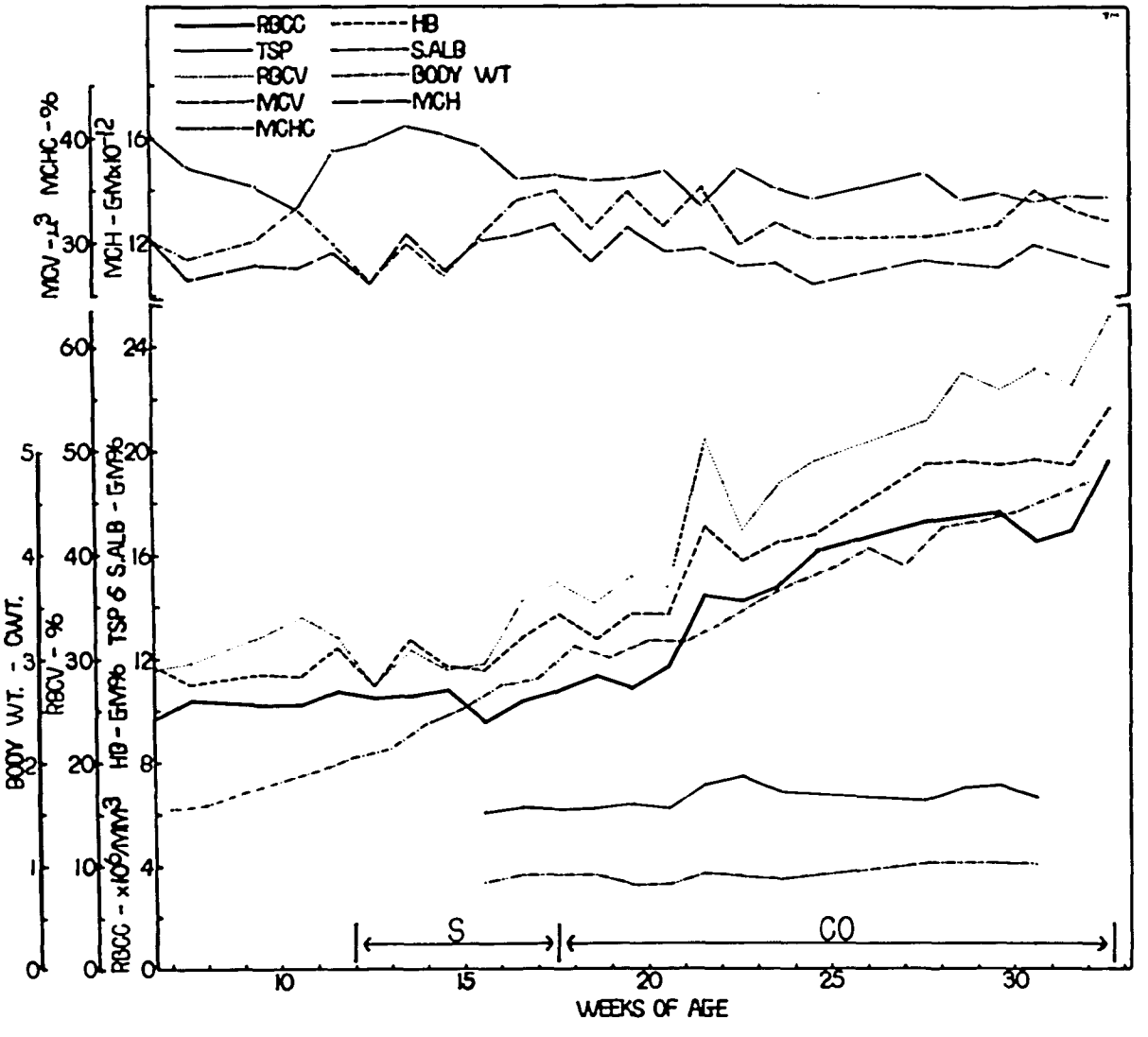

Figure 16. Blood picture and growth curve of animal number 0714--Group 4.

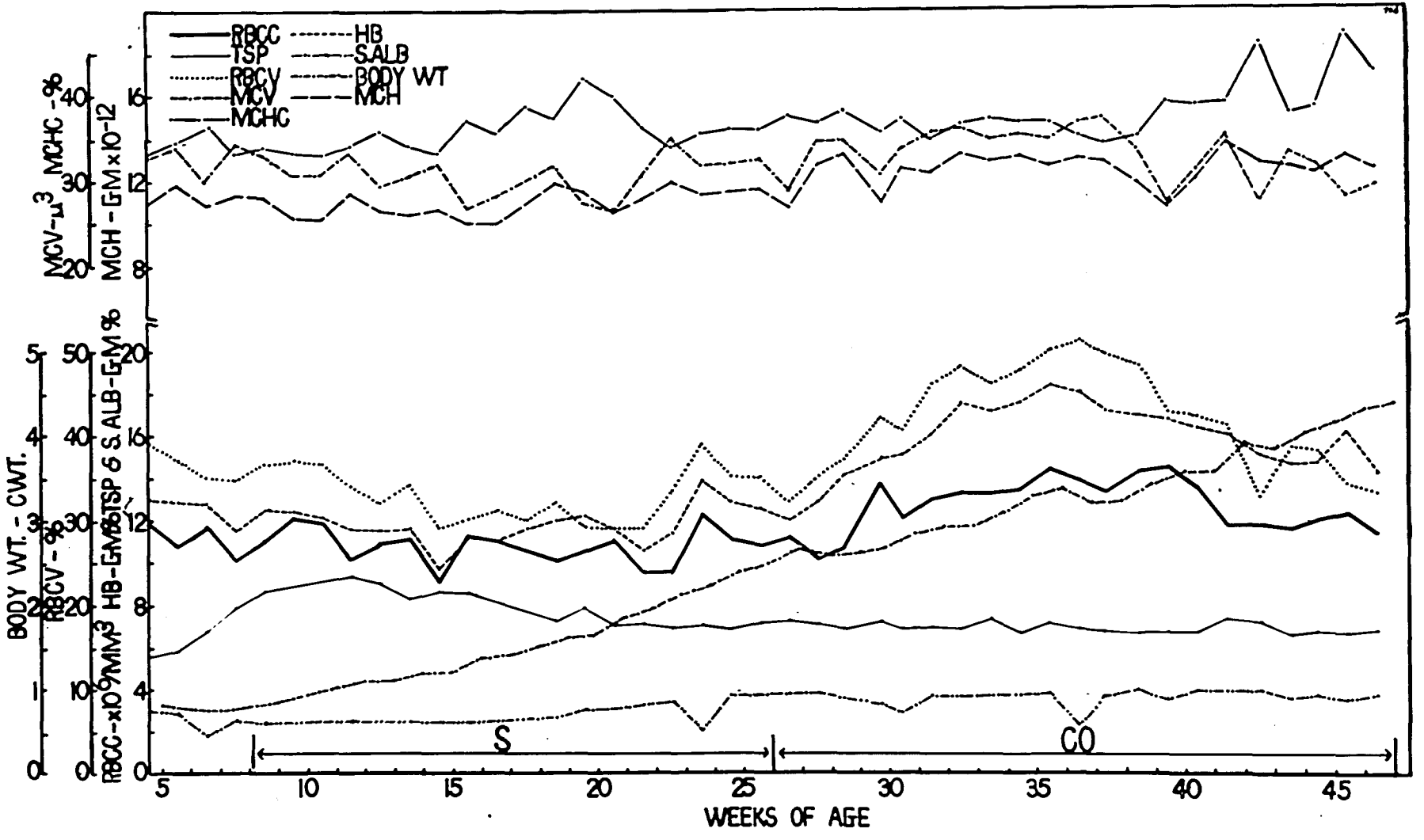

Figure 17. Blood picture and growth curve of animal number 3226--Group 4.

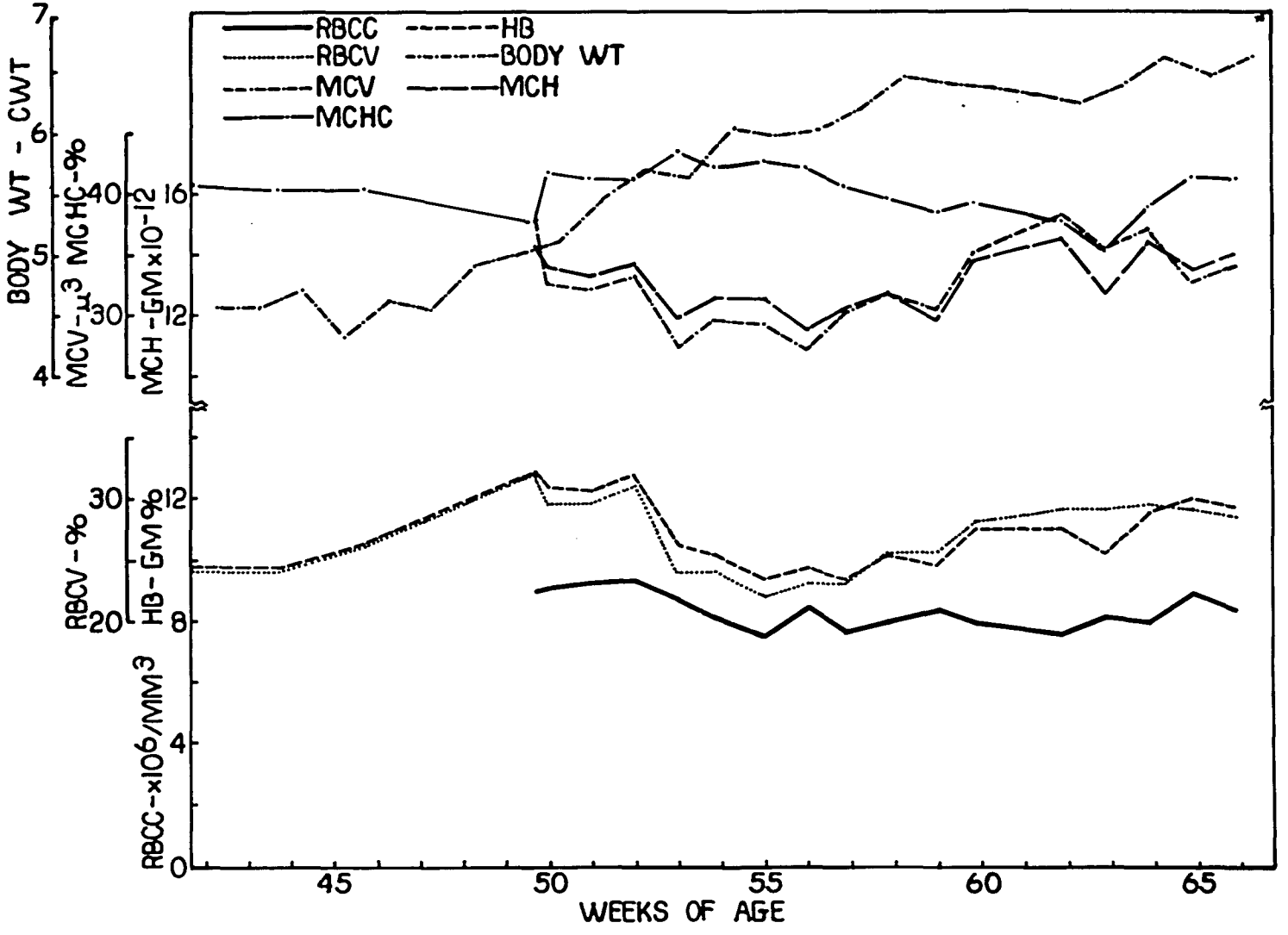

Figure 19. Blood picture of animal number A28--Group 5.

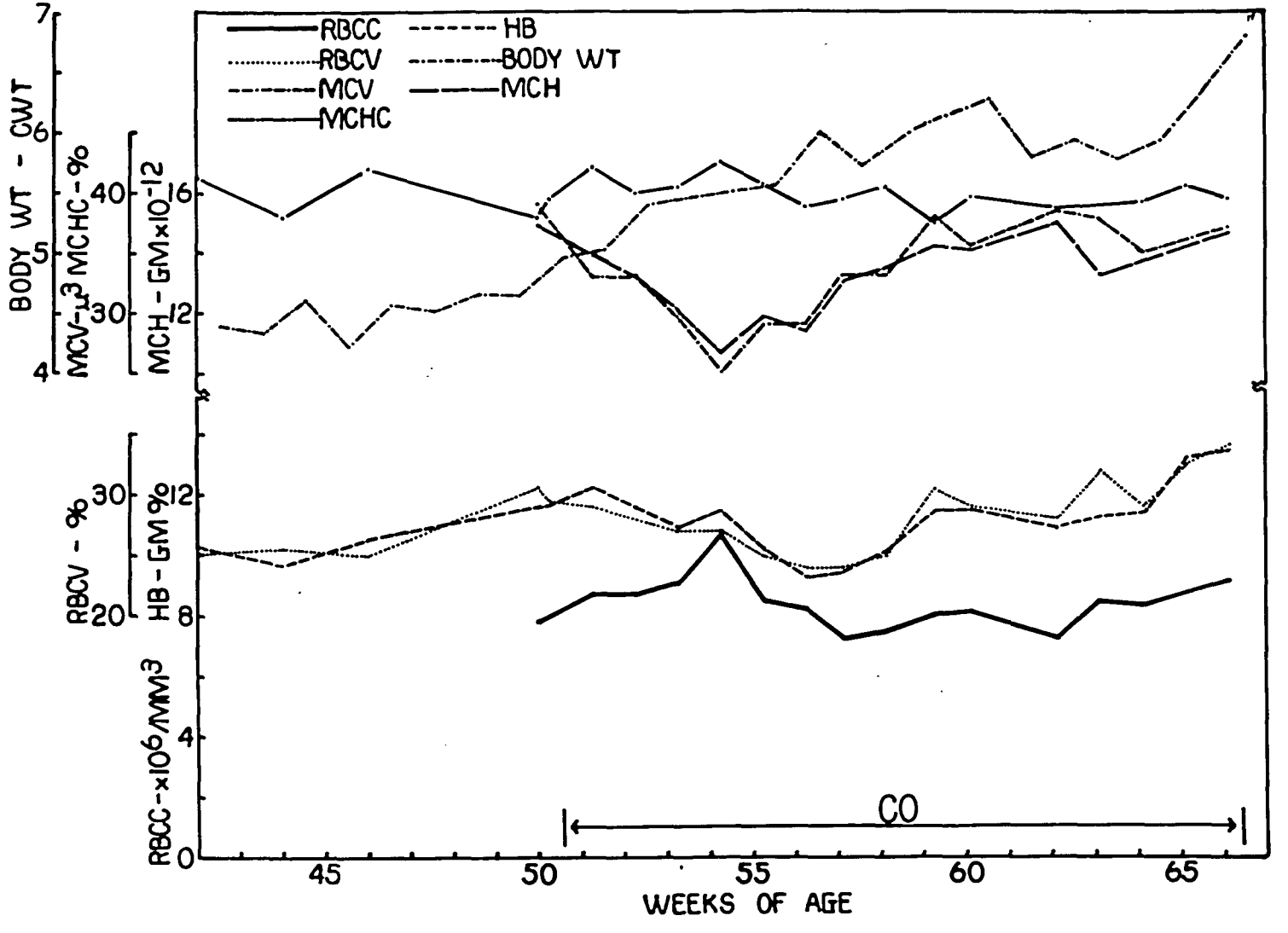

Figure 19. Blood picture of animal number A77--Group 6.

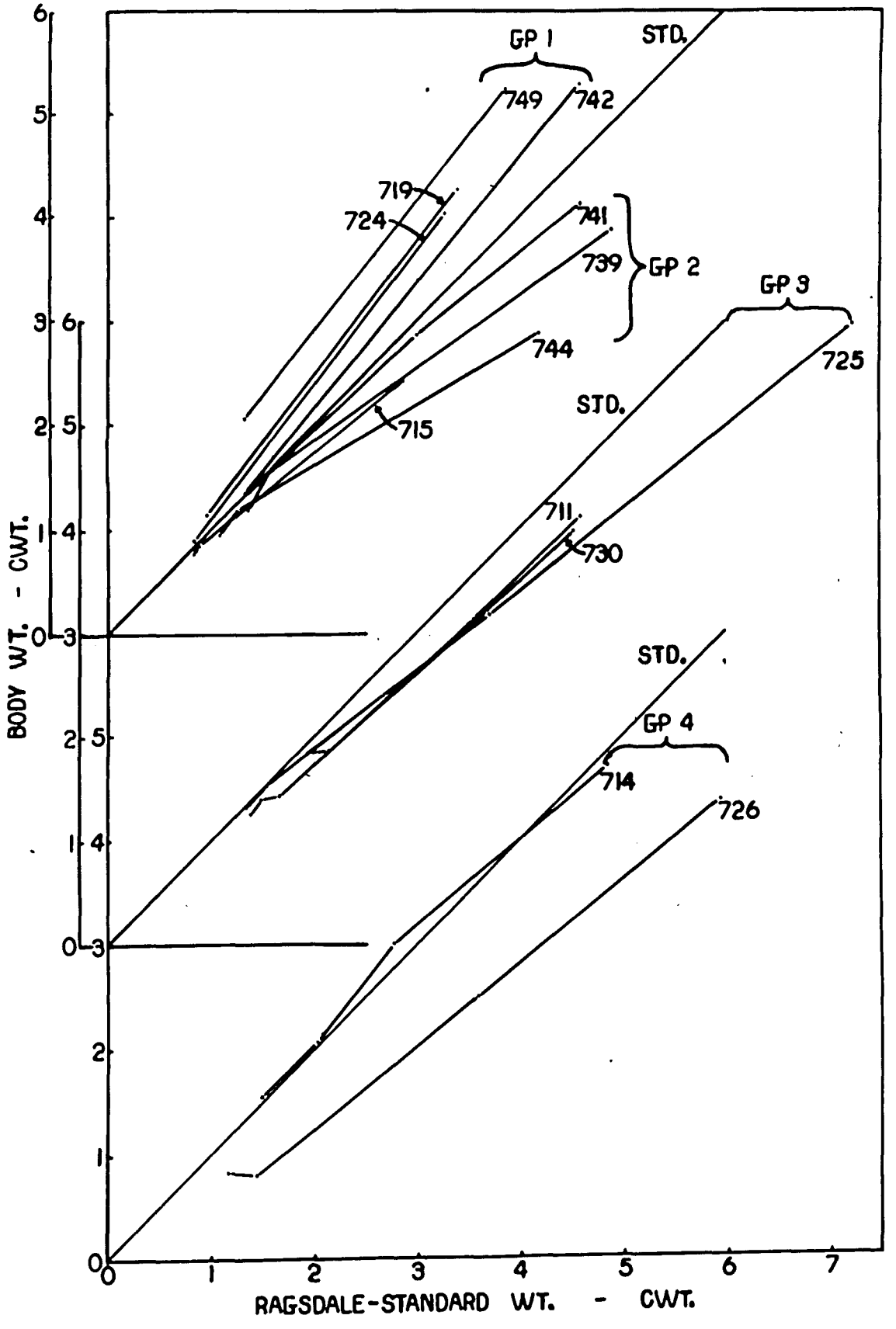

Figure 20. Comparison of the growth of animals in Groups 1, 2, 3, and 4 with the Ragsdale standard.

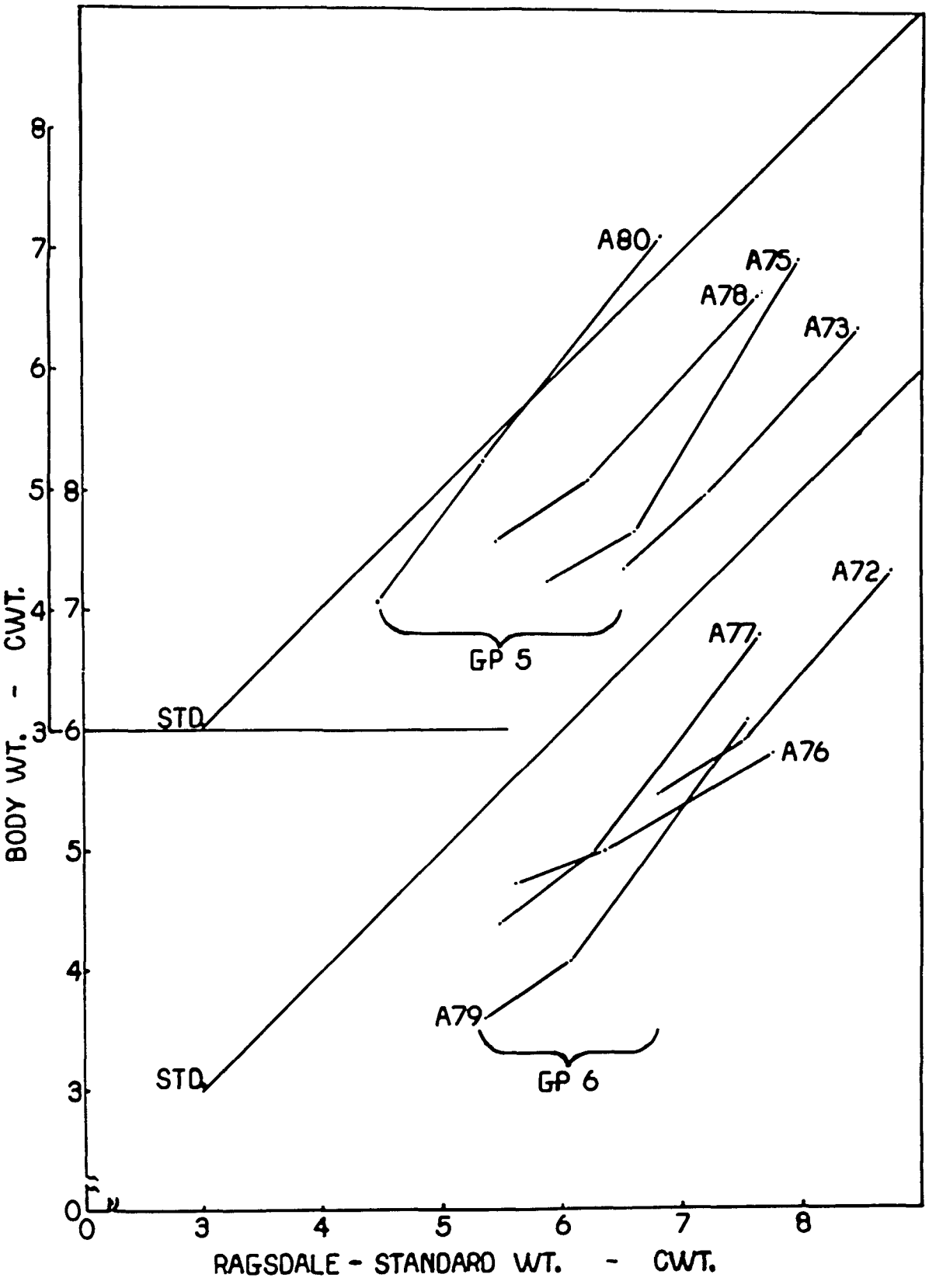
BODY WT. - CWT.
RAGSDALE - STANDARD WT. - CWT.
0
3
4
5
6
7
8
A80
A75
A78
A73
A72
A77
A76
A79
STD
STD
GP 5
GP 6

Figure 11. [illegible]
[illegible]

DISCUSSION

In order to establish the existence of and to characterize the polycythemic condition in cattle it was necessary to analyze the blood of animals in which this condition existed. Determination of the number of red blood cells as well as the characteristics of them yielded insufficient evidence for the characterization. Analyses for noncellular constituents of blood yielded much added information. The fact that the concentrations of these noncellular constituents, especially that of the serum proteins, were not greatly altered as the number of red blood cells increased eliminated concentration of the blood as a factor in the production of the polycythemia. The probability of growth under the conditions of such extreme blood-volume decrease as would be necessary to produce the large red blood cell counts which were encountered in this experiment is very slight.

The data indicate that the ratio of red blood cell count to concentrations of noncellular constitutents is greatly increased in this polycythemia. This is in accord with the results obtained on cobalt-polycythemic rats by Orten et al. (101) and Stenley et al. (119) who found increased blood volume due entirely to increase in the volume of the total erythrocyte mass. Results obtained with dogs concur with this concept (40).

A decrease in the mean corpuscular volume was encountered in the blood of the animals in Group 2. A slight decrease in erythrocyte diameter has been reported in guinea pigs made polycythemic by cobalt administration (132). This decrease would reflect a more pronounced decrease in erythrocyte

volume. Since the mean corpuscular hemoglobin decreased concurrently with the mean corpuscular volume the mechanism involved can only be postulated. Knoop et al. (76) have shown that the effect of iron deficiency in dairy calves is a decline in the hemoglobin concentration concurrent with a lesser decline in red blood cell count. It is possible that the animals in Group 2 did not receive enough iron in their ration to satisfy the increased requirement caused by development of the polycythemia. This, in turn, may have been responsible for the decreased erythrocyte volume thus compensating for insufficient hemoglobin synthesis. Supplementation of the ration of one calf, C741, with iron in the form of ferric citrate at a point in the experiment when the erythrocytes were small seemed to hasten their return to normal size. Admittedly a single case is insufficient for drawing conclusions but the results with this one animal do accentuate the plausibility of the foregoing hypothesis.

The similarity between the blood pictures of the animals in Groups 3 and 4 during the period of cobalt administration appears to be sufficient basis for discussing these two groups as one. Sulfaguanidine supplementation, whether alone or in conjunction with cobalt supplement previous to cobalt supplementation alone, apparently predisposed the polycythemia to be of a lesser severity. In addition the erythrocyte volume and erythrocyte hemoglobin content remained at about the same level for the duration of the experiment which is in direct contrast to the lowering of these two values in the blood of the animals in Group 2. Hemoglobin concentrations for animals in Groups 3 and 4 were not as high at the height of the polycythemia

as they were in the Group 2 animals.

The effect of sulfaguanidine on the microflora of the rumen must be considered. Sulfonamide derivatives have been shown to decrease the number of coliform organisms and increase the number of enterococci in the intestinal flora of rats (51) and human beings (73). It seems likely that a similar situation might arise in the rumen of a calf supplemented with sulfaguanidine. Since it has been demonstrated that cobalt is concentrated in the microorganisms present in the rumen of the sheep (127) it is probable that a similar concentration occurs in the rumen of the calf. A shift in the predominant types of organisms present in the rumen under the influence of sulfaguanidine is probable. It is entirely possible that a shift of this sort could influence the microbial cobalt metabolism. Variations in the resistance to digestion exhibited by various types of rumen microorganisms (103) could also account for the effect of sulfaguanidine supplementation on the supposition that sulfaguanidine resistant microorganisms are predominately resistant to digestion. In this way the cobalt could be concentrated in the microroganisms from the rumen and in a large measure be eliminated as a component part of the microbial cells in the feces of the animal thus lessening the effect of the ingested cobalt on the blood picture by reducing its availability for absorption.

Cobalt in concentrations varying from 1 to 100 parts per million has been shown to inhibit growth and reproduction in Lactobacilli (123) and other representative species of bacteria (112). In vivo experiments (87) have shown that protein synthesis by rumen flora is reduced in the presence of 10 parts per million cobalt although some protein synthesis occurred at

ten times this concentration of cobalt. Inhibition of bacteria by cobalt intimates that these organisms absorb the cobalt since an interruption must occur in some phase of their metabolism for inhibition to occur. This interruption of the bacterial metabolism could be due to the inhibitory effect of cobalt on oxidative enzymes in the bacterial cells. Levy et al. (77) have demonstrated that cobalt inhibits the action of several of the oxidative enzymes but not the phosphorylytic enzymes studied in rat liver and kidney homogenates at a concentration of 59 parts per million, the only concentration used in the investigation. Lower concentrations of cobalt may have the same effect. In contrast to the effect of cobalt on oxidative enzymes it has been shown to double the activity of arginase at a concentration of 34 parts per million (63) and to activate strongly glycylglycine dipeptidase at a concentration of 59 parts per million (116). Inhibition of the bacteria could occur either as the result of inhibition of one or more of their enzymes or by an acceleration of the action of one or more enzymes, in either case by throwing the metabolism of the bacterial cell out of balance,

The polycythemia which was produced in the young calves was not maintained at its original level after the calves reached the approximate age of 30 weeks even though supplementation was continued at its original rate on a weight basis. The severity of the polycythemia was less in the preliminary group composed of animals more advanced in age. A somewhat lesser rate of cobalt supplementation failed to produce a polycythemic condition in yearling heifers. This may be due to the failure of the young animals to develop a normal rumen microflora under the influence of the heavy cobalt

supplementation. It has been shown that some calves fail to develop a normal rumen microflora until they are over 90 days of age (104). As has been indicated above, the rumen microorganisms may be further suppressed by the high concentration of cobalt in the rumen even after this age. The possibility is strong that there is a concurrent increase in the rumen microflora with the lowering of the red blood cell counts encountered as the animals become older. The results obtained with one animal, C711, seem to support the validity of this hypothesis since the withdrawal of sulfaguanidine from the ration coincided with a depression of the polycythemia. It is granted that this did not occur in the cases of the other two animals in Group 3 but neither was any measurement of rumen microflora made on these animals. Again, single cases are insufficient evidence for drawing any conclusion. Schade (112) has shown that the effectiveness of a given cobalt concentration for inhibition of growth in Proteus vulgaris cultures is a function of the number of cells present. This probably explains Josland's inability to produce a polycythemia in 3 of the 4 ewes drenched daily with cobalt for seven months.

The inability of the cobalt supplemented calves to grow at a rate equal to that in Ragsdale's standard in contrast to the faster gain shown by the control group serves to indicate that the level of cobalt supplementation employed in this study was toxic. The yearling heifers (Group 6), supplemented at a somewhat lesser rate, gained weight at a rate equal to that of their controls (Group 5). This is in agreement with the conclusion of Keener et al. (70) who found that growing dairy animals can tolerate up to 0.5 milligram cobalt daily per pound body weight over long periods of time.

Dairy calves can tolerate sulfaguanidine administration at the rate of 2 per cent of their dry matter intake as shown in this study for periods of 39 and 125 days, respectively. This is considerably in excess of the recommended therapeutic dosage. Johnson et al. (64) have shown that the addition of 1 per cent sulfathalidine to the ration of 9 weeks old calves had no effect on growth or food consumption although the bacterial count in the feces was decreased about 80 per cent. There was no evidence of any increased susceptibility to infection subsequent to the withdrawal of the sulfaguanidine supplement.

SUMMARY AND CONCLUSION

Seventeen dairy calves between the ages of 12 and 191 days were allotted to 5 groups. One group received no supplement and the remaining groups received daily supplements of cobalt at the rate of 1 milligram per pound body weight, sulfaguanidine at the rate of 2 per cent of the dry matter intake or a combination of the preceding two supplements. The groups receiving sulfaguanidine were continued on the cobalt supplement after sulfaguanidine supplementation was discontinued. Eight yearling heifers were allotted to two groups, one receiving a daily cobalt supplement at the rate of 0.5 milligrams per pound body weight and the other receiving no supplement. The daily cobalt supplement was revised upward to 0.75 milligrams per pound after 84 days of supplementation and continued for an additional 28 days.

The red blood cell counts of calves receiving only the cobalt supplement starting in their second month of life leveled off at approximately 20 millions per cubic millimeter in 3 of the 4 cases. Concurrent increases in hemoglobin concentrations and red blood cell volumes occurred but at a lesser rate of increase, finally reaching equivalent levels ranging from 15 to 20 grams per cent and from 46 to 57 per cent, respectively. No change attributable to supplementation was noted in levels of total serum proteins, serum albumin, plasma calcium, plasma inorganic phosphorus, plasma magnesium, and plasma ascorbic acid.

Sulfaguanidine supplementation produced no apparent change in the

blood picture. When cobalt supplementation followed or was in conjunction with sulfaguanidine administration, concurrent and equivalent increases occurred in red blood cell counts, hemoglobin concentrations, and red blood cell volumes but not to as great an extent as encountered with animals supplemented with cobalt only.

The severity of the polycythemia decreased as the animals approached the age of 30 weeks and animals which were approaching this age at the time when cobalt supplementation was started reacted in a like manner. No response to cobalt supplementation was noted in the yearling heifer group. The possibility was discussed that as the rumen microflora becomes well established and assumes normal numerical proportions the polycythemic effect of cobalt becomes less severe and finally reaches a point of no consequence.

Subnormal weight gains were encountered in all calves receiving the cobalt supplement. The control calves gained at a rate in excess of Ragsdale's standard. No difference in rate of gain between cobalt supplemented and control yearling heifers was noted.

It is concluded that cobalt is able to induce a polycythemia in calves at a time when their rumen microflora is not yet well established.

LITERATURE CITED

(1) Anderson, H. D., Underwood, E. J., and Elvehjem, C. A.
1940 Factors Affecting the Maintenance of Cobalt Polycythemia in the Rat. Amer. Jour. Physiol. 130: 373-378.

(2) Anonymous
1936 Dept. Agr., Kenya. Ann. Rpt. p87.
Cited by Russell, F. C. (89).

(3) Asenjo, C. F.
1947 Competition between Vitamins and Sulfa Drugs--A Short Review. Bol. del Col. de Quim. de Puerto Rico 4: 3, 4, 6, 8, 10.

(4) Askew, H. O., and Dixon, J. K.
1936 The Importance of Cobalt in the Treatment of Certain Stock Ailments in South Island, New Zealand. New Zeal. Jour. Sci. and Technol. 18: 73-92. Abs. Chem. Abs. 30: 7698. (1936).

(5) Askew, H. O., and Josland, S. W.
1937 The Rate of Excretion of Cobalt by Sheep after Drenching with Cobalt Chloride. New Zeal. Jour. Sci. and Techol. 18: 888-892. Abs. Chem. Abs. 31: 8013. (1937).

(6) Baltzer, A. C., Killham, B. J., Duncan, C. W., and Huffman, C. F.
1941 A Cobalt Deficiency Disease Observed in Some Michigan Cattle. Mich. Agr. Expt. Sta. Quart. Bul. 24: 68-70.

(7) Barron, A. G.
1945 Polycythemia (Caused) by Cobalt. The Action of Ascorbic Acid. Bol. soc. quim., Peru 11: 137-227. Abs. Chem. Abs. 40: 5478-5479. (1946)

(8) Barron, A. G., and Barron, E. S. G.
1936 Mechanism of Cobalt Polycythemia; Effect of Ascorbic Acid. Soc. Expt. Biol. and Med. Proc. 35: 407-409.

(9) Beard, H. H., and Andes. E. J.
1934 The Effect of Iron with and without Other Elements upon the Production of Polycythemia. Amer. Jour. Physiol. 109: 316-319.

(10) Becker, D. E., Smith, S. E., and Loosli, J. K.
1949 Vitamin B_{12} and Cobalt Deficiency in Sheep. Science 110: 71-72.

(11) Beeson, K. C.
1950 Cobalt: Occurrence in Soils and Forages in Relation to a Nutritional Disorder in Ruminants--A Review of the Literature. U. S. Dept. Agr. Inform. Bul. 7: 1-44.

(12) Bell, R. D., and Doisy, E. A.
1920 Rapid Colorimetric Methods for the Determination of Phosphorus in Urine and Blood. Jour. Biol. Chem. 44: 55-67.

(13) Berlin, N. I.
1950 The Distribution of Cobalt in Polycythemic Rats. Jour. Biol. Chem. 44: 41-45.

(14) Berwald, W. P. E., Arseneau, J. H., and Dooley, M. S.
1934 Effect of Cobalt Sulfate on Erythrocyte Count of the Splenectomized Albino Rat. Soc. Expt. Biol. and Med. Proc. 32: 430-431.

(15) Black, S., McKibbin, J. M., and Elvehjem, C. A.
1941 Use of Sulfaguanidine in Nutrition Experiments. Soc. Expt. Biol. and Med. Proc. 47: 308-310.

(16) Boddie, G. F.
1947 Trace Element Deficiency in Livestock in the Hebrides. Jour. Compar. Path. and Ther. 57: 52-61.

(17) Brand, E., and Stucky, C. J.
1934 Cobalt Glutemate in Nutritional Anemia. Soc. Expt. Biol. and Med. Proc. 31: 739-742.

(18) Brewer, G.
1940 A Statistical Study of Cobalt Polycythemia in the Dog. Amer. Jour. Physiol. 128: 345-348.

(19) Briggs, A. P.
1922 A Modification of the Bell-Doisy Phosphate Method. Jour. Biol. Chem. 53: 13-16.

(20) Briggs, A. P.
1924 Some Applications of the Colorimetric Phosphate Method. Jour. Biol. Chem. 59: 255-264.

(21) Bucciero, M. C., and Orten, J. M.
1947 The Effect of Certain Amino Acids and Choline on the Production of Polycythemia by Cobalt. Fed. Proc. 6: 403-404.

(22) Bucciero, M. C., and Orten, J. M.
1948 Choline and the Production of Polycythemia by Cobalt in the Rat. Amer. Jour. Physiol. 154: 513-516.

(23) Bucciero, M. C., and Orten, J. M.
1949 The Effect of Cobalt on the Oxygen Capacity and the Methemoglobin Content of the Blood. Blood 4: 395-397.

(24) Burk, D., Schade, A. L., Hesselback, M. L., and Fischer, C. E.
1946 Cobalt Inhibition of Tissue Respiration, Glycolysis, and Growth. Fed. Proc. 5: 126-127.

(25) Cheng, Y. T., Chen, J. M., and Shen, T.
1943 Induced Polycythemia in Salamander by Cobalt, Ascorbic Acid and Other Water-Soluble Vitamins. Arch. Biochem. 3: 253-259.

(26) Clark, E. P., and Collip, J. B.
1925 A Study of the Tisdall Method for the Determination of Blood Serum Calcium with a Suggested Modification. Jour. Biol. Chem. 63: 461-464.

(27) Comar, C. L., and Davis, G. K.
1947 Cobalt Metabolism Studies. III. Excretion and Tissue Distribution of Radioactive Cobalt Administered to Cattle. Arch. Biochem. 12: 257-266.

(28) Comar, C. L., Davis, G. K., and Taylor, R. F.
1946 Cobalt Metabolism Studies. Radioactive Cobalt Procedures with Rats and Cattle. Arch. Biochem. 9: 149-158.

(29) Comar, C. L., Davis, G. K., Taylor, R. F., Huffman, C. F., and Ely, R.E.
1946 Cobalt Metabolism Studies. II. Partition of Radioactive Cobalt by a Rumen Fistula Cow. Jour. Nutr. 32: 61-68.

(30) Copp, D. H., and Greenberg, D. M.
1941 Studies in Mineral Metabolism with the Aid of Artificial Radioactive Isotopes. VI. Cobalt. Natl. Acad. Sci. Proc. 27: 153-157.

(31) Corner, H. H., and Smith, A. M.
1938 The Influence of Cobalt on Pine Disease in Sheep. Biochem. Jour. 36: 1800-1805.

(32) Cornil, L., Poursines, Y., and Dumont-Lagre, Mme.
1943 Hepatitis in Guinea Pigs Poisoned with Cobalt Acetate. Influence of Splenectomy on Development of the Lesions. Soc. de Biol. (Paris) Compt. Rend. 137: 459-460. Abs. Chem. Abs. 39: 2569 (1945).

(33) Daft, F. S., Ashburn, L. L., and Sebrell, W. H.
1942 Biotin Deficiency and Other Changes in Rats Given Sulfanilylguanidine or Succinyl Sulfathiazole in Purified Diets. Science 96: 321-322.

(34) Daft, F. S., and Sebrell, W. H.
1945 Sulfonamides and Vitamin Deficiencies. Vitamins and Hormones 3: 49-72.

(35) Dann, W. J.
1941 The Synthesis of Nicotinic Acid by the Rat. Jour. Biol. Chem. 141: 803-808.

(36) Davis, J. E.
1937 Cobalt Polycythemia in the Dog. Soc. Expt. Biol. and Med. Proc. 37: 96-99.

(37) Davis, J. E.
1938 The Reduction of Experimental Polycythemias by Liver Administration. Amer. Jour. Physiol. 122: 397-401.

(38) Davis, J. E.
1939 Depression of Experimental Polycythemias by Choline Hydrochloride or Liver Administration. Amer. Jour. Physiol. 127: 322-327.

(39) Davis, J. E.
1940 The Effect of Ascorbic Acid Administration upon Experimental Polycythemias: The Mechanism of Cobalt Polycythemia. Amer. Jour. Physiol. 129: 140-145.

(40) Davis, J. E.
1940 Blood Volume in Cobalt Polycythemia. Soc. Expt. Biol. and Med. Proc. 45: 671-673.

(41) Davis, J. E.
1943 The Effect of Oxygen, Soybean Lecithin, Carbamyl Choline, and Furfuryl Trimethyl Ammonium Iodide on Experimental Polycythemia. Jour. Pharmacol. and Expt. Ther. 79: 37-41.

(42) Davis, J. E., McCullough, A. W., and Rigdon, R. H.
1945 Polycythemia Produced by Cobalt in the Duck. Jour. Lab. and Clin. Med. 30: 327-336.

(43) Dorrance, S. S., Thorn, G. W., Clinton, M., Jr., Edmonds, H. W.,
1943 and Farber, S. Effect of Cobalt on Work Performance under Conditions of Anoxia. Amer. Jour. Physiol. 139: 399-405.

(44) Duncan, C. W., Huffman, C.F., and Robinson, C. S.
1935 Magnesium Studies in Calves. I. Tetany Produced by a Ration of Milk or Milk with Various Supplements. Jour. Biol. Chem. 108: 35-44.

(45) Ely, R. E., Dunn, K. M., Duncan, C. W., and Huffman, C. F.
1946 Some Factors Affecting the Toxicity of Cobalt in the Bovine. Jour. Anim. Sci. 5: 398.

(46) Ely, R. E., Dunn, K. M., and Huffman, C. F.
1948 Cobalt Toxicity in Calves Resulting from High Oral Administration. Jour. Anim. Sci. 7: 239-246.

(47) Ender, F.
1946 Koboltmangelens Betydning Som Sykdomsaarsak Hos Storfe og Sau Belyst ved Terspeutiske Forsøk. (The Therapeutic Effect of Small Doses of Cobalt in Deficiency Diseases in Cattle and Sheep in Norway.) Norsk Vet. Tidsskr. 58: 118-143. Abs. Biol. Abs. 21: 1552. (1947).

(48) Finkelstein, G., Gordon, A. S., and Charipper, H. A.
1944 The Effect of Sex Hormones on the Anemia Induced by Hemorrhage in the Rat. Endocrinology 35: 267-277.

(49) Frost, D. V., and Elvehjem, C. A.
1939 The Role of Iron, Copper, and Cobalt in Hemoglobin Production in Dogs on a Milk Diet. Jour. Biol. Chem. 128: xxxi-xxxii.

(50) Frost, D. V., Spitzer, E. H., Elvehjem, C. A., and Hart, E. B.
1941 Some Effects of Cobalt and Liver Substances on Blood Building in Dogs. Amer. Jour. Physiol. 134: 746-754.

(51) Gant, O. K., Ransome, B., McCoy, E., and Elvehjem, C. A.
1943 Intestinal Flora of Rats on Purified Diets Containing Sulfonamides. Soc. Expt. Biol. and Med. Proc. 52: 276-279.

(52) Geyer, R. P., Rupel, I. W., and Hart, E. B.
1945 Cobalt Deficiency in Cattle in the Northeastern Region of Wisconsin. Jour. Dairy Sci. 28: 291-296.

(53) Goetchius, G. R., and Lawrence, C. A.
1945 A Series of New Sulfonamides Which are Unaffected by p-Aminobenzoic Acid. Jour. Bact. 49: 575-584.

(54) Goodman, J.
1947 Production of Polycythemia in Rabbits by Anoxia and Cobalt. Soc. Expt. Biol. and Med. Proc. 64: 336-342.

(55) Gordon, A. S., Kadow, P. C., Finkelstein, G., and Charipper, H. A.
1946 The Thyroid and Blood Regeneration in the Rat. Amer. Jour. Med. Sci. 212: 385-394.

(56) Greenberg, D. M., Copp, D. H., and Cuthbertson, E. M.
1943 Studies in Mineral Metabolism with the Aid of Artificial Radioactive Isotopes. VII. The Distribution and Excretion, Particularly by Way of the Bile, of Iron, Cobalt, and Manganese. Jour. Biol. Chem. 147: 749-756.

(57) Griffith, W. H., Pavcek, P. L., and Mulford, D. J.
1942 The Relation of the Sulfur Amino Acids to the Toxicity of Cobalt and Nickel in the Rat. Jour.Nutr. 23: 603-612.

(58) Hale, W. H., Pope, A. L., Phillips, P. H., and Bohstedt, G.
1950 The Effect of Cobalt on the Synthesis of Vitamin B_{12} in the Rumen of Sheep. Jour. Anim. Sci. 9: 414-419.

(59) Hindmarsh, W. L., and Blumer, C. C.
1937 Nutritional Anemia of Sheep. New So. Wales Dept. Agr., Vet. Res. Rpt. 7: 15-37. Abs. Chem. Abs. 33: 3849 (1939).

(60) Houk, A. E., Thomas, A. W., and Sherman, H. C.
1946 Some Interrelationships of Dietary Iron, Copper, and Cobalt in Metabolism. Jour. Nutr. 31: 609-620.

(61) Howe, P. E.
1921 The Determination of Proteins in Blood--A Micro Method. Jour. Biol. Chem. 49: 109-113.

(62) Huffman, C. F., and Duncan, C. W.
1944 The Nutritional Deficiencies in Farm Mammals on Natural Feeds. Ann. Rev. Biochem. 13: 467-486.

(63) Hunter, A., and Downs, C. E.
1944 The Measurement of Arginase Activity. Jour. Biol. Chem. 155: 173-181.

(64) Johnson, B. C., Wiese, A. C., Mitchell, H. H., and Nevens, W. B.
1947 The Metabolism of Nicotinic Acid and Its Role in the Nutrition of the Calf. Jour. Biol. Chem. 167: 729-736.

(65) Josland, S. W.
1936 The Effect of Feeding Cobalt to Rats. New Zeal. Jour. Sci. and Technol. 18: 474-480. Abs. Nutr. Abs. and Rev. 6: 1037-1038. (1937).

(66) Josland, S. W.
1937 The Effect of Feeding Excess of Cobalt to Healthy Sheep. New Zeal. Jour. Sci. and Technol. 19: 31-37. Abs. Chem. Abs. 31: 8014. (1937).

(67) Kato, K.
1937 Iron-Cobalt Treatment of Physiologic and Nutritional Anemia in Infants. Jour. Ped. 11: 385-396.

(68) Keener, H. A., Percival, G. P., Ellis, G. H., and Beeson, K. C.
1950 A Study of the Function of Cobalt in the Nutrition of Sheep. Jour. Anim. Sci. 9: 404-413.

(69) Keener, H. A., Percival, G. P., and Morrow, K. S.
1944 Cobalt Treatment of a Nutritional Disease in New Hampshire Dairy Cattle. N. H. Agr. Expt. Sta. Cir. 68: 3-8.

(70) Keener, H. A., Percival, G. P., and Morrow, K. S.
1949 Cobalt Tolerence in Young Dairy Cattle. Jour. Dairy Sci. 32: 527-533.

(71) Kent, N. L., and McCance, R. A.
1941 The Absorption and Excretion of Minor Elements by Man. 2. Cobalt, Nickel, Tin, and Manganese. Biochem. Jour. 35: 877-883.

(72) Kingsley, G. R.
1940 A Rapid Method for the Separation of Serum Albumin and Globulin. Jour. Biol. Chem. 133: 731-735.

(73) Kirby, W. M. M., Rantz, L. A., and Lowell, A.
1942 Treatment of Typhoid and Dysentery Carriers with Succinylsulfathiazole. Amer. Med. Assoc. Jour. 119: 615-618.

(74) Kleinberg, W.
1934 The Hemopoietic Effect of Cobalt and Cobalt-Manganese Compounds in Rabbits. Amer. Jour. Physiol. 108: 545-549.

(75) Klostermen, E. W., Dinusson, W. E., Lasley, E. L., and Buchanan, M.L.
1950 Effect of Trace Minerals on Growth and Fattening of Swine. Science 112: 168-169.

(76) Knoop, C. E., Krauss, W. E., and Washburn, R. G.
1935 The Development of Nutritional Anemia in Dairy Calves. Jour. Dairy Sci. 18: 337-347.

(77) Levy, H., Levison, V., and Schade, A. L.
1950 The Effect of Cobalt on the Activity of Certain Enzymes in Homogenates of Rat Tissue. Arch. Biochem. 27: 34-40.

(78) Levey, S.
1949 Effect of Ascorbic Acid, d-Isoascorbic Acid and Glucoascorbic Acid on Cobalt Polycythemia in the Rat and Rabbit. Amer. Jour. Physiol. 158: 315-318.

(79) Light, R. F., Cracas, L. J., Olcott, C. T., and Frey, C. N.
1942 Inhibition of the Symbiotic Synthesis of B Complex Factors by Sulfonamides. Jour. Nutr. 24: 427-435.

(80) Mackenzie, J. B., Mackenzie, C. G., and McCollum, E. V.
1941 The Effect of Sulfanilylguanidine on the Thyroid of the Rat. Science 94: 518-519.

(81) Marshall, E. K., Jr., Bratton, A. C., White, H. J., and Litchfield, J.T.Jr
1940 Sulfanilylguanidine: A Chemotherapeutic Agent for Intestinal Infections. Johns Hopkins Hosp. Bul. 67: 163-188.

(82) Marshall, L. H.
1935 Antianemic Treatment in Experimental Polycythemia. Amer. Jour. Physiol. 114: 194-203.

(83) Marston, H. R., and Lee, H. J.
1949 Primary Site of the Action of Cobalt in Ruminants. Nature (London) 164: 529-531.

(84) Martin, G. J.
1942 p-Aminobenzoic Acid and Sulfonamides in Rat Nutrition. Soc. Expt. Biol. and Med. Proc. 51: 56-59.

(85) Martin, G. J.
1942 "Folic Acid" in Nutritional Achromotrichia. Soc. Expt. Biol. and Med. Proc. 51: 353-355.

(86) Mascherpa, P.
1930 Le Pouvoir Hematopoietique du Cobalt. (The Hematopoietic Effect of Cobalt.) Arch. Ital. Biol. 82: 112-120. Abs. Chem. Abs. 24: 3280. (1930).

(87) McNaught, M. L., Owen, E. C., and Smith, J. A. B.
1950 The Utilization of Non-protein Nitrogen in the Bovine Rumen. 6. The Effect of Metals on the Activity of the Rumen Bacteria. Biochem. Jour. 46: 36-43.

(88) McNaught, K. J., and Paul, G.W.
1939 Seasonal Variation in Cobalt Content of North Island Pastures. New Zeal. Jour. Sci. and Technol. 21 (B): 95-101.Abs. Chem. Abs. 34: 2511. (1940).

(89) Michalazzi, A. M., and Saviano, M.
1940 Investigations on the Polycythemia from Cobalt. Arch. Sci. Biol. (Italy) 26: 341-361. Abs. Chem. Abs. 35: 8108. (1941)

(90) Mindlin, R. L., and Butler, A. M.
1938 The Determination of Ascorbic Acid in Plasma; a Macromethod and a Micromethod. Jour. Biol. Chem. 122: 673-686.

(79) Light, R. F., Cracas, L. J., Olcott, C. T., and Frey, C. N.
1942 Inhibition of the Symbiotic Synthesis of B Complex Factors by Sulfonamides. Jour. Nutr. 24: 427-435.

(80) Mackenzie, J. B., Mackenzie, C. G., and McCollum, E. V.
1941 The Effect of Sulfanilylguanidine on the Thyroid of the Rat. Science 94: 518-519.

(81) Marshall, E. K., Jr., Bratton, A. C., White, H. J., and Litchfield, J.T.
1940 Sulfanilylguanidine: A Chemotherapeutic Agent for Intestinal Infections. Johns Hopkins Hosp. Bul. 67: 163-188.

(82) Marshall, L. H.
1935 Antianemic Treatment in Experimental Polycythemia. Amer. Jour. Physiol. 114: 194-203.

(83) Marston, H. R., and Lee, H. J.
1949 Primary Site of the Action of Cobalt in Ruminants. Nature (London) 164: 529-531.

(84) Martin, G. J.
1942 p-Aminobenzoic Acid and Sulfonamides in Rat Nutrition. Soc. Expt. Biol. and Med. Proc. 51: 56-59.

(85) Martin, G. J.
1942 "Folic Acid" in Nutritional Achromotrichia. Soc. Expt. Biol. and Med. Proc. 51: 353-355.

(86) Mascherpa, P.
1930 Le Pouvoir Hematopoietique du Cobalt. (The Hematopoietic Effect of Cobalt.) Arch. Ital. Biol. 82: 112-120. Abs. Chem. Abs. 24: 3280. (1930).

(87) McNaught, M. L., Owen, E. C., and Smith, J. A. B.
1950 The Utilization of Non-protein Nitrogen in the Bovine Rumen. 6. The Effect of Metals on the Activity of the Rumen Bacteria. Biochem. Jour. 46: 36-43.

(88) McNaught, K. J., and Paul, G.W.
1939 Seasonal Variation in Cobalt Content of North Island Pastures. New Zeal. Jour. Sci. and Technol. 21 (B): 95-101.Abs. Chem. Abs. 34: 2511. (1940).

(89) Michalazzi, A. M., and Saviano, M.
1940 Investigations on the Polycythemia from Cobalt. Arch. Sci. Biol. (Italy) 26: 341-361. Abs. Chem. Abs. 35: 8108. (1941)

(90) Mindlin, R. L., and Butler, A. M.
1938 The Determination of Ascorbic Acid in Plasma; a Macromethod and a Micromethod. Jour. Biol. Chem. 122: 673-686.

(91) Myers, V. C., Beard, H. H., and Barnes, B. O.
1931 Studies in the Nutritional Anemia of the Rat. IV. The Production of Hemoglobinemia and Polycythemia in Normal Animals by Means of Inorganic Elements. Jour. Biol. Chem. 94: 117-122.

(92) Neal, W. M., and Ahmann, C. F.
1937 Cobalt as an Essential Element in Animal Nutrition. Science 86: 225-226.

(93) Neal, W. M., and Ahmann, C. F.
1937 The Essentiality of Cobalt in Bovine Nutrition. Jour. Dairy Sci. 20: 741-753.

(94) Noland, P. R., Willman, J. P., and Morrison, F. B.
1950 Recent Studies with Vitamin and Mineral Supplements for Growing and Fattening Pigs in Dry Lot. Proc. Cornell Nutr. Conf. for Feed Manuf. 47-52.

(95) Orten, J. M.
1935 Effect of Splenectomy on Production of Cobalt Polycythemia. Soc. Expt. Biol. and Med. Proc. 32: 1091-1093.

(96) Orten, J. M.
1936 On the Mechanism of the Hematopoietic Action of Cobalt. Amer. Jour. Physiol. 114: 414-422.

(97) Orten, J. M., and Bucciero, M. C.
1948 The Effect of Cysteine, Histidine, and Methionine on the Production of Polycythemia by Cobalt. Jour. Biol. Chem. 176: 961-968.

(98) Orten, J. M., and Orten, A. U.
1945 The Production of Polycythemia by Cobalt in Rats Made Anemic by a Diet Low in Protein. Amer. Jour. Physiol. 144: 464-467.

(99) Orten, J. M., Underhill, F. A., Mugrage, E. R., and Lewis, R. C.
1931 Production of Experimental Polycythemia with Cobalt. Soc. Expt. Biol. and Med. Proc. 29: 174-176.

(100) Orten, J. M., Underhill, F. A., Mugrage, E. R., and Lewis, R. C.
1932 Polycythemia in the Rat on a Milk-Iron-Copper Diet Supplemented by Cobalt. Jour. Biol. Chem. 96: 11-16.

(101) Orten, J. M., Underhill, F. A., Mugrage, E. R., and Lewis, R. C.
1933 Blood Volume Studies in Cobalt Polycythemia. Jour. Biol. Chem. 99: 457-463.

(102) Orten, J. M., Underhill, F. A., Mugrage, E. R., and Lewis, R. C.
1933 The Effect of Manganese on Cobalt Polycythemia. Jour. Biol. Chem. 99: 465-468.

(103) Pounden, W. D., Ferguson, L. C., and Hibbs, J. W.
1950 The Digestion of Rumen Microorganisms by the Host Animals. Jour. Dairy Sci. 33: 565-572.

(104) Pounden, W. D., and Hibbs, J. W.
1947 Some Possible Relationships between Management, Fore-Stomach Contents and Diarrhea in the Young Dairy Calf. Jour. Dairy Sci. 30: 582-583.

(105) Ragsdale, A. C.
1934 Growth Standards for Dairy Cattle. Mo. Agr. Expt. Sta. Bul. 336: 1-12.

(106) Ray, S. N., Weir, W. C., Pope, A. L., Bohstedt, G., and Phillips, P.H.
1948 Studies on the Role of Cobalt in Sheep Nutrition. Jour. Anim. Sci. 7: 3-15.

(107) Rickes, E. L., Brink, N. G., Koniuszy, F. R., Wood, T. R. and Folkers, K.
1948 Vitamin B_{12}, a Cobalt Complex. Sci. 108: 134.

(108) Russell, F. C.
1944 Minerals in Pasture Deficiencies and Excesses in Relation to Animal Health. Imp. Bur. Anim. Nutr., Tech. Commun. 15: 7-91.

(109) Sanford, A. H., Sheard, C., and Osterberg, A. E.
1933 The Photelometer and Its Use in the Clinical Laboratory. Amer. Jour. Clin. Path. 3: 405-420.

(110) Saviano, M., and Baccardi, V.
1941 Choline and Cobalt Polycythemia. I. Regression of Cobalt-Induced Polycythemia Following Administration of Choline. Soc. Ital. di Biol. Sper. Bol. 16: 761-763. Abs. Chem. Abs. 40: 6159. (1946).

(111) Saviano, M., and Michelazzi, A. M.
1940 The Action of Liver Extracts on the Polycythemia from Cobalt. Arch. Sci. Biol. (Italy) 26: 545-564. Abs. Chem. Abs. 35: 8108. (1941).

(112) Schade, A. L.
1949 Cobalt and Bacterial Growth, with Special Reference to Proteus vulgaris. Jour. Bact. 58: 811-822.

(113) Schubmehl, Q. D., Wood, I. R., and Warren, C. O.
1943 Studies on the Mechanism of Cobalt Polycythemia. Fed. Proc. 2: 43-44.

(114) Schultze, M. O., Herrick, C. A., Elvehjem, C. A., and Hart, E. B.
1940 Unpublished Results. Cited by: Schultze, M. O. Physiol. Rev. 20: 37-67. (1940).

(115) Shils, M. E., and McCollum, E. V.
1942 The Trace Elements in Nutrition. Amer. Med. Assoc. Jour. 120: 609-619.

(116) Smith, E. L.
1948 Studies on Dipeptidases. III. Hydrolysis of Methylated Peptides; the Role of Cobalt in the Action of Glycylglycine Dipeptidase. Jour. Biol. Chem. 176: 21-32.

(117) Smith, S. E., Becker, D. E., Loosli, J. K., and Beeson, K. C.
1950 Cobalt Deficiency in New York State. Jour. Anim. Sci. 9: 221-230.

(118) Spicer, S. S., Daft, F. S., Sebrell, W. H., and Ashburn, L. L.
1942 Prevention and Treatment of Agranulocytosis and Leucopenia in Rats Given Sulfanilylguanidine or Succinyl Sulfathiazole in Purified Diets. Pub. Health Rpt. 57: 1559-1566.

(119) Stanley, A. J., Hopps, H. C., and Hellbaum, A. A.
1946 Observations on Cobalt Polycythemia. I. Studies on the Peripheral Blood of Rats. Soc. Expt. Biol. and Med. Proc. 61: 130-133.

(120) Stanley, A. J., Hopps, H. C., and Shideler, A. M.
1947 Cobalt Polycythemia. II. Relative Effects of Oral and Subcutaneous Administration of Cobaltous Chloride. Soc. Expt. Biol. and Med. Proc. 66: 19-20.

(121) Stare, F. J., and Evehjem, C. A.
1933 Cobalt in Animal Nutrition. Jour. Biol. Chem. 99: 473-483.

(122) Sutter, J.
1934 Cobalt et Hyperglobulie. Soc. de Biol. (Paris) Compt. Rend. 116: 994-996.

(123) Svec, M. H.
1948 The Effects of Some Metallic Ions on Lactobacilli. Arch. Biochem. 17: 11-19.

(124) Tamura, J. T.
1944 The Action of Sulfonamides and of Para-Aminobenzoic Acid on Bacterium tularense. Jour. Bact. 47: 529-533.

(125) Teeri, A. E., Leavitt, M., Josselyn, D., Colovos, N. F., and Keener, H.
1950 The Effect of Sulfathalidine on the Excretion of Vitamin B by Ruminents. Jour. Biol. Chem. 182: 509-514.

(126) Thompson, J. F., and Ellis, G. H.
1947 Is Cobalt a Dietary Essential for the Rabbit? Jour. Nutr. 34: 121-127.

(127) Tosic, J., and Mitchell, R. L.
1948 Concentration of Cobalt by Microorganisms and Its Relation to Cobalt Deficiency in Sheep. Nature (London) 162: 502-504.

(128) Underwood, E. J.
1940 The Significance of the "Trace Elements" in Nutrition. Nutr. Abs. and Rev. 9: 515-534.

(129) Underwood, E. J., and Elvehjem, C. A.
1938 Is Cobalt of Any Significance in the Treatment of Milk Anemia with Iron and Copper? Jour. Biol. Chem. 124: 419-424.

(130) Underwood, E. J., and Filmer, J. F.
1935 The Determination of the Biologically Potent Element (Cobalt) in Limonite. Austral. Vet. Jour. 11: 82-92. Abs. Chem. Abs. 29: 7011. (1935).

(131) Valerio, V.
1948 Hematopoietic Action of Cobalt. Folia. Med. (Naples) 31: 246-257. Abs. Chem. Abs. 43: 765 (1949).

(132) Valerio, V.
1948 Hematopoietic Action of Cobalt. II. Qualitative Peripheral Hematological Data. Folia Med. (Naples) 31: 409-414. Abs. Chem. Abs. 43: 3524. (1949).

(133) Valerio, V.
1949 Hematopoietic Action of Cobalt. III. Folia Med. (Naples) 32: 104-113. Abs. Chem. Abs. 43: 6311. (1949)

(134) Villarino Ulloa, R.
1936 The Pharmacological Action of Metallic Compounds on Hematopoiesis. Kitasato Arch. Expt. Med. 13: 70-81. Abs. Chem. Abs. 30: 7699. (1936)

(135) Waltner, K., and Waltner, K.
1929 Kobalt und Blut. Klin. Wochenschr. 8: 313.

(136) Warren, C. O., Schubmehl. O. D., and Wood, I. R.
1944 Studies on the Mechanism of Cobalt Polycythemia. Amer. Jour. Physiol. 142: 173-178.

(137) Weissbecker, L., and Maurer, R.
1946 Kobeltwirkungen in Menschen. (Effects of Cobalt on Human Beings). Klin. Wochenschr. 24/25: 855-856. Abs. Nutr. Abs. and Rev. 17: 957. (1948).

(138) Wintrobe, M. M.
1942 Clinical Hematology. Lea and Febriger, Philadelphia, Penn.

(139) Wood, W. B.
1942 Studies on the Antibacterial Action of the Sulfonamide Drugs. I. The Reaction of p-Aminobenzoic Acid to the Mechanism of Bacteriostasis. Jour. Expt. Med. 75: 369-381.

(140) Woods, D. D.
1940 The Relation of p-Aminobenzoic Acid to the Mechanism of Action of Sulfanilamide. Brit. Jour. Expt. Path. 21: 74-90.

(141) Woods, D. D.
1948 Les Sulfamides en Taut qu' Antagonistes de L'acide p-Aminobenzoique. Bul. Soc. Chim. Biol. 30: 730-747.

(142) Woods, D. D.
1950 Biochemical Significance of the Competition between p-Amino benzoic Acid and the Sulphonamides. N. Y. Acad. Sci. Ann. 52: 1199-1211.

(143) Woods, D. D., and Fildes, P.
1940 The Anti-Sulphanilimide Activity (in vitro) of p-Aminobenzoic Acid and Related Compounds. Chem. and Indus. 59: 133-134.

(144) Woods, R.
1946 Nutrition Studies with the Sulfonamides. Borden's Rev. of Nutr. Res. 7: No. 6: 1-10.

APPENDIX

Appendix Table 1.

Blood Picture of Animal Number C680--Preliminary Group

Age	Whole Blood						Plasma				
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus		Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %		mg %	mg %
191	----	10.80	26.0	----	----	41.5	10.1	6.10		1.60	0.311
198	----	9.77	24.5	----	----	39.9	11.4	6.65		1.91	0.328
205	----	10.35	24.5	----	----	42.2	10.7	5.74		1.77	0.268
212	8.42	8.87	24.0	28.5	10.5	37.0	11.0	5.53		2.00	0.364
219	9.30	11.80	31.5	33.9	12.7	37.5	10.9	5.56		1.93	0.450
226	10.38	11.43	30.0	28.9	11.0	38.1	9.5	7.19		1.98	0.284
232	10.18	13.35	33.0	32.4	13.1	40.5	9.5	5.51		2.16	0.437
240	11.04	12.83	33.0	29.9	11.6	38.9	11.0	5.39		2.17	0.457
247	13.56	14.53	39.0	28.8	10.7	37.3	11.0	5.74		2.09	0.532
254	----	15.50	38.5	----	----	40.3	10.6	6.95		1.74	0.477
261	----	17.60	44.0	----	----	40.0	11.5	6.69		2.31	0.344
267	13.57	16.50	45.5	33.5	12.2	36.3	10.7	6.48		2.33	0.480
275	13.49	16.50	41.5	30.8	12.2	39.8	10.4	6.76		2.21	0.313
282	----	16.80	42.0	----	----	40.0	10.7	6.35		1.98	0.508
289	14.60	17.50	47.0	32.2	12.0	37.2	11.8	5.68		2.18	0.422
296	----	18.40	47.0	----	----	39.1	12.8	5.95		2.17	0.537
303	13.40	17.50	44.0	32.8	13.1	39.8	12.3	6.07		2.16	0.377
310	15.40	19.00	50.0	32.5	12.3	38.0	11.6	5.51		2.37	0.565
317	14.88	18.40	48.0	32.3	12.4	38.3	11.6	7.06		3.92	0.461
322	13.93	18.50	48.0	34.5	13.3	38.5	11.3	7.19		2.14	0.536
331	16.76	18.50	46.0	27.4	11.0	40.2	11.4	4.73		2.31	0.511
338	15.95	18.20	48.0	30.1	11.4	37.9	11.6	5.81		2.08	0.522
345	15.92	18.50	47.5	29.8	11.6	38.9	10.5	7.58		2.13	0.512
352	----	17.00	39.0	----	----	43.6	10.8	7.58		2.58	0.550
359	15.55	18.00	47.0	30.2	11.6	38.3	10.8	6.69		2.20	0.580
366	13.90	17.30	41.5	29.9	12.4	41.7	10.9	5.61		2.09	0.580

Appendix Table 1 - Continued

Blood Picture of Animal Number C680--Preliminary Group

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
373	14.70	16.90	35.0	23.8	11.5	48.3	12.0	6.10	2.59	0.449
380	---	16.00	37.0	----	----	43.2	11.9	7.06	2.28	0.445
387	---	16.10	40.0	----	----	40.3	11.0	6.95	2.55	0.439
394	11.76	15.20	36.5	31.0	12.9	41.6	11.7	7.02	2.86	0.428
401	14.23	16.00	39.0	27.4	11.2	41.0	11.6	8.28	2.63	0.437
408	10.90	14.20	36.0	33.0	13.0	39.4	12.3	7.02	2.97	----
415	11.70	14.37	36.5	31.2	12.3	39.4	11.6	7.10	2.37	0.643
422	11.93	15.20	36.5	30.6	12.7	41.6	12.1	6.83	2.17	0.533
429	9.70	13.70	31.0	32.0	14.1	44.2	12.3	7.27	2.85	0.579
436	10.10	13.70	34.5	34.2	13.6	39.7	11.7	6.87	2.40	0.484
443	10.35	15.10	38.0	36.7	14.6	39.7	11.8	7.96	3.63	0.386
449	11.30	14.80	35.0	31.0	13.1	42.3	12.4	5.90	3.10	0.459
456	10.72	15.50	38.0	35.4	14.5	40.8	11.5	5.58	2.47	0.490
463	13.70	12.10	31.0	22.6	8.8	39.0	12.7	7.02	4.08	0.455
470	11.70	17.50	43.0	36.8	15.0	40.7	10.9	5.34	1.67	0.521
483	12.95	17.50	43.0	33.2	13.5	40.7	11.4	6.10	1.99	0.437
491	10.69	16.10	42.0	39.3	15.1	38.3	10.5	5.56	2.62	0.426
498	10.76	16.60	39.0	36.2	15.4	42.6	11.0	6.07	2.36	0.533
505	11.24	16.20	37.5	33.4	14.4	43.2	9.5	5.76	2.07	0.197
512	11.04	16.10	37.0	33.5	14.6	43.5	10.5	6.44	2.29	0.413

Appendix Table 2

Blood Picture of Animal Number C681--Preliminary Group

Age	Whole Blood						Plasma				
	Red Blood Cell Count	Hemo-globin	Red Blood Cell Vol.	Mean Corpus-cular Volume	Mean Corpus-cular Hemo-globin	Mean Corpus-cular Hemo-globin Conc.	Cal-cium	Inorg. Phos-phorus		Magne-sium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %		mg %	mg %
175	----	12.00	32.0	---	---	37.5	11.4	8.33		1.50	0.444
182	----	11.60	30.0	---	---	38.7	11.0	7.35		1.74	0.461
189	----	11.50	30.0	---	---	38.3	10.8	7.81		1.56	0.331
196	9.77	11.80	33.0	33.8	12.1	35.8	10.5	6.04		1.28	0.281
203	10.50	10.87	29.0	27.6	10.4	37.5	10.4	5.56		1.76	0.458
210	----	10.63	29.0	---	---	36.7	10.5	6.58		2.02	0.422
216	13.44	13.70	37.5	27.9	10.2	36.5	10.3	6.95		1.98	0.403
224	10.90	12.77	33.5	30.7	11.7	38.1	10.4	6.83		1.94	0.382
231	12.51	14.20	38.0	30.4	11.4	37.4	9.6	6.48		1.31	0.466
238	----	15.20	42.5	---	---	35.8	10.4	8.45		1.99	0.587
245	---	17.40	44.5	---	---	39.1	10.5	7.06		2.06	0.422
251	13.97	16.25	43.0	30.8	11.6	37.8	9.5	8.23		1.57	0.512
259	13.59	17.10	43.5	32.0	12.6	39.3	10.0	5.19		1.71	0.381
266	---	17.10	48.0	---	---	35.6	11.0	6.38		2.07	0.389
273	14.20	18.00	49.5	34.9	12.7	36.4	10.0	7.14		1.70	0.380
280	---	18.00	48.5	---	---	37.1	10.7	7.06		2.00	0.476
287	14.00	18.00	49.4	35.3	12.9	36.4	11.7	6.69		2.13	0.208
294	15.70	18.60	53.0	33.8	11.8	35.1	10.1	7.06		2.15	0.359
301	15.55	18.25	55.5	35.7	11.7	32.9	10.8	6.87		2.49	0.336
306	14.90	19.10	53.0	35.6	12.8	36.0	9.7	6.65		1.79	0.496
315	16.31	19.00	48.5	29.7	11.6	39.2	10.6	5.61		2.06	0.406
322	15.42	19.20	53.0	34.4	12.5	36.2	10.5	5.87		2.21	0.482
329	15.05	17.80	47.0	31.2	11.8	37.9	10.7	4.92		1.84	0.537
336	----	18.00	55.0	---	---	32.7	9.4	5.61		2.88	0.556
343	13.90	17.00	45.5	32.7	12.2	37.4	11.1	6.79		2.15	0.485
350	14.15	16.60	42.0	29.7	11.7	39.5	11.3	6.13		1.88	0.564
357	16.10	15.20	40.0	24.8	9.4	38.0	10.5	7.06		2.47	0.344

Appendix Table 2 - Continued

Blood Picture of Animal Number C681--Preliminary Group

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemo-globin	Red Blood Cell Vol.	Mean Corpus-cular Volume	Mean Corpus-cular Hemo-globin	Mean-Corpus-cular Hemo-globin Conc.	Cal-cium	Inorg. Phos-phorus	Magne-sium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
364	----	15.40	36.5	----	----	42.2	10.7	6.19	2.11	0.412
371	----	15.50	40.0	----	----	38.8	11.5	7.58	2.30	0.479
378	10.90	13.60	34.5	31.7	12.5	39.4	11.6	6.51	2.82	0.500
385	12.20	13.35	34.0	27.9	10.9	39.3	12.0	7.67	1.55	0.364
392	10.88	11.85	29.0	26.7	10.9	40.9	11.3	7.31	2.25	0.387
399	10.20	11.60	29.0	28.4	11.4	40.0	11.6	6.19	1.57	0.499
406	10.18	11.23	28.0	27.5	11.0	40.1	11.3	9.13	1.73	0.448
413	8.60	10.27	25.5	29.7	11.9	40.3	11.6	7.91	2.63	0.297
420	7.97	10.27	27.0	33.9	12.9	38.0	12.0	7.71	2.15	0.405
427	7.05	9.55	23.5	33.3	13.5	40.6	12.1	8.06	2.75	0.453
433	7.30	9.55	24.0	32.9	13.1	39.8	11.6	7.81	2.49	0.366
440	6.22	9.03	22.5	36.2	14.5	40.1	11.4	6.51	2.02	0.318
447	9.10	11.40	27.0	29.7	12.5	42.2	10.7	7.62	3.36	0.391
454	8.08	9.83	26.0	32.2	12.2	37.8	11.6	6.51	1.76	0.363
467	7.95	9.63	26.0	32.7	12.1	37.0	10.6	8.06	1.68	0.365
475	6.69	9.13	26.5	39.6	13.6	34.5	10.7	6.95	2.00	0.356
482	7.66	10.27	28.5	37.2	13.4	36.0	11.3	7.81	2.08	0.566
489	6.81	10.35	25.5	37.4	15.2	40.6	11.0	6.35	1.88	0.344
496	6.14	9.83	24.5	39.9	16.0	40.1	9.5	7.44	1.71	0.404

Appendix Table 3

Blood Picture of Animal Number C684--Preliminary Group

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
161	----	13.17	34.7	----	----	38.0	11.2	7.96	2.09	0.353
168	----	13.00	33.5	----	----	38.8	11.0	8.93	2.23	0.428
182	11.20	11.60	30.5	27.2	10.4	38.0	11.1	6.19	1.70	0.181
189	10.55	12.60	31.0	29.4	11.9	40.6	11.0	6.35	2.03	0.361
196	14.30	15.20	42.0	27.6	10.6	36.2	10.9	7.86	1.88	0.194
202	13.79	14.80	41.5	30.1	10.7	35.7	8.8	5.87	2.40	0.485
210	14.49	14.55	37.0	25.5	10.0	39.3	10.6	6.48	1.87	0.332
217	11.35	14.10	38.0	33.5	12.4	37.1	11.3	6.19	2.15	0.281
224	----	13.60	36.0	----	----	37.8	11.3	7.91	2.06	0.088
231	----	15.60	39.5	----	----	39.5	11.1	7.02	2.04	0.280
237	12.72	15.00	41.0	32.2	11.8	36.6	9.5	5.48	1.53	0.374
245	16.63	16.50	42.0	25.3	9.9	39.3	10.0	6.83	1.98	0.313
252	----	16.20	43.0	----	----	37.7	10.5	8.33	2.25	0.393
259	13.30	17.10	48.0	36.1	12.9	35.6	10.7	7.10	1.59	0.413
266	----	17.50	43.5	----	----	40.2	12.3	7.58	2.00	0.476
273	15.80	17.10	46.0	29.1	10.8	37.2	11.7	7.27	2.23	0.447
280	15.12	16.40	45.0	29.8	10.8	36.4	11.6	5.79	1.92	0.373
287	13.95	16.80	43.0	30.8	12.0	39.1	10.8	6.79	1.81	0.496
292	13.73	16.25	42.0	30.6	11.8	38.7	10.6	7.81	1.98	0.580
301	14.80	16.80	43.0	29.1	11.4	39.1	11.0	5.81	2.75	0.551
308	15.10	17.20	45.0	29.8	11.4	38.2	11.3	6.32	2.06	0.522
315	14.05	16.80	43.0	30.6	12.0	39.1	10.6	5.81	2.02	0.321
322	----	17.20	41.5	----	----	41.4	10.6	8.81	2.04	0.564
329	14.50	17.50	48.0	33.1	12.1	36.5	12.6	7.96	1.14	0.412

Appendix Table 3 - Continued

Blood Picture of Animal Number C684--Preliminary Group

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
336	12.80	17.70	45.5	35.5	13.8	38.9	10.9	6.72	1.48	0.390
343	17.50	18.50	48.0	27.4	10.6	38.5	9.5	6.69	2.40	0.384
350	----	17.60	45.0	----	----	39.1	9.7	6.48	2.16	0.355
357	----	18.80	48.5	----	----	38.8	9.3	7.62	2.11	0.381
364	16.10	17.90	43.0	26.7	11.1	41.6	11.5	7.35	2.25	0.289
385	18.10	18.10	45.5	25.1	10.0	39.8	9.6	5.63	2.03	0.584
392	13.55	17.50	42.5	31.4	12.9	41.2	10.7	7.62	2.24	0.511
399	14.16	17.00	41.0	29.0	12.0	41.5	11.6	7.71	2.10	0.484
413	13.55	16.50	42.0	31.0	12.2	39.3	10.5	7.44	2.99	-----
419	12.80	15.10	37.5	29.3	11.8	40.3	12.0	6.44	2.75	0.342
426	14.02	15.60	40.0	28.5	11.1	39.0	10.5	6.25	2.63	0.270
433	11.95	13.35	36.0	30.1	11.2	37.1	12.2	7.67	3.96	0.211
440	----	13.77	34.5	----	----	39.9	11.2	6.22	1.70	0.193

Appendix Table 4

Blood Picture of Animal Number C718--Group 1

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
45	9.35	9.77	28.5	30.5	10.4	34.3	---	---	10.1	6.69	2.20	0.484
53	7.45	8.90	28.0	37.6	11.9	31.8	---	---	10.8	7.27	2.15	0.549
60	8.55	9.23	24.0	28.1	10.8	38.5	---	---	10.4	5.61	1.20	0.541
67	7.78	9.40	24.0	30.8	12.1	39.2	---	---	11.3	6.54	1.91	0.571
74	9.48	10.80	26.5	28.0	11.4	40.8	---	---	11.9	8.81	2.37	0.680
81	10.44	11.60	28.0	26.8	11.1	41.4	---	---	11.7	8.17	1.68	0.570
88	9.24	10.13	25.0	27.1	11.0	40.5	5.36	---	11.1	8.81	2.00	0.674
95	10.58	10.63	29.0	27.4	10.0	36.7	5.51	3.74	11.0	10.16	1.58	0.610
102	8.40	10.20	27.5	32.7	12.1	37.1	5.06	3.41	----	6.83	3.83	0.561
109	9.03	9.63	25.5	28.2	10.7	37.8	5.19	3.36	11.2	6.58	2.32	0.427
116	7.95	10.07	27.5	34.6	12.7	36.6	5.72	3.16	11.5	7.10	2.04	0.492
123	7.53	9.33	23.5	31.2	12.4	39.7	5.02	3.08	10.7	7.81	2.23	0.613
130	9.35	10.43	29.0	31.0	11.2	36.0	6.21	3.63	11.5	6.41	2.66	0.346
137	7.71	11.93	32.0	41.5	15.5	37.3	5.83	3.48	12.7	6.83	3.95	0.453
144	9.15	11.07	27.5	30.1	12.1	40.3	5.65	3.61	11.3	6.95	2.17	0.572
151	9.10	10.87	28.0	30.8	11.9	38.8	----	----	11.8	7.67	3.00	0.595
158	8.22	10.13	26.0	31.6	12.3	39.0	----	----	11.1	10.16	2.25	0.561
165	8.22	10.35	26.5	32.2	12.6	39.1	5.49	3.51	12.0	7.53	2.62	0.562
172	8.75	11.00	26.5	30.3	12.6	41.5	5.53	3.53	11.9	7.44	2.31	0.602
179	7.87	10.43	25.0	31.8	13.3	41.7	----	----	11.4	7.96	1.83	0.303
186	9.39	12.45	33.0	35.1	13.3	37.7	6.37	3.92	11.5	9.19	1.94	0.641
193	8.85	12.45	29.5	33.3	14.1	42.2	----	----	12.0	7.35	3.20	0.580
200	8.30	10.93	26.0	31.3	13.2	42.0	----	----	11.2	7.58	2.58	0.402
207	7.64	10.13	25.0	32.7	13.3	40.5	----	----	11.1	7.86	1.81	0.608
214	6.82	10.93	27.5	40.3	16.0	39.7	6.48	3.66	11.3	6.35	2.38	0.545
221	8.14	10.57	25.0	30.7	13.0	42.3	5.88	3.64	11.9	7.27	2.06	0.553

Appendix Table 5

Blood Picture of Animal Number C719--Group 1

Age	Whole Blood						Serum		Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
18	10.50	9.90	24.5	23.3	9.4	40.4	----	----	11.3	7.53	2.25	0.350
25	10.30	12.90	36.0	35.0	12.5	35.8	----	----	11.3	6.32	1.63	0.459
38	10.20	12.53	36.0	35.3	12.3	34.8	----	----	11.2	6.01	1.98	0.460
46	8.80	10.57	33.0	37.5	12.0	32.0	----	----	12.0	6.38	2.09	0.419
53	8.70	10.93	31.0	35.6	12.6	35.3	----	----	10.8	6.32	1.97	0.466
60	8.70	11.85	29.0	33.3	13.6	40.9	----	----	11.6	5.76	1.60	0.421
67	9.86	12.65	33.0	33.5	12.8	38.3	----	----	11.2	6.48	1.93	0.519
74	8.77	11.50	32.0	36.5	13.1	35.9	----	----	11.4	7.71	1.18	0.546
81	8.75	11.50	26.0	29.7	13.1	44.2	5.80	3.46	11.5	8.50	1.90	0.554
88	8.09	11.37	26.5	32.8	14.1	42.9	5.39	3.25	11.9	8.23	1.79	0.570
95	8.33	12.77	32.0	38.4	15.3	39.9	6.13	3.21	11.5	7.91	1.98	-----
102	8.76	11.23	31.0	35.4	12.8	36.2	5.72	3.24	12.2	7.27	2.32	0.586
109	6.80	10.13	25.0	36.8	14.9	40.5	5.53	3.13	10.5	7.49	2.08	0.622
116	7.50	11.30	29.5	39.3	15.1	38.3	5.63	3.26	11.8	8.12	1.50	0.472
123	9.20	13.43	35.5	38.6	14.6	37.8	6.23	3.62	11.5	7.27	2.33	0.496
130	8.08	11.67	31.5	39.0	14.4	37.0	5.61	3.15	12.5	6.65	3.27	0.279
137	8.10	11.50	32.5	40.1	14.2	35.4	5.78	3.43	10.9	7.02	2.06	0.469
144	7.64	11.23	28.0	36.6	14.7	40.1	----	----	11.7	8.74	2.40	0.495
151	8.39	12.00	30.0	35.8	14.3	40.0	----	----	11.5	9.55	1.94	0.458
158	7.85	12.10	30.0	38.2	15.4	40.3	5.98	3.40	11.8	7.06	2.02	0.397
165	9.40	12.90	33.5	35.6	13.7	38.5	6.14	3.55	10.9	9.06	1.90	0.493
172	8.75	11.85	30.0	34.3	13.5	39.5	----	----	11.3	7.91	1.57	0.295
179	8.12	12.45	32.0	39.4	15.3	38.9	6.33	3.41	10.5	6.48	2.15	0.475
186	6.50	12.53	30.5	46.9	19.3	41.1	----	----	12.2	7.35	2.57	0.499
193	7.65	12.10	31.5	41.2	15.8	38.4	----	----	12.7	7.71	3.22	0.386

Appendix Table 6

Blood Picture of Animal Number C724--Group 1

Age	Whole Blood						Serum		Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
32	7.86	10.50	30.5	38.8	13.4	34.4	5.44	3.38	11.7	8.62	1.53	0.245
39	7.40	10.07	27.5	37.2	13.6	36.6	5.51	3.29	11.9	7.44	1.26	0.259
46	8.21	11.15	30.0	36.5	13.6	37.2	5.39	3.50	12.0	6.51	1.76	0.272
53	8.45	11.75	32.0	37.9	13.9	36.7	5.44	3.53	10.2	6.25	1.99	0.359
60	7.35	11.67	33.0	44.9	15.9	35.4	5.39	3.61	12.0	7.86	1.94	0.440
67	9.52	12.45	28.5	29.9	13.1	43.7	5.96	3.84	11.2	5.63	2.07	0.306
74	8.44	11.37	30.0	35.5	13.5	37.9	5.56	3.60	12.1	7.10	2.69	0.279
81	8.25	11.60	31.0	37.6	14.1	37.4	6.00	3.85	11.9	6.95	2.02	0.428
88	7.65	12.00	31.0	40.5	15.7	38.7	----	----	12.5	7.71	2.30	0.393
95	10.67	13.35	38.0	35.6	12.5	35.1	----	----	11.3	8.93	2.36	0.287
102	7.85	11.23	28.0	35.7	14.3	40.1	5.37	3.43	10.7	7.91	1.26	0.365
109	10.30	12.83	34.0	33.0	12.5	37.7	5.98	3.74	10.6	8.39	2.12	0.453
116	7.59	12.00	32.0	42.2	15.8	37.5	----	----	11.0	7.44	1.91	0.371
123	9.07	11.30	28.5	31.4	12.5	39.6	5.81	3.64	11.1	6.91	1.88	0.419
130	8.05	11.23	28.5	35.4	14.0	39.4	5.58	3.71	12.5	7.91	1.84	0.368
137	8.35	12.00	29.5	35.3	14.4	40.7	----	----	13.2	7.71	4.08	0.328
144	----	10.87	27.5	----	----	39.5	----	----	11.5	7.58	1.83	0.345
151	7.74	12.53	31.5	40.7	16.2	39.8	6.14	3.94	12.3	6.65	2.06	0.316
158	9.57	11.93	27.0	28.2	12.5	44.2	6.07	3.94	10.6	8.62	1.63	0.390
165	7.45	12.00	29.0	38.9	16.1	41.4	5.98	3.85	12.0	7.71	2.06	0.451
172	8.32	11.85	32.0	38.5	14.2	37.0	6.21	3.98	11.3	9.33	1.94	0.367
179	9.12	12.10	35.0	38.4	13.3	34.6	6.21	3.92	12.4	10.86	3.10	0.213
186	8.20	12.00	30.5	37.2	14.6	39.3	6.19	3.83	11.2	8.87	2.30	0.394
193	7.50	11.60	30.5	40.7	15.5	38.0	6.02	4.34	11.3	7.02	2.36	0.389
200	7.68	11.30	29.0	37.8	14.7	39.0	----	4.12	11.5	8.50	2.24	0.380
207	7.52	11.93	30.0	39.9	15.9	39.8	6.26	4.14	11.4	9.40	1.82	0.310
214	7.00	10.57	26.5	37.9	15.1	39.9	6.14	4.08	11.3	8.33	1.28	0.279

Appendix Table 7

Blood Picture of Animal Number C742--Group 1

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
33	7.60	9.77	27.0	35.5	12.9	36.2	5.78	3.51	11.9	9.26	2.30	0.445
40	8.64	9.77	26.0	30.1	11.3	37.6	5.64	3.42	11.3	7.44	2.21	0.486
47	9.45	10.13	28.0	29.6	10.7	36.2	5.78	3.56	10.7	9.77	2.11	0.673
54	9.52	9.90	27.5	28.9	10.4	36.0	6.14	3.88	10.5	7.91	2.06	0.640
61	9.42	10.50	28.0	29.7	11.1	37.5	5.86	3.79	11.0	7.58	2.42	0.640
68	10.50	11.30	30.5	29.0	10.8	37.0	6.13	3.86	10.4	8.23	2.13	0.546
75	10.96	10.57	29.5	26.9	9.6	35.8	5.95	3.64	11.5	11.16	2.60	0.499
81	10.70	10.93	30.5	28.5	10.2	35.8	5.70	3.55	11.0	7.58	1.76	0.700
90	10.65	11.23	31.5	29.6	10.5	35.7	5.39	3.29	11.3	7.91	2.31	0.686
95	9.88	12.10	33.5	33.9	12.2	36.1	5.83	3.51	10.9	9.47	1.94	0.684
102	10.90	12.27	32.0	29.4	11.3	38.3	5.86	3.39	11.0	6.51	1.98	0.506
109	10.51	12.60	35.5	33.8	12.0	35.5	5.70	3.50	12.1	8.39	2.75	0.647
116	10.14	11.60	31.0	30.6	11.4	37.4	6.13	----	11.8	8.66	2.17	0.613
123	10.92	12.45	32.5	29.8	11.4	38.3	5.65	3.42	11.5	8.39	1.88	0.556
130	10.57	12.00	32.0	30.3	11.4	37.5	5.72	3.42	10.9	7.96	1.93	0.494
137	11.61	12.45	33.5	28.9	10.7	37.2	5.98	3.70	11.5	7.91	1.80	0.582
143	10.46	11.50	32.0	30.6	11.0	35.9	5.53	3.40	11.1	7.49	2.05	0.498
151	10.36	10.50	28.0	27.0	10.1	37.5	5.53	3.29	10.7	6.89	1.88	0.494
158	11.20	12.00	30.5	27.2	10.7	39.3	5.93	3.53	10.5	6.07	1.74	0.503
165	9.99	11.67	30.0	30.0	11.7	38.9	6.28	3.60	11.2	4.35	2.04	0.296
172	----	12.83	32.5	----	----	39.5	6.51	3.20	10.2	5.14	2.51	0.494
180	10.45	11.50	28.5	27.3	11.0	40.4	6.61	3.55	10.9	7.58	1.78	0.339
187	10.51	11.85	29.0	27.6	11.3	40.9	6.14	3.36	10.8	6.13	1.85	0.435
193	10.56	11.60	30.5	28.9	11.0	38.0	6.63	3.83	11.6	6.10	2.88	0.595
200	9.95	11.50	30.0	30.2	11.6	38.3	6.26	2.83	10.9	5.61	1.65	0.551
207	10.48	11.75	28.0	26.7	11.2	42.0	6.30	3.71	11.1	5.17	2.39	0.390

Appendix Table 8

Blood Picture of Animal Number C749--Group 1

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemo-globin	Red Blood Cell Volume	Mean Corpus-cular Volume	Mean Corpus-cular Hemoglo-bin	Mean Corpus-cular Hemoglo-bin Conc.	Total Protein	Albumin	Calcium	Inorg. Phos-phorus	Mag-nesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
75	10.35	11.75	31.5	30.4	11.4	37.3	6.30	4.01	11.8	7.86	2.44	0.566
82	12.07	11.43	32.5	26.9	9.5	35.2	6.35	3.71	11.3	7.67	2.31	0.448
89	13.33	13.10	36.5	27.4	9.8	35.9	6.58	3.98	11.4	9.33	2.27	0.628
96	9.95	11.43	33.0	33.2	11.5	34.6	----	----	12.6	8.17	2.08	0.374
102	9.75	10.20	28.0	28.7	10.5	36.4	6.19	3.84	11.5	8.06	1.79	0.406
111	8.88	11.23	32.0	36.0	12.6	35.1	5.96	3.79	11.5	8.23	2.55	0.423
116	9.49	12.10	36.5	38.5	12.8	33.2	6.16	3.88	10.8	8.06	1.78	0.444
123	8.88	11.23	30.0	33.8	12.6	37.4	----	----	11.7	7.58	1.90	0.403
130	9.13	11.50	29.5	32.3	12.6	39.0	5.56	3.71	12.2	8.01	2.09	0.545
137	8.30	10.27	27.0	32.5	12.4	38.0	5.58	----	11.8	7.81	1.62	0.519
144	9.57	10.43	29.0	30.3	10.9	36.0	5.25	3.47	12.0	7.86	2.43	0.407
151	9.00	11.00	30.0	33.3	12.2	36.7	5.49	3.48	12.0	8.33	2.15	0.413
158	9.35	11.00	30.0	32.1	11.8	36.7	5.86	3.68	12.5	7.62	2.31	0.464
164	8.39	10.87	28.0	33.4	13.0	38.8	5.41	3.51	11.1	7.44	1.92	0.449
172	9.12	10.50	28.0	30.7	11.5	37.5	5.30	3.43	11.9	6.54	1.58	0.400
179	10.19	11.30	30.0	29.4	11.1	37.7	5.81	3.61	9.5	6.07	1.90	0.370
186	8.34	10.87	27.5	33.0	13.0	39.5	5.84	3.48	10.9	4.73	1.68	0.351
193	10.00	12.00	33.0	33.0	12.0	36.4	6.48	3.78	11.5	5.74	2.75	0.502
201	9.43	11.23	29.5	31.3	11.9	38.1	6.18	3.75	10.3	7.76	2.07	0.403
208	10.00	12.00	29.5	29.5	12.0	40.7	5.98	3.86	12.1	6.98	1.87	0.568
214	10.08	11.30	27.5	27.3	11.2	41.1	5.98	4.01	11.5	7.23	2.71	0.526
221	7.71	10.57	27.0	35.0	13.7	39.1	5.69	3.46	11.6	6.83	1.88	0.612
228	9.62	11.37	29.0	30.1	11.8	39.2	6.28	3.95	11.1	6.13	2.66	0.444

Appendix Table 9

Blood Picture of Animal Number C715--Group 2

Age	Whole Blood: Red Blood Cell Count	Whole Blood: Hemoglobin	Whole Blood: Red Blood Cell Volume	Whole Blood: Mean Corpuscular Volume	Whole Blood: Mean Corpuscular Hemoglobin	Whole Blood: Mean Corpuscular Hemoglobin Conc.	Serum: Total Protein	Serum: Albumin	Plasma: Calcium	Plasma: Inorg. Phosphorus	Plasma: Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
32	8.95	13.35	34.0	38.0	14.9	39.3	---	----	12.5	7.86	1.71	0.367
39	9.60	11.43	30.0	31.3	11.9	38.1	---	----	12.2	6.13	1.68	0.395
52	9.80	11.40	29.5	30.1	11.6	38.6	---	----	11.5	6.95	1.75	0.723
60	9.20	10.63	29.0	31.5	11.6	36.7	---	----	12.5	7.19	2.04	0.480
67	11.34	11.93	27.0	23.8	10.5	44.2	---	----	11.7	5.41	1.28	0.500
74	11.76	12.53	30.0	25.5	10.7	41.8	---	----	12.3	6.07	2.06	0.497
81	12.66	13.17	33.0	26.1	10.4	39.9	---	----	10.7	5.39	2.53	0.552
88	14.29	13.25	32.0	22.4	9.3	41.4	---	----	12.6	5.02	1.83	0.372
95	13.95	13.25	30.0	21.5	9.5	44.2	---	----	11.6	4.55	1.67	0.296
102	15.43	15.50	36.0	23.3	10.0	43.1	7.54	4.13	9.8	6.32	1.98	0.642
109	16.00	16.50	42.0	26.3	10.3	39.3	6.30	3.99	10.1	7.02	3.63	0.576
116	18.95	16.70	41.5	21.9	8.8	40.2	6.94	2.77	12.1	5.17	2.23	0.563
123	14.84	16.50	44.0	29.6	11.1	37.5	7.44	4.14	10.3	5.90	2.47	0.584
130	15.15	18.00	46.0	30.4	11.9	39.1	7.18	4.12	10.7	6.28	2.65	0.488
137	18.60	18.75	52.0	28.0	10.1	36.1	7.38	4.01	10.6	5.79	2.58	0.401
144	16.25	18.10	47.5	29.2	11.1	38.1	7.14	3.91	11.6	4.43	3.79	0.279
151	15.22	18.00	44.0	28.9	11.8	40.9	6.86	4.04	10.5	6.19	2.16	0.596
158	15.81	19.80	58.5	37.0	12.5	33.8	---	----	9.7	6.19	1.26	0.518
165	16.37	19.77	51.0	31.2	12.1	38.8	---	----	9.8	6.28	2.72	0.482
172	15.40	18.60	44.0	28.6	12.1	42.3	6.31	4.14	10.1	6.87	2.11	0.444
179	17.50	19.57	45.0	25.7	11.2	43.5	6.49	4.34	9.6	5.74	2.58	0.610
186	15.87	18.80	49.0	30.9	11.8	38.4	6.37	----	10.1	6.76	2.00	0.486

Appendix Table 10

Blood Picture of Animal C739--Group 2

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
35	9.30	9.70	24.0	25.8	10.4	40.4	----	----	11.4	6.25	2.15	0.437
42	8.68	10.35	27.0	31.1	11.9	38.3	5.60	3.51	12.2	6.58	2.21	0.544
49	9.22	9.90	26.0	28.2	10.7	38.1	5.49	3.46	11.8	8.06	2.23	0.622
56	10.55	11.93	32.5	30.8	11.3	36.7	6.40	3.96	12.7	6.83	1.99	0.682
63	11.59	12.60	34.0	29.3	10.9	37.1	5.48	3.57	10.4	7.86	2.57	0.623
70	11.69	12.77	34.5	29.5	10.9	37.0	5.93	3.92	10.7	4.96	1.53	0.583
77	13.30	13.25	35.0	26.3	10.0	37.9	6.07	4.09	11.7	9.19	2.99	0.499
84	13.60	12.83	35.5	26.1	9.4	36.1	6.07	3.93	10.7	10.41	2.20	0.669
91	15.12	12.53	34.5	22.8	8.3	36.3	6.31	4.03	11.7	6.98	2.07	0.650
97	14.05	12.45	32.5	23.1	8.9	38.3	6.04	4.04	10.0	8.39	1.91	0.670
106	15.99	12.60	35.0	21.9	7.9	36.0	5.95	3.85	11.0	6.51	2.57	0.701
111	14.95	13.10	37.0	24.7	8.8	35.4	6.30	4.17	11.5	11.57	2.69	0.692
118	15.28	12.53	34.5	22.6	8.2	36.3	6.44	4.29	10.1	7.71	2.30	0.712
125	15.28	13.95	42.0	27.5	9.1	33.2	6.37	4.21	12.0	8.87	2.08	0.631
132	16.57	14.45	38.0	20.5	7.8	38.0	6.65	----	11.8	6.83	2.37	0.675
139	19.53	15.00	42.0	21.5	7.7	35.7	6.37	4.26	9.8	7.86	2.47	0.564
146	18.33	14.03	41.5	22.6	7.7	33.8	5.95	3.82	10.1	7.06	2.01	0.597
153	18.31	15.20	48.0	26.2	8.3	31.7	6.61	4.62	10.6	5.63	1.89	0.519
159	19.62	16.00	46.5	23.7	8.2	34.4	6.16	4.14	10.0	6.51	1.92	0.586
167	18.92	16.80	50.5	26.7	8.9	33.3	6.24	2.74	11.3	6.91	1.94	0.563
174	20.30	17.80	47.0	23.2	8.8	37.9	6.66	4.21	10.0	4.63	1.79	0.503
181	---	---	---	---	---	----	6.31	3.61	10.0	5.46	1.76	0.414
188	19.17	17.10	47.5	24.8	8.9	36.0	6.89	4.20	10.5	5.06	1.87	0.525
196	19.77	17.90	47.5	24.0	9.1	37.7	6.75	3.70	10.3	7.31	1.64	0.474
203	18.17	17.80	45.5	25.0	9.8	39.1	6.44	4.16	10.8	4.45	1.56	0.371
209	19.27	18.10	49.0	25.4	9.4	36.9	7.23	4.63	11.3	4.84	2.07	0.369
216	15.81	17.60	48.0	30.4	11.1	36.7	6.30	3.94	9.5	5.53	1.80	0.389
223	18.12	18.67	45.5	25.1	10.3	41.0	7.28	4.59	10.4	3.95	2.58	0.287

Appendix Table 11

Blood Picture of Animal Number C741--Group 2

Age	Whole Blood						Serum		Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm³	gm %	%	u³	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
33	13.77	13.77	40.0	29.0	10.0	34.4	7.29	4.41	11.8	6.83	2.11	0.508
40	12.90	13.50	37.0	28.7	10.5	36.5	5.88	3.37	11.5	7.58	2.21	0.527
47	12.80	13.35	39.0	30.5	10.4	34.2	6.21	3.88	10.6	7.49	2.19	0.698
54	14.44	13.70	42.0	29.1	9.5	32.6	5.91	3.86	11.9	6.95	2.34	0.550
61	15.60	13.77	42.0	26.9	8.8	32.8	6.07	4.03	11.5	8.93	3.50	0.573
68	12.83	13.25	40.0	31.2	10.3	33.1	5.81	3.81	10.1	8.06	2.38	0.596
75	15.57	13.77	40.0	25.7	8.8	34.4	6.16	4.12	11.2	8.28	2.24	0.491
81	18.38	14.10	36.5	19.9	7.7	38.6	5.74	3.79	11.0	8.33	2.47	0.579
90	17.06	14.03	43.0	25.2	8.2	32.6	---	---	11.1	8.61	3.02	0.530
95	18.95	14.70	47.0	24.8	7.8	31.3	5.93	3.98	11.0	9.40	3.02	0.546
102	18.28	14.80	43.5	23.8	8.1	34.0	5.86	4.04	10.6	6.65	2.02	0.614
109	18.85	15.50	47.5	25.2	8.2	32.6	5.98	4.13	11.7	8.39	2.91	0.561
116	20.51	15.60	46.5	22.7	7.6	33.5	6.68	---	10.8	8.06	2.74	0.682
123	20.59	16.10	48.5	23.6	7.8	33.2	6.21	4.11	11.4	9.06	2.05	0.605
130	20.47	16.50	50.0	24.4	8.1	33.0	5.69	3.92	9.5	6.44	2.43	0.729
137	20.88	16.90	51.5	24.7	8.1	32.8	6.40	4.29	10.4	6.58	1.62	0.511
143	20.05	16.80	55.5	27.7	8.4	30.3	5.93	4.08	10.1	6.51	2.15	0.634
151	20.59	17.30	53.0	25.7	8.4	32.6	6.02	3.72	---	---	---	0.593
158	20.03	18.40	54.0	27.0	9.2	34.1	6.26	3.96	11.6	4.90	1.73	0.542
165	19.81	18.50	54.0	27.3	9.3	34.3	6.23	4.03	9.6	3.69	1.88	0.484
172	19.80	19.57	57.5	29.0	9.9	34.0	6.91	4.37	9.6	4.11	1.90	0.494
180	20.15	19.57	56.5	28.0	9.7	34.6	6.89	4.41	9.3	6.98	1.78	0.544
187	20.60	19.87	56.0	27.2	9.6	35.5	6.54	4.24	10.2	4.07	1.53	0.513
193	19.41	19.80	57.5	29.6	10.2	34.4	6.44	4.24	11.5	5.56	2.28	0.534
200	17.22	19.80	54.5	31.6	11.5	36.3	6.14	---	9.4	4.68	1.63	0.459
207	18.42	19.54	48.5	26.3	10.6	40.3	6.49	2.61	10.4	4.12	2.23	0.468

Appendix Table 12

Blood Picture of Animal Number C744--Group 2

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
12	8.39	10.50	28.0	33.4	12.5	37.5	5.08	3.33	11.6	7.76	2.36	0.484
19	9.05	10.57	27.5	30.4	11.7	38.4	5.26	3.40	11.0	8.01	1.65	0.368
26	8.59	9.03	23.0	26.8	10.5	39.3	5.30	3.46	10.8	6.22	2.01	0.480
33	8.94	9.70	26.5	29.6	10.9	36.6	5.78	3.99	10.8	7.02	2.14	0.364
40	9.78	10.50	30.0	30.7	10.7	35.0	5.76	3.77	11.5	8.50	2.10	0.615
47	9.40	9.33	25.5	27.1	9.9	36.6	6.05	3.85	11.4	8.74	1.89	0.555
54	11.52	9.40	28.0	24.3	8.2	33.6	5.88	3.85	11.3	7.91	1.94	0.590
60	11.78	8.87	25.0	21.2	7.5	35.5	5.96	3.90	11.5	7.96	1.90	0.685
69	13.98	9.55	27.5	19.7	6.8	34.7	6.02	3.86	11.3	9.06	2.43	0.657
74	14.85	10.27	31.0	20.9	6.9	33.1	5.98	3.89	11.4	9.92	2.48	0.600
81	12.67	9.20	27.0	21.3	7.3	34.1	---	---	11.5	7.06	2.04	0.660
88	15.50	10.50	31.0	20.0	6.8	33.9	6.09	3.94	11.9	8.93	2.15	0.577
95	17.50	10.50	30.0	17.1	6.0	35.0	6.56	---	11.7	8.17	1.69	0.456
102	16.98	10.43	32.0	18.8	6.1	32.6	5.95	4.01	11.7	8.01	2.26	0.499
109	17.92	10.63	32.0	17.9	5.9	33.2	5.78	3.90	10.5	8.39	2.18	0.683
116	21.38	10.87	35.0	16.4	5.1	31.1	6.13	4.14	11.0	8.39	1.66	0.503
122	19.72	11.50	38.5	19.5	5.8	29.9	6.26	4.21	12.4	9.19	2.72	0.610
130	18.26	11.30	31.0	17.0	6.2	36.5	5.61	3.91	12.1	7.71	1.77	0.555
137	20.82	13.70	41.0	19.7	6.6	33.4	6.53	4.03	11.0	6.72	1.94	0.619
144	19.76	12.10	35.0	17.7	6.1	34.6	6.56	3.53	10.9	4.83	2.07	0.500
151	19.73	12.83	42.0	21.3	6.5	30.5	6.93	4.26	11.2	5.23	2.83	0.603
159	21.45	14.30	45.5	21.2	6.7	31.4	7.24	4.36	13.1	7.35	2.77	0.575
166	21.24	14.55	46.0	21.7	6.9	31.6	6.33	3.97	10.1	6.62	1.88	0.637
172	21.95	14.10	46.0	21.0	6.4	30.7	6.48	4.16	11.3	6.04	2.69	0.526
179	21.20	14.63	46.5	21.9	6.9	31.5	6.40	2.71	11.1	4.70	1.54	0.451
186	21.88	15.50	42.5	19.4	7.1	36.5	7.14	2.96	10.7	3.80	2.14	0.537

Appendix Table 13

Blood Picture of Animal Number C711--Group 3

Age	Whole Blood						Serum		Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
81	10.50	10.87	27.0	25.7	10.4	40.3	----	----	11.7	9.06	1.16	0.269
88	11.95	11.07	30.0	25.1	9.3	36.9	----	----	12.0	7.71	1.59	0.299
101	15.25	14.33	40.5	26.6	9.4	35.4	----	----	11.3	5.76	1.98	0.508
109	15.57	13.60	40.5	26.0	8.7	33.6	----	----	11.5	7.40	2.37	0.434
116	14.34	14.43	36.0	25.1	10.1	40.1	----	----	9.3	5.41	2.16	0.407
123	15.36	14.90	36.5	23.8	9.7	40.8	----	----	10.5	5.08	1.26	0.421
130	15.23	16.00	38.0	25.0	10.5	42.1	----	----	9.5	6.32	2.54	0.503
137	15.85	15.60	41.0	25.9	9.8	38.0	----	----	11.5	7.23	2.11	0.372
144	15.30	15.90	37.5	24.5	10.4	42.4	6.19	3.80	11.5	7.19	2.27	0.455
158	15.55	16.80	41.5	26.7	10.8	40.5	6.89	4.16	11.7	7.71	3.36	0.488
165	12.15	13.35	34.5	28.4	11.0	38.7	6.21	3.86	11.5	6.25	2.22	0.354
172	11.95	12.83	35.0	29.3	10.7	36.7	6.70	3.96	11.2	6.91	2.67	0.461
179	11.10	11.67	30.0	27.0	10.5	38.9	6.23	3.78	11.5	6.58	2.15	0.392
186	10.90	13.17	33.0	30.3	12.1	39.9	7.23	3.79	13.1	6.76	2.40	0.472
193	8.99	11.85	29.0	32.3	13.2	40.9	6.26	----	11.8	7.49	2.43	0.414
200	11.45	13.60	34.0	29.7	11.9	40.0	6.54	4.13	10.1	6.72	1.98	0.485
207	10.62	13.77	37.0	34.8	13.0	37.2	----	----	10.0	6.72	2.01	0.425

Appendix Table 14

Blood Picture of Animal Number C725--Group 3

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
32	11.63	13.70	39.0	33.5	11.8	35.1	6.02	3.04	10.9	6.19	1.87	0.228
39	13.20	13.35	35.0	26.5	10.1	38.1	6.24	3.28	11.5	6.69	2.06	0.399
46	11.98	12.77	36.0	30.1	10.7	35.5	5.96	3.37	12.3	7.31	1.90	0.255
53	12.09	13.35	37.5	31.0	11.0	35.6	6.21	3.37	11.5	7.44	1.95	0.469
60	10.73	12.45	34.5	32.2	11.6	36.1	5.95	3.33	11.5	7.62	1.80	0.456
67	11.35	12.77	35.0	30.8	11.3	36.5	6.58	3.66	11.5	6.48	2.53	0.626
74	12.70	13.77	39.0	30.7	10.8	35.3	6.66	3.66	13.0	6.79	3.89	0.468
81	8.55	13.35	36.5	42.7	15.6	36.6	6.59	3.94	11.1	8.74	1.88	0.658
88	11.85	15.10	42.5	35.9	12.7	35.5	----	----	11.4	7.71	1.96	0.503
95	13.49	14.65	40.5	30.0	10.9	36.2	----	----	10.7	9.47	2.47	0.522
102	13.47	14.90	40.0	29.7	11.1	37.3	6.26	4.18	11.6	8.06	2.93	0.267
109	14.50	16.50	45.0	31.0	11.4	36.7	6.30	3.86	10.5	8.17	2.28	0.555
116	15.19	18.20	50.5	33.2	12.0	36.0	----	----	10.7	8.39	2.31	0.527
123	15.44	17.80	50.5	32.7	11.5	35.2	6.63	3.95	9.6	6.01	2.43	0.419
130	14.58	17.50	47.0	32.2	12.0	37.2	6.19	3.64	9.5	4.66	2.21	0.335
137	16.25	18.30	48.0	29.5	11.3	38.1	----	----	10.7	6.87	2.69	0.345
144	-----	19.54	50.5	----	----	38.7	----	----	11.5	7.02	2.15	0.434
151	16.70	19.20	52.0	31.1	11.5	36.9	6.74	3.85	10.6	6.13	2.53	0.420
158	16.02	19.40	44.5	27.8	12.1	43.6	6.83	3.94	10.0	7.02	2.21	0.437
165	15.91	19.40	50.0	31.4	12.2	38.8	6.74	3.81	10.5	6.19	1.97	0.544
172	17.29	19.66	54.0	31.2	11.4	36.4	7.07	4.18	11.2	8.33	2.44	0.414
179	15.85	18.30	48.0	30.3	11.5	38.1	6.74	3.82	10.5	7.19	1.93	0.360
186	16.10	18.80	48.5	30.1	11.7	38.8	6.65	3.82	9.3	6.13	2.23	0.446
193	17.07	18.10	50.0	29.3	10.6	36.2	6.93	4.03	10.7	4.51	1.88	0.550
200	14.07	17.30	45.0	32.0	12.3	38.4	6.79	3.86	10.6	6.04	2.38	0.482

Appendix Table 14 - Continued

Blood Picture of Animal Number C725--Group 3

Age	Whole Blood: Red Blood Cell Count	Whole Blood: Hemoglobin	Whole Blood: Red Blood Cell Volume	Whole Blood: Mean Corpuscular Volume	Whole Blood: Mean Corpuscular Hemoglobin	Whole Blood: Mean Corpuscular Hemoglobin Conc.	Serum: Total Protein	Serum: Albumin	Plasma: Calcium	Plasma: Inorg. Phosphorus	Plasma: Magnesium	Plasma: Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
207	14.22	18.00	45.5	32.0	12.7	39.6	7.23	4.05	9.1	6.95	2.07	0.455
214	13.73	17.00	41.5	30.2	12.4	41.0	7.07	4.10	10.3	7.81	2.06	0.358
220	14.17	17.85	47.5	33.5	12.6	37.6	7.31	4.22	10.7	6.91	2.11	0.455
229	14.92	17.80	49.0	32.8	11.9	36.3	6.94	3.00	9.9	7.71	2.15	0.515
234	16.51	17.50	47.5	28.8	10.6	36.8	6.53	3.86	10.0	7.44	2.18	0.546
241	13.77	18.10	49.0	35.6	13.1	36.9	6.86	4.18	9.5	6.01	1.90	0.482
248	13.03	18.30	49.0	37.6	14.0	37.3	6.75	3.85	10.5	8.23	2.43	0.561
255	13.63	17.90	44.0	32.3	13.1	40.7	7.01	----	9.5	7.02	2.11	0.613
262	15.56	18.72	47.5	30.5	12.0	39.4	6.53	3.90	9.6	6.98	1.94	0.491
269	16.13	19.10	53.5	33.2	11.8	35.7	6.26	3.75	8.8	6.62	2.33	0.502
276	14.24	18.40	50.0	35.1	12.9	36.8	6.77	----	10.7	5.56	2.58	0.535
282	14.08	18.10	50.0	35.5	12.9	36.2	6.37	3.60	10.1	5.90	2.50	0.466
290	13.91	17.50	51.5	37.0	12.6	34.0	6.37	3.73	9.7	6.58	2.10	0.344
297	13.88	17.50	44.5	32.1	12.6	39.3	6.38	3.53	9.5	5.84	1.74	0.480
304	14.10	17.40	44.5	31.6	12.3	39.1	7.26	3.61	10.8	3.67	1.79	0.343
311	13.02	17.00	42.0	32.3	13.1	40.5	7.13	3.74	10.0	4.15	2.83	0.285
319	12.53	16.60	36.0	28.7	13.2	46.1	7.14	3.98	11.9	5.56	2.74	0.442
326	11.38	16.30	38.5	33.8	14.3	42.3	6.14	2.72	11.4	4.94	2.32	0.451
332	11.55	15.60	39.5	34.2	13.5	39.5	6.93	3.84	12.4	5.27	3.04	0.385
339	11.30	15.40	33.5	29.6	13.6	46.0	6.59	3.64	10.5	5.81	1.76	0.420
346	11.37	15.50	34.0	29.9	13.6	45.6	7.07	3.73	11.1	5.81	2.55	0.319

Appendix Table 15

Blood Picture of Animal Number C730--Group 3

Age	Whole Blood						Serum		Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	mg %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
37	11.11	10.13	27.5	24.8	9.1	36.8	6.09	3.66	12.1	8.45	2.37	0.391
44	10.81	10.13	28.0	25.9	9.4	36.2	5.96	3.71	12.5	7.58	2.13	0.491
51	11.15	13.70	45.0	40.4	12.3	30.4	6.13	3.83	11.6	7.23	2.25	0.477
58	9.53	12.10	35.0	36.7	12.7	34.6	5.65	3.46	11.1	7.02	1.90	0.472
65	-----	13.60	38.0	----	----	35.8	6.05	3.46	11.5	6.95	2.29	0.273
72	10.25	12.53	34.5	33.7	12.2	36.3	6.07	3.59	11.7	7.91	2.55	0.530
79	10.40	14.10	35.5	34.1	13.6	39.7	5.98	3.76	11.2	7.71	2.53	0.689
86	14.90	15.90	45.0	30.2	10.7	35.3	----	----	10.7	7.71	2.49	0.656
93	-----	-----	----	----	----	----	----	----	11.5	8.33	1.53	0.585
100	14.74	15.60	40.0	27.1	10.6	39.0	5.84	3.81	11.9	6.45	2.49	0.507
107	15.20	17.00	49.0	32.2	11.2	34.7	6.04	3.91	10.4	7.62	2.02	0.602
114	14.02	17.50	47.0	33.5	12.5	37.2	----	----	10.0	7.35	1.90	0.671
121	14.99	18.30	52.0	34.7	12.2	35.2	6.66	4.21	10.4	6.98	2.21	0.483
128	15.33	17.90	48.0	31.3	11.7	37.3	6.33	4.14	10.8	5.53	2.20	0.401
135	15.95	18.40	50.5	31.7	11.5	36.4	----	----	10.4	5.53	2.53	0.537
142	-----	19.26	54.5	----	----	35.3	----	----	10.0	7.49	1.80	0.498
149	15.60	19.20	53.5	34.3	12.3	35.9	6.68	3.94	10.5	6.10	2.51	0.380
156	16.14	18.80	49.0	30.4	11.6	38.4	6.63	4.32	9.6	7.02	2.16	0.398
163	17.12	19.54	53.5	31.3	11.4	36.5	6.79	4.34	10.5	7.71	2.20	0.498
170	16.80	18.80	52.0	31.0	11.2	36.2	6.91	4.21	10.5	7.02	1.94	0.646
177	16.70	19.66	59.0	35.3	11.8	33.3	7.18	4.79	11.9	8.17	1.94	0.248
184	16.85	19.54	58.0	34.4	11.6	33.7	6.83	4.19	9.3	7.67	2.46	0.531
191	16.32	19.40	57.0	34.9	11.9	34.0	7.12	4.64	10.7	4.83	2.02	0.583
198	16.34	18.50	53.5	32.7	11.3	34.6	6.72	4.38	10.5	7.81	2.78	0.474
205	18.03	19.50	53.5	29.7	10.8	36.4	6.89	4.84	10.9	5.63	2.47	0.471
212	15.38	18.60	52.0	33.8	12.1	35.8	7.05	4.66	10.0	7.96	2.49	0.327

Appendix Table 16

Blood Picture of Animal Number C714--Group 4

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
46	9.65	11.67	29.0	30.1	12.1	40.2	----	----	11.7	7.27	1.14	0.219
53	10.40	11.00	29.5	28.4	10.6	37.3	----	----	10.5	7.44	1.16	0.323
66	10.25	11.40	32.0	31.2	11.1	35.6	----	----	10.2	10.08	1.61	0.562
74	10.27	11.30	34.0	33.1	11.0	33.2	----	----	11.7	7.96	1.56	0.434
81	10.75	12.45	32.0	29.8	11.6	38.9	----	----	11.5	6.65	1.67	0.407
88	10.52	10.93	27.5	26.1	10.4	39.7	----	----	11.4	6.51	1.62	0.336
95	10.38	12.77	31.0	29.9	12.3	41.2	----	----	11.0	7.44	2.31	0.511
102	10.80	11.75	29.0	26.9	10.9	40.5	----	----	11.0	8.62	1.74	0.422
109	9.60	11.60	29.5	30.7	12.1	39.3	6.07	3.39	9.5	8.81	1.99	0.439
116	10.40	12.83	35.5	34.1	12.3	36.1	6.30	3.68	9.6	8.45	1.80	0.439
123	10.75	13.70	37.5	34.9	12.7	36.5	6.23	3.68	11.5	10.41	2.66	0.432
130	11.34	12.77	35.5	31.3	11.3	36.0	6.28	3.73	11.5	7.35	1.86	0.272
137	10.90	13.77	38.0	34.9	12.6	36.2	6.41	3.29	10.3	7.62	1.98	0.576
144	11.70	13.70	37.0	31.6	11.7	37.0	6.24	3.36	11.5	7.58	1.79	0.408
151	14.45	17.10	51.0	35.3	11.8	33.5	7.21	3.79	10.1	8.01	2.77	0.393
158	14.25	15.80	42.5	29.8	11.1	37.2	7.49	3.62	11.2	6.83	3.80	0.468
165	14.74	16.50	47.0	31.9	11.2	35.1	6.93	3.53	10.3	8.33	1.90	0.493
172	16.10	16.80	49.0	30.4	10.4	34.3	----	----	9.5	7.27	1.58	0.440
179	-----	-----	----	----	----	----	----	----	9.8	7.35	2.15	0.482
193	17.30	19.57	53.0	30.6	11.3	36.9	6.59	4.03	8.7	7.49	2.88	0.610
200	-----	19.67	57.5	----	----	34.2	7.00	----	9.5	6.65	2.44	0.312
207	17.67	19.50	56.0	31.7	11.0	34.8	7.12	4.09	8.4	5.27	2.58	0.238
214	16.55	19.70	58.0	35.0	11.9	34.0	6.66	4.05	8.6	5.79	3.12	0.434
221	17.00	19.50	56.5	33.2	11.5	34.5	----	----	9.0	5.87	3.22	0.394
228	19.65	21.74	63.0	32.1	11.1	34.5	----	----	8.3	6.58	2.43	0.553

Appendix Table 17

Blood Picture of Animal Number C726--Group 4

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
32	11.85	12.90	39.0	32.9	10.9	33.1	5.51	2.91	8.7	4.84	1.26	0.263
39	10.82	12.83	37.0	34.2	11.9	34.7	5.83	2.83	9.1	4.09	1.57	0.237
46	11.70	12.77	35.0	29.9	10.9	36.5	6.75	1.86	10.5	4.26	1.97	0.176
53	10.07	11.50	34.5	34.3	11.4	33.3	7.93	2.54	11.7	5.30	3.55	0.166
60	11.00	12.45	36.5	33.2	11.3	34.1	8.64	2.39	10.7	4.96	1.83	0.197
67	12.00	12.35	37.0	30.8	10.3	33.4	----	----	10.8	6.35	2.33	0.175
74	11.82	12.10	36.5	30.9	10.2	33.2	----	----	10.7	7.23	1.70	0.221
81	10.17	11.60	34.0	33.4	11.4	34.1	9.39	2.56	10.9	5.90	2.67	0.381
88	10.85	11.50	32.0	29.5	10.6	35.9	9.01	2.48	9.5	4.36	1.08	0.252
95	11.12	11.60	34.0	30.6	10.4	34.1	8.28	2.50	7.0	6.38	1.56	0.193
102	9.05	9.70	29.0	32.0	10.7	33.4	8.64	2.46	10.4	6.62	1.64	0.205
109	11.20	11.15	30.0	26.8	10.0	37.2	8.56	2.46	11.7	4.96	1.96	0.318
116	11.00	11.00	31.0	28.2	10.0	35.5	----	----	11.6	6.65	2.15	0.402
123	-----	11.60	30.0	----	----	38.7	----	----	11.5	5.58	1.83	0.386
130	10.11	12.00	32.0	31.7	11.9	37.5	7.27	2.68	11.3	7.02	2.36	0.283
137	10.59	12.20	29.0	27.4	11.5	42.1	7.82	3.06	10.8	9.26	1.75	0.491
144	11.02	11.60	29.0	26.3	10.5	40.0	7.07	3.11	11.1	8.17	1.70	0.294
151	9.50	10.50	29.0	30.5	11.1	36.2	7.14	3.26	11.9	8.23	2.08	0.422
158	9.57	11.37	33.5	35.0	11.9	33.9	6.89	3.44	12.0	9.84	2.37	0.368
165	12.30	13.85	39.0	31.7	11.3	35.5	7.05	2.03	10.7	7.81	2.08	0.480
172	11.13	12.83	35.5	31.9	11.5	36.1	6.84	3.78	10.5	6.48	1.81	0.491
179	10.81	12.53	35.0	32.4	11.6	35.8	7.12	3.72	11.2	8.06	2.21	0.440
186	11.17	12.00	32.0	28.6	10.7	37.5	7.28	3.81	10.7	8.50	1.95	0.412
193	10.13	12.83	35.0	34.6	12.7	36.7	7.10	3.81	11.2	7.91	1.83	0.350
199	10.67	14.10	37.0	34.7	13.2	38.1	6.89	3.61	9.9	8.74	1.63	0.385

Appendix Table 17 - Continued

Blood Picture of Animal Number C726--Group 4

	Whole Blood						Serum		Plasma			
Age	Red Blood Cell Count	Hemoglobin	Red Blood Cell Volume	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Total Protein	Albumin	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	gm %	gm %	mg %	mg %	mg %	mg %
208	13.68	14.90	42.0	30.7	10.9	35.5	7.24	3.38	10.0	8.39	2.06	0.530
213	12.01	15.00	40.5	33.7	12.5	37.0	6.89	2.94	10.3	8.74	1.85	0.499
220	12.97	16.00	46.0	35.5	12.3	34.8	6.96	3.72	9.8	7.27	1.97	0.443
227	13.28	17.50	48.0	36.1	13.2	36.5	6.88	3.68	10.6	8.87	2.44	0.474
234	13.22	17.10	46.0	34.8	12.9	37.2	7.38	----	9.9	7.81	1.66	0.582
241	13.40	17.50	47.5	35.4	13.1	36.8	6.65	3.72	9.0	7.49	2.07	0.424
248	14.38	18.30	50.0	34.8	12.7	36.6	7.09	3.86	9.0	6.83	2.21	0.502
255	13.83	18.00	51.0	36.9	13.0	35.3	6.91	2.28	9.0	5.90	1.98	0.440
261	13.22	17.10	49.5	37.4	12.9	34.5	6.74	3.68	10.1	6.48	2.08	0.514
269	14.26	16.90	48.0	33.7	11.9	35.2	6.65	3.91	10.5	5.79	1.73	0.384
276	15.44	16.70	42.5	27.5	10.8	39.3	6.70	3.56	9.0	4.61	1.61	0.441
283	13.45	16.30	42.0	31.2	12.1	38.8	6.72	3.94	10.1	4.81	1.94	0.414
290	11.66	16.00	41.0	35.2	13.7	39.0	7.31	3.95	11.9	4.94	2.74	0.525
298	11.76	15.00	32.5	27.6	12.8	46.2	7.16	3.99	12.5	6.28	2.53	0.411
305	11.56	14.55	38.5	33.3	12.6	37.8	6.59	3.58	10.6	6.65	1.87	0.474
311	11.94	14.63	38.0	31.8	12.3	38.5	6.72	3.72	11.6	5.95	2.24	0.432
318	12.25	16.10	34.0	27.8	13.1	47.4	6.63	3.59	10.3	5.79	1.64	0.475
325	11.31	14.10	33.0	29.2	12.5	42.7	6.77	3.73	11.1	4.77	2.47	0.483

Appendix Table 18

Blood Picture of Animal Number A73--Group 5

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemo-globin	Red Blood Cell Vol.	Mean Corpus-cular Volume	Mean Corpus-cular Hemo-globin	Mean Corpus-cular Hemo-globin Conc.	Cal-cium	Inorg. Phos-phorus	Magne-sium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
371	-----	11.15	26.5	----	----	42.1	11.3	5.46	1.88	---
385	-----	10.07	25.5	----	----	39.5	11.1	6.28	2.18	0.646
399	-----	9.55	24.0	----	----	40.0	11.5	5.81	1.76	0.390
427	10.13	12.00	31.0	30.6	11.8	38.7	12.5	7.35	2.00	0.504
429	9.05	10.93	26.0	28.7	12.1	42.0	----	----	----	------
436	8.50	11.85	29.5	34.7	13.9	40.2	----	----	----	-----
443	12.75	11.93	29.0	22.7	9.4	41.1	11.3	6.41	2.74	0.528
450	9.18	11.60	26.0	28.3	12.6	44.6	----	----	----	-----
457	9.10	11.23	27.0	29.7	12.3	41.6	----	----	----	-----
464	7.95	10.27	24.0	30.2	12.9	42.8	----	----	----	-----
471	7.55	10.35	24.5	32.5	13.7	42.2	----	----	----	-----
477	7.92	10.67	26.0	32.8	13.5	41.0	11.7	6.07	1.96	0.412
484	9.53	10.63	26.0	27.3	11.2	40.9	----	----	----	-----
492	8.05	10.00	24.5	30.4	12.4	40.8	11.7	6.54	2.02	-----
498	8.20	10.87	28.5	34.8	13.3	38.1	12.2	6.51	1.78	-----
512	9.15	15.00	30.5	33.3	16.4	49.2	10.8	6.79	1.57	-----
519	10.32	12.10	32.5	31.5	11.7	37.2	11.1	6.65	2.19	-----
526	7.24	9.77	23.0	31.8	13.5	42.5	11.4	5.48	2.30	-----
533	7.38	10.50	25.0	33.9	14.2	42.0	11.6	5.81	2.24	0.404
540	8.28	11.00	25.0	30.2	13.3	44.0	12.3	8.39	1.86	0.495

Appendix Table 19

Blood Picture of Animal Number A75--Group 5

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Men Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	%	uug	mg %	mg %	mg %	mg %
323	----	11.60	26.0	----	----	44.6	11.1	6.76	1.90	----
337	----	9.47	23.0	----	----	41.2	11.0	6.58	1.98	0.591
351	----	11.30	26.0	----	----	43.5	12.9	5.81	2.15	0.438
379	10.79	15.50	41.5	38.5	14.4	37.3	10.7	8.81	2.46	0.366
381	10.70	13.43	32.0	29.9	12.6	42.0	----	----	----	-----
388	7.81	12.65	30.0	38.4	16.2	42.2	----	----	----	-----
395	-----	-----	----	-----	----	----	12.6	8.50	2.37	0.291
402	8.73	10.93	25.0	28.6	12.5	43.7	----	----	----	-----
409	7.30	11.30	27.0	37.0	15.5	41.9	----	----	----	-----
416	7.55	10.50	24.5	32.5	13.9	42.9	----	----	----	-----
423	5.05	8.20	19.0	37.6	16.2	43.2	----	----	----	-----
429	6.93	9.20	23.0	33.2	13.3	40.0	11.9	8.56	2.12	0.389
436	6.83	10.07	22.0	32.2	14.7	45.8	----	----	----	-----
444	8.02	13.77	35.5	44.3	17.2	38.8	11.0	8.62	2.15	-----
450	8.56	11.30	30.0	35.0	13.2	37.7	10.9	4.72	1.31	-----
464	7.34	10.93	28.5	38.8	14.9	38.4	11.1	7.19	1.71	-----
471	8.49	12.77	33.5	39.5	15.0	38.1	11.5	8.81	1.86	-----
478	8.65	12.65	29.0	33.5	14.6	43.6	11.0	6.38	1.87	-----
485	8.22	13.70	32.5	39.5	16.7	42.2	10.5	7.31	1.54	0.387
492	9.25	14.20	32.0	34.6	15.4	44.4	11.7	6.98	1.53	0.371

Appendix Table 20

Blood Picture of Animal Number A78--Group 5

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemo-globin	Red Blood Cell Vol.	Mean Corpus-cular Volume	Mean Corpus-cular Hemo-globin	Mean Corpus-cular Hemo-globin Conc.	Cal-cium	Inorg. Phos-phorus	Magne-sium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	umg	%	mg %	mg %	mg %	mg %
292	-----	9.77	24.0	----	----	40.7	10.3	7.35	1.59	------
306	-----	9.70	24.0	----	----	40.4	11.1	4.68	1.87	0.521
320	-----	10.50	26.0	----	----	40.4	11.5	4.92	1.79	0.556
348	8.98	12.83	34.0	37.9	14.3	37.7	12.7	5.71	2.55	0.591
350	9.05	12.35	29.5	32.6	13.6	41.9	----	----	----	-----
357	9.20	12.20	29.5	32.1	13.3	41.4	----	----	----	-----
364	9.35	12.77	31.0	33.2	13.7	41.2	12.0	6.65	1.62	0.544
371	8.75	10.43	24.0	27.4	11.9	43.5	----	----	----	-----
378	8.09	10.13	24.0	29.7	12.5	42.2	----	----	----	-----
385	7.50	9.40	22.0	29.3	12.5	42.7	----	----	----	-----
392	8.45	9.70	23.0	27.2	11.5	42.2	----	----	----	-----
398	7.65	9.33	23.0	30.1	12.2	40.6	12.0	6.79	2.60	0.490
405	8.00	10.13	25.5	31.9	12.7	39.7	----	----	----	-----
413	8.35	9.83	25.5	30.5	11.8	38.5	10.8	6.48	2.15	------
419	7.97	11.00	28.0	35.1	13.8	39.3	12.0	5.00	3.10	------
433	7.60	11.00	29.0	38.2	14.5	37.9	10.2	6.58	1.77	------
440	8.17	10.20	29.0	35.5	12.5	35.2	11.0	7.23	1.67	------
447	7.97	11.50	29.5	37.0	14.4	39.0	10.7	6.28	2.55	------
454	8.87	12.00	29.0	32.7	13.5	41.4	11.5	6.65	2.62	0.438
461	8.37	11.75	28.5	34.1	14.0	41.2	11.1	6.83	2.07	0.446

Appendix Table 21

Blood Picture of Animal Number A80--Group 5

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
228	----	12.45	31.0	----	----	40.2	12.0	7.49	2.13	------
242	----	10.87	27.5	----	----	39.5	11.4	6.91	2.06	0.552
256	----	10.43	21.5	----	----	48.5	11.5	7.10	1.95	0.733
284	7.52	11.30	29.0	38.6	15.0	39.0	12.3	8.28	2.55	0.512
286	8.75	11.30	28.0	32.0	12.9	40.4	----	----	----	-----
293	9.90	10.80	29.5	29.8	10.9	36.6	----	----	----	-----
300	10.80	12.70	34.0	31.5	11.8	37.4	11.9	7.96	2.42	0.241
307	8.89	10.27	25.0	28.1	11.6	41.1	----	----	-----	-----
314	7.80	11.50	27.0	34.6	14.7	42.6	----	----	----	-----
321	9.55	10.87	24.5	25.7	11.4	44.4	----	----	----	-----
328	8.30	10.87	26.0	31.3	13.1	41.8	----	----	----	-----
334	8.09	10.50	24.0	29.7	13.0	43.8	11.5	7.19	2.15	0.428
341	9.63	10.93	24.5	25.4	11.3	44.6	----	----	----	-----
349	10.17	11.07	28.5	28.0	10.9	38.8	11.7	8.39	3.20	-----
355	9.99	12.27	30.0	30.0	12.3	40.9	11.7	7.86	2.19	-----
369	8.78	10.57	29.0	33.0	12.0	36.4	9.1	8.23	1.97	-----
376	6.84	9.90	27.0	39.5	14.5	36.7	12.1	7.31	2.25	-----
383	8.16	11.50	28.0	34.3	14.1	41.1	11.7	5.93	1.60	-----
390	7.60	11.60	26.5	34.9	15.3	43.8	10.5	7.31	2.12	0.533
397	7.60	11.60	26.5	34.9	15.3	43.8	10.7	7.91	2.00	0.814

Appendix Table 22

Blood Picture of Animal Number A72--Group 6

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemo-globin	Red Blood Cell Vol.	Mean-Corpus-cular Volume	Mean Corpus-cular Hemo-globin	Mean Corpus-cular Hemo-globin Conc.	Cal-cium	Inorg. Phos-phorus	Mag-ne-sium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
395	----	12.00	29.0	----	----	41.4	11.4	6.35	1.84	-----
409	----	11.60	29.0	----	-----	40.0	11.6	6.83	2.71	0.409
423	----	11.75	27.5	----	-----	42.7	11.3	5.63	2.10	0.548
451	10.55	12.83	32.0	30.3	12.2	40.1	12.3	7.27	1.90	0.536
453	10.90	12.90	----	----	11.8	----	----	----	----	-----
460	10.02	12.00	29.5	29.4	12.0	40.7	----	----	----	-----
467	12.85	12.77	30.0	23.3	9.9	42.6	12.2	6.28	3.02	0.560
474	9.05	11.50	27.0	29.8	12.7	42.6	----	----	----	-----
481	-----	13.25	31.0	----	----	42.7	----	----	----	------
488	8.85	11.67	27.5	31.1	13.2	42.4	-----	----	----	-----
495	9.50	12.35	29.0	30.5	13.0	42.6	----	----	----	-----
501	12.30	14.45	36.5	29.7	11.7	39.6	12.1	6.19	2.32	0.521
508	12.30	15.10	36.0	29.3	12.3	41.9	----	----	----	-----
516	10.70	17.25	42.0	39.3	16.1	41.1	11.6	6.50	1.94	-----
522	10.75	13.70	38.0	35.3	12.7	36.1	11.5	6.44	1.62	-----
536	9.93	13.77	35.0	35.2	13.9	39.3	11.1	6.35	1.94	-----
543	10.24	12.83	34.0	33.2	12.5	37.7	10.8	5.95	1.88	-----
550	11.02	13.17	32.0	29.0	12.0	41.2	11.3	6.44	1.81	-----
557	10.15	14.80	35.5	35.0	14.6	41.7	10.5	5.25	2.21	0.455
564	10.14	14.80	37.0	36.5	14.6	40.0	11.4	6.69	1.58	0.495

Appendix Table 23

Blood Picture of Animal Number A76--Group 6

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
303	-----	12.90	30.0	----	----	43.0	11.4	8.68	1.86	----
317	-----	11.43	26.5	----	----	43.1	11.3	6.10	1.64	0.336
331	-----	12.53	30.0	----	----	41.8	13.0	6.69	1.92	0.517
359	8.70	13.25	33.0	37.9	15.2	40.2	12.3	7.44	2.13	0.496
361	11.45	13.10	29.5	25.8	11.4	44.4	----	----	----	-----
368	10.30	12.70	30.0	29.1	12.3	42.3	----	----	----	-----
375	10.80	13.70	31.5	29.2	12.7	43.5	11.6	7.35	2.20	0.455
382	11.24	14.10	33.5	29.8	12.5	42.1	----	----	----	-----
389	8.42	16.00	39.5	46.9	19.0	40.5	----	----	----	-----
396	9.95	9.83	32.5	32.7	9.9	30.2	----	----	----	-----
403	10.40	14.45	33.0	31.7	13.9	43.8	----	----	----	-----
409	9.90	12.60	30.0	30.3	12.7	42.0	11.4	6.19	1.90	0.467
416	10.80	13.47	30.0	27.8	12.5	44.9	----	----	----	-----
424	10.86	10.20	26.5	24.4	9.4	38.5	12.7	5.74	1.81	-----
430	10.24	13.17	31.5	30.8	12.9	41.8	10.5	6.44	1.26	------
444	11.33	13.77	36.0	31.8	12.2	38.3	11.7	6.79	1.77	-----
451	10.22	13.60	36.0	35.2	13.3	37.8	12.1	7.71	1.80	-----
458	11.14	13.25	30.0	26.9	11.9	44.2	11.8	5.71	1.76	-----
465	9.65	13.43	31.0	32.1	13.9	43.3	11.9	6.41	1.91	0.387
472	9.60	13.77	31.0	32.3	14.3	44.4	11.3	8.01	1.74	0.536

Appendix Table 24

Blood Picture of Animal Number A77--Group 6

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm^3	gm %	%	u^3	uug	%	mg %	mg %	mg %	mg %
294	----	10.27	25.0	----	----	41.1	11.0	8.12	1.87	.---
308	----	9.70	25.5	----	----	38.0	12.2	6.95	1.73	0.433
322	----	10.50	25.0	----	----	42.0	12.5	6.44	1.99	0.634
350	7.81	11.60	30.5	39.1	14.9	38.0	11.2	7.44	2.43	0.591
352	----	11.67	29.5	----	----	39.6	----	----	----	-----
359	8.75	12.23	29.0	33.1	14.0	42.2	----	----	----	-----
366	8.75	11.60	29.0	33.1	13.3	40.0	12.0	7.91	2.36	0.215
373	9.07	10.93	27.0	29.8	12.1	40.5	----	----	----	-----
380	10.70	11.50	27.0	25.2	10.7	42.6	----	----	----	-----
387	8.55	10.20	25.0	29.2	11.9	40.8	----	----	----	-----
394	8.21	9.33	24.0	29.2	11.4	38.9	----	----	----	-----
400	7.25	9.47	24.0	33.1	13.1	39.5	11.8	5.34	1.88	0.498
407	7.50	10.13	25.0	33.3	13.5	40.5	----	----	----	-----
415	8.02	11.43	30.5	38.0	14.3	37.5	11.8	6.79	1.96	-----
421	8.18	11.50	29.0	35.5	14.1	39.7	12.1	5.17	1.18	-----
435	7.27	10.87	28.0	38.5	15.0	38.8	10.2	6.58	1.77	-----
442	8.44	11.23	32.0	37.9	13.3	35.1	11.1	7.71	1.83	-----
449	8.28	11.37	29.0	35.0	13.7	39.2	11.1	6.58	2.20	-----
456	----	13.17	32.5	----	----	40.5	10.9	6.04	1.99	0.463
463	9.18	13.43	34.0	37.0	14.6	39.5	11.5	8.45	2.16	0.544

Appendix Table 25

Blood Picture of Animal Number A79--Group 6

Age	Whole Blood						Plasma			
	Red Blood Cell Count	Hemoglobin	Red Blood Cell Vol.	Mean Corpuscular Volume	Mean Corpuscular Hemoglobin	Mean Corpuscular Hemoglobin Conc.	Calcium	Inorg. Phosphorus	Magnesium	Ascorbic Acid
days	M/mm3	gm %	%	u3	uug	%	mg %	mg %	mg %	mg %
285	----	10.50	26.5	----	----	39.6	11.0	7.06	2.06	----
299	----	9.83	25.0	----	----	39.3	11.5	6.51	1.92	0.344
313	----	10.50	26.5	----	----	39.6	11.5	8.12	1.76	0.525
341	9.21	11.30	30.5	33.1	12.3	37.0	12.0	7.44	3.27	0.544
343	7.75	10.93	26.5	34.2	14.1	41.2	----	----	----	-----
350	9.35	11.93	28.0	29.9	12.8	42.6	----	----	----	-----
357	11.35	12.70	33.5	29.5	11.2	37.9	10.9	5.79	1.76	0.439
364	10.90	13.25	33.0	30.3	12.2	40.2	----	----	----	-----
371	9.30	13.05	34.0	36.6	14.0	38.4	----	----	----	-----
378	8.45	10.80	28.0	33.1	12.8	38.6	----	----	----	-----
385	7.40	10.87	25.5	34.5	14.7	42.6	----	----	----	-----
391	7.24	9.70	24.5	33.8	13.4	39.6	11.4	6.58	1.88	0.551
398	9.60	10.87	27.5	28.6	11.3	39.5	----	----	----	-----
406	8.65	12.45	28.5	32.9	14.4	43.7	10.8	6.32	2.04	-----
412	7.80	10.80	28.0	35.9	13.8	38.6	10.7	5.17	1.97	-----
426	8.15	10.50	29.0	35.6	12.9	36.2	9.1	7.44	1.95	-----
433	7.59	10.80	31.0	40.8	14.2	34.8	10.9	6.10	1.85	-----
440	8.10	11.30	27.5	34.0	14.0	41.1	11.2	5.90	2.25	-----
447	7.80	12.20	31.0	39.7	15.6	39.4	10.8	5.74	1.96	0.387
454	----	-----	----	----	----	----	11.0	7.71	2.02	0.413

Appendix Table 26

Growth Record by Animals

C680		C681		C684		C711		C714	
Age	Wt.	Age	Wt.	Age	Wt.	Age	Wt.	Age	Wt.
days	lb.	days	lb.	days	lb.	days	lb.	days	lb.
196	186	180	229	166	387	84	187	49	155
203	193	187	250	173	383	91	182	56	158
210	203	194	237	180	377	98	194	63	171
217	195	201	241	187	392	105	190	70	182
224	183	208	256	194	407	112	199	77	192
231	188	215	245	201	379	119	216	84	206
238	196	222	249	208	396	126	223	91	214
245	200	229	251	215	394	133	247	98	238
252	208	236	253	222	423	140	258	105	252
259	227	243	257	229	425	147	285	112	275
266	222	250	252	236	397	154	289	119	282
272	207	256	248	242	417	161	325	126	314
280	234	264	262	250	415	168	330	133	301
288	253	272	274	258	435	175	358	140	318
294	238	278	283	264	429	182	356	147	317
302	262	286	287	272	442	189	378	154	335
309	268	293	274	279	444	196	383	161	355
315	266	299	292	285	433	203	405	168	373
323	281	307	292	293	465	210	410	175	386
333	307	317	327	303	473			184	406
340	302	324	341	310	463			189	390
347	309	331	357	317	489			196	425
354	332	338	362	324	472			203	431
361	345	345	356	331	497			210	442
368	345	352	370	338	500			217	455
375	373	359	392	345	516			224	470
382	377	366	407	352	531				
389	392	373	421	359	550				
396	389	380	424	366	549				
403	423	387	447	373	572				
410	434	394	450	380	589				
417	443	401	470	387	605				
424	471	408	481	394	606				
431	480	415	477	401	634				
438	470	422	498	408	628				
445	460	429	478	415	660				
452	468	436	494	422	642				
459	504	443	535	429	675				
466	500	450	545	436	667				
473	517	457	565	443	713				
480	513	464	561						
487	518	471	580						
494	515	478	567						
501	528	485	582						
508	550	492	598						
515	587	499	634						

Appendix Table 26 - Continued

Growth Record by Animals

C715		C718		C719		C724	
Age	Wt.	Age	Wt.	Age	Wt.	Age	Wt.
days	lb.	days	lb.	days	lb.	days	lb.
35	78	49	164	21	113	35	89
42	85	56	168	28	105	42	96
49	93	63	185	35	126	49	108
56	98	70	195	42	132	56	115
63	101	77	214	49	142	63	128
70	109	84	225	56	152	70	136
77	114	91	242	63	160	77	147
84	118	98	249	70	170	84	163
91	124	105	266	77	180	91	172
98	136	112	269	84	203	100	195
105	133	119	304	91	214	105	196
112	151	126	314	98	228	112	221
119	147	133	303	105	243	119	226
126	163	140	330	112	259	126	240
133	172	147	362	119	275	133	262
140	170	154	379	126	280	140	272
147	182	163	415	133	295	147	277
154	194	168	408	140	315	154	288
161	205	175	455	147	329	160	298
170	216	182	465	156	360	167	306
175	224	189	460	161	365	174	320
182	241	196	486	168	382	181	339
		203	506	175	396	188	363
		210	518	182	419	195	370
		217	552	189	426	202	389
						209	404

Appendix Table 26 - Continued

C725		C726		C730		C739	
Age	Wt.	Age	Wt.	Age	Wt.	Age	Wt.
days	lb.	days	lb.	days	lb.	days	lb.
35	133	35	82	40	126	37	120
42	145	42	77	47	139	44	128
49	149	49	76	54	140	51	152
56	167	56	80	61	143	58	160
63	174	63	85	68	149	65	160
70	183	70	94	75	161	72	173
77	197	79	103	82	176	79	188
84	212	84	110	89	187	86	198
91	224	91	111	98	212	94	202
100	249	98	119	103	213	101	213
105	250	105	121	110	228	107	227
112	260	112	137	117	238	114	230
119	266	119	140	124	250	121	240
126	270	126	150	131	272	128	255
133	282	133	162	138	275	135	263
140	289	140	166	145	281	142	272
147	290	146	185	152	302	149	285
154	305	153	196	158	312	156	295
161	311	160	212	165	320	163	300
167	322	167	222	172	345	170	313
174	342	174	239	179	353	178	311
181	349	181	248	186	353	185	335
188	365	188	265	193	373	192	339
195	373	196	257	200	389	199	351
202	379	203	262	207	397	206	351
209	402	209	266			213	356
217	410	216	285			220	374
224	413	223	292			227	388
230	414	230	292				
237	420	237	307				
244	435	244	326				
251	446	251	335				
258	450	258	319				
265	472	267	320				
272	480	272	340				
279	492	280	355				
286	500	287	356				
293	510	294	390				
301	500	301	383				
308	530	308	400				
315	539	315	413				
322	525	322	428				
329	544	329	436				
336	561						
343	581						
350	598						

Appendix Table 26 - Continued

C741		C742		C744		C749	
Age	Wt.	Age	Wt.	Age	Wt.	Age	Wt.
days	lb.	days	lb.	days	lb.	days	lb.
35	132	35	134	14	95	77	205
42	148	42	143	21	105	84	220
49	160	49	158	28	118	91	233
56	166	56	170	35	124	99	244
63	178	63	179	42	130	106	254
70	182	70	191	49	142	112	275
78	193	78	203	57	144	119	282
85	182	85	218	64	149	126	306
91	203	91	235	70	157	133	312
98	215	98	240	77	159	140	329
105	234	105	270	84	172	147	347
112	249	112	281	91	172	154	360
119	262	119	300	98	187	161	373
126	267	126	315	105	188	168	389
133	287	133	335	112	200	175	410
140	286	140	340	119	197	183	424
147	303	147	356	126	207	190	406
154	319	154	388	133	207	197	441
162	324	162	401	141	215	204	443
169	342	169	393	148	223	211	475
176	341	176	425	155	241	218	500
183	360	183	431	162	250	225	511
190	362	190	467	169	240	232	523
197	372	197	498	176	253		
204	386	204	511	183	262		
211	413	211	527	190	288		

Appendix Table 26 - Continued

A72		A73		A75		A76	
Age	Wt.	Age	Wt.	Age	Wt.	Age	Wt.
days	lb.	days	lb.	days	lb.	days	lb.
399	547	375	433	327	423	307	471
406	515	382	442	334	434	314	451
413	485	389	453	341	448	321	471
420	551	396	440	348	417	328	437
427	559	403	430	355	443	335	471
434	565	410	449	362	431	342	465
441	575	417	473	369	458	349	472
448	582	424	463	376	465	356	500
455	593	431	496	383	466	363	499
462	634	438	532	390	507	370	532
469	670	445	560	397	531	377	543
476	656	452	565	404	530	384	529
483	694	459	572	411	536	391	572
490	697	466	593	418	565	398	578
497	685	473	592	425	550	405	560
504	691	480	597	432	580	412	596
511	720	487	621	439	601	419	621
518	736	494	620	446	581	426	637
525	716	501	681	453	623	433	653
532	722	508	603	460	595	440	612
539	695	515	615	467	655	447	626
546	731	522	609	474	643	454	630
553	730	529	623	481	636	461	649
560	721	536	623	488	658	468	661
567	733	543	637	495	693	475	681

Appendix Table 26 - Continued

A77		A78		A79		A80	
Age	Wt.	Age	Wt.	Age	Wt.	Age	Wt.
days	lb.	days	lb.	days	lb.	days	lb.
298	439	296	457	289	360	232	409
305	432	303	456	296	358	239	428
312	460	310	470	303	374	246	445
319	422	317	432	310	352	253	430
326	457	324	460	317	363	260	455
333	451	331	454	324	389	267	489
340	466	338	491	331	396	274	508
347	465	345	498	338	394	281	497
354	496	352	509	345	407	288	525
361	503	359	545	352	442	295	555
368	540	366	569	359	440	302	580
375	547	373	564	366	454	309	580
382	551	380	604	373	467	316	589
389	556	387	597	380	481	323	600
396	600	394	602	387	500	330	615
403	571	401	619	394	505	337	624
410	597	408	645	401	546	344	654
417	612	415	639	408	539	351	621
424	627	422	636	415	533	358	672
431	580	429	631	422	526	365	681
438	594	436	623	429	575	372	655
445	577	443	637	436	556	379	652
452	592	450	660	443	567	386	656
459	635	457	645	450	574	393	691
466	680	464	662	457	609	400	711

Appendix Table 27

Comparison of Body Weight with the Ragsdale Standard - Groups 1, 2, 3, and 4.

Animal Number	Breed	Sex	Weight Age	Weight Actual	Weight Std.	Weight Age	Weight Actual	Weight Std.	Supplement
			days	lb.	lb.	days	lb.	lb.	
					Group 1				
C718	Br. Sw.	M	49	164	---	217	552	---	----
C719	Ayr.	M	21	113	95	189	426	338	----
C724	Jer.	M	35	89	82	209	404	325	----
C742	Hol.	M	35	134	132	211	527	458	----
C749	Guern.	M	77	205	132	232	523	386	----
					Group 2				
C715	Jer.	M	35	78	82	42	85	88	----
			42	85	88	182	241	285	Co
C739	Hol.	M	37	120	134	53	154	155	----
			53	154	155	227	388	489	Co
C741	Hol.	M	35	132	132	133	287	298	Co
			133	287	298	211	413	458	Co & Fe
C744	Hol.	M	14	95	108	29	119	124	----
			29	119	124	190	288	418	Co
					Group 3				
C711	Hol.	M	84	187	196	88	184	211	----
			88	184	211	158	310	353	Co & Sulfa
			158	310	353	210	410	456	Co
C725	Hol.	M	35	133	132	50	152	151	----
			50	152	151	165	317	368	Co & Sulfa
			165	317	368	350	598	722	Co
C730	Hol.	M	40	126	138	47	139	147	----
			47	139	147	61	143	166	Co
			61	143	166	163	318	363	Co & Sulfa
			163	318	363	207	397	450	Co
					Group 4				
C714	Hol.	M	49	155	150	84	206	204	----
			84	206	204	123	300	276	Sulfa
			123	300	276	224	470	483	Co
C726	Hol.	F	35	82	118	57	81	144	----
			57	81	144	182	250	359	Sulfa
			182	250	359	329	436	592	Co

Appendix Table 28

Comparison of Body Weight with the Ragsdale Standard--Groups 5 and 6

Animal Number	Breed	Sex	Age	Weight Actual	Weight Std.	Age	Weight Actual	Weight Std.	Supplement
			days	lb.	lb.	days	lb.	lb.	
				Group 5					
A73	Hol.	F	375	433	652	431	496	720	----
			431	496	720	543	637	848	----
A75	Hol.	F	327	423	589	383	466	662	----
			383	466	662	495	693	796	----
A78	Hol.	F	296	457	546	352	509	622	----
			352	509	622	464	662	763	----
A80	Hol.	F	232	409	448	288	525	535	----
			288	525	535	400	711	682	----
				Group 6					
A72	Hol.	F	399	547	681	455	593	752	----
			455	593	752	567	733	875	Co
A76	Hol.	F	307	471	562	363	499	636	----
			363	499	636	475	681	776	Co
A77	Hol.	F	298	439	549	354	496	624	----
			354	496	624	466	680	765	Co
A79	Hol.	F	289	360	536	345	407	613	----
			345	407	613	457	609	754	Co