demonstrated that GSH is involved in the inactivation of insulin *in vivo* (2–4) and *in vitro* (1), it is not clear whether the elevation of liver GSH in zinc deficient rats is responsible for the decreased insulin-like activity as reported by others (6). Additional work concerning the effect of zinc deficiency on glutathione insulin transhydrogenase activity is in progress.

Summary. Weanling male rats receiving a diet low in zinc for 2–3 weeks had a significant increase of liver nonprotein SH compounds and glutathione over those fed an adequate zinc diet. Deficiency of this trace element caused an increase in the incorporation rate of glycine-1-^{14}C into liver glutathione moiety, but it had no effect on protein synthesis.

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Acatalasemia and Hypocatalasemia in the Dog and the Duck* (32867)

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For a variety of studies, it is of interest to have available sources of blood very low in, or completely free of, catalase activity. There are now known acatalasemic or hypocatalasemic humans (1,2), guinea pigs (3), and laboratory mice (4). The low catalase members of these species are presumed to be mutants; certainly a far higher blood catalase level is the much commoner occurrence in these species.

Before these low blood catalase sources were available, biologists wanting catalase-free or catalase-low blood would generally select the duck, which had been shown in 1952 (5) to be normally low in this enzyme.

Allison *et al.* (6) suggested that dogs fall naturally into three levels of blood catalase activity: low, intermediate, and high. Unfortunately their mode of expression of catalase activity made it difficult to compare the dog blood catalase activity with that of other species. In the course of studies on the comparative heat stability of blood catalase (7), we observed that *all* dogs we tested were either acatalasemic or hypocatalasemic. We have therefore performed a series of blood catalase assays on dogs and a few on ducks, for comparative purposes. We have also done

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TABLE I. Comparison of Blood Catalase Activity of Dog with that of Other Species.[a]

Species	No. tested	Mean ± SD	Range
Dog (beagle)	83	23 ± 11	0.0– 43
Duck	3	1.4 ± 0.1	1.4– 1.5
Cs[b] (acatalasemic) mouse	10	2.6 ± 1.3	1.1– 4.8
Cs[c] (hypocatalasemic) mouse	10	27 ± 6	18 – 39
Cs[a] (normal) mouse	110	149 ± 14	105 –184
Laboratory rat	3	223 ± 15	204 –238
Guinea pig	2	176 ± 3	174 –178
Rabbit	1	325	
Man	1	455	

[a] Values are expressed as perborate units (8) of catalase activity/ml of whole blood. For a description of the Cs[a], Cs[b], and Cs[c] mouse strains, see (4).

a few tissue catalase assays, to determine whether or not the low erythrocyte levels of this enzyme reflect low tissue levels.

Materials and Methods. Dogs were almost all beagles, bred in this laboratory. A very few other strains of dogs were also treated. Two of the ducks were white pekin; one was a muscovy. Duck blood was taken from a neck vein, and the birds were killed by exsanguination. Dog blood was drawn from the cephalic vein. In those few instances where the animal was to be destroyed, and tissue catalase assays done, the dog was given an overdose of pentobarbital.

Whole blood was diluted with distilled water for lysis of the cells. Duck erythrocytes are not completely laked by this osmotic shock, and the suspension was homogenized before assay. Even so, lysis was not complete. Dog erythrocytes, like those of most mammalian species, rapidly laked upon dilution of the whole blood with 19 volumes of distilled water. Liver, heart, lung, and kidney were homogenized in appropriate volumes of cold water. Catalase assays were performed on whole blood lysate or whole tissue homogenate by the perborate method(8).

Results. Table I compares the blood catalase activity of the dog, the duck, and several other species. It will be observed that, although an appreciable range of canine blood catalase level exists, *all* dogs tested may be considered acatalasemic or hypocatalasemic. The dogs of Table I were all beagles. We have, however, also assayed the blood of one poodle, three German shorthaired pointers, and one mongrel, and they all fall well within the range of dog bloods of Table I.

Because Allison *et al.* (6) suggested that their dogs showed a genetic pattern of blood catalase indicating a low and a high level allele, with intermediate level heterozygotes, we were interested in seeing whether or not the beagles would also naturally fall into low, intermediate, and high classes. Figure 1 provides no encouragement for such a suggestion. The two sexes are combined in Fig. 1, because no significant sex difference in blood catalase level distribution exists in our dog data.

Table II indicates the level of catalase activity of several of the solid tissues of the dog and duck and compares them with the activity levels of the mutant acatalasemic and hypocatalasemic mice we have developed (4). It will be noted that neither dog nor duck is to be considered acatalatic, although the catalase activities of the duck tissues were all well below those of the normal mouse. In the four dogs whose tissues were assayed, only a partial correlation was found to exist between

TABLE II. Comparison of Some Tissue Catalase Activities of the Dog, Duck, and Mouse.

Species	No. of animals	Mean ± SD			
		Liver	Kidney	Lung	Heart
Dog (beagle)	4	921 ± 141	484 ± 46	24 ± 2	15 ± 2
Duck	3	657 ± 11	188 ± 55	6.4 ± 1.1	13 ± 3
Cs[b] (acatalasemic) mouse	10	311 ± 54	30 ± 5	11 ± 2	6.4 ± 1.3
Cs[c] (hypocatalasemic) mouse	10	906 ± 90	284 ± 96	22 ± 4	8.7 ± 1.2
Cs[a] (normal) mouse	10	1274 ± 132	428 ± 123	80 ± 15	25 ± 4

Values are expressed as perborate units (8) of catalase activity/gm of tissue.

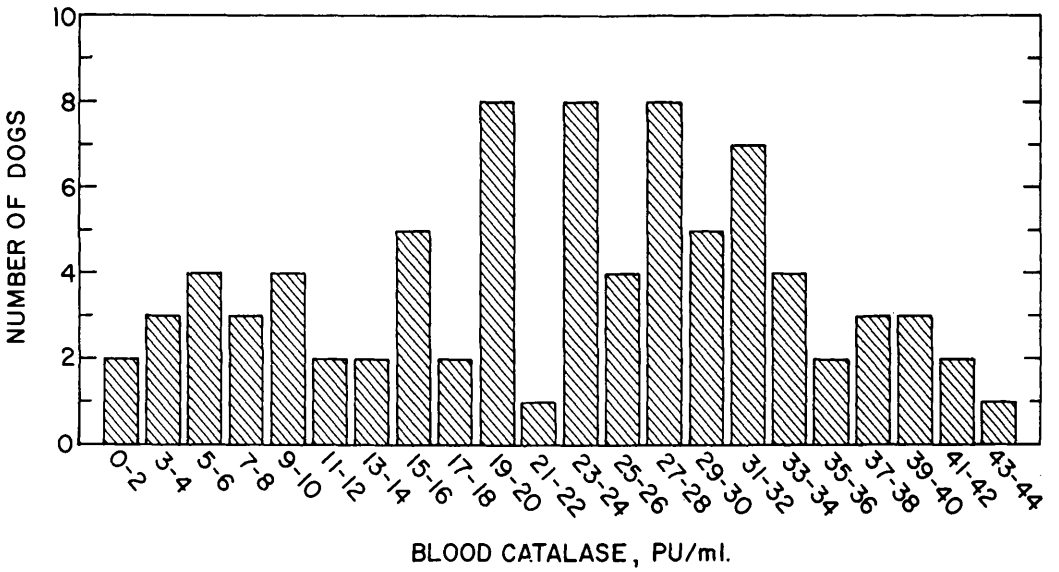

FIG. 1. Distribution of blood catalase activity in a group of beagle dogs.

the order of activity of the bloods and of the other tissues. The two dogs with the lowest blood catalase also had the lowest liver and kidney catalases, but the differences observed were only of the order of 10-20%, and this cannot be considered significant, particularly when only four animals are involved.

Discussion. The data on this laboratory's dog colony are not in accord with the suggestions of Allison *et al.* (6) that their dogs fall naturally into low, intermediate, or high categories of blood catalase activity, and that this results from the existence of two catalase alleles in the dogs they examined. Although we could divide Fig. 1 into three groups, it would be a totally arbitrary decision; overlap occurs throughout. Because of this difficulty of categorizing, it is not possible to calculate the Mendelian ratios of catalase activity in those cases where blood catalase has been assayed in both progeny and parents. We have assayed the blood of 10 males and 13 females who were the parents of 36 assayed dogs. There seems to be a suggestion that progeny catalase tends to be of the same order of magnitude as parental blood catalase. This is true, however, even in animals of intermediate blood catalase levels; if these dogs are considered to be heterozygotes, they would be expected to have not only progeny of intermediate activity, but also high and low. However, from dogs of intermediate activity, we have observed only progeny of intermediate activity. Our tentative conclusion is therefore that our dog colony does not include two alleles for blood catalase. Some confirmation of this conclusion may be derived from the fact that tissue catalase activity in dogs does not correlate well with blood catalase levels, as is the case with acatalasemic and hypocatalasemic mutant mice (9).

The dog has certain obvious advantages as a source of acatalasemic blood, over other acatalasemic species. It is more readily available in most laboratories than the acatalasemic human, guinea pig, or mouse, and it can provide far larger quantities of blood than the latter. It is also somewhat more commonly available than the duck and has the further advantage that dog erythrocytes lake far more readily than do those of the duck. The sole disadvantage appears to be that, while all dog bloods are low in catalase, not all are of the extreme lowness of duck blood, so that if truly acatalasemic blood is required, it may be necessary to test a number of dogs.

It might be noted that the duck is not the only fowl with low blood catalase. Although we have not surveyed fowl to any great extent, we have examined some rooster bloods (10) and found the catalase levels to be approximately 50 perborate units/ml, i.e., hypo-

catalasemic, and not essentially acatalasemic, as the duck. The same difficulty of lysis of rooster erythrocytes was observed as is referred to above in connection with duck blood.

Summary. The dog is shown to have very low blood catalase activity levels, ranging from an immeasurably low blood catalase to a level which in other species would be considered hypocatalasemic. Although some tissue levels of catalase activity are lower than, say, those of the normal mouse, the dog and the duck are not acatalatic.

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The Immune Response of Bursaless Birds as Influenced by Antibiotics and Age*† (32868)

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Bursectomy of young chicks (1,2) or chemical bursectomy during embryonic development (3,4) result in an impairment of the immune response to a variety of antigens. The chemically bursectomized chicks develop a wasting syndrome (5,6) not unlike that observed in thymectomized mice (7). Immunological incompetence in thymectomized mice appears to be a direct result of the thymus since wasting did not occur in thymectomized-germ free mice but the homograft response was impaired in these mice (8). The objective of this experiment was to improve the growth rate and reduce mortality of chemically bursectomized chicks with antibiotics and determine if there would be an accompanying improvement in the immune response of these birds. A portion of this paper has been presented in a preliminary report (9).

Materials and Methods. All chicks were from a strain of New Hampshire, an American breed, developed by our departmental geneticist, Professor L. J. Dreesen. The birds were reared in battery brooders each consisting of 5 vertical decks with a wire mesh floor or in floor pens supplied with wood shavings and infrared brooding lamps. Chemical bursectomy was attained by dipping eggs, incubated for 3 days, into ethyl alcohol containing more than 1.28 gm/100 ml testosterone propionate (10). The penicillin (P), 50 gm/ton, oxytetracyline (O), 200 gm/ton, and tylosin (T), 200 gm/ton, were combined and added to the basal ration of day-old birds reared in floor pens while penicillin, 100 gm/ton, and tylosin, 300 gm/ton, were fed separately to battery-reared birds. The composition of the basal diet has been described (11). The chemically bursectomized birds reared in floor pens were fed basal plus POT or basal beginning at day-old. Each treatment was replicated three times. A total of 93 chicks were started in

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