histidine,[6,7] tyrosine and phenylalanine,[7] tryptophane,[6,8] methionine plus cystine,[9] threonine,[7] leucine,[7] isoleucine,[7,10] valine,[7] and glycine,[7,11] are, evidently, approximately met by the quantities of these amino acids in sesame seed protein when it is fed at a level of 20% of the diet. In conjunction with other proteins which are relatively richer in lysine (*i.e.*, soybean meal, fish meal) sesame seed meal is capable of supporting optimal chick growth rates.

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Effect of Cadmium and Fluorine on the Rat Dentition.

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Wilson *et al.*[1] reported that the addition of cadmium to the diet of rats caused a loss of tooth pigmentation. According to them, the condition resembled the mottled enamel that results from ingestion of excessive amounts of fluorine. Although the latter relationship has been established, the nature of the mechanism by which the pigmentary changes are produced is not clearly understood. Our interest was aroused by the apparently isolated observation of the same authors that cadmium ingestion also produces a marked fall in blood hemoglobin values. Since hemoglobin is an iron-containing protein and since there is evidence that rat incisor enamel pigments are of a similar structure,[2] it seemed plausible that both observations might be related to the ability of cadmium to interfere with normal iron metabolism. Likewise, it seemed possible that the pigmentary changes in fluorosis could be explained on a similar basis. Partial confirmation of this belief would be enhanced by the demonstration of a depression of blood hemoglobin following the ingestion of fluorine.

At the same time it appeared logical to test the ability of cadmium to inhibit experimental rat caries, especially since it has been shown that fluorine can effect such a change. Cadmium in addition to producing mottled enamel also resembles fluorine in its ability to inhibit various enzyme systems. Included among these are those concerned with lactic acid fermentation,[3] a process believed by some to be of considerable importance in the etiology of dental caries.

In addition it seemed opportune to make certain supplementary observations as to the effect of cadmium on the general appearance, body weight, and incisor eruption rate of the rat.

Methods. At weaning 4 groups of rats each containing 18 littermates were placed on a modified Hoppert-Webber-Canniff diet[4] (Comet brand rice was substituted for the coarse corn component).

Group I served as a control. Groups II, III, and IV were maintained on the same diet but received 50 p.p.m. of cadmium ($CdCl_2$) in the food, 50 p.p.m. of cadmium ($CdCl_2$) in

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TABLE I.
Hemoglobin of Rats Receiving Cd and F.
(Average grams per 100 cc blood.)

Determination	Group I Control	Group II 50 p.p.m. Cd in diet	Group III 50 p.p.m. Cd in H_2O	Group IV 50 p.p.m. F in H_2O
1st (30th day)	15.8 (18)*	14.3 (18)	11.6 (18)	15.2 (18)
2nd (44th day)	15.8 (18)	13.3 (18)	10.8 (18)	14.7 (18)
3rd (65th day)	15.6 (18)	12.7 (17)	8.7 (18)	11.8 (18)
4th (86th day)	15.8 (5)	12.6 (16)	7.7 (7)	11.1 (17)

* Numbers in parentheses indicate animals from which average was obtained.

TABLE II.
Effect of Dietary Cd and F on Experimental Rat Caries.

	% of rats with caries	Avg No. of carious teeth	Avg No. of areas affected by caries	Avg total caries score*
Group I Control diet	100	3.5	6.2	12.1
Group II Control diet + 50 p.p.m. Cd in food	100	3.2	6.2	13.0
Group III Control diet + 50 p.p.m. Cd in water	100	5.3	13.8	34.9
Group IV Control diet + 50 p.p.m. F in water	39	.7	1.7	4.4

* For a detailed description of the calculation and significance of the total caries score see Dale, P., and Powell, V. J., *J. Dent. Research*, 1943, **22**, 33.

the water, and 50 p.p.m. of fluorine (NaF) in the water, respectively. The incisor teeth were examined periodically for evidence of mottling. After the animals had been on the diet for 30 days hemoglobin values (Sahli) were determined on blood samples taken from the tail vein. The procedure was repeated on the following 14th, 35th, and 56th day. Also beginning on the 30th day the upper and lower incisor teeth were notched at the gingivolabial margin and the eruption rate measured at suitable intervals over a period of 7 weeks. The weight of the animals was recorded weekly. At the end of 150 days the animals were sacrificed and the dentition examined microscopically for evidences of dental caries.

Results. The observation of Wilson *et al.* that cadmium produced a loss of rat incisor enamel pigment was confirmed. Although the pigmentary changes induced by dietary fluorine were characterized by alternate pigmented and non-pigmented striations, the addition of cadmium to the diet resulted in an overall bleaching devoid of striations. The finding that cadmium produced a significant drop in blood hemoglobin has also been substantiated. A similar change has been observed in rats receiving fluorine. The most marked decrease was evident in Group III animals. The results may be seen in Table I.

The effect of cadmium and fluorine on caries susceptibility is presented in Table II. It can be seen that unlike fluorine, cadmium did not inhibit experimental rat caries. If anything, 50 p.p.m. of cadmium in the drinking water apparently increased caries susceptibility.

Rats in Groups I, II, and IV showed a normal and comparable gain in weight throughout the experimental period. After 8 weeks on the diet, the average weight of these groups ranged between 162 and 172 g. After a comparable period Group III animals weighed on an average of 127 g and the weight differences became more marked with increased age. The incisor eruption rates were comparable in all groups, ranging from 2.1 to 2.2 mm per week for the upper incisors and 3.1 to 3.2 mm for the lower incisors. Group III rats showed lessened physical activity, had dry and scaly skin and tails, and

thinning of the hair especially in the posterior portion of the dorsum.

Discussion. It is of interest that both cadmium and fluorine caused a loss of incisor enamel pigmentation and a drop in blood hemoglobin indicating in each instance an effect on normal iron metabolism. Although the exact mechanism of the interference is in need of further clarification, the ability of cadmium to precipitate iron-containing proteins has been noted[5] and it has been observed that the iron content of fluorosed enamel is markedly diminished.[6]

The failure of dietary cadmium to limit experimental caries in the same manner as fluorine suggests that the caries limiting property of the latter is not related to the inhibition of lactic acid fermentation by oral organisms. Likewise, it does not appear to be dependent on an inhibitory action on bone phosphatase since it has been shown that both cadmium[1] and fluorine[7] limit the activity of this enzyme.

Summary. The ability of cadmium to diminish the degree of pigmentation of rat incisor enamel and to effect a reduction in blood hemoglobin has been confirmed. The ability of fluorine to bring about a comparable reduction in blood hemoglobin has also been observed. It is suggested that the pigmentary changes in the enamel and the fall in hemoglobin that results in the ingestion of both cadmium and fluorine is related to the ability of these elements to interact with iron-containing proteins. Unlike fluorine, cadmium in the concentration studied is ineffective in reducing experimental rat caries.

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Glycogen in Alloxan-Treated Rats.

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Fisher and Lackey[1] found the glycogen content of the heart of the dog to be increased following pancreatectomy. Evans *et al.* found a similar increase in cardiac glycogen in 3 depancreatized cats.[2] Since, in these experiments, both exocrine and endocrine secretions of the pancreas were eliminated, it seemed desirable to study the glycogen changes in the heart when the endocrine secretion alone is disturbed. The demonstration by Dunn and McLetchie[3] and Gomori and Goldner[4] that diabetes mellitus can be produced in rats by a single injection of alloxan, and that this chemical destroys specifically the islet tissue of the pancreas, makes it possible to carry out such a study. Also, alloxan makes it possible to study diabetes mellitus in the rat, an animal in which surgical removal of the pancreas is very difficult.

Method and Results. The glycogen content of liver, heart, and skeletal muscle was determined in 20 control animals (Table I) and 19 animals with alloxan diabetes (Table II). The animals used were full grown rats of approximately the same weight. Three rats in each series were females and the remainder were males. Each animal was kept in a separate metabolism cage with ample food and water.

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4 Gomori, G., and Goldner, M. G., PROC. SOC. EXP. BIOL. AND MED., 1943, **54**, 287.