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Distribution of Ingested Phosphorus in Bone and Teeth of a Dog, Shown by Radioactive Isotope.*

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The penetration of ingested phosphorus into the enamel of cat's teeth has recently been reported by Hevesy and Armstrong.[1] These workers found that the enamel contained up to 10% of the radioactive phosphorus present in the dentine. Armstrong (personal communication) indicated that an important part of the radioactive phosphorus in the enamel might be adsorbed on the outer surface. One of us (M. L. M.) has recently shown that enamel can adsorb phosphates.[2] Before the report of Hevesy and Armstrong appeared, we had attempted to follow the distribution of P*† in a dog. The day before any P* was administered, the dog was anesthetized with nembutal. Grooves exposing or penetrating the dentine were cut with a small dental burr in each lower cuspid and in the upper right first molar to offer local stimuli for calcification. The P* (10 microcuries) was prepared in a solution containing 0.09 g of total phosphorus as Na_2HPO_4 and was given by stomach tube to an 8.8 kg dog in 4 approximately equal doses 2 to 6 hours apart on 2 successive days. The dog was sacrificed by bleeding under anesthesia 12 days after the last dose of P*. Bone samples were taken, the teeth were removed, enamel and dentine separated, and the organic matter extracted. The P* content of the various samples was determined using the Geiger-Müller scale-of-four counter. All counts on tissue samples were calculated to a 100% basis from the decay curve of a P* standard solution. The counts were corrected for total concentrations of calcium phosphate dissolved in each sample.

In Table I are given data for the P* distribution in the various bones examined. The percentage of the P* dose found in 1 g of the various tissues ranges from 0.002 in the diaphysis of the ulna to 0.10 in the spongy portion of the diaphyses of the humerus. In a

* This work was supported in part by grants from the Carnegie Corporation of New York and the Rockefeller Foundation.

1 Hevesy, G., and Armstrong, W. D., *Sci. Proc. A. Soc. Biol. Chem.*, 1940, xliv.

2 Manly, M. F., and Levy, S., *J. Am. Chem. Soc.*, 1939, **61**, 2588.

† P* = radioactive phosphorus.

TABLE I.
Distribution of Marked Phosphorus in Various Bones.

Tissue	Portion	Sample wt, g	% dose per g tissue
Ulna	diaphysis	.5595	.0024
Radius	"	1.0142	.0031
	epiphysis	.6248	.0059
	dense	.1722	.0021
	spongy	.0630	.0075
Humerus	dense diaphysis	.5945	.0039
	spongy "	.0906	.10
	" "	.1969	.075
Scapula	whole bone	.3331	.0121
	dense	.3684	.0086
	spongy	.0953	.057

TABLE II.
Distribution of Marked Phosphorus in Dentine.

Tooth		Wt of sample, g	% dose per g inorganic
Incisor	UL 2	.1906	.0026
"	UL 3	.3543	.0017
"	LR 3	.1529	.0026
Cuspid	LL	.1378	.0024
	LL	.7949	.0033
	UL	.3216	.0029
	UL	1.1926	.0026
	LR	1.2024	.0026
Bicuspid	LR 2	.0466	.0034
	LL 2	.1279	.0027
	LR 3	.2207	.0035
	UL 3	.2795	.0032
	LL 3	.2342	.0039
	LL 4	.2919	.0015
Molar	UL 1	1.1543	.0029
	UL 1	.5012	.0026
	LR 1	1.4079	.0024
	LL 1	1.4393	.0024
	UL 2	.6533	.0027
	LR 2	.1607	.0033
	LL 2	.1871	.0029
	LR 3	.1940	.0034
	UL 4	.1833	.0024

given bone, the dense portion has from 1/3 to 1/5 the P* content of the spongy portion.

In Table II are given the data on the P* content of the dentine samples. The percentage of the dose of P* found per gram of inorganic matter varies from 0.0015 to 0.0039. The principal characteristic of the distribution is the constancy from tooth to tooth; there is no tendency for incisor dentine to contain more or less P* than molar dentine. The amount of P* in the dentine is approximately the same as that found in the dense diaphyseal bone. This is in accord with the concept that dentinal mineral metabolism is similar

to that of cortical bone but differs in degree of activity.[3] The 2 scarred teeth were split in such a way as to isolate the part containing the grooves and estimations were made both on this and the remainder of the tooth. There was no difference between the P* contents of the scarred and the unscarred parts. Within the 12-day experimental period, there was evidently no increase of phosphate turnover or deposition in response to the stimulus of scarring.

Several attempts were made to find evidence of the presence of P* in the enamel. In no case was a count obtained which was more than 0.2 or 0.3 counts per minute above the background count. This difference is either insignificant, showing no P* to be present, or indicates that the enamel contained less than 0.001% of the original P* dose. The disagreement with the findings of Hevesy and Armstrong may be due to the larger doses used by these workers. In a private communication, Armstrong indicated that with similar sized doses of P* he had found questionable evidence of P* in cat enamel.

Summary. The uptake of radioactive phosphorus was greater in spongy than in dense diaphyseal bone when salts of the element were administered orally to a dog. In dentine the amounts of radioactive phosphorus were constant for the various teeth and of the same order as that present in dense diaphyseal bone. No more than traces of P* were found in the enamel.

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Influence of Androgen Therapy on Growth Rate of Hypogonadal Adolescent Boys.*

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The fact that the sex hormones play a rôle in the control of linear growth of the adolescent human has been previously suggested.[1] The exact relationship of the androgen-estrogen levels or the balance

3 Manly, R. S., Hodge, H. C., and Manly, M. L., *J. Biol. Chem.*, 1940, **134**, 293.

* We are indebted to the Ciba Pharmaceutical Products Company, Lafayette Park, Summit, New Jersey, for the testosterone propionate used in the treatment of these cases.

† General Education Board Fellow, 1939. Barbara Henry Research Fellow, 1939-40.

1 Webster, B., *J. Pediatrics*, 1939, **14**, 684.