proximal region of the gland (Fig. 2). The mammary glands of 12 out of 14 injected rats showed alveolar growth.

Conclusions. The injection of 300 γ of testosterone propionate daily for 15 days into spayed hypophysectomized rats failed to induce mammary growth. Lobule-alveolar growth of the mammary glands was induced in spayed hypophysectomized rats by the administration of 300 γ of testosterone propionate plus 0.5 cc of growth hormone daily for 15 days. Therefore some pituitary "mammogen" is essential for lobule-alveolar development of the rat mammary gland when stimulated by testosterone.

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Effect of Magnesium Deficiency on Dentin Apposition and Eruption in Incisor of Rat.

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Seventeen white rats (68-138 days of age) were fed the Kruse-Orent-McCollum diet,[1] which is deficient in magnesium (1.8 parts per million), for a period of 22-85 days. Eleven littermate controls were placed on the deficient diet to which magnesium was added in the form of $MgSO_4 7H_2O$. A group of 7 rats which were fed a modified form of this diet (the salt mixture was reduced one-half in amount) showed similar but less advanced effects.

Radiographic Findings. In the incisor the earliest change seen after 22-40 days on the deficient diet is a widening of the periodontal membrane, an indistinct outline of the *lamina dura* and a disturbed contour of the enamel surface. These changes become more marked with longer survival periods (50-76 days), when the pulp is shifted labially, with concomitant thinning of the dentin and folding of the basal portion. The pulp also shows radiopaque longitudinal streaks. The angle of the incisal bevel is increased from the normal of 45° to as high as 75°.

In the advanced stages the molars show a widened periodontal membrane and a rarefied appearance of the alveolar bone, so that the molar roots stand out clearly by contrast.

Rate of Eruption. In the deficient animals, the first 2 weeks show a

1 Kruse, H. D., Orent, E. R., and McCollum, E. V., *J. Biol. Chem.*, 1932, **96**, 519.

TABLE I.
Comparison of Mean Rates of Eruption During a Period of 12 Weeks of the Incisors of Normal Rats and Rats on Magnesium Deficiency.

Group	No. of individuals	No. of measurements	Mean weekly eruption rate, mm	
			Upper Inc.	Lower Inc.
Normal control	6	140	2.3	3.1
Rats placed on magnesium deficiency	7	140	0.9	1.3

decrease in eruption rate, after which a fairly constant low rate (about one-third the normal) is maintained (Table I).

Fig. 1-C contrasts the total increments of the eruption rates of control animal 18.26 and experimental animal 17.19, and shows the typical trend of the eruption rates.

Rate of Formation. Ground-section measurements of the rate of dentin apposition in the incisor by means of vital staining with alizarine Red S show that the rate of apposition is progressively decreased as the dietary deficiency is prolonged (Table II). The enamel-covered dentin is markedly retarded almost immediately, while the retarding effect is more gradual on the lingual dentin.

Apposition of dentin may cease for a time in any locality, and begin again later. This may be seen in sections where 2 alizarine lines join, indicating a lack of growth between succeeding injections (Fig. 1-A and D.2).

The difference in the dentin response is also seen in the total widths of the labial and lingual portions. These are approximately the same in the normal animal (Fig. 1-B and D.1). In the experimental animal the labial width is one-third or one-half that of the lingual width, and the pulpal outline, therefore, is characteristically distorted (Fig. 1-D.2). The response is in contrast to that found in

TABLE II.
Average Daily Rate of Apposition of Dentin of Incisors Based on Experiments with 10 Rats Placed on a Diet Deficient in Magnesium, and with 8 Controls.

Age range in days	Experimental			Control		
	No. of animals	Avg rate of apposition in μ		No. of animals	Avg rate of apposition in μ	
		Labial	Lingual		Labial	Lingual
45-60	6	8.2	14.3	2	19.2	18.3
60-75	10	6.0	11.4	3	16.2	17.8
75-90	7	3.7	8.7	5	15.7	16.7
90-105	4	2.6	4.5	6	15.7	14.2
105-120	2	2.7	4.2	5	16.3	14.3
120-140	1	1.2	1.0	3	16.3	13.4

Average age of animals at beginning of experiment was 47 days.

vitamin A deficiency where the enamel-covered dentin is accelerated and the cementum-covered dentin is decelerated in the rate of apposition[2] (Fig. 1-D.3). The difference between the labial and lingual portions in magnesium and in vitamin A-deficiency is sharply demarcated at the level of the cemento-enamel junction.

The rate of formation was also slowed in the dentin of the molars. In the alveolar bone, the rate of apposition was one-third to one-half the normal amount.

The food intake of the experimental animals is approximately the same in quantity as that of the control group and the animals gained in weight but at a slower rate. The striking retardation in rate of

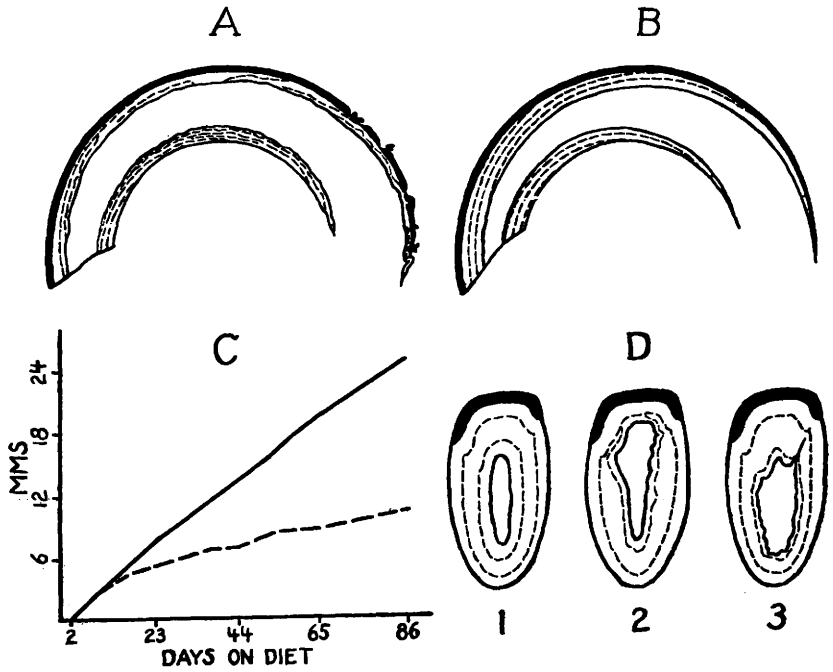

FIG. 1.

A. Diagrammatic representation of the irregular incremental pattern of the incisor of a rat placed on a diet deficient in magnesium and vitally stained with alizarine Red S. This figure was prepared by projecting and tracing the outline and alizarine lines (broken lines) of the incisor of rat 19.32.

B. Diagrammatic representation of the regular incremental pattern of control rat 18.26.

C. Graph showing total increments of eruption of upper incisors of control rat 18.26 (solid line) and magnesium-deficient rat 17.19 (broken line).

D. Diagrammatic representation of dentin growth in transverse section of the upper rat incisor as indicated by alizarine injections given 10 or 14 days apart in (1) normal; (2) magnesium deficiency; (3) vitamin A deficiency.

2 Schour, I., Smith, M. C., and Hoffman, M. M., PROC. SOC. EXP. BIOL. AND MED., 1938, **39**, 447.

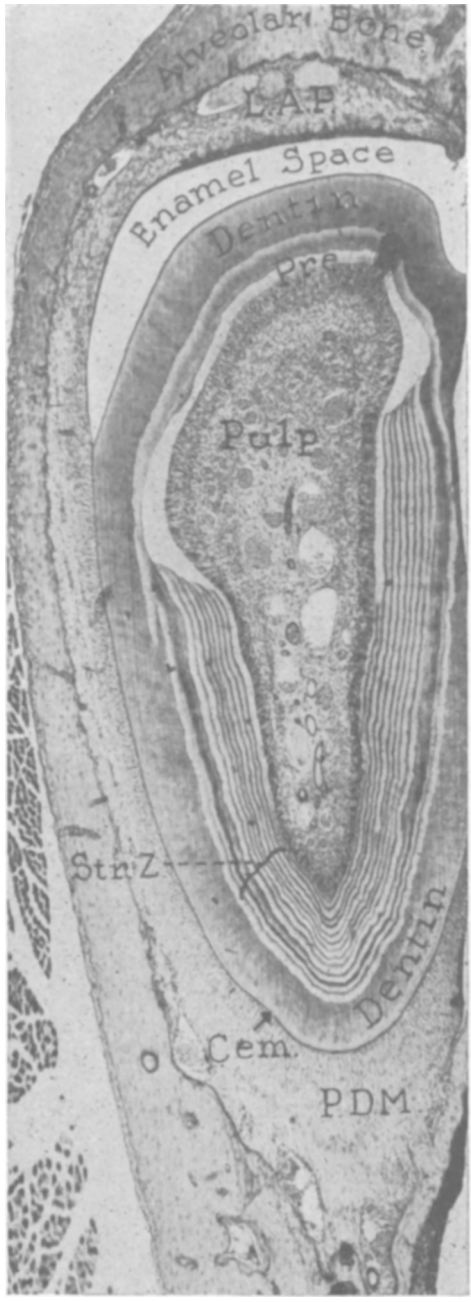

FIG. 2.

Photomicrograph of a transverse section of a lower incisor of a rat 109 days of age that was placed on a magnesium-deficient diet during the last 41 days of life. (×50.) Cem., cementum; L.A.P., labial alveolar periosteum; P.D.M., periodontal membrane; Pre., predentin; Str.Z., zone of prominent stratification.

dentin apposition and of tooth eruption is, therefore, not secondary to the relatively mild retardation in body weight. That the relationship between body weight and tooth development is not a primary one is also shown by the fact that normal animals subjected to insufficient food intake and retarded gain in body weight do not show significant effects upon tooth development.

Calcification. There is a characteristic disturbance of calcification rhythm in magnesium deficiency (Fig. 2). Irving[3] has reported this to be of a 2- or 3-day rhythm on the basis of measurements and comparison with the normal 16 μ daily rhythm. It appears that since apposition is slowed the 16 μ standard cannot be used. The difference between the calcification patterns of the labial and lingual dentin is probably linked with the difference in rate of apposition.

Enamel hypoplasia is not specific for Mg deficiency but is of a severe type (Becks and Furuta[4]).

Summary and Conclusions. In magnesium deficiency the rate of eruption of the incisor is reduced to approximately one-third the normal. The outstanding effect is on dentin apposition which is progressively decelerated, the enamel-covered dentin being affected more acutely than the cementum-covered portion. Temporary local cessations of growth may occur. The formation of alveolar bone is also decelerated to one-half or less of the normal rate and the periodontal membrane is abnormally wide. The dentin of the rat incisor acts not only as a kymograph of calcium metabolism (Fig. 2), but also as a growth kymograph (Fig. 1, D.2).

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Protyrosinase and Polar-Nonpolar Cations and Anions.*

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The sodium alkyl sulfates, which activate protyrosinase,[1] yield polar-nonpolar anions, (RSO_4^-). Alkylamine hydrochlorides, however, give polar-nonpolar cations ($RNH_3.H^+$), and do not activate

[3] Irving, J. T., *J. Physiol.*, 1940, **99**, 8.

[4] Becks, H., and Furuta, W. J., *J. A. D. A.*, 1941, **28**, 1083.

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[1] Allen, T. H., and Bodine, J. H., *Proc. Nat. Acad. Sc.*, 1941, **27**, 269.