

### Vitamin A Requirements of Growing Puppies.

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While observations on vitamin A deficiency in the dog have been reported by several investigators,<sup>1-4</sup> no attempt to determine the dog's minimum requirement of vitamin A has appeared in the literature. This report deals with such a study.

The synthetic vitamin A-free milk previously described<sup>5</sup> was used in these experiments. In that report<sup>5</sup> illustrations are given of xerophthalmia produced with this synthetic milk and cured by the addition of Carotene to this diet.

In this group of puppies herein reported, the curative method was used. All the puppies used were started on the vitamin A-free ration at weaning, or at most, 1 or 2 weeks later. It has been found highly important to rid the animals of any intestinal parasites at the beginning of the experiment. All the animals were devocalized under deep anesthesia. The total number of puppies used was 31.

The first curative levels used were based on the curative dose per 100 gm. of body weight of the albino rat. The negative results obtained with these levels resulted in the loss of a large number of the puppies. With considerably higher levels, a growth response and improvement in the condition of the animals were obtained.

The results of various levels in the largest litter are given in the chart. The minimum curative dose which effected definite increase of weight was 20 U.S.P. units per 100 gm. of body weight per day. The weight used for these figures is the weight at the beginning of the curative dose. The maximum curative dose used in these experiments was 70 U.S.P. units per 100 gm. of body weight per day.

While the daily minimum curative dose seems high in comparison with the rat, no blue units were found in any of the livers of the test animals killed at the end of the experiment. Even the control getting 7,000 U.S.P. units daily from the beginning shows a very low

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<sup>1</sup> Steenbock, H., Nelson, E. M., and Hart, E. B., *Am. J. Physiol.*, 1921, **58**, 14.

<sup>2</sup> Ralli, Elaine P., Pariente, Arthur, Flaum, Gerald, and Waterhouse, Alice, *Am. J. Physiol.*, 1933, **103**, 2.

<sup>3</sup> Stimson, A. M., and Hedley, O. F., *U. S. Public Health Reports*, 1933, **48**, 17, 445.

<sup>4</sup> Olcott, H. S., *PROC. SOC. EXP. BIOL. AND MED.*, 1933, **30**, 767.

<sup>5</sup> Frohring, W. O., *PROC. SOC. EXP. BIOL. AND MED.*, 1935, **32**, 1021.

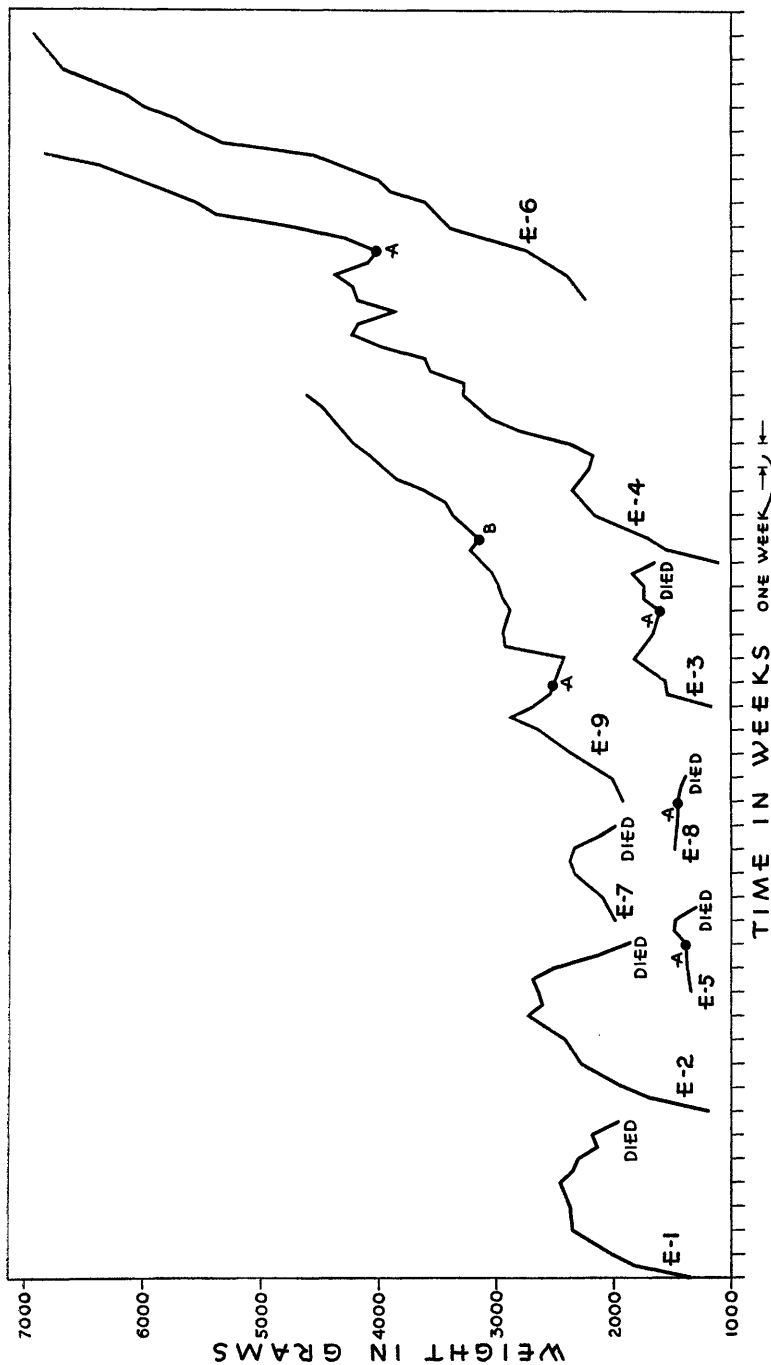


Fig. 1.

E-5 was given 210 U.S.P. units per day, starting at "A." E-8 was given 280 U.S.P. units per day, starting at "A." E-3 was given 420 U.S.P. units per day, starting at "A." E-9 was given 700 U.S.P. units per day, starting at "A." and 1400 U.S.P. units per day, starting at "B." E-4 was given 2800 U.S.P. units per day, starting at "A." E-6 was a control and was given 6500 U.S.P. units per day from the beginning to the end of the experiment. Carotene, as Pro-Vitamin A in cottonseed oil, was used as a source of vitamin A activity in all of the above animals.

reserve of 2 blue units per gram of liver. On the basis of the average daily weight and the total number of units of vitamin A given during the test period, it averages 114 U.S.P. units per 100 gm. of body weight per day.

Loss of appetite was one of the first signs of vitamin A depletion. Eye infections appeared in the animals given sub-minimum doses. A peculiar divergent strabismus was noted in several of the depleted animals which was definitely improved but not completely cured by the minimum amount of vitamin A that permitted resumption of growth. Ataxia was noted in one animal. Nervous running around the cage in circles appeared in some of the depleted animals. This was definitely reduced when sufficient vitamin A for growth was given. This was not cured by giving additional vitamin B complex in the form of brewers' yeast. Autopsy showed no evidence of otitis media or brain lesions. Skin lesions and corneal opacities appeared in a few of the animals. Dr. C. C. Higgins of The Cleveland Clinic autopsied one of the animals that had been depleted and then given a curative dose sufficient to produce a growth response. A calculus was found composed of calcium and magnesium phosphate with traces of calcium-carbonate and no oxalates or urates.

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#### An Attempt to Formulate a Quantitative Theory of Membrane Permeability.

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The fundamental theories of electrolyte diffusion (Nernst,<sup>1</sup> Planck<sup>2</sup>) take into account the electrostatic forces that cooperate with the "osmotic" forces to cause the migration of ions. In these theories, however, no assumption has to be made as to the origin of the charge on the particles in the solution. Accordingly, we may expect that their predictions regarding ionic diffusion may be extended to include other cases of diffusion, where other charged elements are present, regardless of the constitution, shape, etc., of these elements.

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\* Rockefeller Foundation Fellow.

<sup>1</sup> Nernst, W., *Z. physiol. Chem.*, 1888, **2**, 617; 1889, **4**, 154.

<sup>2</sup> Planck, M., *Wied. Ann.*, 1890, **40**, 561.