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Vitamin A in Relation to Growth and to Subsequent Susceptibility to Infection.*

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Previous investigations have repeatedly shown that graded responses in rate of growth may be obtained from the feeding of quantitatively graded allowances of either vitamin A or vitamin B, in each case as supplement to a basal diet adequate in all other respects. And in the case of vitamin B it has been shown, first by Osborne and Mendel[1] and later in a different way by Sherman and MacArthur,[2] that the larger the experimental animal the greater the amount of vitamin needed to maintain a given rate of growth, or the less the rate of growth resulting from the feeding of a fixed limited allowance of the vitamin. This is now found to be true of vitamin A also, larger experimental animals, of a given age and sex, growing more slowly upon a fixed allowance of this vitamin, the allowance in all of these cases being less than would have sufficed to support a fully normal rate of growth.

The bearing of this finding upon the accuracy of the quantitative determination of vitamin A by means of the feeding method is being discussed elsewhere. The purpose of the present communication is rather to invite consideration of the bearing of these and some related observations upon the nutritional rôle of vitamin A in relation to growth and health, with special reference to the importance of this factor in the food of children.

Thus the facts now demonstrated upon experimental animals (albino rats) that the vitamin A requirement increases both with size of body and with rate of growth will mean in the feeding of children that the large child needs a liberal allowance of this vitamin because of his size and the small child needs a liberal allowance to induce and support a more rapid rate of growth.

Our experiments have also shown that the level of intake of vitamin A (and perhaps certain other of the chemical factors in nutrition) during early life, may markedly influence subsequent susceptibility to infection. The characteristic susceptibility to infec-

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[1] Osborne, T. B., and Mendel, L. B., *J. Biol. Chem.*, 1922, liv, 739.

[2] Sherman, H. C., and MacArthur, E. H., *J. Biol. Chem.*, 1927, lxxiv, 107.

tions which develops in animals suffering from lack of vitamin A is well known. We now find, further, that this influence of the level of intake upon the incidence of infection may be pronounced and long continued even when the differences of diet are no greater than may readily occur within the range of ordinary normal or adequate nutrition.

Young rats were taken, when 4 weeks of age, from families belonging to the same strain and which had lived under conditions identical in all respects except as to diet, 38 animals coming from Diet A (a mixture of one-sixth dried whole milk and five-sixths ground whole wheat) and 37 animals from Diet B composed of the same food materials but with a larger proportion of milk (one-third of the dry weight instead of one-sixth). All were alike placed upon vitamin-A-free food for periods of about 1 month, *i. e.*, until in each case the surplus store of this vitamin in the body was depleted, and then received during a further test period of 8 weeks the same limited allowance of vitamin-A-containing food. Autopsies at the end of this test period showed infections established in 75% of the animals which in early life had received Diet A and in only 25% of those which had during the same early period received Diet B with its larger proportion of milk. Taking account of the relative lengths of the rat and the human life cycle, and of the similarity of nutrition in the 2 species, this is an indication of the differences of incidence of infection to be expected among children of around 10 and 12 years, resulting from differences in the way they were fed before they were 3 years old.

In terms of the chief chemical factors involved, the better diet here used was richer not only in vitamin A but also in vitamin G, in calcium, and in certain of the nutritionally important amino acids. It is hoped that future papers from this laboratory may more fully differentiate the rôles of these several chemical factors.

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