pendence of the inactivation curves of the virus as described in this paper to that of urease (Kubowitz and Haas[6]) and of pepsin (Gates[3]). Conclusions are, however, premature as long as we have no information (*a*) respecting the wave-length dependence of inactivation of proteins in general at the shorter wave-lengths, as well as (*b*) more information regarding the destruction spectrum of the virus of typical tobacco mosaic at wave-lengths below λ 2250 Å.

Summary.—The destruction spectrum of a highly purified suspension of the virus of typical tobacco mosaic as compared with the destruction spectrum of *Es. coli* in the same suspension is described for λ 2250 Å to λ 3000 Å. It has been found that: (*a*) at λ 2250 Å the amount of energy which is necessary to destroy 50% of the virus in 1 cc. is only one-fifth the amount required at 2650 Å, whereas (*b*) the energy necessary to inactivate bacteria is greater at λ 2250 Å than at 2650 Å.

This investigation has been carried out under the joint auspices (*a*) of the Committee on Radiation, Division of Biology and Agriculture, NATIONAL RESEARCH COUNCIL and (*b*) of the Graduate Committee of the University of Wisconsin and the Wisconsin Alumni Research Foundation. The inoculations were made chiefly by Dean F. McAlister and Tildon Easley, research assistants in virus investigations.

* Since this work was completed Stanley (*Science*, **81**, 1935) has reported the crystallization of the virus of typical tobacco mosaic, and he characterizes the virus as a protein.

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CALCIUM AS A FACTOR IN THE NUTRITIONAL IMPROVEMENT OF HEALTH

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Investigations extending through successive generations of laboratory animals, with natural foods as the experimental variables, have shown[1-3] that a food supply which constitutes a permanently adequate dietary may still be capable of improvement by more scientific adjustment of the quantitative proportions in which the articles of food are consumed.

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In these experiments, in which growth was well within the boundaries of the normal, the same nutritional improvement of an already adequate diet has induced both a more rapid growth with somewhat earlier maturity and higher adult vitality with longer life. The growth rates involved have been found[4] to have frequency distributions so symmetrical as to justify a high degree of confidence in the statistical interpretation; and simple statistical treatment of the data indicates clearly that the differences found are unquestionably significant.

Our current experiments seek to analyze these findings in terms of the individual chemical factors involved, beginning with calcium. The minimal level of calcium intake for permanent support of normal nutrition appears, from the findings of several investigations, to lie between 0.13 and 0.19 per cent of calcium in the dry food; while the optimal level is evidently higher.

Both by calcium-balance experiments with growing children[5] and by analyses of the bodies of experimental animals[6,7] it is found that even when there is every appearance of normal growth there may be considerable differences in the rate of calcium retention, depending upon the calcium content of the food.

If such observations stood alone, there might remain a question as to the ultimate effect of such a difference in the rate at which the body develops to its normal adult composition. In the experiments just now completed, which cover the entire life cycle and extend into successive generations, it is found that the diets with moderately increased calcium content, which have expedited growth and development, with earlier attainment of an adult percentage of body-calcium, have also induced higher vitality throughout, and improved the life-expectation of the adult as well as of the young.

With all other factors held uniform,[8] this moderate increase in the calcium content of the food has resulted in more rapid growth, more efficient utilization of food value whether computed in terms of calories or of protein, slightly earlier maturity, improvement of the already normal health at all ages, and some increase in the average length of adult life. In this particular series, the gain in longevity by the males is undoubtedly significant, while that by the females is smaller and if it stood alone would not be statistically convincing. Before one concludes, however, that the nutritional reactions of the sexes are different in this respect, there should be similar experiments comparing the effects of the two food supplies upon the life histories of unmated females, and upon groups of families in which the factor of pregnancy and lactation is held constant. For in the experiments just mentioned, the females on the food supply richer in calcium produced and suckled more young and it is conceivable that if the demands of pregnancy and lactation had been less frequent and heavy these females might

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have lived somewhat longer. It is to be hoped that opportunity can be found for such an additional series of experiments.

Meanwhile, experiments are already in progress to determine the effects of further enrichment of the diet in its calcium and phosphorus contents,[9] and with and without simultaneous enrichment in protein content, vitamin values, or both.[10] Inasmuch as other work in this laboratory indicates that both in the case of vitamin A[11] and of vitamin G[12] there is progressive nutritional benefit with increasing liberality of intake up to levels probably at least fourfold higher than the actual or minimal needs of normal nutrition, it seems important to determine, as accurately as possible, the extent of the differences between the minimal calcium requirements of normal nutrition and the intake which induces the best results as revealed by observations extending throughout the life cycle and into successive generations.

With an adequate diet having a calcium: phosphorus ratio of 1.4:1, the level of calcium intake most favorable to general growth is found at 0.64 per cent of the dry food mixture (as suggested by McCollum and Simmonds several years ago); and this high level also increases the rate at which the growing individual approaches the normal adult in its status as to percentage of body calcium. This latter phase of development is expedited still further at the still higher level of intake of 0.8 per cent calcium in the dry food, though here the general growth is slightly less rapid than with food containing 0.64 per cent of calcium. It is planned to continue the studies of the effects of these relatively high levels of intake throughout the life-cycle of at least two generations, and also with a basal diet made up in closer imitation of the average American family food supply.

In so far as can be judged from the considerable amount of evidence now in hand, it would appear that the optimal level of calcium intake is about three times as high as the minimal adequate level which meets the directly demonstrable requirements of normal nutrition; or, in other words, that for best results about three times as much is needed as is required to make the dietary "adequate" in the usual sense of the term.

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