

Furthermore, these methods are capable of increasing the resistance of mice to replants of their own spontaneous tumors. From the evidence at hand it seems then that the immunity aroused by these two physical agents has at least one other point of similarity to that induced by tissue injection, namely, a period of latency after the exposure before the immunity becomes evident. Whether the tissue injection, the small dose of X-rays, or the dry heat induce changes in the organism other than those associated with increase in the lymphoid tissue which would account for the immunity, is impossible to state at the present time; but the evidence now at hand points at least to the lymphoid tissue as an important agent in the immunity reaction to transplanted cancer of mice.

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THE PROTEIN REQUIREMENT OF MAINTENANCE IN MAN

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During the past four years a number of experiments have been carried out to test the nutritive requirements of maintenance in healthy men and women, and the efficiency of diets derived chiefly from the cereal grains in meeting these requirements. In connection with this work the results of all available data from previous investigations which seemed to lend themselves to direct quantitative comparison, have been brought together.

Probably the best present indication of the amount of protein or nitrogen actually required for the maintenance of the average adult is to be obtained by averaging the observed output of nitrogen in all available experiments, upon normal men and women, in which the energy value of the food was appropriate to the size and activity of the subject and the intake of nitrogen appears to have been just about sufficient to result in equilibrium of intake and output. Since a considerable and rather variable amount of time is required for the body to adjust its rate of nitrogen output to the rate of intake, it is probable that the "indicated protein requirement" obtained by averaging all available experiments will be somewhat greater than the minimum amount of protein on which the same subjects could actually have established and maintained equilibrium had the experiments been sufficiently prolonged. In other words, for the practical purpose of indicating how much protein the food must furnish in order to provide for adult maintenance such an average will err on the side of safety in that it may be expected to be appreciably above the minimum which would actually suffice to keep normal individuals in equilibrium. Two other in-

fluences tending toward an over-estimate of the protein requirement should also be noted since one or both of them appear to have played a significant part in the great majority of experiments which have been made in the past. These are: First, the tendency in experiments of this sort to reduce the intake of food as a whole, thus creating a deficit in the energy supply, which must interfere with the economical use of protein; second, hesitation, because of past over-estimates of the protein requirement, to reduce the amount of protein in the food to a sufficiently low figure to really test the minimum on which equilibrium could be established and maintained.

Every effort has here been made to decide in an objective manner which of the past experiments should be included in the average; yet an element of judgment necessarily enters into the selection, especially as some experiments have been more carefully planned and more rigorously controlled than others.

According to the rigorousness of the selection, the results may be given as follows: First, 109 experiments show a range of 21 to 65 grams and an average of 44.4 grams of protein per 70 kg. of body weight per day; second, 94 of these experiments show a range of 29 to 56 grams with an average of 42.8 grams; third, 76 of the same experiments show a range of 30 to 50 grams with an average of 40.6 grams. For convenience of comparison, all the results whether the subjects be men or women were here reduced to a uniform basis of 70 kg. of body weight—the usual basis for the statement of food requirements “per man per day.”

These data reveal no evidence of a sex difference in protein requirement, since 67 experiments upon men indicated a requirement of 0.633 gram and 42 experiments upon women indicated a requirement of 0.637 gram of protein per kilogram of body weight per day.

In our own more recent experiments, including both men and women, although the protein of the food was almost entirely that of the cereal grains, the amounts required for maintenance have usually been less than the averages above given. Thus, a man of 80 kg. established and maintained equilibrium on a daily intake of 37.5 grams of protein, of which 96% was furnished by ordinary wheat bread. A woman of 55 kg. found 27 grams of maize protein (from corn meal) almost sufficient, while 30 grams per day of protein, of which 88% was from corn meal, 10% from milk, and 2% from apple, proved more than sufficient. The same subject showed essentially the same requirement when oatmeal was substituted for corn meal as the chief source of protein, and a second woman subject also found fully adequate a diet which furnished not over 0.6 gram of protein per kilogram of body weight, about nine-tenths of the protein being derived from oatmeal and one-tenth from milk.

Thus it appears that in the maintenance of healthy men and women an intake of not over 35 to 45 grams of protein “per man” of 70 kg. per day is sufficient, even when the protein is not selected as of especially high

nutritive efficiency, and that a "standard" allowance of 1 gram protein per kilogram of body weight per day provides a margin of safety of from 50 to 100% above the minimum amount actually required to maintain equilibrium.

For growth and reproduction the amounts of protein required are relatively larger than for maintenance, and the selection of the protein is also of greater importance.

The data of all of the experiments here considered are summarized, with fuller discussion and with citation of original sources, in a paper which is being offered for publication in the *Journal of Biological Chemistry*.

THE TRANSPLANTING OF SEA ANEMONES BY HERMIT CRABS

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It is well known that hermit crabs inhabit the vacant shells of molluscs, that as they grow they change from smaller shells to shells of larger size and that hydroids, sea anemones and other animals are frequently attached to these shells. Several observers have reported that they have seen hermit crabs remove sea anemones from their old habitations and transplant them on their new shells. Such observations are mentioned in a few zoological text-books but usually the treatment is such as to leave the impression that there is an element of doubt as to the occurrence of the habit. For this reason I shall describe the behavior of individuals belonging to two species of hermit crabs, *Pagurus deformis* and *Pagurus asper*, occurring in the sea about the Philippine Islands, which bear sea anemones on their shells (Dolidae, Strombidae, Cassis, etc.) and which transfer these animals when they change their shells. My observations are worthy of note since they were made in the presence of four co-workers (Dr. L. E. Griffin, Mr. Alvin Seale, Professor A. L. Day and Professor S. F. Light), and since the individuals of the species of hermits mentioned both usually carry two kinds of sea anemones, one, a species whose individuals are large, the other, a species whose individuals are small, the former being fixed, as a rule, on the top of the shell and the latter generally on the under side near the protruding head of the hermit crab.

The following account of the behavior of the hermit crabs and sea anemones with reference to one another is undoubtedly in harmony with what occurs in nature although it deals with observations made in the laboratory: A hermit inhabiting a shell bearing two large sea anemones on the upper surface and a small one in the mouth of the shell was placed