INDIVIDUALITY IN VITAMIN C NEEDS

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If thinking along chemical lines had been commonplace, the existence of vitamin C would have been recognized over 200 years ago—before that of any other vitamin. Its chemical structure has been known for 34 years.

In spite of its long recognition, medical scientists are still almost completely in the dark as to its functions. It has to do in some obscure way with the building and maintenance of collagenous supportive tissues. This is about as much as can be said with certainty regarding its essentiality.

It is well known that deficiency of vitamin C causes loss of weight; anemia; weakness of muscles, including the heart; grave cytological alterations in bone marrow (bones may become very thin and fragile); loosening of the teeth; hemorrhages and aneurisms; and inability to reproduce. The effects of severe deficiency are so diverse that practically every organ in the body has been found to be seriously affected.

Medical reports have persisted over many years indicating that extra vitamin C (beyond that obtained in the usual diets) is valuable in many pathological conditions. Among the reports are those dealing with dental disease, gingivitis, infections, allergies, wound healing, bleeding ulcers, and lead poisoning. It has also been noted that the needs for vitamin C increase markedly in some diseases, particularly tuberculosis. A relatively recent credible report is from the Chief of Neurosurgery of the Methodist Hospital in Houston, Texas, to the effect that from 500 to 1000 mg of ascorbic acid daily has been very beneficial to himself and to hundreds of his patients in the treatment of back pain and in the preservation of disc integrity.[1]

A simple hypothesis will help explain these observations: Individual human needs vary greatly; intakes of vitamin C which may be regarded as safe for the average person may be far below what is necessary to prevent deficiency in some individuals. In particular circumstances, back injury for example, an individual may benefit from large doses because the presence of an abundant supply of vitamin C speeds the building of supportive tissue necessary for healing.

Medical scientists are often loath to recognize or consider extreme human variability because it tends to destroy the orderliness of their science. The existence of extreme variability is therefore not to be accepted lightly. If it is possible to deal with people successfully on the basis of averages, this has enormous advantage. Does high variability of vitamin C needs really exist to a significant degree in the human population?

We have sought to help answer this question by determining the incidence of such variation in guinea pigs. Broad biological considerations, including the biochemical unity in nature, give us considerable assurance that in this respect human beings will not be more uniform than guinea pigs.

Three shipments of male weanling guinea pigs were received and placed on a good

diet including fresh vegetables for a week of observation. The number of animals was smaller than we ordered; some died in transit or shortly after arrival, partly because they were at the minimum age when guinea pigs can thrive under experimental conditions.

Of these animals 102 were judged to be reasonably satisfactory for experimentation and were placed on a vitamin C-free diet (Nutritional Biochemicals) and were given with pipettes by mouth on alternate days the prescribed amounts (Table 1) of fresh ascorbic acid solution. One group received none; the other groups received the vitamin at seven different levels.

In spite of the fact that a few animals died early, probably from causes not connected with the experiment (the majority of these, however, were at low levels of vitamin C intake), none was excluded from the tabulations. One animal at the lowest level of vitamin C intake (B1) was discarded because early in the study on one occasion it was mistakenly given a larger dose of vitamin C than was prescribed.

In Table 1 are presented data with respect to the weight gains of the animals during the first ten days (including the few animals which died within this time). It may be noted that the trend is toward better ten-day performance at the higher vitamin C levels. The absence of a regular progression from group to group is accounted for by the small number of animals in each group. The individual variability in response is high throughout all groups, but is most pronounced at low levels of vitamin C intake.

In Table 2 are presented data with respect to survival times and the incidence of obvious scurvy symptoms (leg weakness and disuse). Again it may be noted that the performance is best at the highest levels, and there is wide individual variation throughout. The numbers of animals in the F, G, and H groups in the second tabulation are smaller than in the first because seven animals which were faltering in their growth at high vitamin C intakes were removed from the experiment as it was originally planned. These seven animals were given higher levels of vitamin C in order to see whether their poor growth could be due to lack of sufficient vitamin C intake. This seemed improbable at the time. In Table 3 are given the results of this experiment.

The results were almost incredibly striking. Each one of the animals exhibited enhanced growth when the high level of intake was further increased. In some animals, F-6 and H-3, for example, the effect of further supplementation was most striking. It becomes impossible to escape the conclusion that levels of vitamin C much higher than heretofore reported are needed by *some guinea pigs* for continued health and maximum growth.

TABLE 1

WEIGHT GAINS DURING FIRST TEN DAYS

Group	No. of animals	Vitamin C levels (mg/100 gm/day)	Average gain (gm)	Range	Showing no gain (%)
A	15	None	23	−37 to +85	27
B	14	0.05	14	−71 to +74	36
C	15	0.1	26	−52 to +87	33
D	15	0.2	41	−24 to +87	13
E	12	0.4	38	0 to +84	16
F	10	0.8	49	+23 to +74	0
G	10	1.6	52	+ 7 to +95	0
H	10	3.2	41	− 8 to +77	20

TABLE 2

SURVIVAL TIMES AND SCURVY SYMPTOMS

Group	No. of animals	Vitamin C levels (mg/100 gm/day)	Survival Times		Living 8 weeks (%)	Percentages showing scurvy symptoms
			Average	Range		
A	15	None	32	12–56*	7	80
B	14	0.05	32	3–56*	29	79
C	14†	0.1	41	7–56*	64	36
D	15	0.2	47	5–56*	73	13
E	12	0.4	47	14–56*	67	25
F	7	0.8	55	48–56*	86	0
G	8	1.6	55	48–56*	88	0
H	8	3.2	51	10–56*	88	0

* The experiment was terminated at 56 days (8 weeks).
† One animal was removed from the experiment and was treated with an extra supplement of ascorbic acid for an arched-back condition. Benefit seemed to result, but no definite conclusion could be drawn.

That some guinea pigs have relatively low requirements is illustrated by the fact that one animal (A-5) with no vitamin C intake developed scurvy symptoms early (10 days) but unlike other animals in the group which lost weight and died on the average 12 days after the first symptoms, it lived and maintained about a constant weight throughout the entire eight-week experiment. Two animals (C-7 and C-13) on a low vitamin C intake (0.1 mg/100 gm/day) remained healthy and gained weight (329 and 382 gm, respectively) over the entire eight-week experiment. The total growth of guinea pig C-13 was larger than that of any in the D, E, F, and G groups which were getting 2, 4, 8, and 16 times, respectively, as much vitamin C. Only two animals in the H group (getting 32 times as much) exhibited total growths (446 and 433 gm) which exceeded that of C-13.

It should be noted that these exceptional animals were found even when there were 15 or less animals in each group. We can only conclude that at least a 20-fold range in the vitamin C needs of individual guinea pigs exists and is evident even in very small groups. On unemotional, scientific grounds it would appear that interindividual variation in human vitamin C needs is probably just as great.

The prevalence of high human needs for ascorbic acid has been indicated on other grounds by Stone,[2] who is of the opinion that this need may be on the order of a few grams per day instead of the 70 mg (the recommended allowance on the Food and Nutrition Board) or 30 mg (the minimum daily requirement of the Food and Drug Administration).

Why extreme variation exists is a subject for speculation. We suspect from our experiments and other observations that guinea pigs, monkeys, and human beings may have varying abilities hitherto undetected to produce ascorbic acid endogenously but unlike other mammals cannot produce it fast enough to maintain health.

TABLE 3

RESULTS OF VITAMIN C SUPPLEMENTATION ON ANIMALS ALREADY AT HIGH LEVELS OF INTAKE

Animal	Level of supplementation (mg/100 gm/day)	Growths Before and After Supplementation (gm)			
		Five Days		Ten Days	
		Before	After	Before	After
F-6	6.4	−16	+38	−43	+45
F-8	6.4	+13	+29	+14	+41
F-10	6.4	+ 1	+21	+ 8	+58
G-5	6.4	+10	+49	+46	+85
G-9	6.4	+44	+98	+69	+137
H-3	12.8	−17	+62	−24	+73
H-7	12.8	+ 1	+63	+15	+62

Some individuals may have relatively high capabilities in this regard and are relatively resistant to scurvy. This idea requires experimental exploration.

A most serious obstacle in the way of the acceptance of extremely variable human needs for vitamin C is the fact that this acceptance opens the door with respect to variation in the needs of all other nutrients. Elsewhere[3, 4] evidence has been presented that such wide variations are probably common.

A psychological situation exists in the medical profession in that there are outside the profession numerous food faddists and partially informed nutrition enthusiasts who are often masters of publicity. The acceptance by physicians of the importance of nutrition in the control of disease is somewhat taboo, because they understandably do not wish to be associated with those who enthusiastically endorse such ideas without adequate evidence.

The Food and Drug Administration suffers from the same kind of influence. The desire of this agency to protect the public against charlatans and extravagant claims is laudable, but when they go so far as to hold that food supplements are valueless "for the average person" they are yielding to an unscientific taboo. It is true that in our supermarkets there is a tremendous variety of good food—"the best in the world"—but this does not guarantee by any means that people select wisely or that the average selection gives the average person everything that is needed in abundant quantities.

Medical scientists are subject to another type of influence. There are fashions in research (as in clothing), and vitamins have to a substantial degree gone out of fashion and have been supplanted by DNA's. As a result there are few research centers in this country where attention is paid in a serious way to the functioning of vitamins, amino acids, and minerals in nutrition. The ever-present possibility of highly variable human needs is rarely even considered.

This is not a minor flaw in medical research. By avoidance of individuality in human needs, possibly in an attempt to keep their science pure, medical scientists are overlooking and failing to develop a set of *major weapons* against disease. The number of types of diseases which may have their roots in faulty nutrition is large[4] and most unfortunately virtually no exploration is taking place. Once the extreme variability of human needs is recognized, it becomes obvious that the origins of many diseases, not now understood, may be clarified. Thorough exploration is required.

Trends in research can recur. Before the end of this century the study of vitamins, minerals, and amino acids and other nutrients will again come to the fore—this time with the recognition of variable individual needs. The tables will turn. No informed person will then say, "In nutrition, only *average* needs count."

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[1] Greenwood, James, Jr., *Med. Ann. District Columbia*, **33**, 274–276 (1964).

[2] Stone, Irwin, "Brief Proposal 'Hypoascorbemia, the genetic disease causing the human requirement for exogenous ascorbic acid,'" *Perspectives Biol. Med.*, **10**, 133–134 (1966).

[3] Williams, Roger J., *Biochemical Individuality* (New York: John Wiley and Sons, 1963).

[4] Williams, Roger J., and Richard B. Pelton, "Individuality in nutrition: Effects of vitamin A-deficient and other deficient diets on experimental animals," these PROCEEDINGS, **55**, 126–134 (1966).