The Roots of Optimal Nutrition

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With the Medline database so readily available, researchers today often think they have few reasons to read the medical literature published before 1966. Yet in reading old medical and nutrition texts, I am frequently amazed by the astute observations of those who came before us.

In 1996, blessed by serendipity and an abundance of used book stores in Portland, Oregon, I came across a copy of *On Oxidation, Fermentation, Vitamins, Health and Disease*, a thin volume containing five lectures given by Albert V. Szent-Györgyi, M.D., Ph.D., in March and April of 1939 at Vanderbilt University. I had found a treasure almost lost to the past.

Szent-Györgyi, who discovered vitamn C and the flavonoids, and who was awarded the Nobel prize for medicine in 1937, was a reluctant "vitaminologist." He felt that research in the field was too easy a way to win accolades and sought greater challenges.

Reluctant as he might have been, Szent-Györgyi quickly began to see vitamin requirements in terms different from those of his peers. At that time, most researchers saw vitamins as substances required in miniscule amounts to prevent deficiency diseases, such as scurvy.

In his fifth lecture, "On Vitamins, Health and Disease," Szent-Györgyi questioned the validity of minimum daily requirements and asked his audience to consider the implications of the *dosis optima quotidiana*—the quantity of vitamins needed to achieve optimal health. Szent-Györgyi lamented the fact that most people, while free of scurvy, go through life with suboptimal vitamin intake.

"I think we must call 'perfect health' not the absense of scurvy or other disease," he wrote, "but a condition of the body in which it is capable of the highest performances, in which it shows the greatest resistance against all noxious influences, physical, chemical and biological."

These were profound words for 1939. And profound words they remain. Szent-Györgyi may very well have been the first scientist to describe a compelling need for optimal nutrition, years before Roger Williams, Ph.D., and Linus Pauling, Ph.D., championed the issue. What Szent-Györgyi had really done was describe the rationale for orthomolecular medicine.

Abram Hoffer, M.D., Ph.D., asked if I would share what Szent-Györgyi had written, so what follows is a reprint of his vitamin lecture. For those who would like a complete reference, it is: Szent-Györgyi A.V., "On Vitamins, Health and Disease," in *On Oxidation, Fermentation, Vitamins, Health and Disease*, Baltimore, Williams & Wilkins Co., 1939: 88-109.

Read, enjoy, and contemplate it with awe and inspiration. I certainly have.

—Jack Challem

On Vitamins, Health and Disease

There is no other domain in biology that, for a while, promised such easily won laurels to the researcher as did the field of vitaminology. That is why vitamins were for a long time my pet aversion. It is the irony of fate to have made me, without my willing it, father of one of the vitamins and to have brought me in close touch with others. Nature, as the old physiologist, Bernstein, used to say, is not a mother, but a mother-in-law of the scientist.To understand what vitamins mean for medicine,we must transport ourselves into the atmosphere prevailing at the end of the last century. Pasteur had shown that epidemic diseases were caused by microorganisms, and it seemed that every disease must have its positive causative agent. On the other hand, extensive studies on nutrition, pur-

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sued chiefly in Germany, showed that food had to contain, besides, a sufficient number of calories, proteins, fats and carbohydrates in a suitable proportion to be satisfactory.

The great problem of feeding had been reduced to a simple mathematical formula. It was in the haze of victory of these two doctrines that Eijkman, a young Dutch doctor, published his observations, according to which beriberi was not caused by a positive infectious agent, but by a lack of something missing from food—a negative factor. F. G. Hopkins at Cambridge showed that this something, necessary for health, acted in minimal, insignificant quantities when one considers their energy content. The name vitamin invented by C. Funk was accepted for this group of substances with the presumption that they were amines, and were connected somehow or other with the mystery of life. They were considered to be something quite special, a peculiar group of mysterious agents. These vitamins prevented certain diseases and were thus the supporters of health. Public interest turned in full measure towards these mysterious agents; special laboratories were founded for their study and a great host of specialists, the vitaminologists, set out to study them, to ascertain their number, their relative quantities in food, the quantity of each necessary for health and to find suitable experimental animals for their study.

I am not a vitaminologist myself and in discussing vitamins I can depend only on the meager experience I have had as a biochemist who has devoted his life to the study of a cellular function, oxidation. What this experience is, I have told you in my previous lectures. I have shown you that biological oxidation is the function of a very involved chemical mechanism in which a great number of different molecules interact harmoniously like wheels in a machine. To me the cell is an immense mechanism with thousands of wheels, the molecules, the harmonious interaction of which is that wonderful thing we call by the one little simple word, "life." The harmony, the smooth running, of this machine is what we call health.

In this mechanism we find wheels, the molecules, of the most varied kinds. We find huge, labile molecules with a weight of several millions, and small molecules acting by themselves or acting together with their more bulky brothers. There are substances that are present only in small quantities and there are others like water making 80 percent of the whole. All these substances are equally as important, equally indispensable as are all the wheels of your watch and whenever a wheel is missing there is disturbed function; there is disease.

Talking now about the more simple molecules present in relatively small quantities, we will find that most of them are fabricated by the cell itself from other elements. A few, however, cannot be made by our cells and must be obtained from food ready-made or at least in such a condition that they will fit into our mechanism after a small adjustment.

This theoretically insignificant and uninteresting quality, of not being fabricated by our cells, gives to this small group of substances, called Vitamins, their great medical importance, for if any of the other substances which we make ourselves is missing from the food there will be no serious consequence. If, however, a vitamin is missing, a substance that we can't make ourselves, we will be unable to replace the corresponding molecules of our cells if they are worn out; there will be a wheel missing, there will be a shortage, disturbed function—there will be disease. These vitamins, thus, can make us ill by their mere absence. This paradoxical behavior is their most characteristic feature. While the great host of all other innumerable substances can make us ill only if we eat them, vitamins make us ill if we do not eat them.

But vitamins have not only a medical importance, they also have a philosophical importance; for what is the source of these vitamins? It is mostly the plant. Now, if we say that we take these substances from the plant, what we really say is that we can take the wheels of the plant cell and put them into our own mechanism and that they will fit in perfectly. Now, two machines, the wheels of which are interchangeable, cannot be very different. In this way vitamins give us a most entrancing vista of the great chemical unity of all living nature.

Now let us start out from the modest experience of the biochemist and examine one by one the ideas which vitaminology has given us and see whether we can accept them. Let us start with the name and its implications. Let us begin with the tail end of vitamin, with the "amin." As far as we know most of them are not amines—that's that.

As regards the "vita," their mysterious vital function, there is no more mystery about that. To be sure, life is a mystery and all its instruments are mysterious but there is no difference at this point between vitamins and common salt or water.

Their function is not a mystery either. In our study of oxidation we have met several vitamins. There was ascorbic acid which has, in all probability, the simple function of giving off and taking up H atoms as do so many other substances. There were co-dehydrogenases, with their pyridine rings; they also are H acceptors and members of the vitamins of the B group. There were alloxazines with an apparently analogous function acting as B_2 vitamin. There was co-decarboxylase with the simple function of being instrumental in splitting off CO_2 from COOH, a substance known as vitamin B_1 and causing, by its absence, beriberi. All these are quite plain and simple functions and we have no reason to suppose that other vitamins should act differently, even if the reaction each may carry out is a different one.

The substances themselves, the vitamins, are no more mysterious either. The biochemist has isolated, analyzed and synthesized them. You can find them now in bottles on the bench of the biochemist, standing in one row with other chemicals such as salt, sugar or oil, looking in no way different. The only difference may be that the biochemist shows them with more pride.

The name vitamin conveys another implication which we must consider more seriously. The name suggests that in some way vitamins form by their very nature a special group of substances. Accordingly, we find theories in literature about "equilibrium of vitamins and hormones," and the like. We must thus consider whether vitamins really constitute a special group, or whether they are just a small number of substances linked together in a more or less haphazard way by the accidental circumstance that we are unable to make them? If they do not form a special group based on some essential quality, then, naturally, all speculations about equilibria between vitamins and other groups have to be rejected. Naturally there is a relation between all substances in our body and the change of any one will induce a change in all the rest. What I mean is, do vitamins as such form a closed group which could act as a whole, having special relations with other groups of substances.

In what way could vitamins be different from the rest? What unity could there be between the different vitamins? Their structure? The chemical structures of these substances are the most varied imaginable. There is no unity in them. There are sugar derivatives, acyclic and cyclic molecules, alloxazines, pyridines, phenanthrenes and others. One could invoke as a special quality the minuteness of quantity in which they act. But hormones and metals act in the same minimal quantities and there are vitamins on the other hand, like vitamin C, which we find in tissue and of much we need correspondingly quite considerable quantities.

We are thus unable to define the vitamins by any other quality than by their capacity to make us ill if we don't eat them, in other words, by the fact that we are unable to synthesize them. This quality is not too characteristic either, for histidine, tryptophane and many other substances share thus property. Thus, we must ask, is this quality, failure of synthesis by our body, due to some special quality of the vitamin molecule which makes its synthesis impossible, or is this rather a defect of our own cells which determines their inability to make them?

There can be no real difficulty in making these molecules or else the plants would be unable to make them. It is difficult to believe that cabbages should be so much cleverer than we. Thus it looks as if it were not a quality of the vitamin molecule itself, but rather our own cellular limitation which determines that we cannot make them.

After all what is behind all this why can't we make them? Is it some essential difference between plant and animal which makes the synthesis possible in the former and not in the latter? First of all, is it really true that animals can't make vitamins? There have been some early observations which suggested that it is not a general defect, shared by all animals, for it had been stated that rats, for instance, can make vitamin C. One of the early American polar explorers made the observation that a rat soup would prevent scurvy. Later, M. Pearce showed experimentally that rats really can make ascorbic acid.

Most of the animals of the temperate climates do not get scurvy if fed on vitamin C free diet, but this is, as we know today, not because they don't need ascorbic acid but because they make it themselves.

The cow, the cat, the fowl and rats all can make ascorbic acid, and if you tell a rabbit that ascorbic acid is a vitamin he will laugh at you because to him it is not a vitamin—he can make it. Why is it then that it is only man, the monkey and the guinea-pig that can't make ascorbic acid? The explanation is, I think, a quite simple one. It lies in one of the fundamental laws of Nature which is laziness. Nature never makes anything unnecessarily, and any function that is not used will be lost. Naturally it will not be lost from one day to the other, but if you bring up a race of animals during a hundred thousand years in a tropical jungle where there is green food all year round with plenty of ascorbic acid in it, you may be sure that race will forget how to make it. This is the reason why our chief experimental animal for vitamin C is the "guinea pig," which comes from the ever-green New Guineas. An equally good object would be the monkey, but not the rabbit, whose race developed in our zone where there is no green food and thus no ascorbic acid during the winter. If the rabbit could not make ascorbic acid, it would die of scurvy during the winter for no animal can live without ascorbic acid. Our inability to make ascorbic acid is evidence of our tropical origin.

You see thus that it is not the quality of the vitamin molecule which prevents its synthesis in the body. It is our defect, that we can't make it and the reason does not lie in the fundamental structure of our cells but in the accidental circumstances of our origin.The vitamin nature of a substance has thus no theoretical importance. Its practical medical importance is of greater significance so let us devote the rest of our time to this aspect of the problem as I think certain principles of medical application can be derived even from the modest experience of the biochemist.

We have seen that the vitamins we have already met had a certain function, for instance, decarboxylation. A certain number of pyruvic acid molecules have to be decarboxylated every day and for this we need a certain number of vitamin B molecules. If there are enough of these molecules, the decarboxylation will run smoothly. An excess will do no good, and were there enough, we could not expect a favorable result from their greater administration. While an overdosage will do no good, we can expect a therapeutic action only if there is a shortage. Thus all that the doctor has to do is to see that the human body should have enough of each individual vitamin, and he will ask us two questions: (1) how many vitamins are there, and (2) how much of each must we ingest daily?

The first problem seems to be hopeless but is, in fact, quite simple. The second seems to be simple but can't be answered at present. As to the first, the number of vitamins, we can make no definite statements. New vitamins are discovered almost every year and there is no reason to suppose that our list is complete. But how can one hope to administer them correctly if he doesn't know how many there are? Nevertheless, I can give a rather consoling answer. We mostly discover a vitamin by the corresponding deficiency disease. The easier a vitamin leads to such a deficiency disease, the greater its practical importance, but, at the same time, the more easily this vitamin will be discovered. Thus it follows that the first vitamins discovered, A, B, C and D, are the most important ones; thus the later a vitamin will come to stand in the alphabet, probably the smaller its importance. Thus the doctor need not think about the vitamins still undiscovered; he may limit his attention to the vitamins designated by the first four letters of our alphabet.

Now let us turn to the second problem, how much of each single vitamin must we eat? To put it more scientifically, what is the minimum daily dose D.M.Q. (dosis minima quotidiana) of every single vitamin? A very great deal of sane and careful work has been done to find this D.M.Q. Let us watch the vitaminologist at his work and see how he arrived at his answer. Let us take, for example, a C-vitaminologist. What he does is this: he takes half a dozen young guinea pigs and puts them on a diet which contains all necessary ingredients except vitamin C. He finds that for a week or so all goes well. The second week the first symptoms of scurvy appear and growth stops. The third week the animals begin to lose weight and at the end of the fourth week they die with typical symptoms of scurvy, loose teeth, swollen joints and multiple hemorrhages.

To a parallel set of control animals he gives increasing quantities of ascorbic acid and finds that 1.5 mg. a day will prevent the appearance of all scorbutic symptoms. Therefore he says this is the D.M.Q., the quantity necessary to maintain health.

This experience was extended to man. There is practically no scurvy or beriberi in our climate, thus, we argued, there can be no lack of the vitamins C or B. All would have been well had the chemist not made trouble by isolating and synthesizing the single vitamins, and putting them into the hands of the clinicians who started injecting them in unlimited quantities to all sorts of patients. These experiments gave unexpected results. To take one example, the clinician found that alcoholic neuritis could be cured by the application of massive doses of vitamin B. What is especially striking and agreeable is that we can go on drinking and yet our neuritis will be cured if only we take enough vitamin B. Now what conclusions must we draw from all this? \We have thought that there was no lack of vitamin B in our climate, and anyway alcoholic neuritis is not an avitaminosis. Does B act then as a chemotherapeutic agent like aspirin or the like? This is in contradiction to our conceptions. How then, are we to understand these effects. Something seems to be missing or to be wrong in our fundamental conceptions and we must find out what it is, or where we have been led astray.

In my opinion, the solution lies in the unwarranted conclusions we made from animal experiments. Let us repeat once more how these were done. We found that if we gave, for instance, 1.5 mg. ascorbic acid daily to guinea pigs, our animals had no scurvy, were thus healthy. But is this true? Is it right to divide the world into "scurvy" and "no scurvy." How do we know that they were healthy just because they had no scurvy—is "no scurvy" the same as health? Can we talk at all about health if we have nothing more before us than a few guinea pigs sitting in a well protected cage, and without scurvy? Do we call it health if we sit in a corner and have no scurvy No, certainly not.

What, then, do we call "health," "perfect health"? We must answer this question, for "health" is the ideal, the highest aim of medicine. I think we must call "perfect health" not the absence of scurvy or other disease, but a condition of the body in which it is capable of the highest performances, in which it shows the greatest resistance against all noxious influences, physical, chemical and biological.

It thus follows that should we wish to find out whether our guinea pigs were healthy, we should not allow them to sit quietly in a corner but should subject them to all sorts of strain, physical, chemical, and biological, should make them work, expose them to cold, toxins, infections and see what is the quantity of vitamin at which they do best. The dose of vitamin, the further increase of which would fail to give increased protection, would be the real optimal daily dose.

We must distinguish between two dosage requirements, the D.M.Q., the quantity of the single vitamins sufficient to prevent scurvy or other manifest deficiency disease, and the D.O.Q., (the dosis optima quotidiana) the quantity necessary to maintain our body optimal condition—in perfect health. Experimental vitaminology has taught us about the first, but has misled us in regard to the second.

In the literature we might find some indication about this D.O.Q. Thus, S. S. Zilva finds that he needs 1.5 mg. of ascorbic acid to keep his guinea pigs "healthy," but must administer about 15 times this quantity to keep them saturated. He thinks this 20 mg. of ascorbic acid a day for a small guinea pig is a crazy amount and has no biological significance since his animals were healthy anyway. But is 20 mg. such a crazy amount? Such a small guinea pig consumes about 100 g. of green food daily in his original surrounding and this green food contains on the average 20 to 30 mg. of ascorbic acid, just the quantity Zilva finds necessary for saturation. This saturation is thus the normal state of the animal. I expect that for any vitamin, the D.O.Q. will be found to be the quantity the animal consumes normally in his natural habitat

Naturally, the D.O.Q., found in the animal experiment can tell us little about man. To establish the necessary data for man we must work on man, and it is most important that this should be done. If the only way to approach this question for man is by statistics and mass experiment. We would have to increase the quantity of vitamins in a big group of the human population and see at which quantity the incidence of disease becomes the least, or at which quantity certain performances become the best. So long as resistance or performance can further be improved, we cannot talk about perfect health, for to increase resistance means to improve health and a health that can be improved is not perfect health.

I find this problem so very important that some years ago I prepared 3 1/2 kg. of pure ascorbic acid in the hope of finding some organization or individual who would care to make such mass experiments. I was disappointed for there is no organization which can undertake such work, and it is difficult to find individuals who care to participate in a work in which personal merit gets lost in a mass of statistics.

If we thus define health not as lack of scurvy, but as something much higher and subtler, all those contradictory clinical experiments become at once intelligible. They simply tell us that there is a great difference between scurvy or beriberi and perfect health.

The two conditions are separated by

a wide margin, corresponding to the condition of hypovitaminosis, a condition in which there is not enough vitamin to keep us healthy but too much to allow us to develop scurvy or another deficiency disease, a condition which has no other symptom than that our body is unable to develop its maximum resistance against noxious influences, a condition in which it will stand a greater chance of becoming ill, and once ill will not be able to develop to the maximum its defense. If we administer vitamin in this situation we will have introduced no chemotherapeutical agent but only will have paid our old debt to Nature, thus enabling the body to develop all its natural forces in its fight against disease.

A considerable part of mankind seems to go through life with such a hypovitaminosis Most of us may perhaps get through unpunished. If, however, this hypovitaminosis associates itself with some lesion like an excess of alcohol, it might lead to a neuritis. If it is associated with an infection, it will lead to some in infectious disease. If it is associated with a congenital debility of the capillary vascular system, it will lead to hemorrhagic diathesis. So, if in a thousand people having exactly the same food, only a few become ill; still a lack of vitamin might have a deciding influence in the development of their disease. It might just have been "the straw that broke the camel's back." How far the administration of the vitamin will have a curative action in that disease will depend on the extent to which the vitamin played a role in its genesis, and on the question of how far the pathological changes are still reversible

Whenever I think about these curative effects obtained by the administration of vitamins, there is always one problem that suggests itself to my mind' The problem is this: If we can cure, or at least ameliorate, some disease by the application of a vitamin, what would have happened if our patient had plenty of vitamin before he contracted his disease? It is an age old experience that it is much easier to prevent than to cure a disease. So the probable answer to my question is that, if our man had had enough vitamin, he would never have become ill.

This leads me to the most important aspect of vitaminology, to the problem how far vitamins can help us to prevent disease. In the end the ideal of of modern medicine is not so much to cure as to prevent disease. This general problem of health and disease which has occupied my mind very much for my whole scientific career, is dominated by two big contradictory impressions. As a medical student, I learned about all those thousand diseases humanity is suffering from I was 32 years old when I failed in my medical exam nation because I could not remember the names of a these thousand ailments. Since then, as a biochemist I am living in silent admiration of the wonderful precision, adaptability and perfection of the living organisms. Medicine taught me the shocking imperfection, biochemistry the wonderful perfection of our body and I have wondered where the contradiction lies. Anything Nature produces seems to be perfect Should, then, man be the only imperfect creature kept alive in face of all his imperfections only by means created by his own mind? If not, where do all these ailments come from, how must we understand them. This is the great fundamental problem of medicine, the great fundamental problem of health and disease, and we must try to answer these problems and try to advance from the description of the single diseases to some more general conception of health and disease; such a concept might help us in our efforts to lead humanity towards a period of better health and greater happiness.

Allow me to terminate this series of lectures by giving you the general theory of health and disease as I have formulated it for myself. Naturally, you will have to excuse me if I, for the last time, forsake the solid ground of experiment. To understand ourselves better we must not study the man on the pavement of some big city; for such a study we had better go back to the surroundings of our remote ancestors in the tropical jungle. The "individual" has little meaning in the jungle; the whole jungle represents one big organism. The nitrogenous matter of the jungle, is in its greatest part, always present in some living form. This nitrogenous organic material is not the private property of the living individual, he got it from the jungle and soon will have to return it to the jungle. Individual life is but a short temporary assemblage of a quantity of matter which, after the individual's end, will soon be dispersed again and will appear in new living form. But even that quantity of organic material which makes an animal, let us say a monkey, is not sharply separated from its surroundings. In the form of food ingested and air respired, a great number of different molecules pass through our monkey's body. In this way our monkey not only lives in his surrounding, he is, in fact, a part of his surrounding. To be able to exist, he must be perfectly adjusted to his surroundings. As soon as his adaptation becomes incomplete he will be ruthlessly destroyed. So long as he is perfectly adjusted he is safe and healthy. Health means, then, no more than such a perfect adaptation to his environment into which our monkey's body fits as a cogwheel into a machine. This is health-adaptation. There is nothing like "healthy" or "unhealthy" in the world. What is "meat for the one is poison for the other." If you put a rabbit under water he will say water is unhealthy; the fish will feel uneasy on land. There is nothing like healthy or unhealthy and it all depends on what we are made for, and all living creatures have to be perfectly adjusted to their surrounding. And they are adjusted, perfectly adjusted, for this is a law of Nature that any individual maladjusted to his surroundings must perish. Anything Nature produces has to be perfect in its essence, and by this rule the monkey is perfect. There is no reason, then, to suppose that our own body is made less perfectly than that of any other individual.

But take now such an individual, perfectly adjusted to the jungle, and put him suddenly on the pavement of New York, give him smoky and dusty air to breathe, put him in this environment which might be too hot or too cold, too dry or too humid; shut him up in a dark room, cover up his body and shut out the sunshine, expose him to noise and to all sorts of undue excitement, put substances into him, feed him with things to which he is unaccustomed, and the formerly perfect body will fail. He will go to the doctor and the doctor will tell him all sorts of funny names of the diseases he has got.

To cut a long story short, I believe that the human body is just as perfect in itself as the body of any other individual, that disease is not the innate quality of our body but arises from the disharmony of our make-up and our surrounding. There have been one or two big experiments in history which prove this point. One of them is the story of the island of Tristan da Cunha where man of our own race lives a natural life and knows no disease.

Naturally, if you accept this general theory of disease, you will ask what to do about it. Shall we go back to the trees? This would not work; maybe there are not even enough trees for all of us. No, we can't go back. But, there is science to help us to find out which of the factors originally present in our original surroundings are essential and which are not; and then we must see to it that we get these factors into our homes, into our lives. These factors might be manifold: the purity, the humidity, and the temperature of the air, the quantity of noise and the excitement, physical work, insolation, etc. But certainly one of the most essential factors in our coordination with our surroundings is our food, for food is the form in which our surroundings penetrate into our body in rough, big quantities; and it is equally certain that vitamins are a most important factor in this coordination. Very much has been done already along this line. Modern transport makes it possible to bring home to us our original primitive surroundings in the form of fruits of the South and it is partly due to this that, as old doctors tell me, running ears, open submaxillary glands, curved and suppurating bones are no more the usual aspect of a child, as they used to be in some European countries a few decades ago. But, there is still a great deal to be done and even expensive food is sometimes shockingly bad from a medical point of view.

I think we all have still a somewhat medieval outlook on disease. We accept disease as one of the innate qualities of life. We think that as death is a quality of life and our machine has to stop some day, so it has to go wrong now and then; this is quite wrong. Death, yes; but disease, no. Disease is not an attribute of life. It is innate in life to be perfect and to know no disease. There are two reservations I must make. The one refers to epidemic infectious disease where our life has to fight another life, that of bacteria which is equally as perfect as ours. Epidemics are known also in the animal world. This danger is not too grave for modern hygiene has dealt with it.

The second reservation is more serious. Any product of Nature is perfect, since any deviation, any imperfection will be ruthlessly culled out– the weaker animal will be eaten by the other. So, Nature gives no chance to the degenerate to reproduce his imperfections. But man, by his charity and other artificial means, keeps the weak alive and gives him a chance to propagate his own weakness; so, unlike other beasts, there has been ample chance for man to produce imperfect forms.

Do not accuse me of having lost myself in useless speculation. These thoughts are capable of immediate practical application. In fact, I am applying them myself in my own life and small family rather successfully. In the course of the autumn, being closely confined to my laboratory, my resistance decreases and in December I usually get my first cold or some other disease. In the early spring I often had to spend a few weeks in bed. I used to call in the doctor who told me a number of Latin names ending with "itis," and gave me pills which I took in good faith but with little success. Now, I deny the existence of all these "itises" and at the first sign of disease I put my body, with a pair of skills, on a snowy slope where I can find the greatest number of my ancestral rights fulfilled, such as fresh air, exercise and sunshine, and the "itises" exist no more for me.

These theories have been, in fact, applied unconsciously. Tuberculous patients are sent to the mountains and it is known that no TB exists above 9000 feet. It is not that the mountain air has a curative effect for it is not a therapeutic agent; it is simply the air we are made for, and if we have what we are made for there will be no TB.

At any rate, I think a wider outlook on life, on health and disease, a wider application of scientific methods and their results might still lead to a drastic reduction of disease and human suffering and a corresponding increase in human happiness. Vitamins, their proper application and knowledge, certainly represent one of the most important factors in this connection If, on the top of this, humanity would learn to use science really to its advantage and would learn to use its methods and results for edification and not for destruction, and in the end, if we could even learn to apply between social groups and nations the same simple code of morals which we accept for our individual life, humanity would march towards a period of health arid happiness unheard of in the annals of our history.

Ladies and gentlemen, I have arrived at the end of my story. Allow me in closing these lectures to sound a personal note.

I have given you a summary of all the problems that have occupied me during these last fifteen years, which have been the source of my great pleasures and disappointments. I am unable to review this work without being filled with the deepest gratitude to all those who helped me on my way, which has not been devoid of hardship. My way took me through many countries and wherever I went I found kindness, good-will and international, intellectual solidarity. Towards your country with its well known broad magnanimity, I feel a double obligation. Some ten years ago when difficulties began to weigh too heavily on me and I staggered under the load, it was the Rockefeller Foundation which stretched out its helping hand, and led me out of my small cellar room and opened the opportunities of the wide world of science to me. I owe it to the Josiah Macy, Jr., Foundation, New York, that I could put, during these last years, all my thoughts to a test unhampered by material difficulties, and could build up a school of young, happy and devoted research men. In fact, the greatest part of the results reported here were reached under the auspices of this foundation. Your kind invitation which brought me from Hungary to Nashville, your kind patience and your splendid hospitality are expressions of the same spirit.

I can only wish that this spirit of human solidarity may spread beyond the limits of science and may conduct us all towards a brighter future.

Albert V. Szent-Gyoryi, M.D., Ph.D.