

## Orthomolecular Enhancement of Human Development

Linus Pauling

Linus Pauling Institute of Science and Medicine  
2700 Sand Hill Road, Menlo Park California 94025

I believe that there are great possibilities for improving the lot of human beings, the health of human beings, including the work of the Institutes for Achievement of Human Potential and I admire the work that has been done in these Institutes very much. I know that considerable emphasis is placed on good nutrition for the people who come to the Institutes and that large doses of vitamin C are given to them.

The human body, like the rest of the universe, is composed of matter and radiant energy. There are electric oscillations in the brain that constitute consciousness and ephemeral memory. They are guided by the material structure of the brain and they interact with it. I can understand that the sort of training, the sort of physical experience that is given to the children in the Institutes, can operate, by way of these electric oscillations, to change the material structure so that good behavioral patterns are laid down.

A human body is made up of thousands of different kinds of molecules. Some of them have structures that are characteristic of the individual person. The genes that a person has inherited from his

parents have determined his structure to some extent. The protein molecules, including those of thousands of different kinds of enzymes, may differ somewhat from person to person in structure. Differences in enzymes may change the rates of chemical reactions so that the simpler chemical molecules are produced in different people in larger or smaller amounts. Moreover, the structure of our bodies is determined to considerable extent by the molecules that we put into our bodies. For example, by smoking cigarettes many people introduce molecules into their bodies that are the cause of large amounts of suffering for them and their relatives and associates, because of decreased life expectancy and decreased length of the period of well-being and effectiveness.

The molecules that we introduce into our bodies by way of the foods that we ingest are especially important. I have become interested in these molecules in recent years. After I had graduated as a chemical engineer from Oregon Agricultural College, I came to the California Institute of Technology in 1922 and began graduate work on the determination of the structure of crystals by x-ray diffraction. I worked in this field and the theoretical field of quantum mechanics in relation to molecular structure for a decade or more. In 1930 this work was expanded to include the determination of the structure of gas molecules by the method of analyzing the diffraction patterns of electron waves. Then in 1934 I became interested in the hemoglobin molecule and other proteins, and in 1936 Karl Landsteiner got me interested in the field of immunology, in which I worked for about ten years. During the following decade I

worked on the hereditary hemolytic anemias, especially sickle-cell anemia, and then for another decade on mental illness. Toward the end of that time, when I had been working on mental retardation and schizophrenia, I learned about what Hoffer and Osmond had done in Saskatoon, Saskatchewan in the control of schizophrenics by giving them a thousand times the amount of niacin or niacinamide, the pellagra preventive factor, that is usually recommended - as much as 17,000 mg per day, rather than 17 mg per day. The idea that a vitamin, a substance that I had always thought of as an organic compound that is needed in small amounts for life, could have important additional effects when taken in a thousand times the amount needed to prevent death by the corresponding deficiency disease astonished me. This idea seemed to me to be something new in physiology and medicine. I was astonished enough to start reading the literature, and I found that there were reports about many other substances affecting the functioning of the brain when they were taken in larger than usual amounts. For example, Milner had shown by a double-blind study that a gram of ascorbic acid per day given to schizophrenic patients led to a statistically significant greater improvement than the placebo that was given to similar schizophrenic patients. Glutamic acid taken in amount 10 grams per day was reported by several investigators to have a significant effect on the intellectual ability of borderline mental retardates, and many other substances were shown to affect the functioning of the brain.

These facts seemed to me to be so important that I invented

a word - orthomolecular, meaning having the right molecules in the right amounts. In 1967-1968 I published two papers, one entitled "Orthomolecular Somatic and Psychiatric Medicine" and the other "Orthomolecular Psychiatry", in which general arguments about dependence of chemical equilibria and rates of reaction on the concentrations of the reacting substances were advanced as the explanation of the value of large doses of nutrients and other substances normally present in the human body. Now we have an orthomolecular medical association and a journal of orthomolecular psychiatry, and there are orthomolecular institutes in several cities in the United States.

The brain is probably the most sensitive of all organs to change in its molecular composition. There are no doubt a great many molecules that must be kept in about the right concentration in order that the brain function well, and we have developed mechanisms to this end. In both guinea pigs and human beings these homeostatic mechanisms function so well that the intake of vitamin C can be varied a thousandfold with only a twofold change in the concentration of vitamin C (ascorbate ion) in the brain cells. Only in the last stages of scurvy, after prolonged deprivation of vitamin C, does the concentration of ascorbate in the brain fall sharply. The twofold range of concentration may not seem to be important, but in fact it probably is important, for really effective mental function, to have the concentration of the ascorbate at the high end of this range, corresponding to a high intake of the vitamin, rather than at the low end.

I could give many examples of orthomolecular medicine, but I shall restrict myself to a few. There is a disease called tardive dyskinesia, which is caused by the drugs that are given to young people, especially, to control mental illness. Tardive dyskinesia is a very distressing disease, because the young people find that the involuntary movements, especially the repeated extrusion of the tongue, make it difficult for them to go out in public. It was reported just a few months ago that an intake of 10 grams of choline per day controls tardive dyskinesia in many patients. Choline, while not a vitamin, is, of course, important to the brain. Acetylcholine was the first of the neural transmitters to be discovered. The usual intake of choline in food is about a gram per day, and the human body can also synthesize choline, so that the dosage of 10 grams per day is not an excessive amount. This increased intake may lead to increased synthesis of acetylcholine or in some other way influence the action of acetylcholine. Studies ought to be made now of the possible value of a high intake of choline for other neurological diseases.

Also, C.R. Burch, a well-known physicist who invented the Burch microscope, has discovered by experimenting on himself that his epileptiform seizures can be controlled completely by an intake of two grams of inositol per day. Inositol is an orthomolecular substance, present in some foods, and it is understandable, as with choline, that changing its concentration might be effective in controlling neurological diseases.

At about the same time that I was working in the field of orthomolecular psychiatry I became interested in vitamin C in relation to the common cold. Irwin Stone, a biochemist who was then living on Staten Island and has now moved to Mountain View, California, wrote to me, a dozen years ago, sending me copies of four papers that he had published in 1965 and 1966 about "hypoascorbemia, a molecular disease". He gave some arguments to the effect that the natural intake of vitamin C is perhaps 100 times as great as the usually recommended intake. He suggested that I would be protected against the common cold if I were to take 3 grams of vitamin C per day. My wife and I tried this regime. It was clear that it did protect us against the common cold. In 1969 I was asked to speak at the opening ceremonies of a new medical school in New York - Mt. Sinai - and in my talk there I mentioned that by taking large doses of vitamin C you could prevent the common cold. A physician on the staff wrote a strong letter to me about encouraging the vitamin quacks, on whom the people of the United States waste six hundred million dollars a year, and asked if I could point out any double-blind study that had shown vitamin C to have any greater value than a placebo. I had not checked the literature about the common cold before 1969, but I began looking in the literature, and found that four double-blind studies had been made, each of which showed that vitamin C had more value than a placebo. When I pointed this out to the physician in New York, he refused to accept the evidence. I was so impressed by this display of bias and by the misrepresentation of the facts in the medical textbooks and the reference books that I wrote

a book about vitamin C and the common cold, published toward the end of 1970. This book "Vitamin C and the Common Cold", was followed in 1976 by a larger one "Vitamin C, the Common Cold, and the Flu". In the meantime Irwin Stone had published in 1972 his book "The Healing Factor: Vitamin C Against Disease".

During the years from 1970 on I was in correspondence with members of the Food and Nutrition Board of the National Research Council-National Academy of Sciences, U.S.A., which every five years puts out a report on nutrition with recommendations about the daily intake of various nutrients, including vitamin C. In earlier years this Board had recommended 75 mg per day, and in 1960 they were recommending 60 mg per day for an adult. In its publication the Board states that the amounts recommended are enough to prevent for most people the corresponding deficiency diseases, and also states that vitamin C in large doses has no value in protecting against the common cold or any other disease. I pointed out that epidemiological studies have indicated that there is a considerable improvement in health and decrease in the age-specific mortality accompanying the ingestion of even an additional 100 mg of vitamin C per day. In 1974, just when I thought that I might be making some progress with the Board, the Board responded by issuing new recommendations, dropping the recommended intake of vitamin C from 60 mg to 45 mg per day. I have no explanation for this action.

There are many reasons for believing that the human body

requires, for optimum functioning, about 10,000 mg per day. One argument is based upon the fact that most animals manufacture vitamin C. The amount manufactured by an animal is proportional to its body weight. A 70-kg goat manufactures 13,000 mg per day, and in addition gets a considerable amount in its food. Other animals manufacture between about 4 grams and 20 grams per day, calculated to 70 kg body, with average about 10 g per day. This is the main reason why I myself take 10 grams per day - I do not believe that the animals would manufacture ascorbate in this amount if it were not important for their health that they do so.

Irwin Stone in his book has discussed the many published reports about the control of viral diseases and bacterial diseases by large doses of vitamin C. Probably the most important study in this field is that carried out by Dr. Morishige of Fukuoka Torikai Hospital, Fukuoka, Japan, with collaboration of Professor A. Murata of the Agricultural College in Saga, Japan. Dr. Fukumi Morishige had made a study of vitamin C in relation to wound healing while he was in medical school. When he was working in another hospital in Fukuoka he tried giving various amounts of vitamin C to surgical patients who were received transfusions of whole blood. He observed what seemed to be a protective effect against serum hepatitis, and when he became the Chief Surgeon of another hospital, Fukuoka Torikai Hospital, in 1967 he carried out some systematic studies, with some surgical patients who received transfusions of whole blood receiving little or no ascorbate and others receiving large amounts. The incidence of serum hepatitis in the patients who received little or no vitamin C was

none among the seven percent, whereas there were / patients, in a series of 1380 who received blood transfusions after surgery, who had been given two grams per day or more.

A striking example of the value of vitamin C in preventing and treating disease is provided by the work of Dr. Ewan Cameron, Chief Surgeon in Vale of Leven Hospital, Loch Lomondside, Scotland. Dr. Cameron developed the idea that a considerable control of cancer might be achieved by stimulating the body's natural protective mechanisms. In 1966 he published a book on this subject, "Hyaluronidase and Cancer", in which he emphasized the possibility of strengthening the intercellular cement in the normal tissues around a malignant tumor by inhibiting the enzyme hyaluronidase that is liberated by the malignant cells, and that attacks the hyaluronic acid of the intercellular cement that binds the tissues together. Then in 1971 Rotman suggested to Cameron that vitamin C might be involved in the production of an inhibitor of hyaluronidase, and I gave a lecture in which I said that Cameron's goal might be achieved by the ingestion of large amounts of vitamin C, in that the intercellular cement is strengthened by fibrils of collagen, and we know that vitamin C is required for the synthesis of these collagen fibrils. Cameron read an account of my lecture that was published in The New York Times, and wrote asking how much ascorbate to give to the patients. In November 1971 he began cautiously administering 10 grams of vitamin C per day to a patient with terminal cancer. The patient responded well, during and/the next few months he tried the same treatment with other patients.

He now has given ascorbate as the only therapy to more than 500 patients with advanced cancer, and to a smaller number with cancer at earlier stages. The results are very promising. In a comparison of 100 patients with advanced cancer who received 10 grams of vitamin C per day and 1000 matched controls, the same age, the same sex, and the same kind of cancer (10 controls per patient) who were treated in the same way, by the same physicians, and in the same hospital except that they did not receive ascorbate, the ascorbate-treated patients have lived on the average 300 days longer than the controls. Fifty times the fraction have lived more than a year after being pronounced terminal - 22 out of 100 ascorbate-treated patients and 4 out of 1000 controls. In 1974 Morishige in Japan began the same treatment, and his observations on the first 55 patients with advanced cancer to be treated with ascorbate are essentially the same as those reported by Cameron.

The use of ascorbate and other nutrients in controlling cancer needs to be thoroughly investigated. We do not yet know what the best dosage of ascorbate is for cancer patients, nor do we know about possible effectiveness of other vitamins, such as vitamin A. In our Institute we have been studying nutrition in relation to skin cancer in mice, caused by ultraviolet light. We find that there is a significant decrease in the number of malignant tumors developed by the mice when they are transferred from ordinary mouse food to a diet of raw fruits and vegetables. The increase is far greater, however, when 2.5 percent of sodium ascorbate is added to the diet of raw fruits or vegetables (or

to the regular mouse food). The mice on the best diet have only  
as many  
17 percent/malignant tumors as those on ordinary mouse food, and  
we think that it might well be possible to protect them completely  
against skin cancer caused by ultraviolet light by finding the optimum  
diet.

I believe that by improvement in nutrition, especially  
increased intake of vitamin C, and by other health practices it will  
be possible for people to remain in good health for 25 years longer  
than at the present time. I think also that it is likely that people who  
suffer from handicaps of one sort or another can show great improvement  
in their condition by following the appropriate nutritional regimes, and  
that in this way the amount of suffering in the world can be decreased  
significantly.