



Henry Borsook

—How It Was

The Institute Archives under the direction of Judith Goodstein has now initiated an oral history program. The staff began by inviting a number of emeritus professors to share their memories with them. One of the first completed accounts in this program is from Henry Borsook, professor of biochemistry emeritus, who was interviewed by Mary Terrall. Borsook, noted for his work in protein synthesis and for his contributions to the field of nutrition, was born in London, England, in 1897, and came to Caltech in 1929. After his retirement from Caltech in 1968, he continued his research until 1978 at the University of California at Berkeley. The Borsooks are now living in Santa Barbara.

E&S has made a shortened version of the original transcript and presents here the second of two parts.

Mary Terrall: When did you begin working on vitamins?

Henry Borsook: The work on vitamins was extracurricular, and it began when I first came to Pasadena in 1929. I found that the doctors around town really didn't know anything about nutrition and certainly didn't know anything about vitamins, and I felt that vitamins were among the most important medical discoveries of the century. So I used to do a lot of public lecturing in the evenings to groups of doctors and nurses and teachers, and then we did a little medical research on the effects of this vitamin or that vitamin.

Then the war came and I was asked to serve as a member of the Food and Nutrition Board, on which I served all through the war. The most important work that Board did was drawing up the table of Recommended Daily Allowances of proteins, vitamins, calories, and so on. This was of practical importance, yes, but it also had a profound ideological importance because it said that a

good diet doesn't consist of food but consists of providing amounts of certain essential nutrients, if you like, and it doesn't matter where you get them from.

This was really a revolution in the whole nutritional concept. It was resisted by some people on the Board and by the Department of Agriculture. At first, because of the great political influence of some of these people, the Recommended Daily Allowances were tailored in some respects to what a person could get from what was considered to be a good diet, rather than what you need. But on the whole we succeeded in making this important distinction between what is needed to prevent or protect against a disease — like beriberi or rickets or scurvy — and how much would be desirable for what we would say was approximately an optimal diet.

Take vitamin B₁. You give people a certain minimum amount, and they won't have beriberi or B₁ deficiency disease, but their growth curve is moderate. If you give them three times that much, the curve is much steeper, and more importantly, senility is postponed, though they don't actually live longer. So this is why they were called Recommended Daily Allowances, whereas the Department of Agriculture and the Food and Drug Administration held out for some years for what they called Minimum Daily Requirements, which were the minimum required to protect you against disease.

MT: So the Recommended Daily Allowances would be much higher.

HB: Yes. For instance, it's known that an average-sized man or woman needs 0.6 of a milligram of vitamin B₁ to protect against getting beriberi, but the Recommended Daily Allowance is 1.5 milligrams. Ten milligrams of vitamin C will prevent anybody getting scurvy, but the Recommended Daily Allowance is 50 milligrams; 2 milligrams of niacin — nicotinic acid — will protect against pellagra,

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but the Recommended Daily Allowance is 20 milligrams; and so on all the way through.

Of course, one had to take into account some individual variations, so this was a kind of safe figure for most people in the population, to give them what we thought was an optimal diet. But the Department of Agriculture had said, "You can't get these allowances from just any reasonably good diet." So this led to enrichment; we enriched flour, we enriched milk, and so on.

MT: There was a lot of opposition to that, wasn't there?

HB: A great deal of opposition. I think that is largely gone now, but for a number of years there was a continual argument. We pointed out that if people are going to get all their vitamins and minerals as well as protein and calories from their food, they'd have to eat altogether too much — much more than what is really good for them. You couldn't get the Recommended Daily Allowances of vitamins and minerals short of 3,000 calories a day, and for the kind of sedentary life that most of us live that's altogether too much.

The field of nutrition that's been most neglected is the calorie requirement. There has been only one good determination of what the calorie requirement is in humans, and this was in young men, 25 years of age on the average, doing 400 calories of physical work a day. And it was shown with them that if you make sure they get all the vitamins and minerals and protein, their calorie requirement, with about 10 percent surplus, is only 2,200 calories. Now when you think we've taken on a kind of responsibility to prevent calorie malnutrition (I won't give it a fancy name like starvation) in Third World countries, the difference between 2,200 calories and 2,500 calories represents hundreds of 10,000-ton ships of food when you're dealing with millions of people.

MT: Let me go back just a bit to before we were in the war, when you wrote that long document, the Memorandum on National Defense. Do you remember that? It was June 15, 1940.

HB: Yes. It was that memo that had me invited to serve on the Food and Nutrition Board.

MT: What prompted you to write that memo originally?

HB: Just from my observations of patients, reading the literature of malnutrition, and studying the results of feeding different levels of vitamins, particularly, and of minerals too, to experimental animals. It was clear to me that most of us who weren't using vitamin concentrates were not getting enough. This is what led to that memorandum.

MT: And what response did you get?

HB: It was resisted, of course, but nevertheless there was a really enterprising and liberal member of the Department of Agriculture who had a lot of influence; his name was Wilson. And he read it and although he was a little uncertain about whether he would agree with me or not, he felt that I would be a good influence on the Board. And so I was invited to serve on the Food and Nutrition Board. They listened to me, but this memo didn't mean they paid much attention. I was not a lone voice, though; there were other people who felt, as I did, that we couldn't rely on diet to provide all the vitamins and minerals we needed.

MT: One of the things that you said in that memo was the importance of a national nutrition program.

HB: Yes, because the troops should have a good diet and so should people working in munitions factories and airplane factories. I think the fact that those people couldn't get enough vitamins and minerals contributed toward acceptance of the Recommended Daily Allowances.

Even in the 1940's it was so easy to add synthetic vitamins and minerals. People could see that all the bread and flour the troops got was enriched, and vitamins A and D were added to the milk they got, and so on. They were playing it safe. Why not, you know?

Then I did a study among aircraft workers at Lockheed. Considering that we were doing it with human beings, the plan of the experiment was all right. There were two groups, and no one knew which group he was in. Half of them got placebos and half of them got the vitamins, and we kept track of their records. At the end of the year it was clear that though there was no dramatic effect of the vitamins — because after all they were not vitamin-deficient people — the performance of those who got the vitamins was better than that of those who got the placebos.

MT: On the job, you mean?

HB: On the job, yes. Their production, absenteeism, morale in general — however you measured it — was definitely better. But when the war was over, all of that stopped. Of course, vitamins now are staples; everybody buys them; they even get them at the supermarket.

MT: I have just a few more questions on the war business. Was it directly the result of the National Research Council committee that the food for the troops was fortified?

HB: Yes. It was partly that Memorandum on National Defense that led to my being invited to come to Washington to talk to some Army and Navy officers, and even to the

Army base in Los Angeles, in terms of what they needed and of how they could get it. And of course I am still, I think, with the minority among nutritionists who insist that the easiest, cheapest, best way to get your vitamins is in a pill. Then you're sure, it's much cheaper, and you can then eat what you like.

You know, it's curious — sometimes when I talked to women about nutrition I'd tell them this, and I'd say, "You get an additional freedom then," and they didn't like it. They felt, I suppose, it was a reflection on their housekeeping and their preparation of meals. I'd say, "You can just give your husband and children vitamin pills for breakfast. Then all you have to be sure of after that is that they get milk or cheese. They can eat what they like after that, as long as they get enough to eat and there's enough variety." And they didn't like that.

MT: Who were the other people on the NRC Board?

HB: I should say the two most important people were Jolliffe and Wilder. They were doctors. Elvehjem later joined the Board. He was from Wisconsin, and he was there chiefly to protect the agricultural interests. I would say he was responsible for having the riboflavin in the Recommended Daily Allowances so high. It was amusing to us: Every man who worked on a given vitamin, like Glen King on vitamin C, or Elvehjem on riboflavin, or Jolliffe on B₁, always wanted the Recommended Daily Allowance for that vitamin way up — and they probably were right. They knew the benefits from giving a lot, especially when it was cheap. And yet the resistance — I remember one time during the war there was an outbreak of scurvy in Maine in the winter. So we said, "Well, that's easy to fix. You just send a truck up there with a load of synthetic ascorbic acid. It's made in the United States, so it's available. You'll wipe that scurvy out in a day." And would you believe it, one of the members of the Board got up and said, "No. I would rather see them have scurvy than not get their vitamin C from food."

What they did was to drag a lot of concentrated orange and lemon juice up there. I said, "Well, that's all right. It's a lot more expensive, but it's all right with us."

MT: You had worked on vitamin B₁, hadn't you?

HB: Yes, I'd worked on it in two respects. One of them was for the treatment of a disease called trigeminal neuralgia, which is a disease of the nerve that affects the face.

MT: Is that the same thing as tic douloureux?

HB: Yes, and it's very painful. I thought I'd like to see whether giving these people massive doses would help

them. The clinic, as it were, was at Caltech, right opposite Morgan's office, so he took a great interest in it.

MT: What was the feeling about having clinical experiments going on at Caltech?

HB: Morgan didn't care. He was very easygoing and, you see, this was done under the nominal auspices of Dr. Kreamers, who was the Institute physician, and I was sitting in on it too. I think the outcome of it all was that about 25 percent of the patients were definitely benefited.

MT: Was this with very high doses?

HB: Yes, we were giving 50 milligrams by injection daily, and the patients would come five days a week. And, as I say, we were satisfied that about 25 percent of these people were definitely benefited. Maybe that's all you have a right to expect, because the fundamental lesion is a restriction of the blood supply to that particular part of the brain.

MT: How did people hear about it?

HB: Through their dentists. People with trigeminal neuralgia would commonly go to a dentist because it looked like a toothache. And there was one dentist, by the name of Wiggins (he is now dead, I think) in Pasadena, who had a special interest in that disease. He used to inject alcohol into the nerve and destroy the nerve that way, which destroyed the pain but usually caused some paralysis as well. He was very good about it, and he sent us many patients, so it spread around.

MT: At this time were there other people at the Institute working with vitamins?

HB: No, I was the only one.

MT: I guess it was also around that time that you wrote the vitamin book. (*Vitamins: What They Are and How They Can Benefit You.*)

HB: Yes. As I say, for ten years I'd been lecturing on vitamins to medical audiences, nurses, and I had written it up thinking that it would be a good thing to get it published. It was turned down by one publisher. At one lecture, by chance Upton Sinclair was there, and afterwards he came up and he said, "Have you published this?" I said, "No. I've tried and failed." He said, "Would you mind, if you've got a manuscript, if I sent it to my publisher?" "Well," I said, "I'd be delighted." So we sent it to Viking Press with his recommendation, and they accepted it. That was very lucky because it was a kind of best seller. We sold about 40,000 copies. For those days,

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for that kind of a book, that was really remarkable. And it was very lucky in another respect because the royalties enabled me to send my daughter to college, which might have been difficult otherwise. It was the first nontechnical book on the subject written for the general public.

MT: Did you enjoy doing that sort of thing?

HB: Well, at that time I did, yes. Since then I've been asked to bring it up to date, and I don't feel like it. But it's still selling as a paperback. Just a month ago I got a \$144 royalty check.

MT: You've never revised it?

HB: I've never revised it, and the reason I haven't — oh, it needs to be brought up to date in a number of respects, but there's nothing wrong in it even now. Whatever it said is true, but I could say much more than I did then, though it would have to be a book twice as thick. Since then there has been so much writing about nutrition I don't feel the same need any more.

MT: After the war, at the Institute, when Millikan really retired and DuBridge took over, can you point out any changes — like the ones you were talking about before — the loose way the Institute was governed?

HB: No, it changed very little. It had to change some because of our funding. Bookkeeping had to be much better, much tighter. After the war I got first an Office of Naval Research grant, and then a National Institutes of Health grant — and so did everybody else. And there was Institute overhead and tight bookkeeping. So that inevitably changed things. But as far as the actual administration of the Institute, we didn't feel it very much. I served a term on the Faculty Curriculum Committee, and DuBridge would come, but he was just one other member. He was very good; we all liked him.

Beadle introduced more administration in the Biology Division than we had when Morgan was running it. Beadle wanted to be the boss, whereas Morgan didn't. But it wasn't really serious. All my time at Caltech I felt the administration was there to help.

I learned how different it can be when I went up to Berkeley, because there you almost have the feeling that the University is run for the benefit of the administration. Caltech was the reverse.

MT: Let's talk about the isotope work a little bit. You've referred to it a few times. This was a direct outgrowth of your earlier protein synthesis work?

HB: Well, it was an outgrowth of my interest in the prob-

lem of the synthesis of protein, and isotopes seemed to be the way to do it. And so as soon as the war was over, and I was back in the lab, I could buy isotopes from the Atomic Energy Commission. They were made at Oak Ridge, and a private company handled the business for them. But it was at cost. We bought the isotopes from them — carbon-14, for instance, in the form of carbonate. We had to convert that into an amino acid before we could use it. I had Peter Lowy, who is an organic chemist, to do that part of the work. And then Geoff Keighley, who was an old friend from Toronto — I had him come out, as a matter of fact, years before — he was very good at mechanical things, so before we could buy Geiger counters and such like, he built them for us to use.

The outcome of the work on the synthesis of protein had an unexpected development. I was studying the synthesis of hemoglobin, and I found that if I added the serum of an anemic animal to the culture medium I was using, it greatly speeded up hemoglobin synthesis. This led to the discovery of the hormone erythropoietin, which is the hormone that regulates the production of red blood cells. That discovery was a direct outcome of the work with isotopes, studying the synthesis of hemoglobin.

MT: You worked with hemoglobin for quite a long time?

HB: Yes, and I have been ever since, as a matter of fact, because it seemed to me the best protein to work with for a number of reasons. There is the obvious intrinsic interest. It's a protein easy to isolate. And it was of clinical interest in anemia and such things.

MT: The medical application is one of the attractions?

HB: The curious thing is that there are no medical applications except by way of interpretation — for the reason that there isn't enough pure erythropoietin in the whole world to treat one patient. It's so hard to come by, and it's protein that hasn't been synthesized. And so its chief value is in understanding certain diseases, and the analysis of the blood for erythropoietin is one of the standard things that clinical labs now do. But to use it as a medicine, as was at one time hoped, is still not possible. How can they get enough erythropoietin? You collect the urine of people who have hookworm, and because you have to have an awful lot of urine, that means an awful lot of people. Then you extract it from the urine, purify it, and so on. The government still has a contract with the Children's Hospital in Los Angeles for making the concentrates. If you apply to NIH for a grant of this erythropoietin, they'll give you a few thousand units, but a few thousand units is only enough to treat mice; not enough even to treat rabbits.

MT: Did you then get into other areas of hemoglobin research?

HB: Yes. Hemoglobin is in the red cell, but it's not made in the mature red cell. (The mature red cell doesn't make any protein.) It's made in the bone marrow. The red cell is preceded by six nucleated cells and one cell that is not nucleated, so there are seven precursors. I was interested, and still am, in that process. In which of these precursor cells is hemoglobin made? It's not made in all of them. It's made in the middle of the series — not at the beginning, not at the end of the process. What regulates the rate? There are still a lot of unanswered questions about the method of going from one stage to the next.

MT: To get back to the 1940's again — that was when you started developing the multipurpose food?

HB: Yes, and that is really the story in its beginning of Clifford Clinton. Clifford Clinton was born of missionary parents and, as a child in China, he had seen famine, and he'd made a boyhood resolve that if he could ever do anything about helping hungry people, he would. So it was not surprising that when he grew up he went into the restaurant business. He has a couple in Los Angeles and I think one in San Francisco. (Clifford Clinton is not alive now, but the restaurants are still going, still using the name "Clifton.") During the depression — '30, '31, '32 — he advertised that anyone who would come to his cafeteria between 2:00 and 4:00 could get a free meal. Later he felt it was being taken advantage of, so he charged a nickel for a meal. The last time I ate there, which was more than ten years ago, the menu said, "You can order what you like — and you can pay what you like."

When the war came, with the enormous expansion of the armed forces from a couple of hundred thousand to twelve million, the Army needed advice on how to feed a lot of people in camps quickly. And so they called in consultants from the restaurant business, and Clinton was one of those consultants. We never met during the war, but we knew of each other.

Then, one afternoon in early 1945 — he'd phoned first — he and his wife and his public relations man came to see me. And before he began to talk, his wife intervened and said, "I want to apologize because my husband is coming here with a perfectly ridiculous proposal. I tried to dissuade him from coming, but he's very stubborn, and so I want you to know that I feel a bit ashamed." So I said, "Well, you needn't be. You're here. Make yourselves comfortable and let's listen."

So Clinton began to talk, and he said that anybody who

thought about it could see the war was coming to an end, that in the countries where the war had been going on a lot of people were going to be hungry, that there was going to be a shortage of food in Europe and in Asia, and he wanted to do something about it. And he said he wanted me to do this — I was to devise a food where a meal would provide one-third of the Recommended Daily Allowances of everything, but it was to weigh not more than two ounces and it was to cost not more than three cents, it was not to offend any religious taboo, there should be an abundant supply of all the ingredients, and it wouldn't draw on the kinds of food Americans are accustomed to eat. (I said, "You needn't worry — at that price.") Also it had to have an indefinite shelf life, be possible to eat in a variety of ways, and not take any special equipment to cook — a can of water and a stick of wood underneath should do it.

And so he went on. And I turned to his wife, and I said, "Well, it's not so wild as you may think, but there are two restrictions I would put on it. It's scientifically impossible to provide a third of the Recommended Daily Allowance of calories in two ounces of anything. It is just not possible. We need about 700 or 800 calories as a minimum, and the most that two ounces would supply would be about 140 or 150 calories. Secondly," I said, "I don't think it would be practical to put vitamin C in because we really don't know how to keep it." At that time we didn't. But I said, "Otherwise, we could provide protein that's as good as meat or milk, and we could add all the vitamins and minerals that they need in two ounces, and I don't think it need cost more than about three cents a meal." So he agreed and gave Caltech the sum of \$5,000, which I was to use to develop this food.

The food itself was no problem. I had a pretty good idea how to do it. It had to be a vegetable protein; animal proteins were too dear. The best vegetable protein was soybean protein, and I knew that during the war we — the government — had greatly expanded the growth of soybeans for their oil. But after the oil was extracted, what was left was thrown down the sewer. It was just wasted. So I knew this would be very cheap, and I knew it was available in large quantities. The vitamins and minerals I knew were also very cheap, and there would be no problem about adding them.

What I wanted the money for was to hire a cook who would develop recipes on how to use this food, how it should be cooked in different ways. And that was done. At the end of a year it was all ready, and we had a whole lot of recipes. One of the fruit and vegetable dehydrator companies in Los Angeles undertook to make it according to

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the recipe that I had drawn up, and that was done. We decided to call it “multipurpose food”: MPF.

Neither Clinton nor I wanted to patent this food, and we agreed that we would give the information to anybody who asked for it. But that wasn’t going to get the food to hungry people, so Clinton, who was a religious man, set up this Meals for Millions Foundation, a nonprofit organization. I was one of the cofounders with two or three others. He hired a woman by the name of Florence Rose and his publicity man, Ernest Chamberlain, was the other, who really were the Foundation. They sent out the appeals for money, they raised the money, bought the food, and so on.

MT: So they raised money from other sources. It wasn’t just his money?

HB: No, I don’t think he put in much money after that, but it was certainly his idea, both to get such a food and then to set up the Foundation to give the food to people who needed it. And I know when we had the food ready we thought it would be useful if the Food and Nutrition Board would approve of it. We sent some to them, and they said, “No. We believe that a good diet consists of meat, milk, fresh fruit, fresh vegetables, and this is not that.” So for more than ten years, we had no government support — in fact, government opposition. So the money was raised from private groups. Two large charitable organizations very soon began to give us large sums of money — \$50,000 to \$100,000 at a time — and we would send the food where they told us to. They were Catholic World Relief and Church World Service.

MT: So other organizations made the arrangements with the countries where the food was going?

HB: Yes. After we had the food, they arranged for the shipping, but we were to attend to its being shipped to the places where they said they wanted it to go. We went along that way for a number of years.

There was one very gratifying experience. At one time my wife, my daughter, and I were traveling in Germany, and we were in a restaurant. You know how people talk to each other, and a man asked, “Where do you come from?” “We come from California.” And he said, “Oh, in 1946-47 I was in an orphanage in Germany, and we were fed this wonder food from California.” And it was our multipurpose food. And there were other like incidents.

From the very beginning I had insisted, and in our publicity made it clear, that the formula I had put together was only one example. I was confident that in many backward countries where there were many malnourished people, some other food just as nutritious could be put together

from what they had, if they would only use what they had.

And in south Asiatic countries, India, they don’t have soybeans. The actual director of the Foundation was Florence Rose, and we sent her around the world. She had no trouble getting the Japanese to make a Japanese equivalent, and they did a very good job. And then in India, she got the head of their Central Food Technological Institute to put together an Indian version of MPF, and he did a first-class job.

I think we gave this man about \$5,000, and he put together — out of peanut meal and chick pea meal, adding vitamins and minerals — a food that was every bit as nutritious as ours. He did a very good job of testing first on mice and rats, then on children who were malnourished. Then he persuaded an Indian businessman who had some money to put up a pilot plant near Madras, and the city of Madras undertook to buy the whole production for use in their school lunch program. They got going, and the Minister for Agriculture for India from New Delhi told people from the provinces to come down to Madras, look, and copy it.

Then along came some representative from CARE, who said to the City Council of Madras, “Look, we’ll give you all the dry skim milk you want for nothing. Why do you want to spend your money on this food?” That killed the project for quite a long time, but it has started up again. Two missionaries in northern India, where they have soybeans, have arranged for the manufacture, and they’re beginning to get it used and widely distributed.

MT: Now?

HB: Yes. They did this entirely on their own, without any connection with us at all. But now, to come back a little, it was clear that charity would only go so far, and it would be much better if these people learned how to help themselves. So we set up a school at the Meals for Millions Foundation, in Santa Monica, where we teach three classes a year. It runs for 12 weeks with about a dozen students from different parts of the world, on scholarships of one kind or another, and they learn how to make food like MPF from what they have. We do more than that. (I say “we,” but I have really nothing to do with it. The idea of the setting up of the school and so on was all the work of other people.) We devise machinery which they can use in their villages, and some of it they could even make themselves, so that they really can help themselves.

MT: When this program was being set up, how involved were you in the organizational part of it in terms of contacting foreign governments and getting programs started?

HB: I had nothing to do with that. The missionaries did that for us — Church World Service and Catholic World Relief.

MT: They were in it from the beginning?

HB: Very early. At first, Clinton with his church connections had connections with missionaries, and so we would send it out to them. I had nothing whatever to do with that, though later on I was in correspondence with Subramanjan, who did the job I mentioned in India, and with the Japanese people. But that was technical really, not much more than that, and also kept some people from making mistakes. You see, the soybean people had tried something like this, but they made the mistake of trying to make soy flour compete with wheat flour. Well, it doesn't make bread. It's not like wheat. And I persuaded them that the best way was not to make flour, but grits — small particles that could be used in soup or as a meat extender, lots of ways. And that is the way to use it. As a matter of fact there's a Texas hamburger chain that uses it in their hamburgers, and it's quite a good meat extender, has the right flavor and so on. The Meals for Millions Foundation was founded in 1946 and miraculously is still going, stronger than ever, really.

The Clinton family has nothing to do with it any more, and I think I'm probably the only one of the original group who's still alive. I'm a member of the Board still and on one of their committees. And now — and I must say I don't know the answer to this; maybe there isn't one — the most important cause, the serious cause of malnutrition in the Third World is poverty. We can overcome the ignorance if we can overcome the poverty. And maybe we could overcome the effect of the poverty to some extent, if we could persuade the governments to get a small businessman to set up a multipurpose food plant, and hand the food out. But I suspect these people are so poor that it would have to be subsidized.

MT: Even at three cents a meal?

HB: Oh, that's much too much. When you think of a man and his wife, with five children, on an annual income of \$100 — they can't afford to spend 21 cents for each meal daily. So it's got to be much cheaper than that. This is where we are now. To overcome malnutrition is no technical problem. We know how to do that, and the means are available. But these people can't afford it.

MT: Has MPF ever been used in this country?

HB: It was used a little, not much now. In some places after the war when the GIs came back, as you know, many

of them were married, there was a baby, and the amount of money they got wasn't much. So we set up a store near Columbia University in New York and sold quite a lot, and we kept it going until that generation of GIs had passed through. It's still being used, for instance, on Indian reservations near Tucson. There's a remarkable woman there, Mary Diamond, who's working with those Indians, and she is using it. There are a few other places like that, but for the most part there's no need for it in the United States.

MT: In the 1960's did your work continue along the lines of hemoglobin?

HB: Yes, along the lines of the hemoglobin and along the lines of the regulation of the process in the bone marrow. We had found, for instance, that under certain pathological conditions abnormally large cells were produced. How were they produced? At what stage in the process? This is the kind of thing. My work shifted from the mechanism of protein synthesis to the mechanism of the regulation of these various stages of the process by which the red cells of the bone marrow and final red cells are produced.

MT: Was this work funded by the Public Health Service?

HB: Yes, and the Atomic Energy Commission. All the way from right after the war until I left Caltech. As a matter of fact, I took both those grants with me when I went up to Berkeley.

MT: When you retired and went to Berkeley, how did that come about?

HB: I had reached the retirement age at Caltech and the rule was, and I still think it's a good rule, that when you reached that age you no longer can work in the lab. Caltech is a small place. Well, my friends at Berkeley put up a lab for me and equipped it, and so I just simply transferred my grants, and that went on for about ten years, until my grants came to an end in the spring of 1978.

MT: You mentioned a bit about the comparison between Berkeley and Caltech.

HB: They are very different places. The impression I have still is that Berkeley is not a corporate entity. Caltech is a community. Berkeley is not. Berkeley is a number of individual departments, small groups, and their vision doesn't really extend beyond that group. The hand of the administration is very heavy. This is not to say that Berkeley isn't a great university, as judged by the number of really first-rate scholars they have there, but Berkeley isn't a place that you can feel you belong to or are loyal to. Caltech is. Or Caltech was, and I expect it still is. □