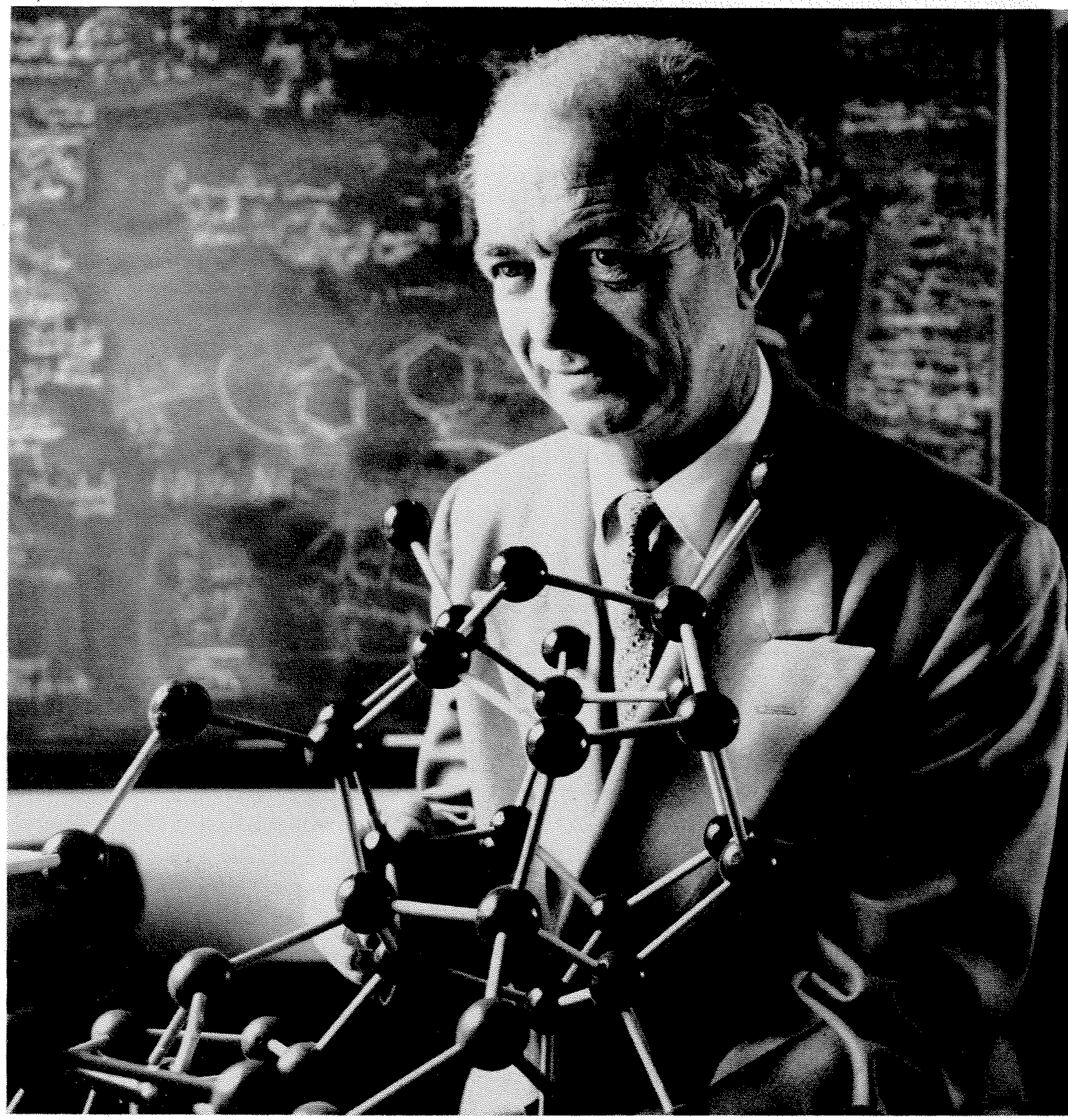
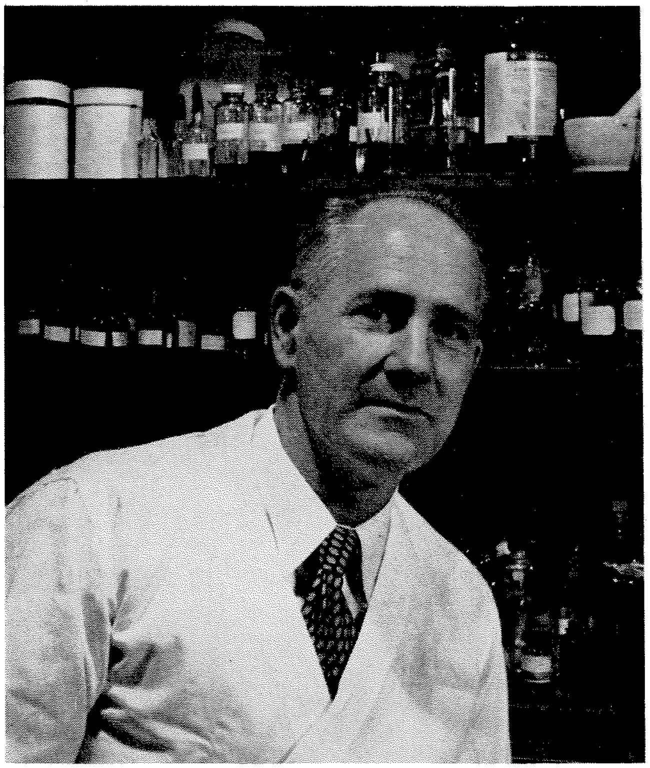


PORTRAIT OF A SCIENTIST

A tribute to Linus Pauling

by GEORGE W. BEADLE

WE HEAR A LOT about science and scientists these days. By some, scientists are believed to be peculiar people. Actually, scientists are merely people who work at science. And I want to emphasize the "people" part of the definition. Scientists *are* people. They obviously have special aptitudes, special interests, and a special kind of ambition. But otherwise, like new cars, they come in all varieties—all sizes, all shapes, all colors, all creeds, and all behavioral patterns. And, if an observation of a colleague of mine is correct, they end up with an equally wide range of spouses. In looking over a group of wives at a Caltech faculty party, he was heard to say, half to himself:



Portrait of another scientist—George W. Beadle, Professor of Biology, Chairman of Caltech's Division of Biology, President of the American Association for the Advancement of Science, and author of this article. "Portrait of a Scientist" has been adapted from a talk given by Dr. Beadle at the National Nephrosis Foundation Dinner in Beverly Hills, on March 25, 1955.

"You know, I believe professors marry a pretty random sample of women."

Scientists, like other scholars, are trained to be receptive to new ideas and to look at them objectively. Being human, they don't always achieve this ideal, to be sure, but their success in science does depend on freedom of inquiry. Follow the lead wherever it may take you. Search for the truth by every method you can devise. And don't be distracted. These are the credos of the scientist. That's why he is so insistent on his right to intellectual freedom—academic freedom, if he is in a university.

Maximum advance in science depends on free exchange of ideas. It is obvious that the chance of correctly fitting together the small bits of knowledge that are the component parts of a big advance will be greatest when the largest possible number of competent workers have access to all the small bits.

This is why so many scientists worry so much about our security system. They are afraid it will be so tight that, in addition to preventing a potential enemy from finding out what we're doing in those sciences applicable to military uses, it will seriously slow down our own progress by retarding internal exchange of scientific information.

The area of science that is subjected to "classification"—that is, available only to persons holding appropriate security clearances—should be reduced to an absolute minimum. A great many scientists believe we have already gone too far, especially in the classification of basic science. They would confine classification largely to phases of science dealing uniquely with military technology.

In addition to requiring that persons working with classified information be cleared, there has been a widespread trend towards requiring loyalty checks of persons working for government or receiving government support, even though they have nothing to do with classified information. The argument sounds convincing enough. "We don't want disloyal persons supported by government, do we?" Of course we don't. We all agree. The difficulty comes when we try to define loyalty. Too often a disloyal person is one who happens to disagree in an entirely defensible way with the then popular political and social views.

What does this have to do with science? A great deal. To take an example, the U. S. Public Health Service has in the recent past been following the practice of denying or terminating grants to universities in cases in which there was evidence of disloyalty on the part of the principal investigators. In the PHS practice, the reason for denial or cancellation is not given in individual cases. There is no statement of the charges, no mechanism for re-examination of evidence for errors, and no possibility of appeal. The practice is so inexcusably bad that there now seems to be real hope that it will soon be discontinued.

The National Science Foundation has a much more reasonable policy. It holds that it is the responsibility of the universities to which research grants are made to determine whom they shall have on their faculties. NSF inquires into the merits of the research and the professional competence of the scientists who do it, but it does not withhold grants for security or loyalty reasons unless an investigator has been convicted, through due process, of a crime involving the security of the nation. This is a sensible policy and one that can be administered fairly and objectively.

Universities do not wish to protect persons who are a threat to the security of the nation—it's the last thing in the world they want to do. But neither do they want their faculty members deprived of an opportunity to contribute to the nation's welfare on the basis of unsupported evidence of disloyalty or as a result of malicious backyard gossip. Universities have excellent records of doing responsible jobs in selecting faculty members of competence and good character. Society has a right to be, and should be, proud of them.

There is no way of determining how many competent and loyal persons are now prevented by unreasonable security and loyalty clearance policies from using their talents to maximum advantage. In science it is surely a large number. The public hears only about the big-name cases. But for every one of these there are dozens or hundreds of less-well-known persons about whom there is allegedly derogatory information, but about whose loyalty there would be no reasonable doubt if the information were competently and fairly evaluated.

There is another aspect of security-loyalty investigation policies about which I want to add a word. This is the misuse of such investigations for political purposes. The so-called game of numbers in which one political party finds it advantageous to boast that it has been responsible for the dismissal of more security and loyalty risks than has its rivals, is a game so dangerous to the survival of the principles of fair play and justice in our society that it should be stopped at once. It is gratifying that Mr. Harry P. Cain of the Subversive Activities Control Board has recently publicly recommended this and other much needed reforms. Those who know his previous record will realize that his present views represent a marked change of heart. Few people are in a better position than he to know the facts.

A contagious disease

A most unfortunate consequence of over-classification of scientific information, inadequate or poorly administered security clearance systems, misuse of loyalty checks, and failure to divorce these matters from politics, is the spread of suspicion and mistrust among us. This loss of faith in the honesty, integrity and character of our fellow men is a dangerous and contagious disease that weakens us at a time when it is so terribly important that we be strong.

The disease is not confined to science. It affects all of society and includes science only because science and scientists are a part of society. That is why I have insisted so strongly that scientists are people. They have the same hopes and aspirations—the same apprehensions and fears—as do other intelligent members of society. They want no special privileges. The intellectual freedom of science is no different in principle from any other kind of intellectual freedom. It is a counterpart of freedom of speech, of freedom of the press and of freedom of religion. None of these freedoms should be a freedom divorced from responsibility. No sensible person would claim otherwise.

But this is enough on science and scientists in general. There's much I've left unsaid. I'd like to discuss the question of whether by itself science is good or bad. (I think it is neither, although society, including scientists, can surely use it for good or for evil.) I've skipped the important question of whether or not scientists should have special responsibilities in determining how society is to use science (I believe they should have in so far as they have special ability and special knowledge—but no further.)

What I want to do now is to discuss a subject of much more immediate interest—a particular scientist.

We all know Linus Pauling is a great scientist—we've been told so many times. But do we all know *why* he is? I'm not going to try to give you all the reasons but I'd like to talk about some of them.

If we were to set out to construct a scientist like Linus Pauling, what kind of a set of directions would we follow?

The ingredients of greatness

Well, first, we'd have to start with outstanding intellectual equipment. We can't make it—we'd have to see that it was inherited. Then we'd add a superior training. A trained intellect is no good unless it has interest, so we'd add that. We'd make it a passionate and dedicated interest and we'd direct it toward chemistry. Greatness in science requires discrimination and good judgment—the ability to distinguish the important from the trivial. We must also have originality and imagination—the ability to see the problem as it has never been seen before and, from the new viewpoint, see the way to the solution. There must be a touch of intuition too, along with the creative ability essential to see how the big picture can be built up from the little pieces. Finally, we'd want to put in a good-sized piece of industry, for a scientist cannot become great without work. It may not be physical work, which is easy, but mental work, which is much more difficult. A successful academic scientist has to have ambition and drive—the ability to generate his own steam—for there is no one to tell him what to do or when he should do it.

But whatever are the ingredients of greatness in science, there can be no doubt that Linus Pauling has them.

What has he done with all his talent and his time? Plenty, I assure you. I'll mention a very few of his accomplishments.

For one thing he has spent a lot of time looking at the insides of molecules—figuratively, of course, since with even the most modern electron microscope most molecules are too small to be seen. He has studied the atoms that make up molecules—and the chemical bonds that hold them together. His book, *The Nature of the Chemical Bond*, is a classic. And even though he wrote it many years ago, it is still widely used as a standard reference.

His investigations of ways in which atoms are put together to make molecules and crystals were made with relatively simple molecules and crystals. Gradually the methods developed were extended to larger and more complex molecules—even to those out of which living things are built.

To a layman this may seem pretty far removed from the world he knows. But I assure you it is not. Pauling's work not only digs right down to the heart of theoretical chemistry but what he has accomplished is also of tremendous importance to all of us in practical ways.

Let me explain with examples. Everyone knows the importance to man of metals and their alloys. The preparation of alloys has been and still is largely an art, not a science. Metallurgists have found useful alloys by mixing metals in different combinations and in varying proportions. If they were fortunate, they got a good alloy. The theory of the structure of alloys was extremely complex mathematically until Pauling put his talents to simplifying it. His success in doing this has gone a long way toward making a true science of metallurgy.

Or to get still closer to home, it has been known for a long long time that our bodies are made of a great variety of molecules, many of them so large that a single one of them may contain thousands of atoms—perhaps in some cases as many as a million.

One category of these large molecules consists of proteins. Proteins come in thousands of varieties. Egg white is one. Each of us is unique partly because each of us has a combination of kinds of proteins slightly different from that of other individuals of our species. Proteins serve many important functions. One kind makes up the fibers of our muscles and its properties are responsible for movement by means of muscle activity. Another is essential in the oxygen-carrying mechanism of red blood cells. Others play an essential role in immunity to disease. Many of them serve as catalysts—enzymes—that regulate the chemical reactions that make up our life processes.

Molecular structures of proteins

Pauling's laboratory was the first to work out what we now believe to be correct molecular structures of proteins. This is an achievement that by itself has greatness for both chemistry and biology.

On the basis of his knowledge of proteins, Pauling was the first to suggest that one of the hereditary anemias of man results from an alteration of hemoglobin molecules—the molecules that give red blood color to our blood and that are involved in oxygen transport. By now there have been found more than half a dozen hereditary anemias, all having the same type of explanation. They are "molecular diseases" in the sense that their primary cause lies in modifications of a specific known molecule of the body.

In response to many infections, we build antibodies in our blood—proteins of specific kinds that incapacitate disease-producing organisms or molecules. The nature of this inactivation, so important in our defense against disease, has become clearer as a result of Pauling's work and that of his associates.

And finally, to get as close as science can get to the purpose of our meeting tonight, I want to mention Pauling's collaboration with the late Thomas Addis, with Addis' student Richard W. Lippman, and with others who have been interested in the workings of that marvelously complex and efficient organ, the human kidney. In this, Pauling has abundantly demonstrated how a knowledge of molecules and their interactions can contribute to a better understanding of the science and practice of medicine.

That's a pretty inadequate account of a small part of what Pauling has contributed to science. I hope it has been sufficient to give you an understanding of why he is a great scientist.

The human side

Linus Pauling is a wonderful example of my thesis that scientists are human. If you know him, you know that a scientist doesn't have to be a recluse who shuts himself up in a dark lab and forgets the rest of the world. You will know that a scientist can be a friendly person with a fine sense of humor, a genuine interest in other people, and a deep concern about problems outside of science. As I said before, scientists come in all types. In addition to inheriting and acquiring that unique combination of qualities that make him great as a scientist, Linus Pauling possesses an array of additional traits that make him an all-around "great guy." And those of you who have been privileged to know his good wife Ava Helen, know he didn't make a random choice when he won her hand.

I want to close by saying I regard it a great privilege to know and to be associated with Linus Pauling. I respect him as a great scientist and an outstanding scholar. I deeply appreciate him as an understanding colleague and as a true friend. And I admire the courage with which he stands by his convictions even at times when his views may not meet with popular favor.

I am proud to belong to the faculty of an institution with the foresight to see his greatness and the wisdom to give its development full freedom. I am proud that Caltech has a president who knows the true meaning of academic freedom and who has the courage to speak and act accordingly. I contrast our good fortune with the lot of a certain few of our sister universities whose presidents belie by their acts the fine-sounding words of their public utterances. I am grateful for a Board of Trustees that has not succumbed to the disease of mistrust and suspicion that could so easily undermine their faith in the wisdom of academic freedom and the rightness of liberal decency.