There are those who fear that the scientific investigator, allegedly cold of heart, devoid of respect for the intangibles of human nature, insensitive to the poetry of life, cannot be intrusted with the training of youth. If there are any such in this audience, let us read a statement of the educational ideals of a man who, more ardently perhaps than any other, fought to increase the influence of science upon education in England and America. In that same essay from which I quoted earlier, Thomas Huxley wrote:

That man [I think] has had a liberal education who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of, whose intellect is a clear, cold logic engine, with all its parts of equal strength, and in smooth running order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of Nature and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of Nature or of art, to hate all vileness, and to respect others as himself. Such an one and no other, I conceive, has had a liberal education; for he is, as completely as a man can be, in harmony with Nature.

If this is the ideal of a liberal education, you will agree that it cannot be achieved unless our best young men and women are enabled to seek the truths of nature and the laws of her operations in the laboratories of experimental science, side by side with men of skill and experience in the unending search for knowledge. "He who teacheth man knowledge, shall not he know?"

The author is indebted to Dr. John B. Blake, Assistant Historian of the Rockefeller Institute for Medical Research, for the use in advance of publication of an article, "Scientific Institutions since the Renaissance: Their Role in Medical Research," Proceedings of the American Philosophical Society, vol. 101, pp. 31–62, February, 1957.

Mr. Bronk: Thank you very much, Mr. Corner. Our next speaker is a remarkable man, with a remarkable range of intellectual interests, who as Secretary General of the Guggenheim Foundation has had a remarkable opportunity to study the qualities of men and institutions which make for great teaching and significant investigation. Mr. Moe.

Mr. Moe: Members of the Academy, and Fellow Guests: I wish I were here to report a series of experiments or even to argue a legal case, proceeding from precedent to precedent, from authority to authority, to a reasoned conclusion—or anything relatively simple like that. As it is, I can only give you my opinions; and I might as well say at the outset that I do not think much of my naked opinions. It is for this reason that you will find me trying to clothe them, even more than Mr. Corner has just done, with evidence from history.

During fifty days spent in the Middle East last autumn, I learned a lesson from history germane to the subject that your president has asked me to discuss here: "Science as Part of General Culture." I had been given what the Navy calls a "roving commission" to find out what I could about the state of higher education
in the Middle East. After I got out there, it came to me, very slowly, that I was not as ignorant nor as unqualified for the assignment as I had thought—for one reason. The ancient Roman Law, the writ of the Roman Law, ran all through the Mediterranean littoral—longer in time in some places than in others, but here and there certainly for a millennium. During some periods the writ of the Roman Law ran as far eastward as the Persian Gulf—in short, through all the territory that we now call the Middle East.

If Professor W. F. Albright is here, and even if he is not, a person like me ought to speak of the Middle East with a certain diffidence, a certain shyness, indeed; and that shyness would commend silence, were it not for one fact: as a Roman lawyer, as a historian of the law of Rome, I was, once upon a time, long ago, deemed qualified to teach the subject in the University of Oxford, as I did.

It was not that I studied or learned last autumn in the Middle East anything about the law of the sale of goods or of commercial practice or about any other branch of the law as it stood in ancient Egypt or Phoenicia. As a historian of the Roman Law, it was rather—to paraphrase James Hastings Nichols—that I could not help being aware, out there, of values created by men in the past in millions of situations and carried into the future in the collective memory of the Mediterranean and Middle Eastern peoples, often as their guide and quite as often for their inspiration.¹

History is always before one’s eyes in the Middle East, but, I suppose, only if one has the eyes to see. I do not mean only visible evidence; I mean also remembered evidence. I remembered that Beirut in the Lebanon, the Berytus of ancient Roman Phoenicia, had had a law school which was accredited along with those of Rome and Constantinople as one of the Roman Empire’s three schools of law. And I remembered that the Roman emperor, Justinian himself, decreed, to insure the quality of legal instruction: “We have been informed that in Alexandria, Caesarea and in other cities, ignorant men have imparted spurious instruction to their pupils: these we prohibit, and those who shall be so presumptuous as to constitute themselves professors of law, otherwise than in the royal cities or Berytus, shall be liable to a penalty of twenty-one pounds of gold, and to be expelled from the city, where they, instead of having taught the law, have contravened the law.”

Such standards are hardly to be found there now; just the same, the modern Beiruti lawyers do not allow one to forget that Tribonian, head of Justinian’s Commission for the Codification of the Roman Law, was a teacher in the Berytus law school, as were three others of Justinian’s commission. Justinian’s code was, I should perhaps explain, the greatest triumph of codification—with the most lasting effects throughout the whole of the ancient and, no less, the modern world—that the world ever has known to come to pass. And the modern Beiruti lawyers think it quite natural that Ulpian, deemed by common consent one of the two greatest of Roman jurisconsults of all Roman times, was a Phoenician.

History, recorded history, is long in the Middle East—five thousand years or so; and the sensing of past values of past civilizations gives a man a certain perspective on his own. As Jacob Burckhardt has said, “We know so much more and are so much more than all the peoples who have not known the living historical breath of the Mediterranean.”²
Contrasting the present with the great Middle Eastern past, I asked myself, "Why?" In the Middle East, I stress again, the present has deep roots. What happened to the deep roots of the law? And, lest I seem legally parochial, I call to witness that one ought not, historically speaking, look at the face of a clock without remembering the method developed in ancient Babylon for reckoning time; one cannot read or write a Western language without being in debt to what went on in Byblos in ancient Phoenicia. And again I asked, "Why?" I asked, "Why then and why not now?"

The law has had a very long experience with problems of causation, longer—much longer—than the sciences. In the law we differentiate causes in many ways, but here I shall speak only of proximate and remote causation, explaining that by remote causation we do not necessarily mean remote either in time or in space. An event denominated a remote cause may be concurrent in time or coincident in place with the event in question: but, to the law, it is "remote" if too long or too cogent a series of other factors intrudes on the event in question. Thus, if I as a lawyer say that the successive conquerors of the Middle East, with their burnings, lootings, and killings, provided only the remote causes of the difference between Babylonian mathematics and Babylonian medicine then and now, you may understand what I mean. To get at what the law calls the proximate cause—causa causans, the causing cause—we must ask ourselves questions of another order. These questions, no less than their answers, are difficult.

As for me, I start from this basis—which, at least for me, is established historically: The human mind has no limits in its ability to take flight to new values, to new conclusions based on new evidence—if the conditions are right for the individual human being.

I am aware that my use of the word "right" begs the question and that unless and until I can clarify what makes conditions right I am saying approximately nothing. I do not pretend to be able to enumerate all the factors that make the conditions right, but I think I can, with reasonable certainty, enumerate some of them. A statement by a present-day Lebanese statesman and historian, Dr. Costi K. Zurayk, is revealing: "So long as it [Islam] preserved its original urge and spontaneity, it acted as a leaven, vitalizing the political system, opening before the people ever new and wider horizons of action and contemplation. When, however, it became reduced to a set of doctrines to be taken on credence, and a code of law and morals to be applied rigidly and blindly, it turned out to be, as other religions in the same state, a paralyzing shackle instead of a liberating force, the letter that killeth all real endeavor and progress."

And lest the results of the latter-day Islam be thought to be an isolated phenomenon, let us think back to our own Middle Ages, when, for many centuries, the letter—the rulebook of life—killed inspiration and progress. It was then that the world of Europe—but not then the world of Islam—mistrusting reason, trustful of authority and revelation, weary of argument, and apathetic to the wonder of the capacity of men's minds, stamped free inquiry as a sin.

In proof of this, listen to the words of Abelard of Bath, an English scholar of the twelfth century who had studied with Arab scholars in Spain and Syria, addressing his nephew, who had studied in the universities of the Franks: "I," said Abelard, "with reason for my guide, have learned one thing from my Arab teachers, you,
something different; dazzled by the outward show of authority you wear head-stalls. For what else should we call authority but head-stalls? Just as brute animals are led by the head-stall where one pleases, without seeing why or where they are being led, and only follow the halter by which they are held, so many of you, bound and fettered as you are by a low credulity, are led into danger by the authority of writers. . . . Reason has been given to individuals that, with it as chief judge, distinction may be drawn between the true and the false."

Such conditions of the mind as Abelard described them to be in Arab lands were also the conditions of the mind in ancient Greece—out of Mesopotamia via Palestine, I venture to say—and there the mind of man soared as the eagle flies. And such likewise were the conditions in ancient Rome—out of Greece, as is well known: then and there the rule of law achieved a firm expression, and concepts of equity and justice were both developed and applied to be every man’s due.

But later came the spell of the Middle Ages’ system of authoritative revelation, and until that went by the boards in the refound freedom of the Renaissance, the search for new truth was hopeless. Then came Mercator, Leonardo, Copernicus, Galileo, Kepler, and—your list would be better than mine. I had thought to mention Maimonides here, but he was too early, and besides, although Maimonides lived in the period of Europe’s Middle Ages, he lived without the shackles of Europe’s Middle Ages; for he lived in Arab territory, in Spain and elsewhere.

The law is the key to the answer to the question previously asked, “Why then and why not now?” A catalogue would be as endless as the details of the legal code—any legal code, provided only that it guided and restrained the ruler—any ruler—and safeguarded the individual—any individual. Such a code of law made the difference between civilization and barbarism, between order and chaos, between a static society and progress. But more than that: such a code of law, fostering the individual as an individual, gave each individual, wherever born and wherever living within the territorial limits of the writ of that law, his chance. And I do not need to remind this audience that there are, even now, no data which will tell whence, when, or in whom the combination of genes that result in genius will appear.

In the ancient Middle East, the waterboy could, and often did, become king—just as Aurelian, of most humble origins from Pannonia in what we call the Balkans and in his early years an infantry soldier, became emperor of Rome, as wise as he was brave, the restorer of the empire in the third century A.D. And Kant, the saddler’s son from Königsberg, became probably the modern world’s most influential philosophic thinker.

It is easy to say, “We know all this”; and I hope we do. Yet some recent history would indicate that no peoples know it as well as they ought. Given the code of law, within whose protecting and avenging arms the individual is free, what then? What must be added for fulfilment of the possibilities of the individual, any individual? The answer, clearly, is education.

For the purposes of this paper, I am not much interested in curricula. I shall simply note that, so far as is known to me, none of the world’s great men—great, that is, in things of the mind and spirit—were specialists solely. Copernicus was lawyer, theologian, and astronomer; Maimonides was jewel trader, physician,
rabbincal scholar, and philosopher; Voltaire was poet, historiographer, and political thinker; Jefferson was farmer, botanist, natural philosopher, political thinker, and politician. Benjamin Franklin was practically everything! Churchill is journalist, man of letters, statesman, and somewhat of an artist and bricklayer. Leonardo was engineer, painter, sculptor, musician, and poet. Thomas Aquinas was a pupil of Albertus Magnus, known as *doctor universalis*—theologian, ancient historian, mineralogist. Darwin studied theology and medicine, was entomologist and geologist, and with this varied background became the author of *On the Origin of Species*.

And so it has been, and so, I think, we may be sure it will continue to be. For to be more than a specialist argues that one has better than a specialist’s chance to see relationships; and without a certain inclusiveness of vision, path-breaking steps seldom, if ever, are taken. Without a certain inclusiveness of vision, the road ahead appears to be the only road, or at least the only road worth traveling. But this, all history shows, is not so.

What, then, am I talking about? Assuredly, I am not saying that science is narrowing. Assuredly, I am not saying that science is not as much a part of humanistic learning as is literary criticism. Assuredly, I am not saying that there is any conflict between the learning of science and the learning of the so-called humane and liberal studies.

Assuredly, I *am* saying that the study of science, any science, can be as humanistic and as liberal as the study of, say, Greek sculpture of the age of Pericles. Assuredly I *am* saying that study of Greek sculpture of the age of Pericles can be as narrowing as the study of the properties of prime numbers can be—but either study is not necessarily narrowing in either instance. The main point is that any study, pursued in and for itself, makes a situation from which no great things come.

The adjective “Alexandrine” was long ago applied to narrow erudition for the sake of such erudition, learning for the sake of being learned in a field. And I shall say that, viewed from where I sit in a foundation office, the term “Alexandrine” has much more general application now to nonscientists in the twentieth-century United States than it has to American scientists of the twentieth century. The reason may be that, whereas the American scientist—at least the scientist of my own and older generations—generally has some education other than scientific, the American nonscientist rarely has any knowledge of science beyond what he gets from the popular periodical press.

Recently, while we were considering an application from a professor of English who proposed to prepare a variorum edition of one of the greatest of English path-breaking scientific essays and a study of the development of that scientist’s thinking, I took it upon myself to inquire what he knew, critically, of the scientific subject matter of the essay and of the scientist’s relation to his predecessors’ and contemporaries’ thinking in the field. My query made the professor of English furious; he told me that if I were not an ignoramus, I would know that no knowledge of the scientific subject matter was necessary, that any well-trained literary scholar could do the job—that a literary scholar could do the job even if the text were in a foreign language he did not understand, and that perhaps he could do it better in such a case. The so-called Alexandrians never, I should guess, went as far as this twentieth-century professor of English in defending narrowness of range.
But if my generation of scientists was more broadly trained than my generation of nonscientists, the signs are that this is less true now than it was before. The past generations of future specialists—whatever their specialties were to be—were brought up on the Bible, which was good training in English as well as for other purposes, with training in religion and in history (good general training, not specialists' training), on the Latin language and Roman history, sometimes even Greek and Greek history, a modern language, either French or German, and mathematics. This may not have been broad enough in science for the future non-science specialist, but it surely was good training for the future science specialist.

This was, in fact, the education of all our scientific specialists who went to college before 1900, of most of those who went before 1910, and of a large proportion of those who were graduated before the first World War.

The present drive for more science in the preparatory and secondary schools in order to make more and better scientists seems to me to have elements of great foolishness: it might well make more but worse ones, and it would probably make more technicians in science and fewer scientists. And I am concerned about that, for there is no historic evidence known to me that technicians, even supertechnicians will suffice for science, let alone for life.

I do not decry, for I do not doubt the need of, training large numbers of technicians, even supertechnicians; but I do remember that this is a paper for the National Academy of Sciences, the official scientific adviser to the government of the United States, where scientific statesmanship abideth if it abideth anywhere. And you will agree with me that we need more good scientists even more than we need more scientific technicians, however good.

Nor, agreeing with your president, am I swerved from what I think and have said by the fact that the Russians have other ideas. We did not get where we are by imitating the Russians, and I submit that we will not acquire or maintain leadership by imitating, which means following, anybody—not the Russians, surely!

Such are my opinions: I wish they could be documented more fully; and, of course, I recognize that if I were able to document myself more fully, I might have formed other opinions!

But of one thing I am sure—needing no more documentation than all of us have available—and that is that it takes a long time to educate a creative scientist. When the chips of national need are down, it does no good to make an appropriation and demand the miracle of an adequate supply of scientists, who are scientists in your terms and not technicians. The miracle could not come, no matter how big the appropriation, for at least seven years after secondary school; and seven years, as the world moves nowadays, is a long time.

On still another point I need no more documentation than I have, and that point may be stated this way, and firmly; it is another lesson that I learned firmly in perspective from the history of the Middle East. Beginning in the nineteenth century, the Middle East eagerly took to Western inventions; but those inventions, it now is clear, did not produce for them the good things they seemed to produce for the West. By Western inventions I mean not only the tractor, the bulldozer and the motorcar but also secular education, technical education, and the ballot box. And the reason that the Western inventions did not produce for the Middle East what they seemed to some to produce for the West is clear. Some men of the
Middle East said it to me clearly: "We know we could not achieve your material position—let alone your other positions—without the breadth of your education, based on humane and liberal studies, which you have and which we used to have but have no more." This is a message, perhaps the most important message, from the five thousand years of the history of the cradle of our civilization.

2 Ibid., p. 68.

Mr. Bronk: Thank you very much, Mr. Moe, for this heartening challenge to evaluate our own position on the basis of our own ideals. Lest you think that Mr. Moe is foreign to this Academy, it might be appropriate to point out that, I believe, sixteen of the thirty Members of the Academy elected yesterday were fellows under his grants.

Our next speaker, Mr. Arthur Adams, has had a unique opportunity as a scientist and an engineer, as a university professor, as a university president, and now as President of our sister Council on Education to see the relationship of science to organized education. We will value whatever he chooses to contribute to this symposium. Mr. Adams.

Mr. Adams: Members of the Symposium, Members of the Academy, Ladies and Gentlemen: I have been charmed, as I know all of you have been, by the two preceding papers and by the enormous range of perspective that they have made available to us in considering the subject we are discussing this afternoon. Before beginning my own remarks on this subject, I wish to note particularly two facts which strike me as being of extreme significance. The first fact is that this body is addressing itself to the question—the issue, if you wish—of science in education. I think that Mr. Corner made perfectly clear the interacting influence between science and education that is bound to occur. For a long time now, I have been concerned by the apparent division of the educational world into those who believe that all education is a matter of subject matter and those who believe that education is a matter of conditioning of the individual. We recognize this conflict. It is too bad that it occurs, but it is a fact. With Mr. Corner's analysis—that there is essentially and inherently an interaction between these two points of view—we have taken a great step forward, and I wish, Mr. Chairman, to express my applause to the National Academy of Sciences for its wisdom in holding this symposium this afternoon. It is a major advance to have scientists concerning themselves with broad educational problems.

The second fact that I wish to note before starting my general remarks is that I recall so well that when I was engaged in scientific and technical matters in the West, I used to look longingly eastward when my seniors in the academic hierarchy departed for the "eastern meetings" and I was left behind to do the work. It is wonderful to be here today under this particular circumstance. It makes me feel very good indeed.