Prologue: The worlds of health science and medical care delivery are, in most respects, irrevocably wed. But when it comes to the processes of Washington policymaking, they relate to these worlds, such is not always the case. Different sets of congressional committees, composed of legislators with different philosophies and thus varying priorities, deal with the increasingly complex issues of health science and medical care delivery finance, thus creating an artificial separation that adds a high degree of difficulty to coherent policymaking. Authors David Hamburg and Elena Nightingale, two physicians who have largely left their medical and behavioral research careers behind to pursue new vistas, point out the importance of recognizing health sciences as a chain. Links in the chain range from the quest for basic information on the nature of living organisms to demonstrably useful interventions in prevention, diagnosis, and treatment of disease. Since January 1, 1983, Hamburg has been president of the Carnegie Corporation of New York, a philanthropic foundation which has traditionally invested its resources in projects dealing with education, social justice, and international affairs. Under Hamburg’s leadership, the foundation has broadened their interests to include the health sciences and the prevention of nuclear war. A former professor of psychiatry at Stanford University, Hamburg served as president of the National Academy of Sciences’ Institute of Medicine (IOM) from 1975 to 1980. After departing the IOM, Hamburg joined the faculty of Harvard University as director of its Division of Health Policy, Research and Education. Most recently, he was named president of the American Association for the Advancement of Science in May 1984. Nightingale, a clinical geneticist, spent fifteen years of her career as a laboratory scientist. Most recently, she has accepted a full-time appointment at the Carnegie Corporation as Hamburg’s principle advisor in health programming. Throughout a distinguished career in laboratory research, medical education, and health policy, including stints at the National Academy of Sciences, IOM, and Harvard University, Nightingale has maintained a close affiliation with the practice of medicine by treating patients, most of whom have been children with birth defects.
A great policy challenge for the future is to engage the methods of science in addressing the entire gamut of factors affecting health; these include behavioral and environmental influences on health as well as the effects of health care per se. The family living room and the city streets are locations as appropriate for health research as the laboratory bench and the patient’s bedside. Thus, we must consider all levels of biological organization—from cellular and molecular to functional systems, organisms, and populations.

If we see urgent social needs for broad-based, long-term scientific advances, if the opportunities for science and science-based technology are indeed unprecedented, if such advances have profound and pervasive influences on the world of the future, are we doing everything in our power to foster such progress and to ensure its application for humane and compassionate purposes?

When considering the role of science in health we may be forgiven for indulging ourselves in a moment of self-congratulation. Then we will face some tough problems that lie ahead.

Past Contributions Of Science To Health

Research and development in the health sciences, particularly since 1940, have resulted in important contributions to the health of the public. Some of the advances that illustrate these contributions include the development of antibiotics and other drugs for the control or care of many bacterial and parasitic diseases; the development of immunizations for a variety of viral and other infectious diseases; improvements in surgery and anesthesiology which have afforded effective surgical treatment for a wide range of disorders such as congenital anomalies, many forms of neoplastic growth, valvar heart disease, and skeletal disorders; the ability to eliminate many gross nutritional deficiency diseases; and deepened understanding of reproductive biology, leading to the development of contraceptives and treatments for infertility, both of which hold out the promise of voluntary reproduction.

Additional advances include the development of effective noninvasive diagnostic procedures such as ultrasound imaging and radionuclide techniques, and computed tomographic scanning techniques; the construction of a wide variety of prostheses including joints, heart valves, and pacemakers; and the development of effective pharmacologic agents to manage such serious disorders as cardiac arrhythmias, angina pectoris, congestive heart failure, hypertension, Parkinson’s disease, psychoses, and several neoplastic diseases. Major advances have been made in prenatal diagnosis and neonatal therapy to ease the burden of certain congenital disorders, and in the treatment of end-stage kidney disease through dialysis and transplantation. The decrease in mortality from coronary disease...
and strokes in the past two decades has been effective through a combination of therapeutic and preventive measures based on deeper understanding of pathogenesis.

Advances in knowledge and skill brought about by scientific research are the most dynamic, potentially transforming influences in the entire health arena. We are witnessing an acceleration of established sciences, the emergence of new ones, and the reinvigoration of old ones. Current advances in such fields as genetics, immunology, and neurobiology are among the most significant in the entire history of science. This is a strong statement, but it can be well justified. We have all been privileged to see glimpses of these truly dramatic developments in recent years. Developments in the health sciences have the potential to improve greatly the quality of health care, probably to reduce its cost in the long run, and to improve health outcomes in many ways, not least through disease prevention.

A View Of The Health Sciences

The health sciences can be viewed as a chain, each link of which must be strong if the whole chain is to bear the full weight of improving health in the years to come. This chain links the quest for basic information on the nature of living organisms to demonstrably useful interventions in prevention, diagnosis, and treatment of disease. In this country, we have been forging this chain for a long time. In the past four decades, the accomplishments of the United States—some just cited here—have earned us the respect of the rest of the world and have made the health of our people the best it has ever been. But there is no room for complacency.

There has been a pronounced change over the past several decades in the profile of disease, disability, and death in the United States as chronic diseases, accidents, and violence have largely supplanted communicable infectious diseases as the major health problems of our society. This shift in the burden of illness, coupled with a new understanding of the determinants of human health and disease, presents a challenge to the health sciences—what they are, what their research agendas should be, and how they relate to each other.

To diminish illness in the future, and to cope with recently emerging patterns of disease and disability, particularly with the health needs of our increasing population of older citizens, we must make the entire chain of the health sciences strong. Put another way, we must complete the spectrum of health research, keeping in mind the social context in which scientific advances are applied to changing disease patterns, or we will not make optimal use of the present opportunities to diminish the burden of human suffering.

The evolution and assessment of useful innovations in health care will depend on continuing advances in biomedical research, including clinical
investigation; and such progress will depend in turn on the young field of health services research. The systematic comparison of alternative delivery systems will be a great challenge to the health sciences in the years ahead, yet the future of clinical investigations and health services research are currently in jeopardy because resources, both human and fiscal, are decreasing.

The chain of health sciences must, in the long run, include these links: (1) fostering basic inquiry on living entities at all levels of organization, including molecules, organisms, behavior patterns, environmental conditions, and populations; (2) scanning the knowledge base for promising, health-relevant applications in a continuing, long-term way and to see that such applications are timely, substantiated, dependable, and usable equitably throughout our society; (3) analyzing burdens of illness in relation to scientific opportunities, with explicit attention to the distinctive burdens of disadvantaged populations in the U.S. and abroad; and (4) building the practice of the health professions on as solid a scientific base as feasible, and providing mechanisms for assuring that the knowledge base for health care will develop strongly in the years to come. This effort will involve research on new interventions and on organization, financing, and delivery of health services.

Support For Health Research

Research outlays, as a percentage of total health spending, are quite modest. In 1977, only about 3.4 percent of all public and private expenditures for health was devoted to research. Though public funds for health research grew steadily in the ensuing several years, the budget for fiscal 1985 shows a decline in constant dollars. Since 1981, cutbacks have been selective, with the Alcohol, Drug Abuse, and Mental Health Administration and the National Science Foundation hit particularly hard. Funding for social and behavioral science research was reduced drastically in 1981. In spite of current proposed increases for some programs in these sciences, other programs are being cut still further. Many social and behavioral science programs have not regained the level of support they had prior to 1981. Support of biomedical research in general has not been eroded as much as that for disciplines of particular importance for disease prevention and health promotion, in spite of the apparent priority given to prevention by the administration.

A few private foundations have recently taken a creative interest in the field of health and behavior so necessary to prevention. But, such efforts are small in relation to governmental research support capability. In 1981, the total expenditures of all foundations for all purposes came to about $2.6 billion. The amount allocated to research on health and behavior was no more than several million dollars. Thus, foundations can play a path-breaking role, but they cannot take primary responsibility for sus-
tained progress in this sphere for the long term. Although research in the pharmaceutical and chemical industries is very strong, it is not likely to become a major source of support for basic research, though closer relations with universities have been forged in biotechnology.

Although it is encouraging to see that some areas of support have been expanding in the past few years, the overall trend has been, at best, no increase in funding. Given the enormous burden of illness, resource commitments to research on behavioral factors and their biological substrates still are very small compared to other major domains in health. Support for research on such crucial behavior as heavy cigarette smoking was slight for a long time. Recently, there has been an upsurge of awareness of the importance of such behavioral factors as smoking, not only in the scientific and health professional communities, but also, and perhaps especially, in the public at large. Now, there are manifestations in the media and elsewhere of general public interest and concern about the impact of behavior on health problems.

At every point along the spectrum of health sciences, we must build opportunities for feedback. Knowledge does not advance along a linear continuum, gaining sharpness and focus in a step-by-step march from the laboratory bench to the bedside. Indeed, it is more often circular than linear in its progress. There is, under favorable circumstances, a highly stimulating interplay between clinical investigation and basic science. The discovery that DNA is the genetic material has long been recognized as one of the most significant advances ever achieved in the life sciences. Yet it was not the product of basic research alone, but rather was the serendipitous result of a clinical search for understanding pneumonia with a view toward attaining immunization. Communication must be strengthened so that knowledge gained through basic research can be translated into practical applications. By the same token, clinical problems uncovered by practitioners can increasingly have a stimulating effect upon scientists. The rapidly growing computer capabilities for storage and retrieval of data may enhance the ability of practitioners to contribute to the data base. Facilitation of pooling data will also lead to generation of testable hypotheses. There is a continuing need for science-based analysis of prospects for disease prevention as they emerge from the ongoing streams of research and the changing social context of health. We are entering an era of testing the extent to which the methods of the sciences illuminate the entire range of factors that determine the health of the public—not only through medical care, but also in the way we manage our personal behavior patterns and our changing environment.

Today’s health problems, not only in countries like ours but also in the developing nations that comprise almost three quarters of the world’s population, reflect the rapid and profound changes in human life that have occurred since the industrial revolution. Indeed, this is one of the most drastic...
tic transformations any species has ever brought about in so short a time
and its consequences deserve a high priority in the science of the future.
Two examples that are unprecedented in the history of the species are:
(1) enormous population growth, probably beyond sustainable resources;
and (2) remarkable changes in the age composition of contemporary
populations, such as the aging of our population. These dramatic changes
in the human condition are not only health problems. The profound
transformation of this century increases the urgency of our need to know
more about our health, our environment, our behavior, our relations
with each other as individuals, as institutions, and as nations. When we
put our health interests in the framework of populations, such as popula-
tion biology, population-based medicine, and public health, we are led
to consider the social context of health and the great sociotechnical changes
of our time. This in turn broadens our view of the sciences we need to
understand ourselves.

The enormous contribution of behavioral factors to the current burden
of illness in this country and the critical need for scientific exploration of
that contribution has been emphasized. But the point is more general, When
the burden of illness changes, the sciences of value for lessening it also
change. As new scientific opportunities arise, those responsible for the health
of the nation must search out their relevance to disease. The practical prob-
lems of clinical medicine and public health demand these novel conjuctions
and open-minded, cooperative explorations.

To keep the stream of developments in the life sciences flowing, research
opportunities need to be replenished. Support of the spectrum of sciences
relevant to health is fragile and vulnerable to ideological biases. A cloud
on the horizon of science policy now is the tilt toward weapons-related re-
search and development. Even though overall R&D budgets for the na-
tion continue to grow, an increasing share is weapons-related. The
consequences of continuing such a trend have been insufficiently explored.

A Nurturing Environment For Research

In 1976, Americans made a clean sweep of the Nobel prizes in all fields,
an unprecedented event. At the ceremony of Nobel prize presentations,
Sune Bergstrom, a great biochemist and former chairman of the board of
the Nobel Foundation, pointed out that Americans had won about half
the prizes during the preceding twenty-five years. In his opening address,
he went on to point out some of the reasons for the preeminence of Amer-
ican science: (1) the recognition that basic science can have powerful prac-
tical consequences; (2) generous immigration policies which permitted
many outstanding scientists from Europe and elsewhere to come to the
United States; (3) recognition of the importance of science and technol-
ogy for economic progress; (4) the intellectual stimulation and fostering
of innovation made possible by political freedom and open communication; (5) the strong national commitment to support of basic science through institutions such as the National Science Foundation and the National Institutes of Health; (6) the democratic atmosphere of American universities and their laboratories which is in contrast to the hierarchical, authoritarian structures prevailing in many other countries; (7) special attention to the fostering of research by talented and dedicated people.  

He pointed out that other democratic societies are now emulating these American conditions that promote excellence in science and are making tangible, rapid progress—so much so, that we are feeling threatened in our ability to remain the world leader in science and technology.

"The important thing now is to make the most of these experiences in order to master such a development in the world as a whole," said Bergstrom, adding, "all knowledge can be abused. . . . But this fact must not be made a pretext for coercive measures to impede the work of increasing our knowledge. The only result would be to restrict the supply of alternatives and new possibilities of improving conditions in societies and cultures of various kinds."

American science and technology have earned great respect throughout the world. In fields such as health, agriculture, and space, the world’s respect for American science-based achievement borders on awe. But does it matter in any “bottom-line” sense? In a time of economic stringency, wouldn’t it be wise to cut back on the national commitment to science to save money and reduce the responsibility of the federal government? While some things we could do would be more foolish, there are not many.

Through most of our history as a people, our economic success was in substantial part predicated on an open-minded, pragmatic orientation to utilization of natural resources through technology for the general well-being. Much of this was based on a common sense approach to imaginative craftsmanship, as exemplified by many of our great inventors. Increasingly in the history of the country, the new technologies central to economic progress and national defense, or national security in the broad sense, came to depend upon advances in fundamental science. This was recognized as early as 1863 when President Lincoln mobilized the modest scientific community of the time for the Civil War by creating the National Academy of Sciences. Similarly, President Wilson mobilized the scientific community for World War I by creating the National Research Council. These closely related institutions are much larger today and deal not only with defense but with health, agriculture, energy, transportation, communications, and, indeed, the entire gamut of the functions of modern societies. The reason is simple: science and science-based technologies have become a pervasive part of human experience in the twentieth century and the key to future well-being. Science is not a separate activity,
remote from the lives of people, however arcane it may be. Science provides the basis for most of the requirements for modern living and much of its promise for the future, not only in a material sense but also in relation to social justice.

Prudent Use Of The Power Of New Knowledge

If we are seriously concerned with economic growth, productivity, innovation, and equitable distribution of resources, then we must be seriously concerned with the vigor of our scientific enterprise. Our opportunities are increasingly science based. Our food supply, health, ability to make a living, to improve the quality of life and diminish human suffering all depend increasingly on science-based activities. Moreover, scientific opportunities to deepen knowledge and use the knowledge for progress in such crucial spheres as food, health, and energy are now expanding.

Two good examples are provided by information and communications technology, based on powerful advances in the physical sciences; and biotechnology based on unprecedented progress in molecular and cellular biology. Consider the latter case briefly. In the remainder of this century, we will, through biotechnology likely gain the most fundamental understanding of life that has ever occurred. An example of this may be the detailed specification of the entire hereditary makeup of the human body. Moreover, applications of this technology are likely to be of far-reaching economic and social value in health, agriculture, industrial processes, and environmental quality.

Recombinant DNA. One example of an extremely powerful biotechnologic development of great promise (and also the possibility of misuse) is that of recombinant DNA. The history of modern genetics goes back more than one hundred and twenty years. However, it is only in the past forty years that we have understood the chemical nature of the genes of cellular forms of life to be DNA. And it is only in the last dozen years that we have worked out the techniques enabling deliberate and extremely specific construction of novel combinations of pieces of DNA from widely divergent sources. This latter process—recombinant DNA methodology—made possible genetic engineering. Two fundamental questions occurred immediately upon the discoveries of these methods: How will they be used? And what are the potential dangers to man and the ecosystem?

Consideration of how to deal with the second question led to the recombinant DNA controversy. Donald Fredrickson, speaking to the American Association for the Advancement of Science in 1982, reviewed the history of this controversy. In 1974, as the director of the National Institutes of Health (NIH) he was invited to: “give immediate consideration to establishing an advisory committee charged with overseeing an experimental program to evaluate the potential biological and ecological hazards of
... recombinant DNA molecules; developing procedures which will minimize the spread of such molecules within human and other populations; and devising guidelines to be followed by investigators working with potentially hazardous recombinant DNA molecules.”

When NIH undertook to promulgate the guidelines the scientists had drafted by the end of 1975, it pursued three major objectives in parallel: (1) to establish means of communication which were more complete and rapid than the usual scientific channels so that all information bearing on the putative hazards could be assessed and experimentation guided accordingly; (2) to assure that the guides to experimentation would represent standards that were common and conservative but would allow new information to be obtained; and (3) to permit the public to be fully informed and to participate in the continuing assessment and revision of research guidelines.6

The Recombinant Advisory Committee (RAC) of NIH proved to be a valuable institutional invention. The Academy Forum of the National Academy of Sciences, in which all views were thoroughly explored in public, was also useful. These and other institutional responses taught us how to cope on a voluntary basis with serious questions concerning the public safety of scientific research. Important elements in coping were the initiation of the process by the scientists involved and the deep involvement of two great institutions, one nongovernmental (the National Academy of Sciences), and one governmental (NIH). The scientists had to exert self-discipline, to inform the public, to assess options, and help to formulate policies that could reconcile conflicting values.

Overall, the prospects for beneficial contributions of genetics to health, agriculture, and other domains are profoundly encouraging. We note with interest that many leaders of medicine in the 1940s, when DNA was discovered to be the genetic material, gave a poor prognosis regarding practical applications of genetic research. When it comes to long-range foresight, modesty becomes us. But more importantly, we need institutional mechanisms for strengthening our anticipatory capability with respect to science and its uses.

But there is a jarring note. In a world saturated with hostility, possibilities of deliberate misuse of recombinant DNA technologies for creation of biological warfare weapons emerge. Institutional mechanisms are needed to appraise intended harmful uses. It is not possible to depend on the isolated scholar or the lonely voice of conscience. So far, to our knowledge, recombinant DNA technologies have not been misapplied; how to deal with such a possibility was discussed by the Recombinant DNA Advisory Committee in June 1982. But consider the current dwarfing of the peaceful uses of nuclear power by the threat of its misuse. The lonely voices of Albert Einstein and Leo Szilard were unheeded in the post-war period. How can the scientific community contribute more effectively to
the humane uses of science and technology?

Neurosciences. Similar opportunities and concerns apply to other newer fields of knowledge, for example, the neurosciences. Here again, our power is rapidly increasing both for better and for worse; that is, for highly constructive use, for inadvertent side effects, and for deliberate misuse. How can we learn to sort these out and manage them wisely? Progress in neurobiology pertinent to health and behavior has been recognized increasingly in the past decade. An unprecedented array of molecules, cells, circuits, systems, techniques, and concepts are now available for research on problems of central interest to health and behavior. Neurobehavioral science has far-reaching ramifications as basic science and is likely to have many clinical implications in the 1980s.

The potential misuses of the fruits of neuroscience research may be far reaching because they deal with the biologic basis of cognition, sensation, behavior—the essence of being human. The ability to manipulate thinking and behavior may pose problems for which we are not prepared. The promise of this field is so profound and pervasive that it must be pursued with great vigor. At the same time, we should be strengthening our modes of assessing potentially negative aspects, learning lessons as rapidly as possible from the experience in genetics and elsewhere.

Immunology. Extraordinary advances in immunology, together with our sharply expanded ability to manipulate genetic information, make possible the development of new vaccines and immunotherapies. Recombinant DNA technology, cell hybridization, radioimmunoassay, sequencing and chemical synthesis of nucleic acids and proteins, and affinity chromatography, will enable the development of highly effective and safe new vaccines and immunotherapeutic agents. Two recently developed vaccines, providing protection against hepatitis B and foot-and-mouth disease, illustrate the potential of these new technologies. Immunotherapy of diseases of worldwide significance such as malaria, schistosomiasis, and certain cancers is now a realistic expectation. The new field of psychoneuroimmunology seeks to discern the physiological mechanisms that relate the influence of emotional factors on the onset and outcome of a variety of diseases that result from less than optimal immunologic function. The immune system declines with age, making advances in this field of special importance to geriatric medicine.

Interplay of the sciences. The dynamic interplay between basic science and useful application in the health field is remarkably intimate. To fulfill the potential of these dramatic advances in the life sciences requires vigorous support and facilitation of the entire spectrum of the research and development enterprise from cell to society. No one part alone will suffice, and the crucial underpinning for it all is basic science, the most powerful form of free inquiry, fostered not only by adequate facilities and equipment, but, just as crucial, by open communication and political freedom. So far,
the United States has been the clear world leader in this field, as we have been in physics and electronics at the basic level. This leadership is certainly beneficial to American society, but it can also benefit people everywhere—not only through international trade, involving better processes and products, but also by cooperative scientific work in which, for example, we help developing countries to create focused technical capability to solve their own problems and, particularly, improve health. The World Health Organization at its assembly in 1984, made a commitment to harnessing the resources of universities for worldwide improvement of health in the remainder of this century. American universities, with the distinctive experience of the land-grant institutions in economic development, have a special role in this science-based humanitarian effort.

Can science itself help us toward the judicious use of its fruits or even toward the resolution of fearful problems of human nature and relationships? Here we must recognize the unity of the sciences. It is no longer useful to separate physical, biological, and behavioral sciences. They blend into one another, conceptually and technically. Increasingly, they rely upon each other even for basic inquiry and above all for realistic analysis of urgent human problems. Though the scientific study of human behavior is difficult—chiefly because of proper ethical constraints upon human experimentation—progress has been made in these relatively new sciences, and much more can be made if we focus on ways to strengthen them. We need such strength to address great problems of conflict, education, economic development, the linkage of technological and social change, and the understanding of diverse cultures. Indeed, one of the most striking needs is in the linkage of behavior and health; about half the mortality in this country is directly related to health-damaging behavior such as heavy alcohol use, heavy smoking, risky vehicle use, poor diets, and violence. Promising lines of inquiry have recently emerged. New technologies such as the use of computers in the social sciences are likely to be helpful. So, the strengthening of behavioral sciences and their connection with the other sciences is one of the principal challenges for science policy in the remainder of this century.

The American scientific eminence to which Bergstrom referred in his Nobel address is in danger of eroding. While recent analyses raise serious questions about the adequacy of investment for research and development by large sectors of American industry (in contrast with such brilliantly successful fields as computers, electronics, and pharmaceuticals), we refer here only to the policies of the federal government which, as a practical matter, must provide most of the support for basic research and for some applications of social value that are unlikely to be developed in the private sector without government support. The peak of federal funding for science, as Harvey Brooks has pointed out, was passed in 1966 and declined since then by more than a factor of two when measured in dollars of constant
purchasing power per eligible active investigator. The start of the decline, after a very long period of productive growth, was in part related to the Vietnam War. That war was also a factor in the disbanding of the valuable mechanism of the President’s Scientific Advisory Committee. Despite valiant efforts from time to time in the intervening years, and great substantive progress, the extraordinary vigor of American science has been slowly ebbing ever since, and may come into jeopardy if weapons-related expenditures dominate the federal research and development budget.

Some Desiderata For Health Science Policy

We suggest some steps for health science policy, oriented to the future improvement of worldwide health status. Although they are especially aimed at policy formulation in the United States with its leadership role in biomedical and behavioral sciences, these suggestions may have some relevance to other countries. We propose that health sciences policies should nurture the growth of fundamental knowledge regarding the essential nature of living organisms, especially the human organism.

These policies should address the research needs and opportunities of all agencies whose missions relate to health even if their primary mission is service and they have not been considered “research agencies.” It is time for a broadly integrative view of all research and development directly relevant to health.

Policies are needed to assess recent and foreseeable changes in the burden-of-illness and to inquire whether research directions are keeping up with changing circumstances. This analysis should include plausible threats to health, such as possible long-term effects of the new chemical environment, importation of new diseases from one country to another, and demographic trends, especially the increasing proportion of elderly people, as well as the increasing problem of children born to children.

We need policies that recognize the recent awareness of the many factors relevant to the health of the public. In light of this new understanding, what concomitant readjustments are needed and what tasks must each health-related agency accomplish to bring research to bear on its problems? Such considerations should include the behavioral and environmental aspects of health and the implications of these relationships for research priorities.

Health sciences policies should also consider opportunities for international collaboration in such research as randomized clinical trials, where costs are great and might be shared among the nations likely to benefit from the findings. The mutual stimulation of international collaboration can become a strong asset in future health research.

We also propose that these policies should weigh options for the long-term financing of health care in a way that includes research expenditures, that is, research as a tool for improving the care and maintaining the qual-
ity of services provided; give high priority to the need for research that measures the health outcomes of diagnostic, therapeutic, and preventive interventions; increase the attention of the health sciences community in technically advanced nations to addressing the disease burdens of developing countries and thus move toward a worldwide perspective on health; and finally, continue developing and refining the measures of the burden of illness in ways that can specify with increasing reliability the nature and scope of health problems.

These suggestions must all be associated with a set of fundamental, recurring themes: guiding uses of the sciences toward widely shared ends—for example, the relief of human suffering, more equitable distribution of resources, more peaceful resolution of disputes; broadening participation in the conduct of scientific activity and in the benefits of the applications of sciences; maintaining the highest standards of excellence, technical competence, and efficiency in the conduct of research; and encouraging scientists to participate analytically in the uses of science—at the interfaces of fact and value—neither avoiding nor dominating the processes by which the social uses of science are decided.

Science Policy Desiderata: Health And Beyond

We propose some steps to promote the positive social uses and the constructive unity of the sciences—going beyond health to foster constructive building of national science policy.

First, we need to steadily build support beyond inflation, at least through the remainder of this decade, for the great research-sponsoring agencies of the federal government such as the National Science Foundation, the National Institutes of Health, and the Alcohol, Drug Abuse and Mental Health Administration, and the health monitoring agencies such as the Centers for Disease Control and National Center for Health Statistics, that provide information on changing health status and burden of illness of the population.

In making judgments on such support, science policy should place special emphasis on basic research across the entire spectrum of the sciences; provide distinctive opportunities for young people who have promise in research regardless of race, gender, or religion; foster the continuing interplay of basic and applied sciences so that each can stimulate the other; and encourage cooperation among government laboratories, universities, and industry.

We should build a bipartisan consensus to provide incentives for industry to strengthen research and development across the board, not only in the obviously high-tech industries.

Strengthening basic research on problems related to agriculture is important since it is crucial to our well-being, our health, and our role in the
world. We have done so well that complacency is a danger here. (The same
is true for health.) However, there are warning signals: soil erosion, wa-
ter problems, decrease in genetic variability of plants, shortage of botani-
cal scientists. We must take advantage of the new biotechnology in the
agricultural context, but with proper caution with regard to interfering
with ecologic balance. Indeed, its worldwide utility may well be ultimately
greatest in that sphere.

The oil glut is temporary. Not only are the sources politically volatile,
but the long-run supply is seriously limited, and the cost of extraction will
become a formidable problem. Therefore, a national commitment to re-
search on energy sources and alternatives is urgently needed—from fusion
to solar to conservation, Ours is the most energy-intensive society in the
world. We must take a long-term view. Both incentives to private indus-
try and federally supported university research should be important parts
of this research effort.

We need several mechanisms, both governmental and nongovernmental,
for analyzing thoroughly and objectively the various options bearing on
long-range science policy: what science can do for society, and how soci-
ety can keep science healthy. In government, the principal overview
functions of this sort can be performed for the Executive Branch by a
reconstituted President’s Science Advisory Committee, meeting fre-
quently, facilitated by adequate professional staff, and reporting directly
to the President. This committee should be independent but should work
closely with the President’s Science Advisor in the Office of Science and
Technology Policy. It should have regular communication with the Of-
fice of Management and Budget. Similar functions should be performed
on the legislative side by a strengthened Office of Technology Assessment.
This office has done a good job of providing the Congress, for the first
time in its history, with adequate technical analysis under its own control.
This mission can now be broadened to cover the full range of science-
related problems and opportunities.

The nation must capitalize on the extraordinary capability of our diverse
nongovernmental institutions to get the best possible analysis and advice
on long-term questions of great national importance. We are fortunate to
have remarkable institutions that pull together the sciences very broadly
and effectively. The federal government should appropriate funds for a
one-time endowment so that such institutions could undertake indepth
studies of several critical issues. This would include early warning signals
on emerging problems; the identification of neglected opportunities; the
formulation of new ways in which science and technology could contrib-
ute to the general well-being, here and abroad. Institutions appropriate
for such endowment include the National Academy of Sciences, Ameri-
can Association for the Advancement of Science, American Academy of
Arts and Sciences, and the Social Science Research Council.
The principal research-supporting agencies of the government, such as the National Institutes of Health and the National Science Foundation, should undertake national programs supporting science education in elementary and secondary schools as well as in the universities. Indeed, grants should foster local and regional linkages between precollegiate educational institutions and universities so that the former can benefit from the scientific knowledge of the latter. Science literacy is a serious national problem. Opportunities must be created for all—including minorities and women—to reach scientific literacy, and barriers to entering science professions must be removed.

The Department of Defense should return to its earlier and distinguished tradition of supporting a wide range of high quality research, specifically basic science. Nowhere is the strength of the national scientific community more useful than in relation to defense. This of course applies to the traditional definition of defense; and it also applies to that crucially important aspect of defense in the nuclear age which goes under the name of international security and arms control. A new level of commitment of the scientific community is urgently needed to reduce the risk of nuclear war. This requires a mobilization of the best possible intellectual, technical, and moral resources over a wide range of knowledge and perspectives. A science-based effort is essential to maximize analytical capability, objectivity, and respect for evidence—the outlook that is characteristic of the scientific community worldwide.  

Conclusion

Many initiatives would flow from the allocational and institutional steps described. A long-term invigoration of science and technology for constructive social uses can certainly be envisioned. But our recent efforts have been very uneven. The consequences of decline in this sphere would be very serious in the long run. Science is above all a mode of inquiry with the greatest problem-solving capability our species has so far evolved. This nation has developed scientific capability beyond any other in history. Rather than let this strength ebb away, we should not mobilize ourselves for war but for sustained, science-based attack on the great problems of our time.
NOTES

5. Bergstrom, Opening address.