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STATEMENT BY

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ON

REGULATION, BUSINESS OPPORTUNITIES, AND ENERGY

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Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to appear before you to discuss the future of the biomedical research enterprise in the 21st century and its relationship to the economic health of our nation. Accompanying me today are Dr. Jay Moskowitz, Associate Director for Science Policy and Legislation, and Mr. Reid G. Adler, Director of the Office of Technology Transfer.

As the 21st century approaches, we must pause to consider the enormous potential of biomedical research and ask ourselves whether this enterprise, and the American public, are poised to meet the challenges of the future. I would like to explore with you the role the National Institutes of Health (NIH) can play in addressing these opportunities, and especially as they apply to the development of our strategic plan for biomedical research.

No nation can be prepared to meet its challenges and provide domestic national security without a healthy population and a vigorous economy. In this regard, our domestic national security in no small measure relates to our investment in the biomedical research enterprise and in NIH. The National Institutes of Health plays a major role in ensuring the health of the nation's people through the development of therapies and interventions that prevent disease and reduce suffering from disabilities. This investment also contributes to the vigor of the country's economy. New dimensions in biomedical research, centering on the promising area of molecular medicine and biotechnology, stimulate economic growth. Molecular medicine represents this nation's exploration of "inner space" - the cells, genes, and molecular structure of the human body. This research is uncovering a vast array of opportunities

flowing from a new, expanding knowledge base. These opportunities provide the intellectual basis for the industry of the future: biotechnology. Our achievements in molecular medicine become the raw material that is forged into biotechnological products, that may one day dominate the international marketplace. I doubt that there is a more future-oriented industry than biotechnology. By harnessing the very energy of life, products are created from living materials to improve health today and reinforce the fabric of life tomorrow.

The benefits of these processes were recognized thousands of years ago by our ancestors, who used yeast to raise bread dough. Today, a more sophisticated application of this technology, which uses the raw materials of life, has enabled NIH scientists to pioneer gene therapy experiments. Such experiments replace a defective gene with a normal one or use gene therapy to augment the body's own natural resources to restore health. Currently, there are only a few identified genes on which we base this research. It is estimated however, that the human genome is made up of well over 100,000 genes. We have had startling success using those few genes we have been able to isolate, thus far, pointing to the magnificent promises of tomorrow that draw from our ability to tap into the vast data base contained within each human cell. This human genome data base will also provide the codes to produce a wide array of biotechnology products that will lead to a transformation in medical therapeutics as we know it today. Such work is so new and so revolutionary that it reminds me of a quote from--not a scientist, but a statesman: Dean Rusk.

He said, "The pace of events is moving so fast that unless we can find some way to keep our sights on tomorrow, we cannot expect to be in touch with today."

In addition to the potential that such work holds to improve our lives it holds enormous promise to reinvigorate our nation's economy. A recent report by the Office of Technology Assessment (OTA), "Biotechnology in a Global Economy," stated: "Biotechnology...has the potential to improve the nation's health, food supply, and the quality of the environment." The report further stated, "Since the discovery of recombinant DNA technology in the early '70's, biotechnology has become an essential tool for many researchers and the underpinning of new industrial firms [and] is viewed by several countries as a key to the marketplace of the 21st century." In fact, this year the President's Council on Competitiveness Report on National Biotechnology Policy asserted that the biotechnology industry has the "potential to surpass the computer industry in size and importance...this $2 billion domestic industry is expected to increase to $50 billion by the year 2000."

In 1990 alone, 11 biotechnology products were approved for therapeutic application, the same number as approved during the entire preceding 5 years. A National Science Foundation survey of 48 biotechnology companies found that foreign sales, mostly to Western Europe and Japan, accounted for one-quarter of total sales. The biotechnology industry already has contributed to a positive trade balance, and for pharmaceuticals and medical devices we now lead the world.

This country became an international economic power in part because our manufacturing industries were able to refine raw materials of the earth into innovative products. The biotechnology industry transforms the raw materials of life using mainly the resources of the mind. The industry is inseparably linked to the scientific creativity of individual human talent. The future of biotechnology and our nation's economic strength in no small way depends on our ability to tap the imagination of our scientists and sustain the vigor of the scientific enterprise. This vital resource, however, may be threatened. In assessing our capacity to meet the challenges of the future, I would raise some concerns, and suggest some positive steps towards addressing them.

CHANGES IN OUR HUMAN CAPITAL BASE

First, the human capital base: Science can be no better than its scientists. Examination of our educational system is one prognostic measure of the fate of our biomedical research enterprise and the prognosis is worrisome. Documented scientific illiteracy among millions of young students and declining SAT scores provide continued evidence of a "rising tide of mediocrity" among American youth. A 1988 international report comparing science achievement among students in 13 developed countries placed U.S. students of all grades at the bottom half. U.S. high school seniors placed 13th in biology, and 9th and 11th in physics and chemistry, respectively. Furthermore, on biology tests, the mean scores of U.S. high school seniors are a dismal 37.9 percent, well below those of 11 other countries, including Japan, Hungary, and the United Kingdom. Statistics show that this trend continues through college. Life science as a career choice for American youth has been in decline for some

time. Changes in the market-share of undergraduate majors in 4-year schools reflect this fact as sciences across the board are losing, while business, social sciences, and the humanities are gaining. For example, first-time freshmen majoring in business jumped from one in five in 1978 to almost one in four in 1987, while those choosing physical and biological sciences declined. Bachelor's degree awards over the past 20 years in the biological sciences, premedicine, engineering, and the physical sciences have declined significantly, while those in business, management, and the social sciences continue to rise in popularity. Predictably, there is a similar trend in the awarding of doctoral degrees in the sciences. Also of great concern is the ever-growing number of doctoral recipients in this country who are not U.S. citizens. Many doctorates are awarded to individuals on temporary visas who must return to their countries contributing further to the erosion of our human capital base.

A major factor in the decision of Americans not to pursue careers in biomedical research is the inordinate cost associated with advanced education. Because of the huge debts accrued during their education, an increasing number of students, regardless of their intelligence, talent, or ability, are choosing careers that have bigger financial payoffs and are turning away from scientific investigation. Financing an education through loans has increased disproportionally to scholarships over the past ten years. In 1983, an estimated 30 percent of student funds were in the form of scholarships, while in 1989 that number dropped to nearly 20 percent. The mean debt of senior medical students, which has steadily increased over the past decade, also reflects this increasing financial burden. On the average, a senior medical

student leaves school owing close to $50,000. Unfortunately, the high risk and personal sacrifice of a career in science does not improve after those training years. It is not just that the salaries are lower in research than nonresearch fields. Close to zero growth of Federal research endeavors in biomedical research has closed out opportunities for new and established researchers to pursue their craft. Due to the escalation in cost of individual grants, the NIH has seen almost no growth in its portfolio of research awards in the past 5 to 6 years. Moreover, the number of principle investigators supported by the NIH has declined over the past 3 years. The research grant portfolio represents "our nation's response to opportunity"--and the principle investigators, the intellectual brain trust needed to develop this field. That three out of four highly meritorious research proposals were turned down for support by NIH in 1990 has a resoundingly negative impact on the career scientist, and an even greater dampening impact on science.

Perhaps of equal concern is the knowledge that our research community is aging. Of persons submitting competing research project grant (RPG) applications, those between ages 46-50 are steadily increasing while those age 35 and below are steadily decreasing. This information is both startling and worrisome. Science in particular needs its young, not just to renew itself but to do its job intellectually. There is enormous wisdom in the words of Sir Francis Bacon in his essay "Of Youth and Age":

> "Young men are fitter to invent than to judge; fitter for execution than for counsel; and fitter for new projects than for

> settled business...Young men...embrace more than they can hold, stir more than they can quiet, fly to the end without consideration of the means and degrees; pursue some new principles which they have chanced upon absurdly...(Whereas) men of age object too much, consult too long, adventure too little, repent too soon, --- and content themselves with a mediocrity of success."

These words are even more powerful today--Science moves ahead because of bold questions, challenges to established dogma, and irreverence to naysayers. Science will calcify and crumble if we lose our youth.

DECLINING SCIENTIFIC PRESTIGE ABROAD

A second warning sign for science and its ability to contribute to this nation's economy is the erosion of our world leadership in science and engineering. The percentage of GNP invested in civilian research and development by the United States is lagging relative to other industrialized nations particularly Japan, West Germany and France. These countries have been increasing their investment, while ours has been declining. For example, nondefense R&D as a percentage of GNP in Japan rose from about 2 percent in 1977 to 3 percent by 1987, while U.S. spending in the same category remained stable (at around 1.5 percent). Our world neighbors have steadily increased their market share of scientists, as a matter of focused national priority while our technical strength has declined. One example of this decline is the lower percentage of Americans registering patents in this country. We are

seeing a decline in absolute numbers of patents held by American inventors and as a result are losing our prestige as a nation of innovators. Another measure of the relative strength of our nation's biomedical research is an examination of its market share of world scientific and technical articles. Here too, we are witnessing an erosion of the U.S. preeminence.

An analysis of Nobel Prizes awarded to Americans over the last five decades indicates a fluctuation in recipients with the trend also on the decline. During the decade from 1950-1959, 70 percent or 14 of the 20 total prizes were awarded to Americans. In contrast, from 1980-1989, 57 percent of 23 prizes were awarded to Americans and the first ever to a Japanese scientist. This past year two Nobel prizes in physiology or medicine went to Germany--and no prize to a U.S. scientist. The figures clearly suggest a global change as other countries are challenging our leadership. Is it that they are getting better, or are we getting worse?

Cumulatively, the erosion of our human resource base, and of its productive output, places American biomedical research, biomedicine, and biotechnology, at risk. Erosion of our biomedical research enterprise will impact, not only on our Nation's economic well being in the years ahead, but also on the quality of life of our people.

PUBLIC SUPPORT FOR BIOMEDICAL RESEARCH

I believe that we can positively address these issues, which are so vital to our Nation's security. One of the single most positive prognostic signs is

that at the "grassroots" level we know that the public strongly supports the biomedical research enterprise. When asked in a recent poll, public support for research in the health sciences was overwhelmingly greater than all other scientific endeavors, including the environment, energy, space, or defense. The public has consistently seen our medical research enterprise as a high priority and indeed a top national priority. Public servants must listen.

STRATEGIC PLAN

As NIH prepares to address the challenges and respond to our mission to serve the public interest, we have begun to take those steps necessary to ensure a strengthened, vigorous, biomedical research enterprise, ready to confront the challenges ahead.

As the world's leading and largest benefactor of biomedical research, the NIH must have goals and strategies that transcend its immediate concerns and point to the future. We must be bound by a compelling vision, and sustain and enrich the public's interest and support. To do this, we have embarked on a process to create a "corporate" sense of common mission and goals and articulate the vital areas of science and policy which the whole of NIH must address, along with the disease oriented targets of individual institutes. Our Strategic Planning process which we embarked upon eight months ago is aimed toward that end.

The development of the first phase of the NIH Strategic Plan is now nearing completion, and is the culmination of the past year's dedicated and concerted

effort by the senior staff of the Office of the Director and of the Institutes, Centers, and Divisions at the NIH, with input from the chartered advisory councils. In the process we have identified our corporate NIH goals and specific high priority areas of research and policy that cut across all institutes. How well we handle each of these areas, largely will measure the overall success of the NIH as we look ahead.

The Strategic Plan, while focusing on the future of biomedical research, sets four clear cut goals that are both realistic and sensitive to changing public needs. They are:

- To foster innovative research strategies designed to advance significantly the Nation's capability to improve health.

- To provide a scientific base that will strengthen the Nation's capability to deliver more effective disease prevention and health care to enhance the quality of life for its citizens.

- To provide the scientific base in biology and medicine that will strengthen the Nation's economic competitiveness and ensure a continued high return on the public's investment.

- To be a model for public accountability, scientific integrity, and social responsibility.

With these goals in mind, we developed specific areas of biomedical and behavioral science and administrative policy that are critical to our success today and tomorrow. Some of these areas highlight our efforts to translate existing basic knowledge into clinical benefit for patients of today--for example--Prevention; Infant Health and Mortality; Population-Based Studies; Aging; Health of Women, Minorities, and Underserved Populations. Other areas focus on prime and promising areas of basic science and investment in future cures in areas such as Molecular Medicine; Biotechnology; Reproductive Biology and Development; Vaccine Development; Structural Biology; and Neuroscience and Behavior.

Among our identified Strategic Policy issues are Technology Transfer, Science Education and Human Resource Development, Long Term Research Funding, and Emerging Social, Legal, and Ethical Issues. Another issue being addressed is one of the most vexing problems of our society today -- the impact of research on the spiraling cost of health care. It is clear that a major solution to mitigating these rising health care costs must be the prevention and cure of chronic debilitating diseases that place an especially undue burden in both human and economic terms.

Before turning to our plans for public review of the draft of the Strategic Plan, let me say a few words about what the Strategic Plan is not. The Plan is not a comprehensive, detailed road map for all NIH programs and activities. We are not attempting to specify the details of basic research or to micromanage the direction of scientific endeavors. Such planning would be foolhardy and, indeed, be against the methods that progress science. There

will always be unexpected breakthroughs in science--leaps into new dimensions that will create unanticipated opportunities. No plan can predict these developments. Even within the broad overarching goals and priorities delineated in the Strategic Plan, new directions will necessitate adjustments and fine-tuning as the enterprise evolves. With this flexibility underpinning the Plan, our efforts will chart a broad course for the future and be driven by a recognized need to nurture intellectual creativity and imaginative scholarship and to foster an environment fertile for innovation and interdisciplinary collaboration, all necessary for path-breaking research discoveries.

As we have progressed, we have sought input broadly from the scientific community. Before the Strategic Plan can be finalized, however, we will seek additional, more formal input from the scientific community as a whole. A draft of the entire plan, incorporating comments from the National Advisory Councils of the National Institutes of Health, will be publicly presented for the first time on February 2, 1992, at the Southwest Biomedical Research Symposium. NIH will hold hearings to receive public comment on the plan on February 12 at Occidental College, in conjunction with Drew University of Medicine and Science, in Los Angeles, and February 25 at the University of Connecticut Health Center, in Farmington, and in early March in the Southeast and Midwest. Following public and advisory council review, we will finalize the plan, and be prepared to present it to the Congress during the fiscal year 1993 Appropriations hearings. It is our expectation that the Strategic Plan will provide a coordinated structural framework for growth and development of the NIH--and, in a nutshell, that development must ensure that the best ideas

of science are efficiently explored to fulfill our responsibilities to the millions who still suffer from diseases and disabilities; it must rejuvenate our human resource base and must contribute to the economic health of our Nation.

MOLECULAR MEDICINE -- BASIS FOR UNDERSTANDING AND TREATING DISEASE

Let me now mention some major components of the NIH's Strategic Plan. A central thrust is molecular medicine.

Molecular medicine will transform medicine as we know it today. We are evolving a capability for precise biological "trouble shooting" by identifying cellular and molecular targets for preventive and therapeutic responses that rest on fundamental knowledge of the ultimate causes of disease. The ideas and discoveries that derive from molecular medicine embrace molecular biology and cell signalling, structural biology and rational drug design, molecular genetics of living organisms, vaccine development not just for infectious diseases, but for cancers and chronic debilitating illnesses, and the development of novel bioengineered products. It is a field that is erasing distinctions between basic science and preventive and therapeutic medicine, between behavior and biology. Let me give you but a few recent examples of the breadth of the impact of molecular medicine.

Cancer Therapy: A whole new biological approach to cancer treatment utilizes natural components or cells, such as growth factors, receptors, and immune

system cells, to deliver drugs in a targeted manner to tumor cells or to enhance the body's immune response to cancers. Using recombinant technology, bacterial toxins can be coupled to monoclonal antibodies, growth factors, or other molecules that are able to target the toxin to a specific cell type. One such conjugate, derived from a portion of the *Pseudomonas* exotoxin molecule joined to transferrin growth factor alpha, can kill bladder cancer cells in culture and in animal model systems. A Phase I clinical trial has been initiated in which this recombinant toxin will be administered into the urinary bladder as local therapy for patients with bladder cancer. Another modified toxin molecule has been constructed which has been effective *in vitro* in killing T lymphocytes infected with HIV. Further, the combination of this recombinant toxin and AZT has shown an even more powerful effect *in vitro* than either agent administered separately. A phase I clinical trial at NIH has recently begun to evaluate the recombinant toxin in patients with AIDS.

A major area of gene therapy research is directed toward inserting genes into human tumor infiltrating lymphocytes (TILs) to increase their tumor killing effect. In January 1991, the first patients received TILs that had been genetically modified with the tumor necrosis factor (TNF) gene. The focus of this phase of investigation is to determine if the antitumor activity of the TIL cells can be augmented by a biological response modifier. In a complementary approach, NIH scientists are starting two cancer vaccination trials, in which tumor cells from patients' cancer are modified in the laboratory by gene transfer of either IL-2 or TNF genes. The cells are then injected into the patient in the hope that the modified cancer cells will stimulate an immune response to the cancer.

Alzheimer's Disease: An Indiana family in which early-onset autopsy-proven Alzheimer's disease appears to be inherited in an autosomal dominant fashion has been shown to carry a mutation in the amyloid precursor protein (APP) gene. Affected members of this family show clinical onset of the disease at about age 40. Unaffected members of the family do not carry the mutation, nor is it found in the general population. This discovery considerably strengthens our evolving insight that alterations in APP metabolism are among the causes of Alzheimer's disease.

Three teams of scientists have succeeded in developing a transgenic mouse model that overexpresses the human amyloid precursor protein (APP) gene in the brains of the mice. This first animal model of Alzheimer's disease already has developed the plaques and neurofibrillary tangles that are hallmarks of human Alzheimer's disease and could previously only be observed at autopsy. The new strain of mice may be used to test therapeutic agents against the progression of Alzheimer's disease, in addition to enhancing our understanding of how APP alterations can cause the disease. This new opportunity -- to experiment with the APP metabolism and with possible drug treatments in these mice -- is especially important, because it represents our first *in vivo* approach to Alzheimer's disease.

ADMINISTRATIVE AND POLICY ISSUES

Included in the Strategic Plan are administrative and policy issues that are critical to the successful outcomes of biomedical research. Strategic policy issues include such complex and important topics as the ethical and legal

dimensions of biomedical research; the transfer of information and technology to the public; and patent and pricing issues relating to drugs and biologics developed with public funds. All are important to the subject of this hearing.

Ethical, Legal, and Social Issues: Controversial issues sometimes accompany the emergence of new technologies. We have seen it for recombinant DNA, we have seen it for fetal tissue transplantation, and we have seen it for RU 486. As we look ahead, these challenging interfaces between science and the ethical and legal concerns of the society at large will only increase. For example, as more is known about the genetic basis of disease, questions have begun to confront us about how this genetic information will be managed. Who should have access to such information? Unwarranted release of an individual's genetic composition could have very disturbing effects. Those individuals predisposed to certain diseases, especially those affecting mental health, may face a stigma in our society. Discrimination based on fears that the individual will become a financial burden could prevent the individual from obtaining employment or insurance, and possibly result in psychological trauma for an entire family.

The NIH's National Center for Human Genome Research (NCHGR) has created a precedent-setting research program entitled, Ethical, Legal, and Social Issues (ELSI), to address the multi-faceted social implications of biomedical research related to the human genome program. Recognizing the importance of this program, a commitment was made to devote 3 to 5 percent of the NCHGR budget to ELSI. The ELSI program will address these emerging issue areas and

develop policy through a variety of mechanisms such as grants, contracts, conferences, special workshops, and advisory committees. One of our first goals is to establish guidelines for the insurance industry's handling of genetic information. We are committed to maintaining the integrity of an individual's personal genetic information, and fully recognize the need to improve societal protection against discrimination employing such information. We are also committed to participating in these kinds of debates within the newly established Science Policy Center at NIH, and as part of our social responsibility as a public agency.

Technology Transfer: Another issue of major importance to the future of this country is how the basic discoveries of NIH are transferred to public good. The United States is the world's front-runner in biomedical research because of its strong basic research structure and because we have been able to convert research discoveries into products. Technology transfer, a major policy issue identified in the Strategic Plan, refers to the dissemination of knowledge and intellectual property rights. It also includes "information transfer," to enhance technology utilization so that biomedical research advances are incorporated rapidly and appropriately into clinical applications.

To aid in the transfer of new discoveries, in 1988 the NIH established the Office of Technology Transfer to ensure the successful patenting of inventions and licensing to the private sector. The office has been successful in implementing programs to ensure that inventions from the intramural laboratories are transferred to the private sector, using both patent license

agreements and Cooperative Research and Development Agreements (CRADA). CRADAs are written agreements between Federal laboratories and companies that allow the participants to direct personnel, services, property, and funds toward collaborative joint research projects.

As one example, a CRADA established between the NIH and a private company, Genetic Technology Inc. (GTI), made it possible for Dr. W. French Anderson and his colleagues to conduct a historic gene therapy experiment. The CRADA provided the company with an incentive to financially exploit the technology with an option for exclusive licensing rights, while enabling NIH to develop a better biological delivery vehicle. The company contributed to the partnership by providing intellectual expertise and essential materials, as well as financial support for the laboratory personnel. NIH has filed several patent applications on inventions made under this CRADA, which relate to various aspects of human gene therapy, and several of these have been licensed to the company.

To maintain our world leadership in biotechnology the United States must continue robust support of the programs of NIH, the engine that drives this developing industry. NIH's role as a major stimulus for industrial developments in biotechnology has been fostered by a series of key pieces of legislation starting in 1980 with the Stevenson-Wydler Technology Transfer Innovation Act and the Bayh-Dole Act of 1980, and more recently with the Federal Technology Transfer Act of 1986 and Executive Order 12591 of April 10, 1987. This legislative portfolio has stimulated academic--industry--government collaborations through favorable patent arrangements for grantees

and cooperative research agreements with NIH laboratories. Continued growth in public and private sector collaborations is essential to established and emerging U.S. biotechnology firms.

The United States is still the world leader in biotechnology because of its strong basic research structure and its ability to convert research into products. Few fields have greater promise or potential than biotechnology. We at NIH regard the transfer of this technology not as just a part of our agency's business, but as central to our mission -- "science in pursuit of knowledge to extend healthy life and reduce the burden of illness and disability." Undertaking to expedite the transfer of technology involves both material and human elements.

REGULATORY AND INTELLECTUAL PROPERTY RIGHTS ISSUES

If we are to assure our nation's leadership in this still fragile biotechnology industry, there are specific matters that require attention. Biotechnology's health is dependent upon strong and growing support of basic research, targeting biotechnology as critical for economic development, encouraging a responsive regulatory system, and protecting intellectual property. The issues surrounding the protection of intellectual property have many historical precedents. Historian Daniel Boorstin has described how, "In earlier times to possess an idea or a fact meant keeping it secret, having the power to prevent others from knowing it. Maps of treasure routes were guarded, and the first postal services were designed for the security of the

state. Physicians and lawyers locked their knowledge in a learned language. The government helped craft guilds to exclude trespassers from their secrets."

Boorstin was describing the situation in Europe up until the middle of the seventeenth century. Fortunately, we live in a more open, democratic society and have 200 years of an evolving patent law system started by Thomas Jefferson. Yet, some of the issues surrounding NIH's efforts to patent discoveries made with NIH support, thereby, ensuring public disclosure of these discoveries, remind me of earlier times. That is, we still have uncertainty of how we share powerful new knowledge, as opposed to keeping it secret for proprietary reasons. As we continue to push the frontiers of discovery and the innovative use of the knowledge derived from molecular genetics and the human genome programs, we are likely to develop new dimensions in our patent system. Handling these matters well is of vital importance to the nation's economy.

DRUG PRICING

Another technology transfer issue gaining wide general interest concerns the pricing of drugs or devices developed through Federal intramural research. Should not the public benefit from the public-industry partnership that has facilitated product development? NIH's technology transfer program can speak to a recent success in grappling with this issue, setting an example to be followed by other Federal agencies.

With the recent approval of dideoxyinosine, or ddI, by the FDA, we have added another and needed therapeutic agent to our arsenal for use against HIV, the AIDS virus. At the time that the licensing process for ddI was initiated, approximately five years ago, the National Cancer Institute (NCI) had found from experience that pharmaceutical companies generally will not proceed with the scientific and commercial development of an agent unless they have exclusive rights to that agent. This reticence was particularly noted in the development of AIDS-related therapeutics, because the number of patients known to have AIDS was small in the early years of the epidemic, and for a significant time only AZT had FDA approval for marketing. Rapid development of ddI for clinical use in AIDS patients was considered by the NCI to be essential, in fact, an emergency, and the granting of an exclusive license was considered to be the only mechanism to ensure that the development of ddI proceeded expeditiously. An additional factor was the recognition that AZT, ddC, and ddI, all drugs in the same family, would each be in the hands of a different competing company. Finally, the Government does not have the capability of developing and distributing such a drug on its own and therefore must find effective partners in the private sector. In October, the FDA granted approval for the use of ddI as an AIDS therapeutic. Under the terms of the license, Bristol-Myers Squibb has exclusive rights to make, use, and sell products for ten years from the date of the first commercial sale. But, the license also includes a clause addressing the company's responsibility to arrive at a fair and reasonable price for the drug. Thus, ddI is the first drug to be marketed under a Government license that includes a reasonable pricing clause.

This pricing clause is just one mechanism by which we can work to ensure that technology developed by Federal intramural research is delivered to the American people at a reasonable price. To my knowledge, NIH is the only Government agency that has interpreted the FTTA as giving it the authority to insert a reasonable pricing clause in a licensing agreement. We have also stressed that competition in the open marketplace is another important mechanism at our disposal. In the arena of AIDS drugs, as already mentioned, ddI is licensed to Bristol-Myers Squibb, ddC, a drug under consideration by the FDA, is licensed to Hoffman-LaRoche, and AZT was developed with Burroughs-Wellcome. Inventorship of AZT currently is being litigated. Thus, for this class of anti-AIDS drugs, we can expect a vigorous level of competition to benefit the consumer. Indeed, competition within a family of drugs is an important general end-result of NIH-supported research and technology transfer. So is the accelerated pace of pharmaceutical development that we have witnessed so dramatically in the case of AIDS antiviral agents.

The overall outlook for technology transfer among NIH and its contractors and grantees is both exciting and encouraging. Already NIH CRADAs have cut years off the clinical development time frame for several therapeutics and have accelerated the development of animal models for various human diseases. In addition, almost 1200 inventions made in Public Health Service (PHS) intramural laboratories have been patented or are pending patents, 300 of which have been licensed to industry. Products already on the market resulted in $4.8 million in royalties for the PHS in fiscal year 1990, and contribute to dramatic improvements in the public health.

NIH is acknowledged to have one of the most aggressive and effective technology transfer programs in government, and holds over 50 percent of CRADAs from all Federal laboratories. Yet there is still much we can and must do. The strategic plan is highlighting the critical need to encourage a technology transfer culture at NIH that is essential to NIH's mission. Thus, it will be necessary to continue to infuse our human resource base with the keen young minds poised not only to seize on the new discoveries but also to envision the subsequent benefits to our Nation.

CONCLUSION

In conclusion, Mr. Chairman, we feel the opportunities for major achievements in biomedicine and the life sciences have never been greater. For us, the Strategic Plan provides a means by which we can more aggressively address future challenges and seek to sustain and enliven this vital and magnificent model of scientific pursuit. We look forward to working with you and other Members of Congress as we launch the Strategic Plan and begin to address global issues confronting all of us as we approach the 21st century.

Let me end with one final piece of history that reminds me that the importance of biological science to both health and economics is not an entirely new phenomenon. It is the story of Louis Pasteur. It is captured well in a summary of his accomplishments, briefly and pointedly written in the Encyclopedia Britannica. Permit me to read it to you: "Pasteur proved that microorganisms cause fermentation and disease; he originated and was the first

to use vaccines for rabies, anthrax and chicken cholera; he performed important pioneer work in stereochemistry; he originated pasteurization; and he saved the wine, beer and silk industries of France and elsewhere."

This concludes my prepared statement. I would be pleased to answer any questions you may have.