Testimony
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House Committee on Financial Services
"The Role of Public Investment in Promoting Economic Growth"
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Good afternoon, Chairman Frank, Ranking Member Bachus, and Committee members. Thank you for the opportunity to appear before you today to address the very important issue of public investment by the federal government in basic scientific research. This hearing serves as a reminder of the value of long-term public investment in general, and I look forward to discussing this issue with Committee members.

First, I should introduce myself and my institution. I am the Chancellor of the University of California, Irvine, which is one of ten campuses of the University of California (UC) system. At UC Irvine (UCI), we have nearly 26,000 students, and we conduct research in a wide range of the sciences that are supported by the National Institutes of Health (NIH), the National Science Foundation, the Departments of Defense and Energy, NASA, NOAA and several other federal research agencies. In 2006, UC Irvine received approximately $197 million from federal agencies to support peer-reviewed research projects. UC Irvine is among six UC campuses that belong to the Association of American Universities, an organization of 60 U.S. and 2 Canadian research universities that generally represent the cream of America's public and private research universities. AAU members perform about 60 percent of federally supported university-based research.

Our nation's system of higher education, particularly its diverse range of public universities, is a unique example of public investment that has paid enormous dividends for our nation. Federal investments in students and research build our human capital, propel the economy, improve health and quality of life, strengthen our national security, and help to ensure a strong and lasting democracy. In short, the American model of intertwining investment in education and research at thousands of independent public and private institutions has forged a success story unprecedented in history and is a model that is now being imitated by other nations in Asia and Europe.

America's colleges and universities produce human and intellectual capital that are the twin engines of economic growth. While public investment is not the only source of support, it is the single most important and certainly the added ingredient that has made U.S. research universities the envy of the world. As you well know, Mr. Chairman, from your personal experience, it is that formula that spawned the "Route 128" economic phenomenon in Massachusetts, as well as Silicon Valley in my state of California.

I am here today as the leader of a research university and my testimony will focus on the benefits of the research we and other universities conduct with the support of and on behalf of the federal government.

THE FEDERAL INVESTMENT IN STUDENTS

Before I do, given the nature of this hearing, I would not want to miss the opportunity to reiterate briefly the importance of the federal investment in student aid. The federal government is a critical partner in higher education, as we educate students, perform research, and provide healthcare services. Federal government funding is key to helping students attend college regardless of their income. The United States has made great progress in providing educational opportunity for all, but more work needs to be done. Since 1973, the portion of the nation's workforce with a college degree or higher has doubled. This growth would not have been possible without the partnership between the two largest sources of financial support for college students: the federal government and postsecondary educational institutions.

Federal student aid has helped to shape American postsecondary education since World War II. Starting with the GI Bill, enacted in 1944, the federal government has extended higher education opportunities to millions of men and women who otherwise might never have gone to college. Several landmark measures that followed the GI Bill have laid the foundation of our current federal student aid system.

These include the 1958 National Defense Education Act, which created what is now called the Perkins Loan Program; the 1964 Economic Opportunity Act, which established the college work-study program; and the 1965 Higher Education Act, which set the framework for federal aid and now authorizes Pell Grants, the Supplemental Educational Opportunity Grant (SEOG), Leveraging Educational Assistance Partnership (LEAP), and the Federal Family Education Loan (FFEL) and Direct Loan (DL) programs.

The Pell Grant is the cornerstone of today's federal need-based student aid programs. It constitutes 68 percent of federal grant aid to students, helping more than five million undergraduate students attend college. Unfortunately, the maximum Pell Grant has lost considerable buying power over the past several years, dropping 20 percent in constant dollars since 1975. We appreciate that, for the first time in five years, Congress enacted an increase in the maximum Pell Grant award to $4,310, but this is far short of the higher education community's recommended goal for 2008 of $5,100. Investing in Pell Grants is the most important way the federal government can continue to provide access and opportunity to all those who wish to attend college.

Congress also has established two programs that are very important to research universities because they assist graduate students – the Graduate Assistance in Areas of National Need (GAANN) and Javits Fellowships. These programs support the entire range of academic disciplines, including the sciences, arts, social sciences, and the humanities. Recipients of these awards are expected to become experts who will contribute to the research, training, and innovation that are critical to maintaining and advancing our technology infrastructure, national security, and economic prosperity.

It is also important to note that the largest portion of grant aid to students actually comes from colleges and universities themselves. They provide 41 percent of total grant aid, with federal grants (including loans) composing 31 percent and states and private sources providing the remaining support. AAU's 60 U.S. institutions alone provided approximately $2 billion in grant aid to complement the federal investment in student aid in FY2005-06. My own university provided nearly $63 million in institutional aid in 2005.

THE FEDERAL INVESTMENT IN RESEARCH

Now I would like to turn to the federal government's investment in university-based research. It is important first to provide some historical context. Mr. Rohatyn has done an excellent job of describing some of the important investments made by the United States government, in the 19th and 20th centuries particularly, that laid the foundation for this nation becoming the superpower and the global economic powerhouse that it is today.

I would like to describe one more, and that is the series of legislative and budgetary actions that followed the successful launch of Sputnik by the Soviet Union on October 4, 1957, 50 years ago next October. That event was a signal that our nation's scientific and educational leadership could not be taken for granted, that instead we needed to expand our investment in the system if we wanted to stay ahead. After Sputnik, a national strategy making education and research central to the building of American strength emerged virtually overnight.

Our government's investment in scientific research grew significantly after World War II, due to the belief that it had been a very important contributor to our military success. Based in part on a groundbreaking report, "Science – The Endless Frontier," by the Massachusetts Institute of Technology's (MIT) Vannevar Bush, who served as President Franklin Roosevelt's unofficial science advisor, we created a number of new scientific institutions. In 1948, Congress established the National Institutes of Health and in 1950 the government also created the National Science Foundation to support basic research.

The launch of Sputnik in 1957 prompted Congress to vastly strengthen the government's scientific enterprise and to create a number of new institutions such as NASA and the Department of Defense's Advanced Research Project Agency – now known as DARPA. In the years immediately following Sputnik, between 1957 and 1961, the federal investment in research and development more than doubled, and total government outlays for basic research at NSF and other agencies tripled. Based on a model established during World War II, much of this investment went into laboratories at U.S. universities, which were viewed as the government's partners in conducting research.

The education portion of the post-Sputnik strategy was embodied in the National Defense Education Act (NDEA) of 1958. It created new programs to support the development of modern curricula in K-12 science and math and to upgrade the quality of science teaching; it created new graduate fellowships to encourage development and expansion of Ph.D. programs in all disciplines; it provided for low-interest student loans to undergraduate and graduate students with financial need; and it authorized the creation of foreign language and area studies centers to

improve the nation's knowledge of languages and cultures, as well as institutes to train elementary and secondary foreign language teachers.

These combined developments created an unrivaled research enterprise, helping to quadruple the number of U.S. Nobel prize winners in science in the second half of the 20th century and leading to untold discoveries that helped to transform the country and, indeed, much of the world.

There is no doubt that university research is a vital building block in our nation's R&D enterprise. Universities perform 54 percent of the nation's basic research. The system under which the federal government supports university research has long been a uniquely American system. Many other nations maintain bureaucratic control over research through national research institutes.

In our country, the merit review system ensures that support for research is based on scientific merit rather than other considerations such as politics or heavy-handed bureaucratic control. Indeed, the merit review process has provided the opportunity for the world's best research to be conducted at universities both small and large across this country, an opportunity that has fostered the development of the extraordinary science that we have experienced for the past half century and more.

Moreover, this system produces what I believe is one of the world's great "twofers." Because along with creating new knowledge and the foundation for new products and processes, U.S. universities use their research activities to educate students who will become the next generation's scientists, teachers, and leaders in government and industry.

My own university is an excellent example. Over the past 40 years, as a consequence of hard work, many good recruitment decisions, and important state and federal investments, UCI has risen to become of one of our country's leading research university campuses. We are now an important part of our nation's innovation system, and of our regional economic growth. Of course our graduate students spend much of their time in our laboratories, and much of the work in which they have the opportunity to participate is federally funded. But this is often true of undergraduate students as well. Faculty-mentored research has become an integral component of the education an undergraduate receives at UCI, including participation in research supported by NIH, NSF, and other federal agencies.

The American model of higher education, in which education and research are intricately entwined, allows for fusion of the educational experience. This close linking of education and research is training the future workforce of our nation. A fundamental reality of American science is that, as likely as not, the scientist who produces the next great discovery will have worked as a graduate student in a lab funded by a federal research agency and have conducted his or her own award-winning research with federal support. And every American is better off for our having developed this unique combination of research and education.

Indeed, the successes of this system are so extraordinary, that we often take them for granted. We often forget how big a role federally supported university research has played in laying the foundation for products and other advances that have fundamentally changed how Americans

live, dramatically improved the quality and length of our lives, made business and our economy exponentially more productive, helped us to defend our country, and taught us ever more amazing things about the world and the universe in which we live.

In my own field of medicine alone, annual cancer deaths in the United States have fallen for the second consecutive year. This drop in cancer mortality, a first in history, is occurring despite the aging of our population.

The rapid identification of HIV/AIDS in the early 1980's was a result of research from the War on Cancer into the possibility that a newly discovered class of viruses, retroviruses, might cause cancer.

Herb Boyer, a University of California San Francisco professor and later the founder of Genentech, developed the Recombinant DNA technique, which revolutionized the field of biology and spawned the modern biotechnology industry. This led to the creation of such artificial substances as human growth hormone, interferon, interleukin II, hepatitis B vaccine, and blood clotting and blood dissolving substances.

Based upon projections from the 1970's, NIH estimates that there has been a 60-percent drop in mortality from heart attack and stroke. Savings from the improved prevention and treatment of cardiovascular disease are estimated by The New York Times to return $500 billion to our economy annually.

It used to take years, and often decades, to develop vaccines. But this is no longer the case, and our ability to identify viruses and develop vaccines continues to accelerate. Four years after the arrival here of the West Nile virus, candidate vaccines were in clinical trials. One month after the World Health Organization sounded the alarm on Sudden Acute Respiratory Syndrome (SARS), the virus that causes SARS had been genetically sequenced and after another six months, the first candidate vaccine entered a clinical trial at NIH.

These are truly revolutionary advances, with enormous positive benefits, that were made possible by our government's support of basic research. None of this would have been possible as recently as fifteen years ago.

There are countless other examples. University researchers:

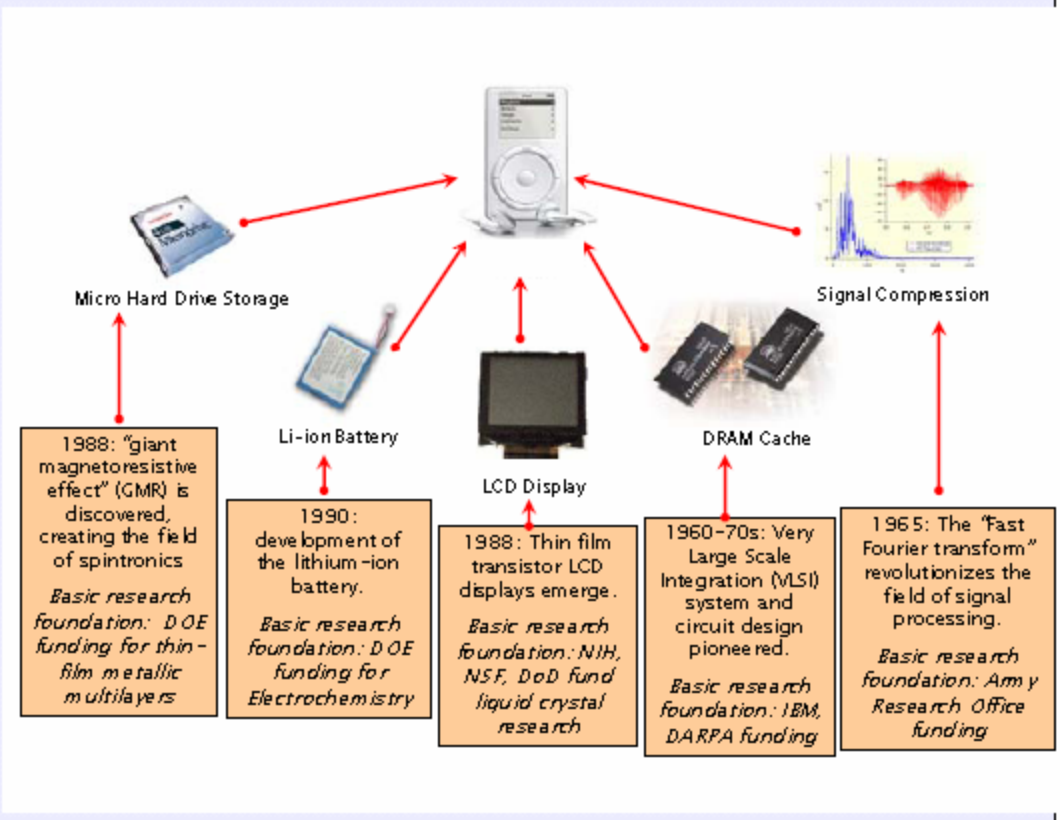
- Pioneered the development of satellite camera technology, which has led to precise photography vital to space exploration, weather forecasting, geology, and military surveillance.
- Performed the fundamental research that led to development of the Global Positioning System (GPS), which has had extraordinary military and civilian applications.
- Revolutionized agriculture by developing vaccines and treatments that have eliminated or controlled hundreds of plant and poultry and livestock diseases, and by developing high-yielding, disease-resistant fruits, vegetables, and grains.
- Created the first digital computer and played leading roles in all phases of subsequent computer processing and microprocessing developments.

- Provided the basis for what became the Internet, and then the modern search engine.
- Developed the first atom smasher and pioneered and developed the science of nuclear physics, creating the modern age of nuclear power, weapons, and medicine.
- Laid the groundwork for space exploration by developing the fundamental principles and technology of rocketry and played a key role in America's space program from the beginning to the present.
- Developed the technologies that make possible the ubiquitous cell phones and PDAs that help define the way many of us live today. These technologies also make it possible for developing countries to acquire communications technologies quickly and advance their standards of living.

And we should not forget to mention the benefits of social science research in economics, psychology and political science areas among others. For example, research done by economists on auction theory was used by the FCC to structure the phenomenally successful auctions for cellular spectrum that yielded tens of billions more for the government than previously expected.

And how many inventions over the past decade have captured the public's enthusiasm as the MP3, the best-known example of which is Apple's iPod? The following graphic, created by the White House Office of Science and Technology Policy (OSTP), shows how this extraordinarily popular and innovative device is built upon several technological developments which had their origins in basic research funded by the federal government and conducted in large part at research universities.

IMPACT OF BASIC RESEARCH ON INNOVATION



The development of MP3 technologies illustrates the unexpected benefits of basic research. In 1965, a hand-sized storage and playback device that would hold 15,000 recorded songs was the stuff of science fiction. Even simple hand-held calculators were rare and expensive at that time. Research funded by the Department of Defense, the National Science Foundation, the National Institutes of Health, the Department of Energy, and the National Institute of Standards and Technology contributed to the breakthrough technologies of magnetic storage drives, lithium-ion batteries, and the liquid crystal display, which came together in the development of MP3 devices. The device itself is innovative, but it built upon a broad platform of component technologies, each derived from fundamental studies in physical science, mathematics, and engineering.

As OSTP notes, this is also an excellent example of the sometimes serendipitous nature of basic research discoveries. They can lead to developments the scientists themselves never dreamt of. Even the laser—which does everything from performing eye surgery to playing music to printing out this paper—was originally dubbed, when it was first developed by a Columbia University professor, as a "solution without a problem."

ECONOMIC IMPACT

There are various measures of the economic impact of basic research and of research and development in general. Most notable is the work of Nobel prize-winning economist Robert Solow who found that significant levels of economic growth could be attributed to technological advances and ”technical change in the broadest sense.”

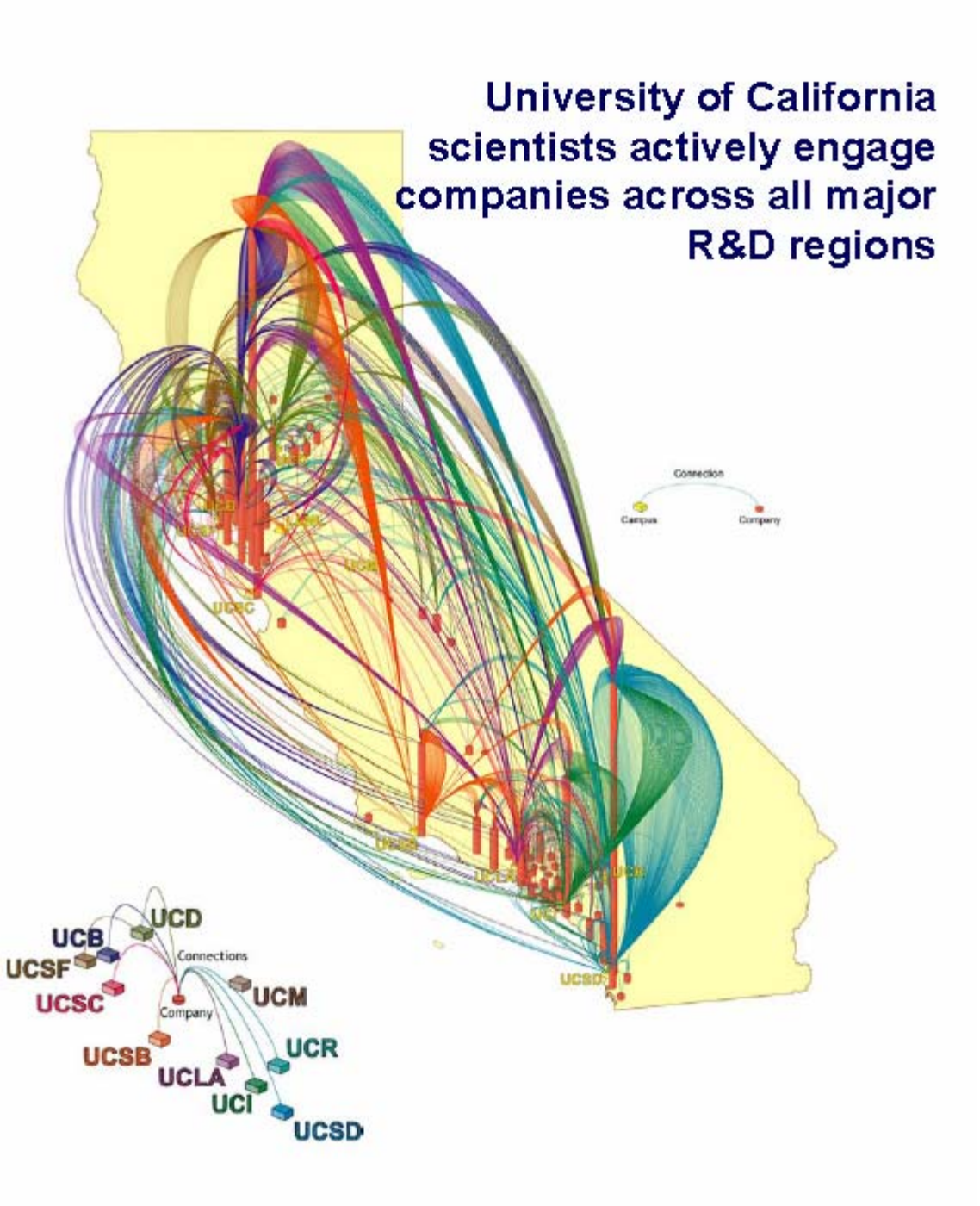
Economists attribute a significant amount of economic growth – as much as 50 percent over the last half century – to innovation, that is scientific and technological advances many of which were the result of federal investments in education and research. Citing innovation as the reason for the gains in productivity during the 1990’s, then-Federal Reserve Chairman Alan Greenspan told Congress: “Had the innovations of recent decade, especially in information technologies, not come to fruition, productivity growth during the past five to seven years, arguably would have continued to languish at the rate of the preceding twenty years.”

One of the most comprehensive analyses of the economic benefits of academic research was conducted in the early 1990’s by Edwin Mansfield of the University of Pennsylvania. Based upon his research, Mansfield concluded that the average annual rate of return to society from academic research was anywhere from 28 to 40 percent. The Congressional Budget Office, in a 1993 review of Mansfield’s estimates, said that “the return from academic research, despite measurement problems, is sufficiently high to justify overall federal investments in this area.”

More recently, a study by the Federal Reserve Bank of Cleveland on economic growth in individual states noted that innovation and education – the two primary outcomes of the federal research investment at our universities – were the most important factors in determining growth in state per capita income. The study calls into question the view held by some that manufacturing is the most important source of wealth. It also suggests, as more and more industrial leaders have stated, that the U.S. will not be able to compete in the global economy based on cheap labor costs. Instead we need to be smarter and more innovative if we are to remain globally competitive and to keep high-wage, high-value jobs from going abroad.

Again, investments in research at our universities are critical to this process. To quote Alan Greenspan again, from remarks made in October 2002, “If we are to remain preeminent in transforming knowledge into economic value, the U.S. system of higher education must remain the world's leader in generating scientific and technological breakthroughs and in preparing workers to meet the evolving demands for skilled labor.”

In my own state of California, one can readily see the impact on our economy of research at the ten campuses of the University of California. Following is a chart that we fondly refer to as the “bad hair” chart. This chart, developed by Dr. Cherisa Yarkin, director of economic research at the UC Industry-University Cooperative Research Program, shows collaborations between scientists at UC campuses and businesses around our state. The color version of the chart distinguishes among the campuses. But the black-and-white version tells the overall story. Some 1,320 California R&D companies put UC research to work.


University of California scientists actively engage companies across all major R&D regions
Connection
Campus
Company
UCSC
UCSD
UCD
UCB
UCSF
UCSC
Connections
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UCLA
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WHY THE FEDERAL GOVERNMENT?

A fundamental question that we have to answer in this discussion is, why shouldn't somebody else do this? After all, private industry develops this research into products, so these inventions and discoveries are ultimately a source of revenue for them. Why don't they pay for the research? That's a fair question. The fact is that business spends an enormous amount of money on research and development. Indeed, several decades ago, the federal government used to perform or support two-thirds of all R&D in the U.S., while business was responsible for about one-third. Today, the opposite is true, as the private sector supports or conducts two-thirds of all R&D.

However, there is a big difference between what the government does and what business does. Most of what business does is development of final products, not the basic research that produces the building blocks that make it possible to create that final product. The iPod, which I have already cited, is a product that reflects the ingenuity and creativity of the American private sector. And Apple undoubtedly spent a very substantial amount of money to develop it. But the iPod would not have been possible without the basic research that came before it.

So why doesn't business do more basic research? For example, the private-sector labs of the 1960's, such as Bell Laboratories, are no longer doing the groundbreaking research for which they were so well known. The answer is that companies can't afford to do it. For the private sector, basic research is a high-risk investment for a number of reasons. First, the outcome is very uncertain in terms of products and profitability. In fact, while such investments have broad-based societal and economic benefits, a breakthrough in basic research supported by a company may ultimately benefit a competitor or an entirely different industry more than the company performing the research.

Moreover, investments in basic R&D may take years to bear fruit. A potential return ten or twenty years out is not something our highly competitive private sector can invest for and be guaranteed the ability to make a profit. Norm Augustine, the former CEO of Lockheed Martin, chair of the National Academies of Science committee that wrote the landmark report "Rising Above the Gathering Storm," and a passionate advocate of federal support for basic research, frequently tells how his company proudly announced a program of long-term investment in basic research, only to watch its stock sink. The fact is, the stock market simply won't allow companies to invest significantly in long-term basic research.

With few exceptions, the states simply lack the means to invest heavily in R&D. California as the world's 7th largest economy is an exception to the rule.

In my own state of California, Governor Arnold Schwarzenegger and the state legislature have recognized the role of university research in helping the economy. As an example, on December 27, Governor Schwarzenegger announced his Research and Innovation Initiative, which proposed to spend nearly $95 million in the state budget – $25 million from the general fund and $70 million from lease revenue bonds – for the four California Institutes for Science and Innovation. These institutes link two or more UC campuses with industry partners to focus on a specific area of research such as nanotechnology, biotechnology, information technology, and

telecommunications. One of these institutes, the California Institute for Telecommunications and Information Technology (Calit2), is a partnership between my campus and UC San Diego. Calit2 has built effective intercampus collaborations and new paradigms for performing multi-disciplinary research and education. It also is defining worldwide and community-based networking scenarios to serve a broad spectrum research areas and global societal needs.

The Governor's 2007 Budget proposed $30 million in lease revenue bonds to the Helios Project, run by the UC-managed Lawrence Berkeley National Laboratory, to create sustainable, carbon-neutral sources of energy. This includes the next generation of super-efficient solar energy technology that will help reduce greenhouse gases and oil dependency. The proposal also included $40 million in lease revenue bonds for UC in the event that one of its campuses won the global competition for British Petroleum's $500-million grant to build and operate an Energy Biosciences Institute. The Institute will focus on converting biomass materials into fuels, converting fossil fuels to energy with less environmental damage, and maximizing oil extraction from existing wells in environmentally sensitive ways. On February 1, BP announced that UC Berkeley and the Lawrence Berkeley National Lab, in partnership with the University of Illinois at Urbana-Champaign, had won this global competition.

Investment in basic R&D requires both the means and being risk tolerant; two variables that the federal government can absorb more effectively and efficiently then states can.

Sometimes the states seek to pick up the slack when they believe the federal government is lagging. For example, several states have undertaken research initiatives using embryonic stem cells. But as NIH Director Elias Zerhouni told Congress just last week, state-by-state pursuit of any kind of research does not provide the necessary leadership. Back in California, we passed Proposition 71 which created the California Institute for Regenerative Medicine (CIRM). And while my campus receives large million dollar grants from CIRM, and continues to be a leader in the area of stem cell research we still fall short in terms of funding. I applaud Congress' leadership on the stem cell issue and their efforts to pass legislation that will expand access to this valuable area of research. It is critically important that NIH has adequate funding to support all types of biomedical research, including stem cell research. The reality is, leadership in basic research must be at the national level.

But the federal commitment to basic research has had a mixed record in recent years. It's true that Congress and two successive Administrations doubled funding for the NIH over the five year period of FY 1998-2003. However, since that investment, NIH funding has not kept pace with inflation and the benefits of that historic investment have already started to erode. Additionally, research in the physical sciences and engineering has been nearly flat-funded over some three decades. There is now recognition in both political parties of the need for greater funding of research in the physical sciences, as well as a continuation of Congress' commitment to fund the life sciences. Given the growing importance of interdisciplinary research, adequate funding for both the life sciences and the physical sciences is essential. Without it, the country will miss opportunities that are developing in, for example, bioinformatics, bioengineering, and biophtonics. These fields allow scientists to attack problems in new, innovative ways.

THE FUTURE

If Congress does indeed strengthen the federal role in funding basic science, what future opportunities should we pursue? That is for policymakers, with advice from scientists who can tell them about the possibilities, to decide. However, an obvious area is the development of reliable and environmentally sound water systems. For example, the Urban Water Research Center at UCI is working with the Environmental Protection Agency, along with local and state organizations to advance the understanding of the distinct characteristics of the urban water environment in order to assist people and institutions in their effort to promote health, enhance the efficient use of water resources, and protect environmental values. The Center is a partnership with 60 faculty members and a variety of departments at UCI, including Civil and Environmental Engineering, Earth System Sciences, UCI Ecology and Evolutionary Biology, Occupational and Environmental Medicine, Planning, Policy, and Design, UCI College of Health Sciences, and many others. Working together, these departments are able to effectively address the multitude of interdisciplinary water problems that people face in the modern urban environment.

Other obvious areas for research likely to be fruitful in the coming years are global disease prevention and cures; new diagnostic tools based on our understanding of the human genome and proteomics and further advances in the physical sciences; how to address our compelling environmental problems, including global climate change; and national and homeland security related problems, from improving technologies for detection of weapons of mass destruction to improving how we protect our soldiers in combat.

One other powerful opportunity is the focus of a report issued earlier this week by the Alzheimer's Association. The report stated that more than five million Americans now have that disease. While this is a 10-percent increase over five years ago, the number may triple by 2050, as baby boomers age. The disease afflicts one in eight people over 65, and 42 percent of those over 85. Anyone who has a family member with Alzheimer's can tell you how wrenching this disease is, and how devastating the costs of handling the disease can be. I believe that enormous progress could be made in diagnosing and treating this disease in the next ten years if the funding were available.

And then there is that extraordinary discovery we can't even imagine. Who could have predicted the Internet revolution? Who could have thought that HIV/AIDS, in less than ten years could be turned from a near-certain death sentence to an onerous but survivable burden for those fortunate enough to live in the United States and receive triple-drug therapies? Who could have thought that mortality due to childhood cancers, surely among the cruelest of diseases, could be made to decline for more than a decade? And who could have thought that we could peer twelve billion years into the past to view the universe in its infancy? These accomplishments are a direct result of the federal government's commitment to research funding.

CONCLUSION

As a university chancellor, I often have to think in terms of revenues and infrastructure and hiring packages. But when it comes to the extraordinary research we have done and will do, I also put on my physician's cap and marvel at how the diagnostic tools and therapies and preventive knowledge that have been developed in recent decades have transformed the practice of medicine and changed the quality of life in America for nearly 300 million people. As a physician, it's easy to remember to thank the scientists and the technicians and the industries that made the discoveries and produced a final product. But we can never forget that none of this would be possible without public investment in basic research. There is no doubt that the long-term investment by the federal government in basic scientific research has improved the lives of the citizens of the United States and made this a better country and a better world.

Now we must find the national vision and the political will to transform how the debate over support for research and education is framed. We must make it politically unacceptable for policymakers to fight over research and education funding at the margins of a $2.7 trillion federal budget. We must persuade our national political leadership that sustained investment in research and education will help to ensure continuing U.S. global leadership and produce medical innovation, economic growth, and a higher quality of life for all of our citizens.

We are encouraged by, and appreciate, the recent actions taken by this Congress in its FY07 funding decisions to increase research funding for NIH, NSF, NIST and the Department of Energy's Office of Science and renewable energy activities. I request that you continue these trends into FY08.

Only the federal government has the resources and the ability to support this vital research. I know that it is difficult to obtain additional funding resources in a discretionary budget that is nearly frozen at the overall level. But the good news is that the additional resources needed to sustain our leadership in scientific research are not excessive. I thank this committee for bringing the nation's attention to this incredibly successful partnership and hope it will continue to spread that message through the Congress and the Administration.

Thank you.