Statement of

American Chemical Society

American Mathematical Society

American Physical Society

Federation of American Societies for Experimental Biology

On

FY 2002 APPROPRIATIONS FOR THE

NATIONAL SCIENCE FOUNDATION

Before the

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Committee on Appropriations

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George Trilling, American Physical Society

Mr. Chairman, Mr. Mollohan and members of the Subcommittee, I am George Trilling, President of the American Physical Society. I am here today with my colleagues, Mary Hendrix, President of the Federation of American Societies for Experimental Biology; Hyman Bass, President of the American Mathematical Society; and Eli Pearce, President-elect of the American Chemical Society, to testify in support of the National Science Foundation. Together we represent almost 300,000 scientists in academia, industry and national laboratories. Let me begin by expressing thanks on behalf of all of our organizations for the strong endorsement this committee has made to the NSF in the last few years. We believe that it has been money well spent in the public interest and that it will pay extraordinary dividends in the years to come.

Our nation is fortunate to have experienced a decade of unprecedented economic growth and improvement in quality of life. We have made extraordinary advances in medicine; we have cleaned up the environment; we have kept unemployment and inflation down as real income has risen; and in support of peace we have maintained the strongest military in the world. This is a remarkable record. But none of it would have occurred without the scientific discovery and technological innovation that have been the hallmarks of America during the last half-century.

This was not always the case. Prior to World War II, science and technology was largely the province of Europe, and much of the American economy was agrarian. Our wartime success, largely based upon advances in technology, changed all that. After the war ended, Vannevar Bush submitted a report to President Roosevelt that led to the establishment of the National Science Foundation and set our nation on a new and exceptional course. Prominent economists, among them Nobel Laureate Robert Solow, Michael Boskin, Paul Romer and Alan Greenspan, have noted that more than 50 percent of our nation's economic growth since the end of World War II has stemmed from technology driven by science. It has been quite a run.

As the years have passed, our science and technology enterprise has evolved in fairly significant ways. Let me mention just two of them.

First, the scientific disciplines have become inextricably intertwined and fundamentally interdependent. That is why the four of us are here today presenting joint testimony. Our fields are joined intellectually and technologically. Advances in one scientific area have extraordinary impact, often unanticipated, on other areas. My colleagues will amplify on this point.

Second, in an era of global competition, industry, increasingly driven by the need to meet the short-term bottom line, has closed the central laboratories that were once celebrated incubators of high-risk, long-term research. Fortunately, the government-university partnership has been able to meet the challenge. Our interlocking systems of education and research have spawned creativity and a string of Nobel Laureates. American industry has been able to pick and choose its own winners from the fount of scientific discovery in the public domain. All of us have been the beneficiaries, and we are now the envy

of the world.

Yet, there are some who would have us conduct an enormously high-risk experiment: to remove the federal government from its central role in supporting basic research and wait for industry to step in. We hope that you would agree that rolling the dice in that fashion would be grossly unwise public policy.

Others, while supporting the investment of public money in scientific research, argue that our present level of investment is quite sufficient. We disagree. Since the mid 1960s, during an era when our economy has become increasingly dependent on technology, our federal R&D investment has slowly dropped as a fraction of the Gross Domestic Product, so that today it is only half of what it was in 1965. We are rapidly exhausting the seed corn of scientific discovery from which today's technology flows. We must reverse this course. Our nation's future is at risk. For this reason, we urge the Subcommittee to sustain the vitality of the NSF and maintain the Foundation's budget on the doubling path, which the Subcommittee began last year, with an increase of 15 percent to $5.1 billion for FY 2002.

My colleague, Mary Hendrix, of FASEB will continue.

Mary J.C. Hendrix, Federation of American Societies for Experimental Biology

Thank you George. Mr. Chairman, Mr. Mollohan, and members of the Subcommittee, I am grateful for the opportunity to testify before you today on behalf of the NSF. Since its inception in 1950, the NSF has served the nation exceedingly well by investing in the core disciplines of science and engineering. Over the years, NSF's investments in research and education have helped the nation achieve an unmatched capability in scientific and technical fields. Since 1960, a total of 109 Nobel prizewinners had received NSF funding prior to their award. This year's NSF-funded Nobelists include a neuroscientist, a physicist, two chemists and two economists exemplifying NSF's multi-disciplinary influence.

NSF support and encouragement for research across the breadth of science is why FASEB strongly supports the funding goal that my colleague George Trilling just mentioned. It is more than justified by the scientific achievement that NSF has supported in the past and the scientific promise that beckons.

Let me mention some examples of NSF supported activities that specifically emphasize the multidisciplinary nature of science and the interdependence of the scientific disciplines, examples that illustrate not only how we have advanced our fundamental understanding of nature and the world, but also how we have succeeded in fighting disease, hunger and human suffering. I have selected four case stories: the influence of weather on disease, the science of the brain, patient monitoring and cancer research.

Researchers working in diverse scientific disciplines have made significant progress in identifying and tracking sources of dangerous new diseases. The Hantavirus, which recently infected rodents and other animal populations of the North American continent, is one of them. Research, supported in part by the NSF, has shown how specific weather patterns influence outbreaks. Interdisciplinary teams have been able to associate the unique weather pattern of El Niño with increased cases of Hantavirus, as well as the human

plague. Climate conditions have also been found to explain the cycling of Lyme Disease in New York State.

NSF has also played a significant role in elucidating the science of the brain. The Nobel Prize winning research of Dr. Paul Greengard, for example, has helped provide basic new information on how the brain and nervous system function at the molecular level. Over the past 30 years, Dr. Greengard and his co-workers have given detailed explanations of how stimuli to individual nerve cells produce specific physiological responses. Abnormalities in neural signaling are the basis of a number of neurological disorders such as Parkinson's disease, schizophrenia and attention deficient hyperactivity disorder.

NSF's role in patient-monitoring is illustrated by the results from the University of Kentucky, where researchers have developed very small, thin-film sensors that can measure pressure, temperature and fluid viscosity in the body. The sensors are small pieces of magnetic tape that are coated with polymers and swallowed by a patient, and raise the possibility of new, minimally-invasive diagnostic tools for physicians. As the sensors travel through the body and are exposed to magnetic fields, they emit signals whose frequencies change with differing conditions inside the body. The changes in frequency are measured by monitors located outside the skin, which have no physical connections to the sensors.

Finally, let me mention an example of the critical contribution made by NSF to science in my own field of cancer research. New advances in the treatment of cancer will depend upon our knowledge of protein structure present on the surfaces of cancer cells. These advances will depend on structural biology – a new and very exciting area of science that relies upon accelerated beam technology. To realize the promise held out by structural biology, to apply this knowledge to better understanding and fighting cancer cells in the human body, we depend upon critical NSF support of mathematicians and physicists.

We at FASEB applaud and strongly support the Subcommittee's effort to provide sustained funding for the National Science Foundation and the multi-disciplinary research it supports. I now turn to my distinguished colleague, Hyman Bass, to continue our testimony.

Hyman Bass, American Mathematical Society

Thank you Mary. Mr. Chairman, Mr. Mollohan, and members of the Subcommittee, research supported by the National Science Foundation has had a monumental impact. The NSF investment has enabled the U.S. to build a scientific infrastructure second to none, facilitated revolutionary research that pushes the frontiers of knowledge, and laid the groundwork for innovation that has resulted in a vibrant economy and a superior quality of life. Many new products, procedures, and methods have accrued from the NSF investment in basic research - research performed over many years and not always pre-determined toward a specific application. Society, unaware for the most part how basic research impacts daily life, enjoys many benefits from NSF investments. I would like to highlight a few examples.

Mary Hendrix just presented four brief case stories about NSF supported research in medicine and disease. Let me add one more that illustrates the role of mathematics in this arena. Every year tens of

thousands of people in the U.S. receive artificial heart valve implants. NSF currently supports a group of mathematicians studying unsteady fluid flows driven by dynamic boundaries. The heart valve is an excellent example of such a boundary. The results of this kind of mathematics research have had a dramatic impact on heart valve design and functionality.

Lighter replacements for structural steel, such as strong and resilient plastics, are also the result of research supported by NSF, in this case in the area of chemical engineering. In less than a minute, two or more reactive chemicals can now be mixed, molded and cured. The result is molded plastic that reduces automobile repair and insurance costs and reduces fuel consumption. Public benefits accrue from reduced air pollution, as well.

Let me turn to Web searching and surfing, which have become as commonplace as driving a car. Today's web browsers and search engines grew out of NSF-supported research. Mosaic, software developed by a University of Illinois student, is the basis for Internet Explorer and Netscape. The search engines Excite and Infoseek owe their origins to the NSF, as does Thomas, the search engine used by the Library of Congress.

Bar codes -- those ubiquitous symbols stamped on everything from packages and magazines to store tags and grocery items – provide another example of benefits from NSF supported research. In the 1970's NSF helped fund research to improve the accuracy of bar code scanners. Later in the 1990's NSF supported efforts that eventually led to a new type of bar-code reader that can operate under adverse and messy conditions. Continuing research is focused on developing two-dimensional bar codes that will allow more information to be represented in a very compact form. I think it safe to say that almost every citizen in the U.S., perhaps even the world, has been affected by this research.

I would be remiss if I didn't mention the contribution that NSF makes to science and mathematics education, an area that is critical to our nation's future. Trained as a mathematician who has spent the bulk of his career in mathematical research, I personally have pursued research in the teaching and learning of mathematics for the past decade.

We must improve student learning in mathematics and science if our population is to participate fully in our country's technological growth and development. The NSF funds centers for learning and teaching that provide a mix of research, teacher education, and leadership development. These centers promote innovative professional development opportunities for in-service and pre-service teachers.

Along with the Department of Education, the NSF also supports research in learning processes in mathematics, science and reading, an effort to identify ways of improving student learning. Finally, NSF supports educationally innovative projects in undergraduate education and is the lead federal agency supporting graduate research assistants in the physical sciences and mathematics.

The work of NSF plays a critical role in the vitality of our country, in research and education. A future that will provide the opportunities and discoveries that will measure up to the successes of the last fifty years will require a continuing chain of discoveries in mathematics and science and a population better

educated in mathematics and science. The health of the National Science Foundation is central to that success.

I turn now to my colleague, Eli Pearce, who will conclude our testimony.

Eli M. Pearce, American Chemical Society

Thank you, Hyman. Mr. Chairman, Mr. Mollohan, members of the Subcommittee, as my colleagues have stressed, the nation benefits tremendously from NSF programs.

Although NSF makes up less than 4 percent of the federal R&D budget, it serves as the cornerstone of government support for R&D. By supporting basic research across all fields of science and engineering, NSF is the only agency specifically charged with ensuring a broad and deep base of fundamental knowledge across disciplines. This mission is essential to technological innovation in the private sector.

As this Subcommittee is well aware, colleges and universities, large and small, can testify to the critical importance of NSF. Yet, interestingly, some of the loudest calls for increased investment in NSF come from our members working in industry. The chemical and other industries place enormous value on federal investment in university-based research. And as the largest provider of non-medical basic research at universities, NSF is vital to the health of academic research.

We applaud NSF and Congress for renewing the emphasis last year on investigator initiated research across disciplines—the heart of NSF's mission. We urge the Subcommittee to devote increases this year to ongoing core research across a spectrum of disciplines. This research underpins our success in all areas of science and engineering.

Our joint appearance is also testament to the importance of multi-disciplinary research in areas where opportunities are rich and the potential payoff to society enormous. Examples include nano-technology and environmental research, which cut across biology, chemistry, physics, and mathematics. With a variety of scientists working together to study these complex problems, breakthroughs will likely accelerate and novel fields of investigation may emerge that will give us a better understanding of our world. An appropriate balance between cross-disciplinary initiatives and individual-initiated research is key to the health of NSF.

The NSF must also maintain a balance between its investment portfolios in research and education. As my colleague Hyman Bass just noted, NSF programs not only provide the underpinning for technological innovation, but also help prepare the next generation of scientists and engineers for the jobs of the future. Many of NSF's undergraduate and graduate education activities are supported through the research directorates, such as the Integrative Graduate Education and Research Traineeship program. And NSF's Education Directorate provides critical support for K-12 science and mathematics education, helping teachers do a better job teaching children math and science and motivating them to choose careers in these fields.

We recognize the constraints on spending that this Subcommittee will have and the competing demands it will have to deal with. For this reason, my colleagues have emphasized the enormous societal and economic returns of basic research. In fact, many economists, including Alan Greenspan, attribute much of America's 1990s boom to increased productivity stemming, in large part, from scientific research. In addition, NSF traditionally receives high marks for quality research and resource management. And so we welcome the administration's efforts to optimize and improve efficiency in the federal research process.

NSF prides itself on investing in the best ideas from the most capable scientists and engineers, as determined by outside reviewers through a rigorous, merit-based competitive process. It evaluates proposals based on both intellectual merit and broader society impacts and selects 10,000 new awards each year from more than 30,000 proposals. Increased funding would allow NSF to pursue many unmet opportunities, including more high-risk proposals that provide the potential for the next generation of dramatic scientific advances. More funding would also allow for increases in the average size and duration of NSF grants – a longstanding goal of the Foundation -- that can improve the efficiency and output of the research process.

Mr. Chairman, Congress took an important step last year when it increased funding for scientific research for FY 2001. To nourish the roots of innovation in all fields and help ensure long-term economic growth and improvement in the quality of life, we urge the Subcommittee to support a 15 percent increase for NSF in FY 2002 and approve a $5.1 billion budget. Increased funding will enable the Foundation to more fully meet the unmet and emerging opportunities in core disciplinary research areas, enhance multi-disciplinary research, and increase its impact on science and mathematics education.

The NSF represents a true investment in our nation's future and, as such, we hope you will make it a priority as you craft this year's VA-HUD Appropriations bill. Thank you for the opportunity to offer our united support for NSF. We would be delighted to answer any questions the Subcommittee has.