Increased Funding for NIH: A Biomedical Science Perspective

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IN THE LAST FEW MONTHS, science policy has become a major focus of attention in our nation's capital. Numerous major reports and studies examining current science policies have been published, and several other high profile studies are currently under way. Thoughtful reviews of the nation's research policies were completed by economist Kenneth Brown and political scientist Donald Stokes (1). The National Academy of Sciences released its analysis of the federal science and technology budget (2) and congressional reviews of our science policies are being chaired by Representatives Vern Ehlers (R-MI) and George Nethercutt (R-WA). The spotlight on science in general, and medical research in particular, reflects the priorities of the American public, who believe that science is vital for our nation's future. Polls conducted by Research!America consistently demonstrate that Americans support additional expenditures for medical research. Almost three-fourths were willing to pay more in taxes to support it, and 90% believe the United States should remain preeminent in this research (3).

Health research has been at the center of this heightened interest in science, interest that has included proposals for substantial increases in funding. President Clinton's FY 1999 Budget released last February contained the largest increase for NIH ever proposed by a president (8.4%). Budget resolutions prepared by the House and Senate Budget Committees also recognized the national priority for investing in science, singling out the importance of increased funding for NIH. The Senate Budget Resolution included an 11% increase for NIH while the House counterpart was reported to have assumed an increase of about 8% for NIH. The FY1999 appropriations bill marked up by the House Labor-Health and Human Services-Education Appropriations Subcommittee contained a 9.1% increase for NIH. The Senate Appropriations Committee proposed a 14.7% increase.

THE HISTORICAL CONTEXT

From 1987 to 1997, the NIH budget rose from $6.685 billion to $12.740 billion, an increase of 90.6% (**Table 1**). Against which benchmarks can we assess the meaning of this increase? For example, the growth of NIH has been slower than that of other health-related federal agencies. Between 1990 and 1998, NIH grew by 78%; by comparison, funding for the Health Resources and Services Administration increased by 104% and the Centers for Disease Control and Prevention expanded by 115%. Adjusting the growth in NIH funding to account for increases in the cost of biomedical R&D by using the NIH Biomedical R&D Price Index, we see that the constant dollar (adjusted for inflation) rate of growth for NIH from 1987 to 1997 is 27.5%. It turns out that much, but not all, of the growth in NIH spending during the past 10 years has been necessary just to keep up with the increased costs of doing research.

The 27.5% increase has helped to fuel a remarkable expansion of knowledge in the biomedical sciences. During this same decade, however, the entire federal budget grew by 16.5% in constant dollars (4). The economy as a whole, measured in terms of the gross domestic product, grew by 27.3% between 1987 and 1997. Over a comparable period (1986–1996), industrial R&D spending in the United States rose by 37.5% (5). While research discoveries in biomedicine were fueling economic growth and stimulating the emergence of the biotechnology industry, the federal investment in the source of much of this technolog-

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TABLE 1. *NIH funding by category for fiscal years 1987–1997 (dollars in thousands)*[a]

	1987		1997 (estimated)		1987–1997 increase	
	Funding	% of total	Funding	% of total	Nominal	Real
Research grants	$4,665,566	69.8%	$8,822,984	69.2%	89.1%	26.5%
Research training	256,407	3.8%	417,873	3.3%	63.0%	9.0%
R&D contracts	503,586	7.5%	788,704	6.2%	56.6%	4.8%
Intramural research	748,637	11.2%	1,333,131	10.5%	78.1%	19.1%
Res. mgmt. and support	289,925	4.3%	479,368	3.8%	65.3%	10.6%
Cancer control	67,457	1.0%	238,103	1.9%	253.0%	136.1%
Construction	9,550	0.1%	23,000	0.2%	140.8%	61.1%
Library of Medicine	61,675	0.9%	150,828	1.2%	144.6%	63.6%
Office of the Director	56,917	0.9%	286,852	2.3%	404.0%	237.1%
Buildings and facilities	25,786	0.4%	200,000	1.6%	675.6%	418.8%
Total	$6,685,506		$12,740,843		90.6%	27.5%

[a] Source: NIH, OFM: http://www.nih.gov/od/ofm/primer96/page31a.htm; http://www.nih.gov/od/ofm/cj98/page41.htm

ical progress did not increase in proportion to the entire economy and did not grow as rapidly as private investment in R&D.

SCIENTIFIC OPPORTUNITY

The last 'doubling' of the NIH budget was really quite modest relative to some baseline economic indicators. But even these comparisons are of limited use for assessing the *adequacy* of our level of investment in biomedical research, because they ignore the most important element that should be guiding our decision making—the scientific opportunities before us. Unfortunately, scientific opportunity is not measured by a simple index number.

We are in a unique epoch in the history of the life sciences. As a result of the progress made over the last 30 years, we are experiencing a truly unprecedented expansion in knowledge. We are making exciting discoveries every day, and increased investment in biomedical research will accelerate the pace of this progress. Our champions in Congress and the administration are working to increase funding for research, and we need to support this bipartisan effort.

Scientists must step forward and take the lead. As citizens, we need to make our concerns and views known to our elected officials. As experts on issues related to medical research, we need to be more vocal in advocacy settings. Working within our own scientific societies as well as in broader coalitions with patient advocacy groups and outreach organizations like Research!America, we must make sure that our expertise influences the decisions that will shape our progress in the next century.

As the group most able to assess today's scientific opportunity, we must assume our responsibility for guiding the investment in research. This means identifying the areas of research that are most likely to prove fruitful and advising the policymakers in Congress and the administration about where to invest the public's research funds. In study sections, advisory councils, and other peer-review processes, we help select research targets and guide the development of the research portfolio of NIH and other agencies that fund research. Our input is also required in discussions of how and where to expand research investment: If our efforts to increase the growth in funding for the NIH are successful, where should the additional resources be directed? What types of investments will be most productive?

We have endorsed the view that there is a role for broad public input into the NIH planning and priority-setting process in a joint statement issued by the leadership of the Federation of American Societies for Experimental Biology and several other major health and research organizations. Members of these groups concerned with the prevention and treatment of disease who are familiar with the concerns of patients and their families, including those individuals from disease specific advocacy groups, must actively participate in planning and prioritizing research at NIH (6). But we also maintain that scientific opportunity should be the primary criteria for the allocation of research resources, and we are gratified that the recently released report of the Institute of Medicine supported the criteria that NIH uses now to establish priorities (7).

FUTURE INVESTMENT

FASEB recently convened a meeting to examine the opportunities for and needs of medical research in the first 20 years of the next millennium. Chaired by Lawrence S. Goldstein of the University of California, San Diego, this group of leading scientists from each of FASEB's member societies analyzed NIH budgets, funding projections, and proposals for additional investment from the scientific community. Their discussion identified promising areas of research and the mechanisms needed to reach the desired goals. The executive summary, which FASEB's Board of Directors endorsed (8), concluded that progress in biomedical research has given us untold knowledge about the structure, function, and development of cells, organs, and organisms. With the completion of the sequencing of the human genome in sight, scientists are learning more about what these genes do, how they do it, and how genetic aberrations result in disease. Progress in this area will bring about the era of molecular medicine in which insights from basic science will radically alter medical diagnosis and treatment.

This goal, however, will require a substantial investment of talent and resources. We are still without the means to capitalize fully on the vast potential before us. We will need to expand the foundation we have built and ensure its vitality into the early years of the next century. Key to this are the high-quality scientific personnel and the research resources they need in order to guarantee maximum productivity. The two are closely connected, for without the means to pursue the research we will lose the benefit of our investment in scientific talent and will be unable to recruit the next generation of scientists needed to generate the knowledge that will continue to improve our nation's health and quality of life. The effort will also require development of advanced technologies, infrastructure support, and more translational research. We therefore recommend the following actions.

1. Increase funding for investigator-initiated research

Investigator-initiated research has been the key to this nation's success in science. It distinguishes the organization of science in the United States from the research programs of almost every other country (9). Unlike many other nations, where the research agenda is determined in a 'top down' fashion by administrative bureaucracies, scientists in the U.S. compete for funding in a highly selective, dynamic system. At NIH, research projects are selected for funding on the basis of competitive merit review. Initial funding decisions are subject to periodic review, and only the most productive projects are renewed. This creates a highly fluid system that is quite open to change, one that is very compatible with the research process itself.

In recent years, resource limitations have forced many constraints onto the peer-review system, constraints on the size, length, and flexibility of grants that have obliged investigators to submit multiple, partial, or revised proposals. NIH should provide full funding to reach the stated research objectives and fund longer term grants in order to reduce the time researchers spend in writing proposals. Greater use of supplements will allow scientists to pursue promising leads without the delay and cost entailed in preparing and reviewing new grant applications. Additional funds would also restore flexibility to the system by allowing applicants to apply for significant increases in funding to correspond to a revised scope of work.

Short-term funding fluctuations can result in devastating setbacks to established research programs. While competition is essential to the well-being of the research enterprise, there also needs to be a significant increase in support for short-term 'bridge funding' in order to keep productive research laboratories together in times of temporary loss of research support.

From 1987 through 1997, NIH funding for research grants grew by 26.5% after adjusting for inflation, roughly the same rate of growth as for all NIH spending. Of the four major research grant categories (research projects, centers, small business innovation, and other), the two largest categories (research projects and centers) grew at about the same rate as total NIH spending, i.e., approximately 27% after adjusting for inflation (**Table 2**).

A closer look at the spending trends within the 'research project' classification is complicated by the creation and modification of grant programs over that decade. While the traditional R01 awards grew at a slightly slower pace than the total research grant category, two grant categories drawing on the same general applicant pool as the R01 awards—MERIT awards (R37) and First Awards (R29)—increased rapidly during this same period. When all three of these programs are combined, real spending grew by 24% between 1987 and 1997.

If funding for research projects has grown by approximately one-fourth in the last 10 years, then what accounts for the widely held view among investigators that the competition for research funding has increased? Data from NIH indicate that, for a substantial part of the 1987–1997 period, success rates (percentage of grant applications funded by NIH) declined. Specifically, from 1987 to 1990 and from 1992 to 1993, there was a downward trend in success rates (**Table 3**). The combined success rate for new and competing continuations was 35.7% in 1987 and reached a low of 23.5% in 1993.[2] Since then, the success rate has been increasing, and by 1997 it was 30.5%. This improvement reflects both a rise in the number of grants awarded and attenuated growth in the number of applications submitted. Between 1993 and 1997, the success rate base (i.e., number of applications under review) rose by only 589 proposals

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[2] The success rate for the *new* grant applications fell to 17.9%, while the success rate for *competing continuations* dropped to 37.9%.

TABLE 2. *NIH research grants, by activity (Fiscal years 1987–1997)*[a]

	1987			1997			1987–1997 Change		
	Number	Dollars in thousands	Percent of total	Number	Dollars in thousands	Percent of total	Number of grants	Nominal spending	Real spending
Research projects: Total	21,403	3,719,501	78.6%	26,221	7,047,117	77.9%	22.5%	89.5%	26.7%
Traditional (R01)	18,102	2,765,324	58.4%	19,285	4,840,041	53.5%	6.5%	75.0%	17.1%
Research program project (P01)	733	597,394	12.6%	794	870,769	9.6%	8.3%	45.8%	−2.5%
New Investigator Res. (R23)	676	34,033	0.7%	0		0.0%	−100.0%	−100.0%	−100.0%
MERIT awards (R37)	395	89,184	1.9%	990	321,436	3.6%	150.6%	260.4%	141.1%
Outstanding Investigator (R35)	58	35,122	0.7%	70	67,547	0.7%	20.7%	92.3%	28.6%
First awards (R29)	590	55,686	1.2%	2,819	295,817	3.3%	377.8%	431.2%	255.3%
Other (R55, U01, P42, U19)	849	142,757	3.0%	2,263	651,508	7.2%	166.5%	356.4%	205.3%
SBIR/STTR	464	52,732	1.1%	1,298	249,501	2.8%	179.7%	373.1%	216.5%
Research centers	655	575,286	12.1%	939	1,101,294	12.2%	43.4%	91.4%	28.0%
Other research	4,172	387,600	8.2%	3,651	648,631	7.2%	−12.5%	67.3%	11.9%
Total	26,694	4,735,118		32,109	9,046,544		20.3%	91.1%	27.8%
Total R01 + R23 + R37 + R29	19,763	2,944,227	62.2%	23,094	5,457,294	60.3%	16.9%	85.4%	24.0%

[a] Source: NIH, OER: htt://www.nih.gov/grants/award/trends96/pdfdocs/TAB32R92.PDF; http://silk.nih.gov/public/cbz2zoz.@www.trends97.rgbyact.fy8897.dsncc

(2.5%). This reflects neither the increasing number of scientists working in medical research (during the 1993 to 1995 period, U.S. institutions awarded an average of 5700 new Ph.D.'s in the biomedical sciences each year) (10) nor the expansion of knowledge in our field today. Rather, it indicates an untapped reservoir of talent and an underutilization of valuable human resources.

2. Ensure opportunities for the development and maximum use of scientific talent

We need to find mechanisms to facilitate the transition of talented young scientists from training to independent investigator status. A prestigious and well-endowed program of portable funding for senior postdoctorals would allow them to move to an institution of their choice. Ideally, such programs would provide portable funding for salaries and research expenses that senior postdoctoral associates could take with them as they moved from mentors' laboratories to independent research positions.

TABLE 3. *Success rates for NIH competing research project applications (fiscal years, 1987–1997)*[a]

Year	Number awarded	Success rate base	Success rate
1987	6,921	19,386	35.7
1988	6,631	20,757	31.9
1989	5,883	20,704	28.4
1990	5,267	21,509	24.5
1991	6,127	21,416	28.6
1992	6,380	21,734	29.4
1993	5,551	23,632	23.5
1994	6,475	25,511	25.4
1995	6,760	25,226	26.8
1996	6,651	23,819	27.9
1997	7,388	24,221	30.5

[a] Sources: National Institutes of Health. (1996) NIH Extramural Trends, Fiscal Year 1996, http://www.nih.gov/grants/award/trends96, page 22; and National Institutes of Health. (1997) NIH Extramural Trends, Fiscal Year 1997, http://silk.nih.gov/public/cbz2zoz@www.trends97.succrate.fy8897.dsncc.

In addition, a program of NIH Professorships should be established to provide institutions with shared funding for senior scientists. With this money from NIH, institutions would be expected to open additional tenure-track positions for midcareer scholars, thereby providing an opportunity for their upward mobility and development.

The ability to produce a new generation of biomedical researchers of the highest caliber, scientists capable of continuing our progress in medical research and building on the foundation that our current investment has yielded, must remain a national priority. The future of medical research depends on our willingness to develop and maintain a pool of talented scientists. The research career is very selective and very demanding, and more funding will enable us to recruit the most talented students to this profession. Funding for training has grown at a slower pace recently than other aspects of the NIH budget. From 1987 to 1997, the training budget at NIH rose by only 9% in constant dollars (i.e., after adjusting for increases in the Biomedical R&D Price Index).

3. Provide additional resources to facilitate clinical and therapeutic applications of basic science

We know that translating new insights from fundamental bioscience science into medical practice will yield tremendous benefits to human health in the form of cures, therapies, and preventive measures. The application of functional genomics to human health holds tremendous potential. An expanded program of patient-oriented clinical research is needed to take full advantage of the exciting discoveries emerging from basic biological research. Today's shortage of skilled clinical researchers forcefully illustrates the need for additional resources that would support rigorous clinical research training programs. The current structure for clinical research (including the General Clinical Research Centers) needs to be expanded and enhanced in order to facilitate the transition to the new era of molecular medicine. This will require more physician-scientists and greater collaboration between basic scientists and clinicians. A program of awards should be initiated to encourage basic scientists and clinicians to collaborate on specific projects related to human diseases. It is difficult to find funding to pay for the clinical expertise needed for research involving human patients. Without these resources, there is no mechanism to encourage and facilitate the participation of clinicians in research related to their areas of practice.

4. Support the development of scientific infrastructure, advanced technology, and specialized facilities required to ensure progress in medical research

Research support must be broadly based and include fields other than biology—physics, chemistry, mathematics, and computer science. Because they generate fundamental insights and powerful new research tools, advances in these fields are vital to progress in medical research. A narrow focus on biomedicine or immediate medical applications would constrain the potential for major breakthroughs and long-term advances.

Medical science has been greatly accelerated by the development and application of new technology. Grant programs should not place arbitrary limits on instrumentation purchases, and investment in shared equipment should be increased. We must provide more money for state-of-the art facilities and equipment, and ensure that the creation of the next generation of technology is fully supported.

The use of transgenic animals in research gives us unprecedented information about how genes function, yet this important development has created an enormous storage and distribution problem. We need centralized resources for archiving and disseminating transgenic and other model research animals, as well as additional resources to ensure that local housing constraints do not impede or restrict the use of these important research tools. Unless this is done, our progress in understanding and curing many diseases will be delayed.

CONCLUSION

Over the past decade, the NIH budget has increased. But this growth in funding has not been large in comparison to the growth of our economy. More important, the increased funding has not been sufficient to stay consistently ahead of the growth in high-quality grant applications. Continued growth, possible only through increased funding, is needed to take advantage of the scientific opportunities before us.

Now is the time to build upon the significant advances of the past three decades and lay the foundations for continued progress in the next century. The time is ripe for a bold initiative in the biomedical sciences. We need to maintain our efforts to form broad coalitions in support of medical research by working with patient advocacy groups, research institutions, and other organizations to maintain the momentum on behalf of increased funding. Now we have the chance to accelerate our progress in medical research and improve the health of the American people. FJ

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