DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTES OF HEALTH

National Institute of Biomedical Imaging and Bioengineering

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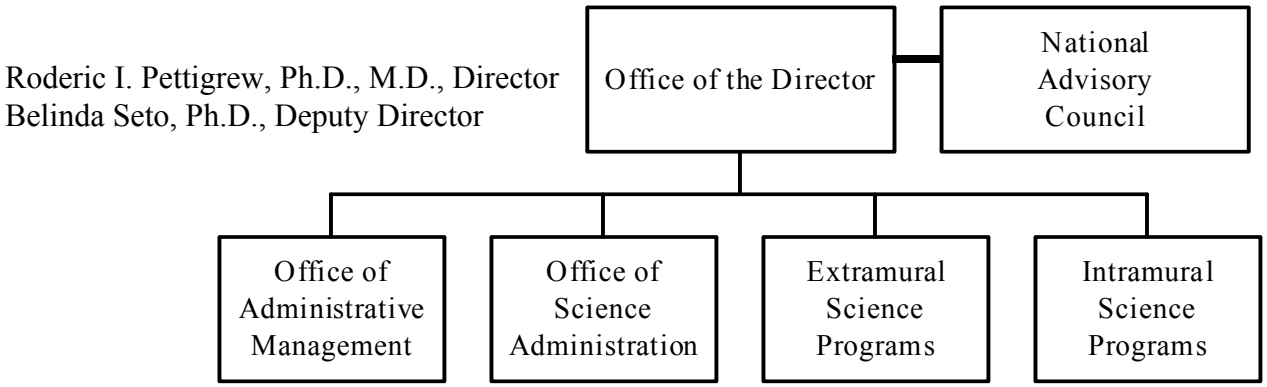


NATIONAL INSTITUTES OF HEALTH

NATIONAL INSTITUTE OF BIOMEDICAL IMAGING AND BIOENGINEERING

For carrying out section 301 and title IV of the Public Health Service Act with respect to National Institute of Biomedical Imaging and Bioengineering, [$288,900,000] *$297,647,000.*

[Departments of Labor, Health and Human Services and Related Agencies Appropriations Act, as enacted by the Omnibus Consolidated Appropriations Act for Fiscal Year 2004]

National Institutes of Health
National Institute of Biomedical Imaging and Bioengineering

Amounts Available for Obligation 1/

Source of Funding	FY 2003 Actual	FY 2004 Final Conference	FY 2005 Estimate
Appropriation	$280,100,000	$288,900,000	$297,647,000
Enacted Rescissions	(1,821,000)	(1,771,000)	---
Subtotal, Adjusted Appropriation	278,279,000	287,129,000	297,647,000
Comparative transfer to NIBIB for Radiology Program	1,705,000	1,733,000	---
Comparative transfer to Buildings and Facilities	(33,000)	(32,000)	---
Comparative transfer to Office of the Director for program changes	(8,000)	(0)	---
Subtotal, adjusted budget authority	279,943,000	288,830,000	297,647,000
Unobligated Balance, end of year	---	---	---
Subtotal, adjusted budget authority	279,943,000	288,830,000	297,647,000
Unobligated balance lapsing	---	---	---
Total obligations	279,943,000	288,830,000	297,647,000

1/ Excludes the following amounts for reimbursable activities carried out by this account:
FY 2003 - $21,000; FY 2004 - $3,001,000; FY 2005 - $3,001,000

Justification

National Institute of Biomedical Imaging and Bioengineering

Authorizing Legislation: Section 301 of the Public Health Service Act, as amended. Reauthorizing legislation will be submitted.

Budget Authority:

FY 2003 Actual		FY 2004 Final Conference		FY 2005 Estimate		Increase or Decrease	
FTEs	BA	FTEs	BA	FTEs	BA	FTEs	BA
48	$279,943,000	55	$288,830,000	56	$297,647,000	1	$8,817,000

This document provides justification for the Fiscal Year 2005 activities of the National Institute of Biomedical Imaging and Bioengineering (NIBIB), including HIV/AIDS activities. A more detailed description of NIH-wide Fiscal Year 2005 HIV/AIDS activities can be found in the NIH section entitled "Office of AIDS Research (OAR)."

INTRODUCTION

The mission of the National Institute of Biomedical Imaging and Bioengineering (NIBIB) is to improve health by leading the development and application of emerging and breakthrough biomedical technologies based in the biological, physical and engineering sciences. These technologies will facilitate an improved fundamental understanding of complex biological processes and facilitate disease detection, management, and prevention. To champion its mission, the Institute will support focused and multidisciplinary research in biomedical imaging and bioengineering to advance the Nation's health care agenda; develop and implement programs that provide interdisciplinary training in the quantitative and biomedical sciences to ensure the availability of future generations of highly trained researchers; promote trans-NIH, interagency, and multi-organizational collaborations aimed at translating fundamental research discoveries into biomedical applications; and establish an intramural research and training program focusing on emerging biomedical technologies that span multiple disciplines and applications. The research promoted and supported by NIBIB is strongly synergistic with the other NIH Institutes and Centers as well as across government agencies, and has the potential for direct positive medical application. Ultimately, NIBIB seeks to translate research findings from the laboratory into practical solutions that will benefit public health.

Research in biomedical imaging and bioengineering is progressing rapidly and is becoming increasingly interdisciplinary. Recent technological advances have revolutionized the diagnosis

and treatment of disease and provide unprecedented opportunities for furthering understanding of biological processes and for conducting powerful biological investigations. To capitalize on these opportunities, the NIBIB is developing a robust research program in biomedical imaging and bioengineering that will focus on developing fundamental new knowledge, fostering potent new technologies, supporting promising researchers, and facilitating cross-cutting capabilities.

NIBIB is also planning activities in fiscal year (FY) 2004 that will provide further guidance in setting a future research agenda in biomedical imaging and bioengineering. The NIBIB, in close collaboration with members of our National Advisory Council and with broad public input, is embarking on the development of a Strategic Plan that will be reflective of our unique mission and science.

STORY OF DISCOVERY

Historical Perspective of Biomedical Imaging: From MRI to fMRI

The first successful nuclear magnetic resonance (NMR) experiments were performed in 1946 by two U.S. scientists. They found that when certain naturally-occurring nuclei were placed in a magnetic field they absorbed energy in the radio frequency range of the electromagnetic spectrum. This energy was re-emitted when the nuclei relaxed back to their original state, a phenomenon termed NMR. With this discovery, NMR spectroscopy became an important analytical method in the study of the composition of chemical compounds. Felix Bloch and Edward Purcell were awarded the Nobel Prize for Physics in 1952 for this discovery.

During the 1950s and 1960s NMR spectroscopy became a widely used technique for the nondestructive analysis of small samples, and many of its applications were at the microscopic level using small-bore, high-field magnets. In 1973, Paul Lauterbur described his research on the high level of contrast that could be realized in nuclear magnetic resonance imaging (MRI). His approach was based on the independent discoveries by Bloch and Purcell of the properties of certain nuclei in the periodic table. Specifically, when some naturally-occurring elements, such as the common hydrogen atom, are exposed to powerful magnetic fields, they emit signals that differ from tissue to tissue. Sir Peter Mansfield developed methodology to analyze the signals and assemble them rapidly into three-dimensional images. Dr. Lauterbur, a long-time NIH grantee, and Dr. Mansfield were recently awarded the 2003 Nobel Prize in Physiology or Medicine for their discoveries in MRI.

In 1977, the first MRI exam was performed on a human being. The procedure was long and complicated, taking over 5 hours to produce a single image. Although researchers had struggled for over 7 years to reach this point, by today's standards, the image was unrefined and coarse. Critical advances in technology development now allow physicians to image in seconds what used to take hours. MRI has been used successfully for over 15 years to generate soft tissue images of the human body, making it the technique of choice for the routine diagnosis of many diseases and disease processes. Today more than 60 million noninvasive, diagnostic MRI procedures are performed worldwide each year.

Although there is no doubt that the development of MRI has revolutionized the practice of medicine, one must recognize that individual imaging methods have both intrinsic strengths and weaknesses. NIH researchers are striving to capitalize on these strengths and improve upon known weaknesses to further propel advances that improve medical care. For example, it has long been recognized that tumor oxygenation is a significant factor that influences cancer therapy. Hypoxia, a decrease in oxygen supply, is thought to negatively affect response to radiotherapy and some chemotherapies in solid tumors and may even be a mechanism for malignant progression and

metastasis. NIH researchers recently developed a novel *in vivo* MRI approach for measuring oxygen tension at specific locations within a tumor while observing dynamic changes with respect to intervention. They have now investigated oxygen dynamics in two types of rat tumor models and found considerable intratumoral differences in the distribution of oxygen values between the tumor types. The faster-growing metastatic tumors were more hypoxic than the slow-growing tumors, suggesting that the level of hypoxia may be related to tumor growth rate and poor vascularity. This approach can provide valuable insight into tumor physiology and response to interventions, assisting in the development of novel therapeutic strategies.

Image-guided surgery systems strive to enhance a surgeon's ability to utilize medical imagery to decrease the invasiveness of a procedure as well as to increase accuracy and safety. NIH researchers have designed and developed a guidance and visualization system which uniquely integrates data analysis and on-line guidance into the interventional MRI setting. Use of this system enhances and speeds up tissue characterization and precise localization and targeting. To date, this tool has been used in numerous neurosurgical procedures and has been critical in providing surgeons with full access to all available imaging data. The system's flexible design will allow its expansion into a highly integrated suite of tools for image analysis and visualization.

Functional magnetic resonance imaging (fMRI) is a relatively new technique that builds on the basic properties of MRI to measure quick and tiny metabolic changes that take place in the active brain. Thus, fMRI studies are capable of providing not only an anatomical view of the brain, but a minute-to-minute recording of actual brain activity. This technology is now being used to study and compare the anatomy of the normal, diseased, and injured brain and to assess risks associated with surgery or other invasive treatments. Functional MRI can also help physicians determine exactly which part(s) of the brain is/are responsible for crucial functions such as thought, speech, movement, and sensation. This information can help physicians monitor the growth and function of brain tumors and therefore better plan surgeries and radiation therapies; enable the detection of abnormalities that might be obscured by bone tissue with other imaging methods; develop novel treatment and intervention strategies for brain disorders such as dementia and seizures; and enable detection of a stroke at a very early stage such that physicians can initiate effective treatments earlier.

To date, the most popular fMRI technique utilizes blood oxygenation level-dependent (BOLD) contrast, which is based on the differing magnetic properties of oxygenated and deoxygenated blood. These magnetic susceptibility differences lead to small, but detectable, changes in image intensity. Unfortunately, head movement and physiological sources of variability often make detection of signal changes difficult. NIH investigators have recently introduced a new method for removing movement variability artifacts using a motion sensor system combined with adaptive noise filtering techniques. This computerized filtering approach can be implemented in real-time to allow for continuous monitoring of fMRI during clinical and cognitive studies.

Functional MRI has been used extensively to study language processing in adults, and is being increasingly applied to the study of language function in children. To date, abnormalities in brain structure, cognition, and behavior have been described in children born prematurely. However, there is no direct *in vivo* evidence demonstrating abnormal neural processing in these children. As language deficits have important and far-reaching implications for academic and social functioning throughout development, researchers compared brain activity associated with phonetic (sounds) and semantic (meaning) processing of language between term and preterm children. Analyses of brain activity associated with the phonologic and semantic processing of a children's story demonstrated that 8-year old term and preterm children differ in their brain processing of language-based tasks. In addition, brain activity correlated significantly with verbal comprehension IQ scores in preterm but not term children. Additional studies are underway to determine whether the patterns of brain activity observed during language processing tasks can be useful diagnostically or in monitoring educational or therapeutic interventions.

Functional MRI also provides tremendous opportunities for the study and treatment of epilepsy. NIH researchers are using fMRI to integrate information on the suspected location of a brain seizure with information about surrounding brain function in order to improve surgical outcome in epilepsy patients. Initial developments have already been

applied to surgical procedures used to alleviate brain seizures in patients with epilepsy. In one case, an early form of surgery employing fMRI strategies was used to treat a patient suffering from as many as 100 seizures daily. Post-surgery, the patient's seizures have almost completely stopped resulting in a significant increase in quality of life.

Dr. Lauterbur was recently quoted as saying "I knew it [MRI] would be a useful tool from the very first ideas, but not how useful." Early research on MRI ignited a spark in the minds of scientists that has led to unforeseen and unimaginable advances in visualization techniques and equipment that have in turn revolutionized the practice of medicine. As we look toward the future, one can only imagine what wondrous advances are yet to come.

SCIENCE ADVANCES

The NIBIB is the newest of the research Institutes within the National Institutes of Health, and was established by law in December 2000. NIBIB received its first appropriation and grant funding authority in FY 2002. Although scientific accomplishments often take years to generate new diagnostic technologies and methods to treat and prevent disease, the NIBIB is pleased to report that it has already begun to yield significant results.

Optical Biopsies. Correct diagnosis is the first step in the successful treatment of disease. In some cases, such as Alzheimer's disease, unequivocal diagnosis is possible only after a patient's death. More often, diagnosis depends on the surgical retrieval of a tissue sample, a process that can be painful and carries risk from complications. Scientists have now harnessed a powerful but gentle laser and put some basic principles of physics to work to develop a technology that allows them to visualize cells and molecules in living tissues. This technology is remarkable in that it does not require the use of toxic stains and it allows the investigators to focus not just on the tissue surface but on the layers buried beneath. Using tissue samples from autopsy material and animal models, researchers have demonstrated that they can see the subcellular structures that characterize an Alzheimer's brain, distinguish breast tumors from normal tissue, and visualize tissue morphology and cellular metabolism. Although this technique is in its infancy, it is already yielding new information on the structure of normal and diseased tissues and the localization of particular classes of molecules within cells and tissues. In the future it may prove useful for the rapid examination of biopsy samples, replacing the standard, time-consuming methods. Far more exciting is the potential for combining this technology with endoscopy or arthroscopy to permit clinicians to look directly at potentially diseased tissues deep within the human body.

A Bed of Microneedles Measures Smooth Muscle Contraction. It is widely recognized that cells respond to chemical signals in their environment and can also sense and respond to the extracellular scaffold that supports them. However, measurement of the mechanical interactions between a single cell and its environment are technically difficult. Typically these measurements are indirect, relying heavily on mathematical models and calculations, which introduce substantial uncertainty into the process. A new microdevice permitting the direct measurement of the strength, duration and timing of cellular contractions has been fabricated using technologies similar to those that produce computer chips. The investigative team, which

includes biomedical engineers, a physicist, a molecular biologist, and a chemical engineer, describes the device as a "bed" of silicon microneedles. Smooth muscle cells were among the first cell types studied with this new device. These cells line the airways and blood vessels, and their contractility plays an important role in asthma and hypertension. Alterations in smooth muscle cell contractility are also involved in intestinal dysfunction and cardiac abnormalities. This new device will enable investigators not only to describe the properties of normal and diseased cells but to screen drugs that might alter cell contractility in therapeutically useful ways. Finally, tissue engineering and regenerative medicine depend on appropriate scaffolds for the generation of three dimensional cellular assemblies. Information obtained with microneedle arrays will greatly facilitate scaffold design and evaluation.

Brain-Computer Interface. Degenerative neuromuscular diseases impair the neural pathways that control muscles or the muscles themselves. In extreme cases, an individual may loose all voluntary muscle control, including the ability to communicate, and become locked within their body. A brain-computer interface, a communication system that translates electrophysiological signals from the brain into commands that operate a computer or prosthetic device, has the capacity to restore valuable communication and control capacities. It is known that individuals with neuromuscular diseases can learn to control certain portions of their brain wave activity. These "thoughts" can then be used to control a cursor on computer screen or a prosthetic device. Investigators are using a brain-computer interface system to allow individuals lacking voluntary muscle control to communicate using cursor-based letter or icon selections on a computer screen and to allow quadriplegic individuals to control neuroprosthetic devices.

In related work, researchers are developing a wireless communication system for transmission of signals within the body. The most common form of wireless communication depends on radio frequency (RF) waves. Unfortunately, the water and dissolved substances that make up the bulk of living tissue constitute an effective shield for RF transmission. Investigators have focused their efforts to capitalize on the electrical properties of biological fluids to transmit information. They have designed and built an implantable antenna that can wirelessly convey signals from the brain to electrodes outside the skull. In addition, signals can be sent wirelessly into the brain from skull-mounted external electrodes. Further refinements in wireless communication between the brain and an external computer would make the system far less cumbersome than an interface dependent on direct wiring.

Advances in the development of the brain-computer interface could provide new hope to individuals affected by degenerative neuromuscular diseases by allowing them to communicate, to control some bodily functions, and perhaps eventually, to restore some movement. In combination with electrical stimulation, such a system could restore control of muscles that can no longer respond to nerve impulses. Operating in reverse, the system could generate brain stimulation of the sort that has been used in the treatment of Parkinson's disease and other motor disorders.

Novel Tools to Study Cystic Fibrosis. Cystic fibrosis (CF), the most common lethal genetic disease in Caucasians, is caused by mutations in the gene that codes for the CFTR (cystic

fibrosis transmembrane conductance regulator) protein, a pump protein that is important for the normal function of the lungs and the intestines. NIH investigators have developed and used a robotic screening procedure to examine small molecules in the search for potent and selective inhibitors and activators of the CFTR protein. To date, they have identified seven pump inhibitors and 17 pump activators, the first highly selective modulators ever identified. When tested in an animal model, these molecules were found to be nontoxic. This automated screening technique allows for the identification of molecules that may potentially alter the function of the CFTR protein. Investigators could use the most potent protein inhibitors to inhibit the protein *in vivo,* thus producing a large animal model for CF, and as an adjunct to oral rehydration therapy in the treatment of bacterial diarrheas. Protein activators can be useful as therapeutic agents to restore function to the genetically-damaged forms of the CFTR protein in individuals with CF. Finally, both inhibitors and activators will be useful tools in understanding the biochemical mechanisms that underlie CFTR protein function, thereby suggesting new approaches to managing the disease.

A Bioinformatics Toolkit for the Modern Biologist. Microarray technology allows investigators to screen tens of thousands of genes simultaneously. A typical result of a microarray experiment is a number of gene expression profiles, which in turn are used to generate hypotheses and locate effects on many, often unrelated, biological pathways. The challenge lies in analyzing the staggering amounts of data generated and translating results into an understanding of the underlying biological phenomenon. This is usually accomplished by searching the literature as well as various online databases, a very tedious and time consuming task. NIH researchers have developed a set of four seamlessly integrated databases, collectively referred to as Onto-Tools, that help address this problem. Onto-Express is a tool designed to mine available functional annotation data and help a researcher find relevant biological processes. Onto-Compare helps researchers analyze the biological bias of various commercial microarrays to find the array, or combination of arrays, that is best suited to investigate a particular hypothesis. Onto-Design can be used to quickly design a microarray by constructing an optimal set of genes for a given set of biological pathways or processes. Lastly, Onto-Translate is a utility that facilitates quick conversion among any type of gene identifiers. All the tools described are integrated and data can pass seamlessly from one to another. The Onto-tools package is available online at http://vortex.cs.wayne.edu/Projects.html.

A Marker for HIV/AIDS Prognosis. Compounds that contain sulfhydryl (-SH) groups have been implicated in the pathology of HIV/AIDS. Low levels of intracellular glutathione, a small molecule that contains an -SH group, are often associated with poor prognosis. In addition, -SH groups on the T-cell CD4 protein and a viral glycoprotein appear to regulate the process by which the virus enters cells, suggesting that a comprehensive description of -SH group metabolism would be useful in understanding HIV infection and disease progression. NIH researchers have developed a cell-sorting procedure that can detect the sulfhydryl status of different populations of T-cells using a single measurement. This technique has been used to demonstrate that, *in vitro*, manipulation of intracellular glutathione levels produces changes in cell surface -SH levels. This newly reported technique, which allows the measurement not only of intracellular glutathione levels but also of cell surface -SH groups for well-defined

populations of T-cells, has the potential to lead to the refinement of -SH group measurements both as a diagnostic tool and a means for monitoring the effectiveness of anti-HIV/AIDS therapies.

NIH ROADMAP

To transform the nation's medical research capabilities and to speed the movement of research discoveries from the bench to the bedside, the NIH has laid out a series of far-reaching initiatives known collectively as the NIH Roadmap for Medical Research. The NIH Roadmap provides a framework for strategic investments that NIH needs to make to optimize its entire research portfolio and builds on the tremendous progress in medical research achieved thus far. In setting forth a vision for a more efficient and productive system of medical research, the NIH Roadmap focuses on the most compelling opportunities in three main areas: new pathways to discovery, research teams of the future, and re-engineering the clinical research enterprise.

The tie between the NIBIB mission to lead the development and application of biomedical technologies in the physical and engineering sciences and the NIH Roadmap is direct–the Roadmap will facilitate the development of innovative, novel and multidisciplinary science and technology that has the potential to further advances in health care. Roadmap activities will improve health by providing researchers with tools and capabilities to make new discoveries and to quickly allow basic research discoveries to be translated into new therapies.

A key focus of the Roadmap and NIBIB is molecular libraries and imaging; a component of new pathways to discovery. More specifically, the NIBIB is participating in an initiative entitled *Development of High Resolution Probes for Cellular Imaging*. This initiative will facilitate the formation of collaborative research teams capable of generating novel probes for molecular and cellular imaging. The overall goal is to establish programs to create complete tool sets for the detection of single molecule events in living cells and to generate new strategies for dramatically increasing the resolution of imaging dynamic cellular processes. Although the probes initially developed under this initiative will be used for the study of basic molecular and cellular processes, the technology may eventually be adapted for clinical use. The clinical evaluation of specific diseases and how they present in individual patients will enable doctors to obtain personal profiles of molecular and genetic disease markers. Using this information, doctors can then tailor treatments to each patient.

Other areas of immediate interest to the NIBIB under the Roadmap area of new pathways to discovery include nanomedicine, new tools for the study of proteomics and metabolic pathways, computational biology, and bioinformatics. Under the Roadmap effort, NIH Institutes and Centers, including the NIBIB, have developed a 10 year plan to create approximately eight National Centers of Excellence in Biomedical Computing to cover key bioinformatics areas such as image processing, modeling, genomics, systems biology, computer-assisted surgery, and computer-aided diagnosis and treatment of disease. The NIBIB also strongly supports the NIH

Roadmap theme, research teams of the future, due to our inherent interest in building collaborations and multidisciplinary research teams to accomplish our mission.

NIBIB NEW INITIATIVES

An important goal of the NIBIB is to nurture a new generation of researchers equipped to meet the modern needs of interdisciplinary and transdisciplinary research. Researchers trained in biomedical imaging and bioengineering must be able to demonstrate technical competency in multiple fields as well as the ability to think independently, communicate ideas effectively, work in teams, and contribute to a strong vision that transcends a narrow discipline. To this end, the NIBIB will capitalize on existing NIH training mechanisms, collaborate on trans-agency training programs, and work with the community to develop new programs that cross-train research scientists in the biological and quantitative sciences. For example, the NIBIB is planning two new initiatives–a Postdoctoral Scholar Development and Faculty Transition Award and a Supplements Program for Medical Resident Research Training to help accomplish these goals.

NIBIB Postdoctoral Scholar Development and Faculty Transition Award. This program will support individuals who have demonstrated potential for a highly productive research career in an area of interest to the NIBIB, first as postdoctoral scholars and then as they make the transition to independent researchers. This transition has been shown to be a time of career vulnerability. Adoption of the career development award represents a mechanism to bridge this transition, first by providing initial funding during the postdoctoral period and then, pending internal administrative review, continued funding once an individual obtains a faculty position. The ability to begin employment with funding enhances an individual's attractiveness as a faculty candidate and improves their chances of success. It is anticipated that recipients of this award will subsequently obtain a research project grant to support continued research efforts. This model has been used successfully by other NIH Institutes and Centers and is widely approved by the bioengineering and imaging communities.

NIBIB Supplements Program For Medical Resident Research Training. This initiative will provide supplemental training funds to existing NIBIB research grants, or to research awards made by other institutes but of direct relevance to the NIBIB mission. The program is designed to serve as a "first step" in attracting medical residents to research careers in biomedical imaging and/or bioengineering and will support research training experiences (1 to 2 years) for medical residents who have demonstrated potential for productive research in scientific areas of interest to the NIBIB. Program participants would then be expected to apply for other grants, such as the NIH Career Development Awards, upon completion of their training experience. New training opportunities for medical residents were viewed as a priority by participants in a recent NIBIB-sponsored training workshop. This initiative is also consonant with priorities identified by the Clinical Workforce Training Roadmap Group.

INNOVATIONS IN MANAGEMENT AND ADMINISTRATION

Building on planning efforts that took place in the previous fiscal year, management and administrative structures continue to be established by the NIBIB. Consistent with the Institute's area of expertise, we will continue to use state-of-the-art technology and lead technology development.

NIBIB Reorganization. A priority of the NIBIB Director is to have an organizational structure and management plan that reflects the emerging mission of the Institute. In May 2003 such a plan was implemented. The new structure and management plan provide an infrastructure that supports NIBIB's mission and operational precepts, defines organizational component responsibilities and management hierarchy, facilitates internal checks and balances, and enhances staff cooperation and communication. The new organization clearly delineates responsibilities with regard to Institute activities and operational aspects that include extramural science programs, intramural science programs, science administration, and administrative management. These four elements improve the overall efficiency and effectiveness of the organization by reducing the number of "modular" elements reporting to the Director.

Strategic Plan Development. The NIBIB, in close collaboration with members of our National Advisory Council and with broad public input, is embarking on the development of a Strategic Plan that will be reflective of our unique mission and science. Although the NIBIB Strategic Plan will build upon many existing planning processes already in place, we would like the plan to reflect comments from the broadest constituency possible. Therefore, we are seeking to enhance liaisons between the Institute, its constituency groups, the research community, and the general public. The development of our plan, which will cover a 2 to 3 year time horizon, will be a continuous and iterative process, and a draft document will be shared with the community to solicit input and comments at various steps along the way.

Grant Tracking System. The Electronic Image Management System (eGrants) provides electronic access to NIBIB official grant files and replaces paper grant files. In fact, the entire NIBIB grant portfolio is electronic, enabling authorized users access to the various components of official multipage grant files such as grant applications, progress reports, and other administrative grant information, and improving overall grant tracking ability. This more efficient system provides long-term cost reduction by reducing the number of staff needed to operate the file room, reducing storage space requirements (and accomplishing goals set forth in the Government Paperwork Elimination Act [P.L. 105-277]), reducing contractor expenditures, and reducing the staff time and cost dedicated to tracking the location of a paper grant file. This system also facilitated the transfer and fiscal stewardship of over $200 million in funded grants transferred from other NIH Institutes and Centers to NIBIB in fiscal years 2002 and 2003.

Continued Administration of the NIH Bioengineering Consortium. On September 19, 2001, the administration of the Bioengineering Consortium (BECON) transitioned from the Office of Extramural Research, Office of the NIH Director, to the NIBIB. Since its establishment in 1997, the Bioengineering Consortium has been coordinating bioengineering activities at the NIH. The Consortium consists of senior-level representatives from all of the NIH Institutes and Centers

plus representatives of other Federal agencies concerned with biomedical research and development. In its administrative role, the NIBIB is committed to maintaining the successful coordination of trans-NIH bioengineering research, training, and related programs. For example, in FY 2003, the NIBIB, in coordination with BECON members, sponsored a symposium entitled "Catalyzing Team Science" as well as the Third Annual Bioengineering Partnership grantee meeting.

Developing an Intramural Research Program. The NIBIB is taking several steps toward initiating an intramural research program (IRP) in FY 2004. The NIBIB is working with the National Institute of Standards and Technology (NIST) to set up a collaborative research program in tissue engineering at their site in Gaithersburg, Maryland. In addition, the Food and Drug Administration's Center for Devices and Radiological Health (CDRH) has proposed a joint research program for the assessment of medical imaging systems in which all laboratory space will be contributed by the CDRH. There are also two laboratory operations currently located within the NIH Clinical Center, in radiochemistry and molecular probe development, that are scheduled to be reassigned to the NIBIB in FY 2004. During FY 2005, the NIBIB will continue to work with NIST and the Food and Drug Administration to set up collaborative research programs.

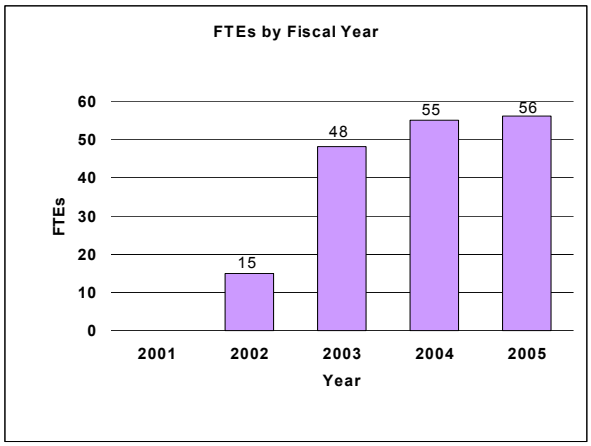
SUMMARY

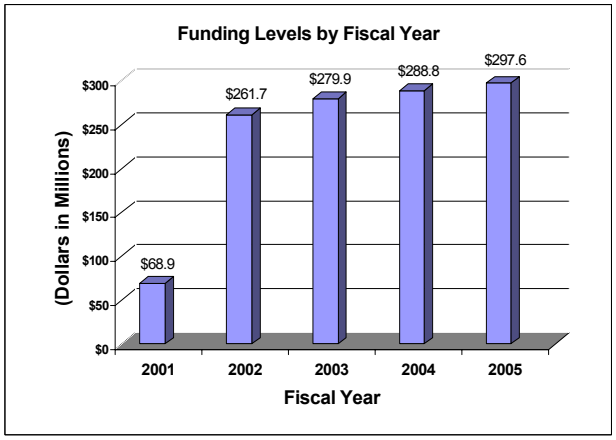
The fields of biomedical imaging and bioengineering are expanding rapidly–from the detection, diagnosis and treatment of diseases and disabilities at the level of tissues and organs, to the analysis of structure and function at the molecular and genetic levels. The establishment of NIBIB was predicated on present and potential advances in these exciting fields. As the Institute evolves in the coming years, our research mission will allow us to capitalize on emerging scientific areas where biomedical imaging and bioengineering approaches can be used to explore promising new directions.

Budget Policy

The Fiscal Year 2005 budget request for the NIBIB is $297,647,000, an increase of $8,817,000 and 3.1 percent over the FY 2004 Final Conference Level. Also included in the FY 2005 request, is NIBIB's support for the trans-NIH Roadmap initiatives, estimated at 0.63% of the FY 2005 budget request. This Roadmap funding is distributed through the mechanisms of support, consistent with the anticipated funding for the Roadmap initiatives. A full description of this trans-NIH program may be found in the NIH Overview.

A five year history of FTEs and Funding Levels for NIBIB are shown in the graphs below. Note that the Fiscal Year 2001 FTE figure is not comparable to the figures in the succeeding years due to NIH's consolidation of its Human Resources function in FY 2003.
NIH's highest priority is the funding of medical research through research project grants (RPGs).

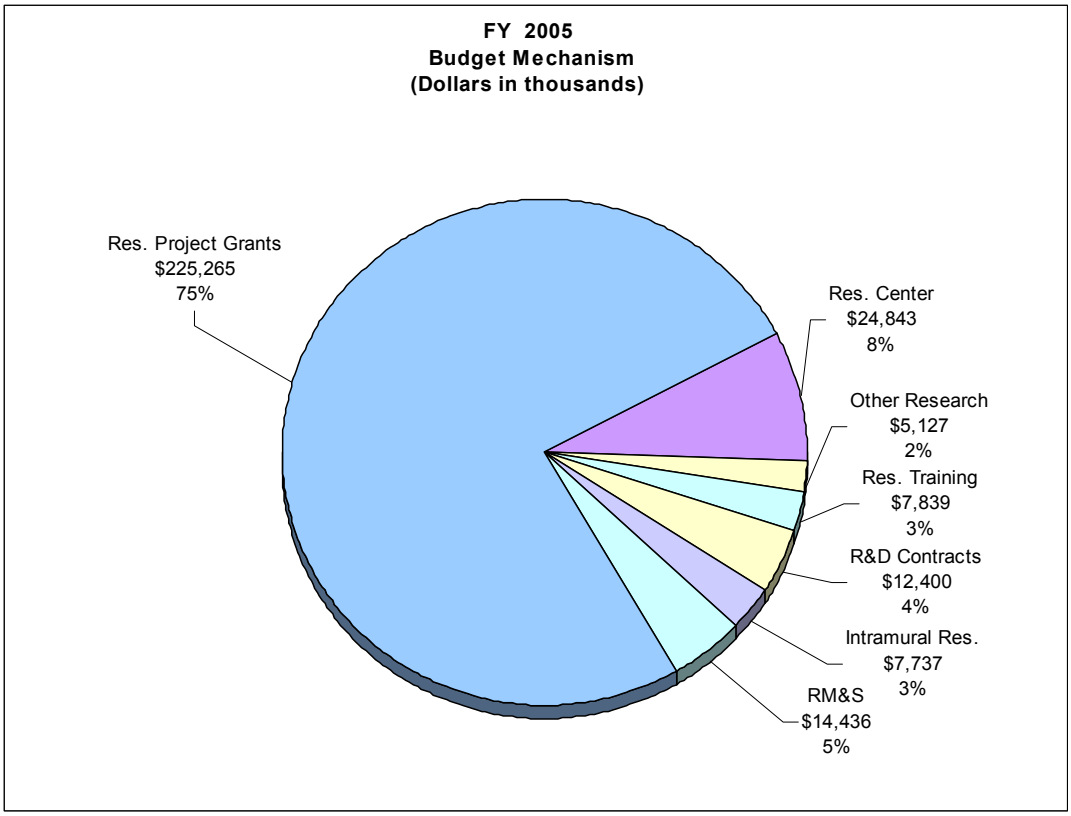


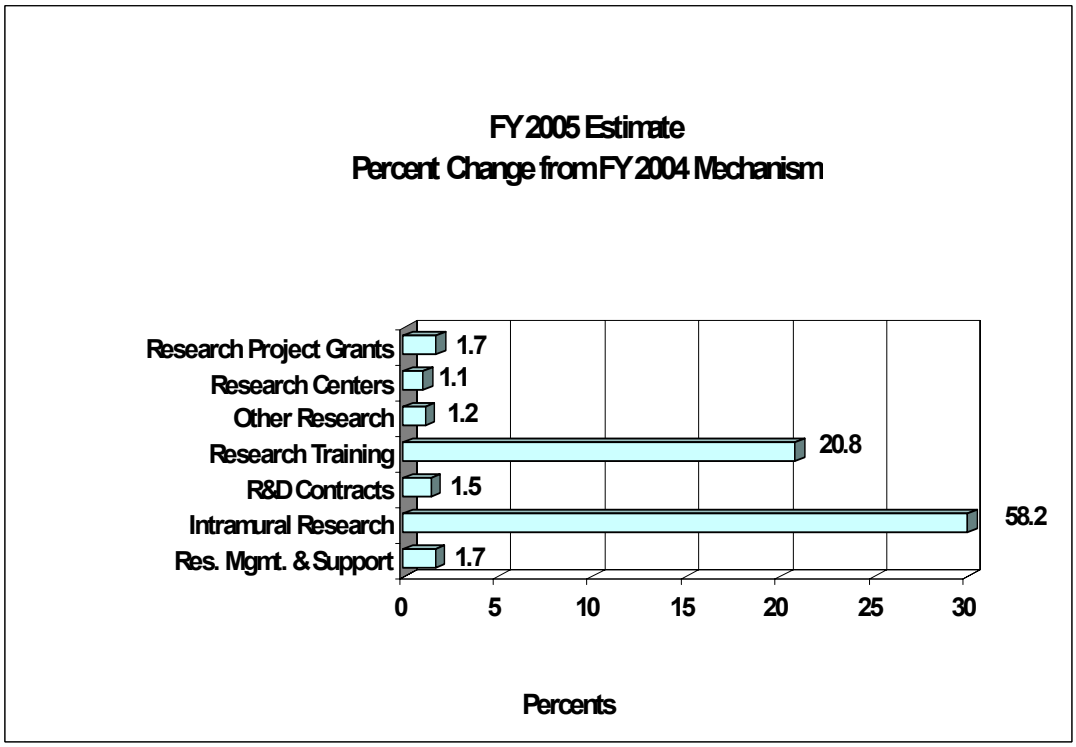


Support for RPGs allows NIH to sustain the scientific momentum of investigator-initiated research while providing new research opportunities. The FY 2005 NIH request provides for an aggregate 1.3 percent increase in average cost for Research Project Grants, consistent with the Gross Domestic Product deflator. The NIBIB is providing an average cost increase of 1.9 percent for direct recurring costs in noncompeting continuation awards. Competing RPGs are based on an average cost increase of 1 percent.

Advancement in medical research is dependent on maintaining the supply of new investigators with new ideas. In the Fiscal Year 2005 request, NIBIB will support 153 pre- and postdoctoral trainees in full-time training positions. Stipend levels for pre-doctoral and post-doctoral recipients supported through the Ruth L. Kirschstein National Research Service Awards will remain at FY 2004 levels.

The Fiscal Year 2005 request includes funding for 24 research centers, 28 other research grants, including 7 R&D contracts. Intramural Research and Research Management and Support receive increases to support increased pay and estimated inflationary increases in FY 2005.
The mechanism distribution by dollars and percent change are displayed below:


FY 2005
Budget Mechanism
(Dollars in thousands)
Res. Project Grants
$225,265
75%
Res. Center
$24,843
8%
Other Research
$5,127
2%
Res. Training
$7,839
3%
R&D Contracts
$12,400
4%
Intramural Res.
$7,737
3%
RM&S
$14,436
5%


FY 2005 Estimate
Percent Change from FY 2004 Mechanism
Research Project Grants
Research Centers
Other Research
Research Training
R&D Contracts
Intramural Research
Res. Mgmt. & Support
1.7
1.1
1.2
20.8
1.5
58.2
1.7
0
5
10
15
20
25
30
Percents

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

Budget Mechanism - Total

MECHANISM	FY 2003 Actual		FY 2004 Final Conference		FY 2005 Estimate	
Research Grants:	No.	Amount	No.	Amount	No.	Amount
Research Projects:						
Noncompeting	343	$129,275,000	482	$176,956,000	422	$170,119,000
Administrative supplements	(10)	436,000	(14)	602,000	(14)	642,000
Full funded	1	134,000	2	300,000	2	303,000
Single year	284	85,101,000	111	34,630,000	144	45,298,000
Renewal	30	12,432,000	12	5,194,000	14	6,448,000
New	254	72,669,000	99	29,436,000	130	38,547,000
Supplements	0	0	0	0	0	0
Subtotal, competing	285	85,235,000	113	34,930,000	146	45,601,000
Subtotal, RPGs	628	214,946,000	595	212,488,000	568	216,362,000
SBIR/STTR	54	11,246,000	40	8,903,000	40	8,903,000
Subtotal, RPGs	682	226,192,000	635	221,391,000	608	225,265,000
Research Centers:						
Specialized/comprehensive	5	3,566,000	5	3,811,000	5	4,034,000
Clinical research	0	0	0	0	0	0
Biotechnology	19	20,047,000	19	20,770,000	19	20,809,000
Comparative medicine	0	0	0	0	0	0
Research Centers in Minority Institutions	0	0	0	0	0	0
Subtotal, Centers	24	23,613,000	24	24,581,000	24	24,843,000
Other Research:						
Research careers	9	1,182,000	17	2,463,000	21	3,109,000
Cancer education	0	0	0	0	0	0
Cooperative clinical research	0	0	0	0	0	0
Biomedical research support	0	0	0	6,000	0	7,000
Minority biomedical research support	0	0	0	0	0	0
Other	10	3,324,000	9	2,598,000	7	2,011,000
Subtotal, Other Research	19	4,506,000	26	5,067,000	28	5,127,000
Total Research Grants	725	254,311,000	685	251,039,000	660	255,235,000
Research Training:	FTTPs		FTTPs		FTTPs	
Individual awards	4	156,000	10	422,000	16	701,000
Institutional awards	61	2,685,000	119	6,065,000	137	7,138,000
Total, Training	65	2,841,000	129	6,487,000	153	7,839,000
Research & development contracts	6	7,270,000	7	12,221,000	7	12,400,000
(SBIR/STTR)	(0)	(0)	(0)	(0)	(0)	(0)
	FTEs		FTEs		FTEs	
Intramural research	7	1,689,000	7	4,891,000	7	7,737,000
Research management and support	41	13,832,000	48	14,192,000	49	14,436,000
Cancer prevention & control	0	0	0	0	0	0
Construction		0		0		0
Total, NIBIB	48	279,943,000	55	288,830,000	56	297,647,000
(RoadMap Support)		(0)		(986,000)		(1,875,000)
(Clinical Trials)		(0)		(0)		(0)

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

Budget Authority by Activity
(dollars in thousands)

ACTIVITY	FY 2003 Actual		FY 2004 Final Conference		FY 2005 Estimate		Change	
	FTEs	Amount	FTEs	Amount	FTEs	Amount	FTEs	Amount
Extramural Research:								
Biomedical Imaging and Bioengineering		$264,422		$269,747		$275,474		$5,727
Subtotal, Extramural research		264,422		269,747		275,474		5,727
Intramural research	7	1,689	7	4,891	7	7,737	0	2,846
Res. management & support	41	13,832	48	14,192	49	14,436	1	244
Total	48	279,943	55	288,830	56	297,647	1	8,817

National Institute of Biomedical Imaging and Bioengineering

Summary of Changes

FY 2004 Final Conference				$288,830,000
FY 2005 Estimated Budget Authority				297,647,000
Net change				8,817,000
	FY 2004 Budget Base		Change from Base	
CHANGES	FTEs	Budget Authority	FTEs	Budget Authority
A. Built-in:				
1. Intramural research:				
a. Within grade increase		$1,415,000		$25,000
b. Annualization of January 2004 pay increase		1,415,000		14,000
c. January 2005 pay increase		1,415,000		16,000
d. One less day of pay		1,415,000		(6,000)
e. Payment for centrally furnished services		397,000		12,000
f. Increased cost of laboratory supplies, materials, and other expenses		2,923,000		38,000
Subtotal				99,000
2. Research Management and Support:				
a. Within grade increase		5,164,000		85,000
b. Annualization of January 2004 pay increase		5,164,000		52,000
c. January 2005 pay increase		5,164,000		58,000
d. One less day of pay		5,164,000		(20,000)
e. Payment for centrally furnished services		2,017,000		61,000
f. Increased cost of laboratory supplies, materials, and other expenses		6,916,000		103,000
Subtotal				339,000
Subtotal, Built-in				438,000

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

Summary of Changes--continued

CHANGES	FY 2004 Budget Base No.	FY 2004 Budget Base Amount	Change from Base No.	Change from Base Amount
B. Program:				
1. Research project grants:				
a. Noncompeting	482	$177,558,000	(60)	($6,797,000)
b. Competing	113	34,930,000	33	10,671,000
c. SBIR/STTR	40	8,903,000	0	0
Total	635	221,391,000	(27)	3,874,000
2. Research centers	24	24,581,000	0	262,000
3. Other research	26	5,067,000	2	60,000
4. Research training	129	6,487,000	24	1,352,000
5. Research and development contracts	7	12,221,000	0	179,000
Subtotal, extramural				5,727,000
	FTEs		FTEs	
6. Intramural research	7	4,891,000	0	2,747,000
7. Research management and support	48	14,192,000	1	(95,000)
Subtotal, program		274,638,000		8,379,000
Total changes	55		1	8,817,000

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

Budget Authority by Object

	FY 2004 Final Conference	FY 2005 Estimate	Increase or Decrease
Total compensable workyears:			
Full-time employment	55	56	1
Full-time equivalent of overtime & holiday hours	0	0	0
Average ES salary	$145,797	$148,713	$2,916
Average GM/GS grade	12.3	12.3	0.0
Average GM/GS salary	$75,340	$77,196	$1,856
Average salary, grade established by act of July 1, 1944 (42 U.S.C. 207)	$129,000	$131,000	$2,000
Average salary of ungraded positions	121,925	124,363	2,438

OBJECT CLASSES	FY 2004 Final Conference	FY 2005 Estimate	Increase or Decrease
Personnel Compensation:			
11.1 Full-Time Permanent	$4,244,000	$4,383,000	$139,000
11.3 Other than Full-Time Permanent	796,000	815,000	19,000
11.5 Other Personnel Compensation	217,000	223,000	6,000
11.7 Military Personnel	129,000	131,000	2,000
11.8 Special Personnel Services Payments	0	0	0
Total, Personnel Compensation	5,386,000	5,552,000	166,000
12.1 Civilian Personnel Benefits	1,161,000	1,220,000	59,000
12.2 Military Personnel Benefits	32,000	32,000	0
13.0 Benefits for Former Personnel	0	0	0
Subtotal, Pay Costs	**6,579,000**	**6,804,000**	**225,000**
21.0 Travel & Transportation of Persons	329,000	354,000	25,000
22.0 Transportation of Things	75,000	80,000	5,000
23.1 Rental Payments to GSA	0	0	0
23.2 Rental Payments to Others	28,000	28,000	0
23.3 Communications, Utilities & Miscellaneous Charges	75,000	75,000	0
24.0 Printing & Reproduction	119,000	124,000	5,000
25.1 Consulting Services	50,000	50,000	0
25.2 Other Services	2,298,000	2,558,000	260,000
25.3 Purchase of Goods & Services from Government Accounts	15,775,000	19,853,000	4,078,000
25.4 Operation & Maintenance of Facilities	200,000	200,000	0
25.5 Research & Development Contracts	4,474,000	10,169,000	5,695,000
25.6 Medical Care	0	0	0
25.7 Operation & Maintenance of Equipment	90,000	90,000	0
25.8 Subsistence & Support of Persons	0	0	0
25.0 Subtotal, Other Contractual Services	**22,887,000**	**32,920,000**	**10,033,000**
26.0 Supplies & Materials	560,000	799,000	239,000
31.0 Equipment	652,000	2,100,000	1,448,000
32.0 Land and Structures	0	0	0
33.0 Investments & Loans	0	0	0
41.0 Grants, Subsidies & Contributions	257,526,000	254,363,000	(3,163,000)
42.0 Insurance Claims & Indemnities	0	0	0
43.0 Interest & Dividends	0	0	0
44.0 Refunds	0	0	0
Subtotal, Non-Pay Costs	**282,251,000**	**290,843,000**	**8,592,000**
Total Budget Authority by Object	**288,830,000**	**297,647,000**	**8,817,000**

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

Salaries and Expenses

OBJECT CLASSES	FY 2004 Final Conference	FY 2005 Estimate	Increase or Decrease
Personnel Compensation:			
Full-Time Permanent (11.1)	$4,244,000	$4,383,000	$139,000
Other Than Full-Time Permanent (11.3)	796,000	815,000	19,000
Other Personnel Compensation (11.5)	217,000	223,000	6,000
Military Personnel (11.7)	129,000	131,000	2,000
Special Personnel Services Payments (11.8)	0	0	0
Total Personnel Compensation (11.9)	**5,386,000**	**5,552,000**	**166,000**
Civilian Personnel Benefits (12.1)	1,161,000	1,220,000	59,000
Military Personnel Benefits (12.2)	32,000	32,000	0
Benefits to Former Personnel (13.0)	0	0	0
Subtotal, Pay Costs	**6,579,000**	**6,804,000**	**225,000**
Travel (21.0)	329,000	354,000	25,000
Transportation of Things (22.0)	75,000	80,000	5,000
Rental Payments to Others (23.2)	28,000	28,000	0
Communications, Utilities and Miscellaneous Charges (23.3)	75,000	75,000	0
Printing and Reproduction (24.0)	119,000	124,000	5,000
Other Contractual Services:			
Advisory and Assistance Services (25.1)	50,000	50,000	0
Other Services (25.2)	2,298,000	2,558,000	260,000
Purchases from Govt. Accounts (25.3)	7,005,000	7,857,000	852,000
Operation & Maintenance of Facilities (25.4)	200,000	200,000	0
Operation & Maintenance of Equipment (25.7)	90,000	90,000	0
Subsistence & Support of Persons (25.8)	0	0	0
Subtotal Other Contractual Services	**9,643,000**	**10,755,000**	**1,112,000**
Supplies and Materials (26.0)	560,000	799,000	239,000
Subtotal, Non-Pay Costs	10,829,000	12,215,000	1,386,000
Total, Administrative Costs	**17,408,000**	**19,019,000**	**1,611,000**

NATIONAL INSTITUTES OF HEATH

National Institute of Biomedical Imaging and Bioengineering

SIGNIFICANT ITEM IN SENATE APPROPRIATIONS COMMITTEE REPORT

FY 2004 Senate Appropriations Committee Report Language (S. Rpt. 108-81)

Item

Positron Emission Tomography [PET] – The Committee continues to encourage the Institute to devote significant resources to molecular imaging technologies such as positron emission tomography [PET] and microPET to take advantage of the capacities of molecular imaging to detect disease process at the molecular level and to monitor the effectiveness of targeted gene therapies now under development. The Committee also encourages the Institute to develop its research agenda in close collaboration with other, disease-specific Institutes at NIH, so that new imaging technologies are closely tied to the research projects being undertaken by the various other Institutes of NIH. (p. 157)

Action taken or to be taken

The National Institute of Biomedical Imaging and Bioengineering (NIBIB) recognizes the significant potential associated with molecular imaging technologies to detect disease genesis and process at the earliest stages and to monitor the efficacy of targeted gene therapies. The NIBIB continues to devote significant resources to support the development and application of molecular imaging, including PET and microPET. In FY 2003, the NIBIB funded numerous molecular imaging grants submitted in response to four initiatives, *Research and Development of Systems and Methods for Molecular Imaging, Low-Cost Medical Imaging Devices, Improvements in Imaging Methods and Technologies, and Systems and Methods for Small Animal Imaging*. The NIBIB also collaborated with the National Center for Research Resources on the *Technology Development for Biomedical Applications* initiative and with the National Cancer Institute on an initiative entitled *Development of Novel Technologies for In Vivo Imaging*. Several research grants from these initiatives aim to improve PET imaging devices and PET imaging agents used in disease detection. To further the development of disease-specific biomedical imaging and bioengineering research, NIBIB has also collaborated with other NIH Institutes on Bioengineering Research Partnerships and Bioengineering Research Grants.

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

Authorizing Legislation

	PHS Act/ Other Citation	U.S. Code Citation	2004 Amount Authorized	2004 Final Conference	2005 Amount Authorized	2005 Budget Estimate
Research and Investigation	Section 301	42§241	Indefinite	$282,343,000	Indefinite	$289,808,000
Imaging and Bioengineering	Section 464z	42§285r	Indefinite		Indefinite	
National Research Service Awards	Section 487(d)	42§288	a/	6,487,000	b/	7,839,000
Total, Budget Authority				288,830,000		297,647,000

a/ Amounts authorized by Section 301 and Title IV of the Public Health Act.
b/ Reauthorizing legislation will be submitted.

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

Appropriations History

Fiscal Year	Budget Estimate to Congress	House Allowance	Senate Allowance	Appropriation 1/
2002	40,206,000	39,869,000	140,000,000	111,984,000
Rescission				(33,000)
2003	120,502,000	270,494,000	283,100,000	280,100,000
Rescission				(1,821,000)
2004	282,109,000	282,109,000	289,300,000	288,900,000
Rescission				(1,771,000)
2005	297,647,000			

1/ Reflects enacted supplementals, rescissions, and reappropriations.

NATIONAL INSTITUTES OF HEALTH

National Institute of Biomedical Imaging and Bioengineering

Detail of Full-Time Equivalent Employment (FTEs)

OFFICE/DIVISION	FY 2003 Actual	FY 2004 Final Conference	FY 2005 Estimate
Office of the Director	7	4	4
Office of Administrative Management	10	16	16
Office of Science Administration	15	13	13
Extramural Science Programs	9	15	16
Intramural Science Programs	7	7	7
Total	48	55	56

FISCAL YEAR	Average GM/GS Grade
2002	12.3
2003	11.9
2004	12.3
2005	12.3

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

Detail of Positions

GRADE	FY 2003 Actual	FY 2004 Final Conference	FY 2005 Estimate
ES-6			
ES-5	1	1	1
ES-4			
ES-3			
ES-2			
ES-1			
Subtotal	1	1	1
Total - ES Salary	$142,881	$145,797	$148,713
GM/GS-15	6	6	6
GM/GS-14	9	14	15
GM/GS-13	14	11	11
GS-12	1	1	1
GS-11	3	3	3
GS-10			
GS-9	4	6	6
GS-8	1	1	1
GS-7	6	4	4
GS-6			
GS-5			
GS-4			
GS-3			
GS-2			
GS-1			
Subtotal	44	46	47
Grades established by Act of July 1, 1944 (42 U.S.C. 207):			
Assistant Surgeon General			
Director Grade	1	1	1
Senior Grade			
Full Grade			
Senior Assistant Grade			
Assistant Grade			
Subtotal	1	1	1
Ungraded	18	20	20
Total permanent positions	46	48	49
Total positions, end of year	56	68	69
Total full-time equivalent (FTE) employment,end of year	48	55	56
Average ES level	ES-5	ES-5	ES-5
Average ES salary	$142,881	$145,797	$148,713
Average GM/GS grade	11.9	12.3	12.3
Average GM/GS salary	$71,997	$75,340	$77,196

NATIONAL INSTITUTES OF HEALTH
National Institute of Biomedical Imaging and Bioengineering

New Positions Requested

	FY 2005		
	Grade	Number	Annual Salary
Health Science Administrator	GS-14	1	$93,279
Total Requested		1	