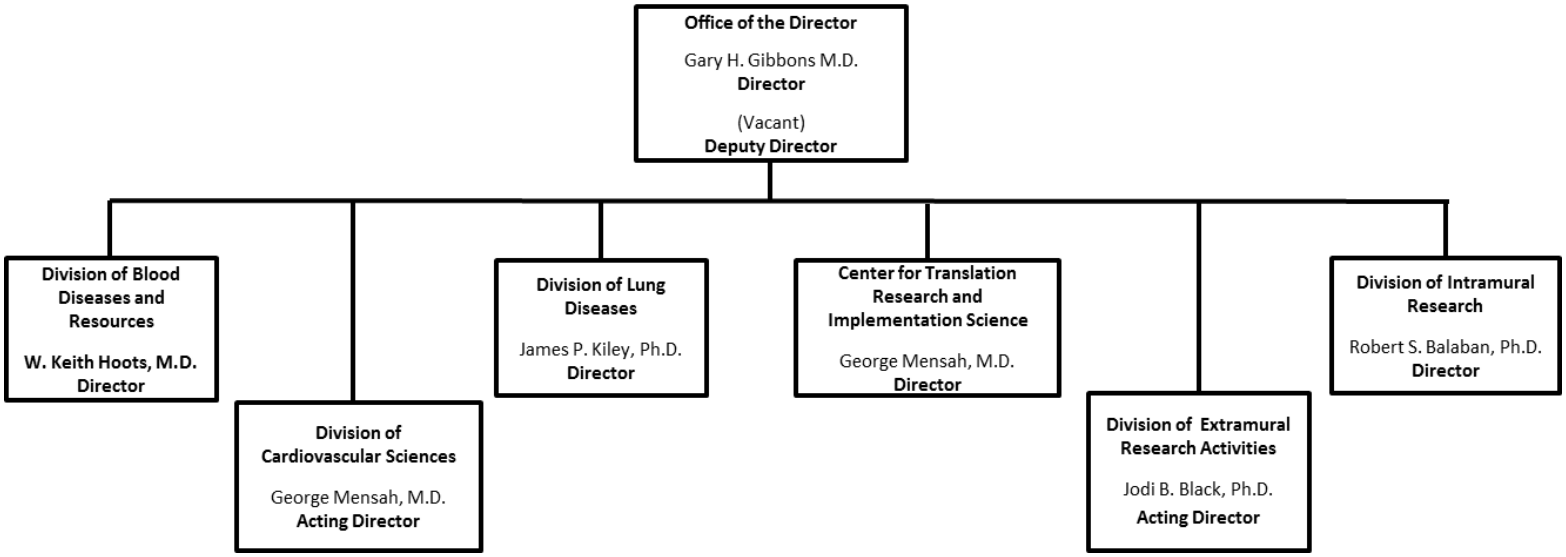
DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTES OF HEALTH

National Heart, Lung, and Blood Institute (NHLBI)

NOTE: The FY 2016 Enacted funding amounts cited throughout this chapter reflect the effects of OAR HIV/AIDS Transfers.

NATIONAL INSTITUTES OF HEALTH
National Heart, Lung, and Blood, Institute



NATIONAL INSTITUTES OF HEALTH

National Heart, Lung, and Blood Institute

For carrying out section 301 and title IV of the PHS Act with respect to cardiovascular, lung, and blood diseases, and blood and blood products, [$3,115,538,000]*$3,069,901,000*.

NATIONAL INSTITUTES OF HEALTH
National Heart, Lung, and Blood Institute
Amounts Available for Obligation[1]
(Dollars in Thousands)

Source of Funding	FY 2015 Actual	FY 2016 Enacted	FY 2017 President's Budget
Appropriation	$2,997,870	$3,115,538	$3,113,533
Mandatory Appropriation: (non-add)			
Type 1 Diabetes	*(0)*	*(0)*	*(0)*
Other Mandatory financing	*(0)*	*(0)*	*(43,632)*
Rescission	0	0	0
Sequestration	0	0	0
FY 2015 First Secretary's Transfer	0	0	0
FY 2015 Second Secretary's Transfer	0	0	0
Subtotal, adjusted appropriation	$2,997,870	$3,115,538	$3,113,533
OAR HIV/AIDS Transfers	-2,005	-2,005	0
National Children's Study Transfers	0	0	0
Subtotal, adjusted budget authority	$2,995,865	$3,113,533	$3,113,533
Unobligated balance, start of year	0	0	0
Unobligated balance, end of year	0	0	0
Subtotal, adjusted budget authority	$2,995,865	$3,113,533	$3,113,533
Unobligated balance lapsing	-319	0	0
Total obligations	$2,995,546	$3,113,533	$3,113,533

[1] Excludes the following amounts for reimbursable activities carried out by this account:

FY 2015 - $15,798 FY 2016 - $15,896 FY 2017 - $16,011

NATIONAL INSTITUTES OF HEALTH
FY 2017 Congressional Justification
NHLBI
Budget Mechanism - Total[1]
(Dollars in Thousands)

MECHANISM	FY 2015 Actual No.	FY 2015 Actual Amount	FY 2016 Enacted No.	FY 2016 Enacted Amount	FY 2017 President's Budget[3] No.	FY 2017 President's Budget[3] Amount	FY 2017 +/- FY 2016 No.	FY 2017 +/- FY 2016 Amount
Research Projects:								
Noncompeting	2,261	$1,339,759	2,380	$1,466,406	2,346	$1,445,423	-34	-$20,983
Administrative Supplements	*(95)*	24,404	*(39)*	10,000	*(39)*	10,000		
Competing:								
Renewal	203	130,187	252	135,300	280	150,400	28	15,100
New	720	377,094	732	392,572	743	398,755	11	6,183
Supplements	5	642						
Subtotal, Competing	928	$507,923	984	$527,873	1,023	$549,155	39	$21,282
Subtotal, RPGs	3,189	$1,872,086	3,364	$2,004,279	3,369	$2,004,578	5	$299
SBIR/STTR	141	74,452	165	86,649	170	89,483	5	2,834
Research Project Grants	3,330	$1,946,538	3,529	$2,090,928	3,539	$2,094,061	10	$3,133
Research Centers:								
Specialized/Comprehensive	24	$72,024	31	$69,806	23	$52,912	-8	-$16,894
Clinical Research								
Biotechnology								
Comparative Medicine	1	2,339	1	1,193		0	-1	-1,193
Research Centers in Minority Institutions								
Research Centers	25	$74,364	32	$70,999	23	$52,912	-9	-$18,087
Other Research:								
Research Careers	461	$68,635	493	$71,793	531	$84,846	38	$13,053
Cancer Education								
Cooperative Clinical Research	67	37,917	53	44,263	32	26,394	-21	-17,869
Biomedical Research Support								
Minority Biomedical Research Support	2	1,168	1	847		554	-1	-293
Other	121	40,165	129	32,920	145	38,029	16	5,109
Other Research	651	$147,886	676	$149,823	708	$149,823	32	
Total Research Grants	4,006	$2,168,788	4,237	$2,311,750	4,270	$2,296,796	33	-$14,953
Ruth L Kirchstein Training Awards:	**FTTPs**		**FTTPs**		**FTTPs**		**FTTPs**	
Individual Awards	276	$12,488	358	$16,854	371	$17,699	13	$845
Institutional Awards	1,648	83,133	1,789	92,028	1,935	99,537	146	7,509
Total Research Training	1,924	$95,622	2,147	$108,882	2,306	$117,236	159	$8,354
Research & Develop. Contracts	365	$407,099	323	$360,435	324	$361,611	1	$1,176
(SBIR/STTR) (non-add)[2]	*(19)*	*(15,700)*	*(12)*	*(12,311)*	*(12)*	*(12,311)*		
Intramural Research	468	$198,646	473	$203,612	473	$207,032		$3,421
Res. Management & Support	449	125,710	453	128,854	453	130,857		2,003
Res. Management & Support (SBIR Admin) (non-add)[2]		*(518)*		*(1,758)*		*(1,758)*		
Office of the Director - Appropriation[2]								
Office of the Director - Other								
ORIP/SEPA (non-add)[2]								
Common Fund (non-add)[2]								
Buildings and Facilities								
Appropriation								
Type 1 Diabetes								
Program Evaluation Financing								
Cancer Initiative Mandatory Financing								
Other Mandatory Financing						-43,632		-43,632
Subtotal, Labor/HHS Budget Authority		**$2,995,865**		**$3,113,533**		**$3,069,901**		**-$43,632**
Interior Appropriation for Superfund Res.								
Total, NIH Discretionary B.A.		**$2,995,865**		**$3,113,533**		**$3,069,901**		**-$43,632**
Type 1 Diabetes								
Proposed Law Funding								
Cancer Initiative Mandatory Financing								
Other Mandatory Financing						43,632		43,632
Total, NIH Budget Authority		**$2,995,865**		**$3,113,533**		**$3,113,533**		
Program Evaluation Financing								
Total, Program Level		**$2,995,865**		**$3,113,533**		**$3,113,533**		

[1]All Subtotal and Total numbers may not add due to rounding. [2]All numbers in italics and brackets are non-add. [3]Includes mandatory financing.

Major Changes in the Fiscal Year 2017 President's Budget Request

Major changes by budget mechanism and/or budget activity detail are briefly described below. Note that there may be overlap between budget mechanisms and activity detail and these highlights will not sum to the total change for the FY 2017 budget request for NHLBI, which is unchanged from the FY 2016 Enacted level, for a total of $3,113.533 million.

Research Project Grants (RPGs) (+$3.133 million; total $2,094.061 million):
NHLBI will fund 1,023 competing RPGs and approximately 2,346 noncompeting RPG awards totaling to $2,004.578 million, in FY 2017. NIH budget policy for RPGs in FY 2017 continues the FY 2012 policy of eliminating inflationary increases for future-year commitments. However, adjustments for special needs (such as equipment and added personnel) will continue to be accommodated.

Research Centers (-$18.087 million; total $52.912 million):
There is a shift in the receipt of proposals normally supported under this mechanism to submitting applications in response to Program Announcements and Requests for Funding Announcements for research project grants (RPGs) to provide innovative research in the heart, lung, and blood disease areas.

Research Training (+$8.354 million; total $117.236 million):
The Ruth L. Kirschstein NRSA budget reflects a stipend increase for entry-level postdoctoral trainees and fellows at two percent over FY 2017 Enacted levels. The number of FTTPs are increased by 159 from the FY 2016 level of 2,147.

NATIONAL INSTITUTES OF HEALTH
National Heart, Lung, and Blood Institute
Summary of Changes
(Dollars in Thousands)

FY 2016 Enacted	$3,113,533
FY 2017 President's Budget	$3,113,533
Net change	$0

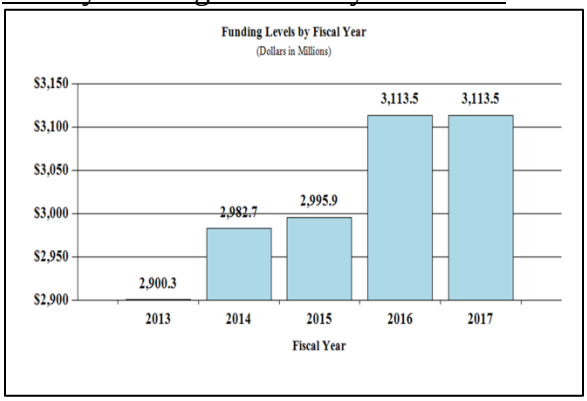
CHANGES	**FY 2017 President's Budget[1] FTEs**	**FY 2017 President's Budget[1] Budget Authority**	**Change from FY 2016 FTEs**	**Change from FY 2016 Budget Authority**
A. Built-in:				
1. Intramural Research:				
a. Annualization of January 2016 pay increase & benefits		$80,958		$149
b. January FY 2017 pay increase & benefits		80,958		234
c. Two less days of pay		80,958		-623
d. Differences attributable to change in FTE		80,958		0
e. Payment for centrally furnished services		31,228		762
f. Increased cost of laboratory supplies, materials, other expenses, and non-recurring costs		94,846		1,830
Subtotal				$2,352
2. Research Management and Support:				
a. Annualization of January 2016 pay increase & benefits		$69,335		$128
b. January FY 2017 pay increase & benefits		69,335		201
c. Two less days of pay		69,335		-533
d. Differences attributable to change in FTE		69,335		0
e. Payment for centrally furnished services		1,259		31
f. Increased cost of laboratory supplies, materials, other expenses, and non-recurring costs		59,933		1,253
Subtotal				$1,079
Subtotal, Built-in				$3,430

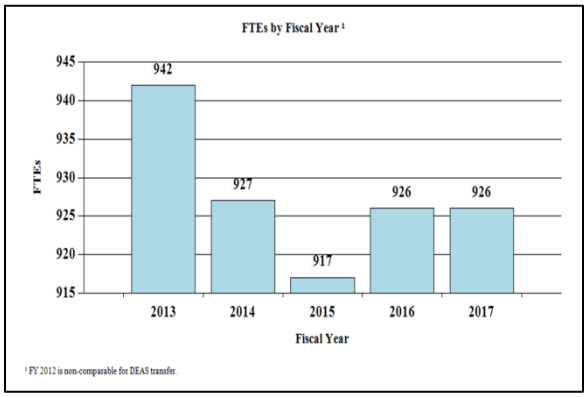
CHANGES	**FY 2017 President's Budget[1] No.**	**FY 2017 President's Budget[1] Amount**	**Change from FY 2016 No.**	**Change from FY 2016 Amount**
B. Program:				
1. Research Project Grants:				
a. Noncompeting	2,346	$1,455,423	-34	-$20,983
b. Competing	1,023	549,155	39	21,282
c. SBIR/STTR	170	89,483	5	2,834
Subtotal, RPGs	3,539	$2,094,061	10	$3,133
2. Research Centers	23	$52,912	-9	-$18,087
3. Other Research	708	149,823	32	0
4. Research Training	2,306	117,236	159	8,354
5. Research and development contracts	324	361,611	1	1,176
Subtotal, Extramural		$2,775,643		-$5,424
	FTEs		FTEs	
6. Intramural Research	473	$207,032	0	$1,069
7. Research Management and Support	453	130,857	0	924
8. Construction		0		0
9. Buildings and Facilities		0		0
Subtotal, Program	926	$3,113,533	0	-$3,430
Total changes				$0

[1] Includes mandatory financing.

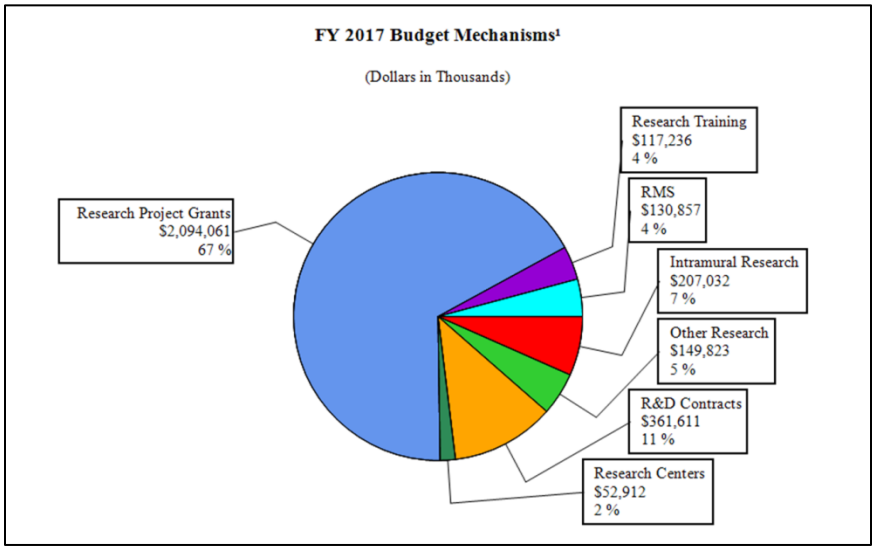
Fiscal Year 2017 Budget Graphs

History of Budget Authority and FTEs:

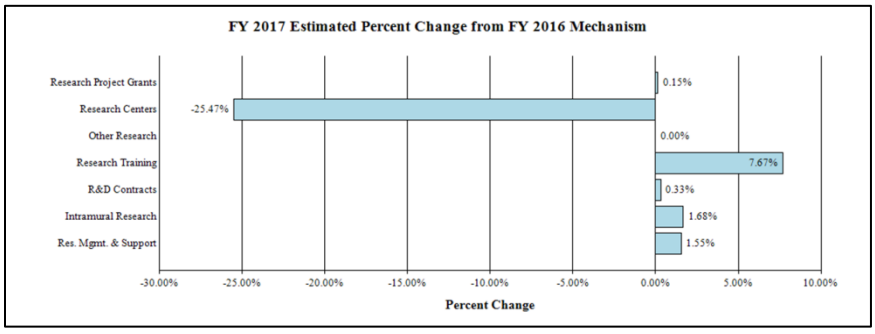




Distribution by Mechanism:



Change by Selected Mechanism:



NATIONAL INSTITUTES OF HEALTH
National Heart, Lung, and Blood Institute

Budget Authority by Activity[1]
(Dollars in Thousands)

Extramural Research	FY 2015 Actual FTE	FY 2015 Actual Amount	FY 2016 Enacted FTE	FY 2016 Enacted Amount	FY 2017 President's Budget[2] FTE	FY 2017 President's Budget[2] Amount	FY 2017 +/- FY2016 FTE	FY 2017 +/- FY2016 Amount
Detail								
Heart and Vascular Diseases		$1,674,327		$1,742,991		$1,739,591		-$3,399
Lung Diseases		638,251		664,425		663,130		-1,296
Blood Diseases and Resources		358,931		373,651		372,922		-729
Subtotal, Extramural		**$2,671,509**		**$2,781,067**		**$2,775,643**		**-$5,424**
Intramural Research	**468**	**$198,646**	**473**	**$203,612**	**473**	**$207,032**	**0**	**$3,421**
Research Management & Support	**449**	**$125,710**	**453**	**$128,854**	**453**	**$130,857**	**0**	**$2,003**
TOTAL	**917**	**$2,995,865**	**926**	**$3,113,533**	**926**	**$3,113,533**	**0**	**$0**

[1] Includes FTEs whose payroll obligations are supported by the NIH Common Fund.

[2] Includes mandatory financing.

NATIONAL INSTITUTES OF HEALTH

National Heart, Lung, and Blood Institute

Authorizing Legislation

	PHS Act/ Other Citation	U.S. Code Citation	2016 Amount Authorized	FY 2016 Enacted	2017 Amount Authorized	FY 2017 President's Budget[1]
Research and Investigation	Section 301	42§241	Indefinite	$3,113,533,000	Indefinite	$3,069,901,000
National Heart, Lung, and Blood Institute	Section 401(a)	42§281	Indefinite		Indefinite	
Total, Budget Authority				$3,113,533,000		$3,069,901,000

[1]Excludes mandatory financing.

NATIONAL INSTITUTES OF HEALTH
National Heart, Lung, and Blood Institute

Appropriations History

Fiscal Year	Budget Estimate to Congress	House Allowance	Senate Allowance	Appropriation
2007	$2,918,808,000	$2,901,012,000	$2,924,299,000	$2,918,808,000
Rescission				$0
2008	$2,894,341,000	$2,965,775,000	$2,992,197,000	$2,974,900,000
Rescission				$51,972,000
Supplemental				$15,542,000
2009	$2,924,942,000	$3,025,500,000	$3,006,344,000	$3,015,689,000
Rescission				$0
2010	$3,050,356,000	$3,123,403,000	$3,066,827,000	$3,096,916,000
Rescission				$0
2011	$3,187,516,000		$3,182,524,000	$3,096,916,000
Rescission				$27,192,768
2012	$3,147,992,000	$3,147,992,000	$3,036,189,000	$3,084,851,000
Rescission				$5,830,368
2013	$3,076,067,000		$3,085,390,000	$3,079,020,632
Rescission				$6,158,041
Sequestration				($154,545,663)
2014	$3,098,508,000		$3,077,916,000	$2,988,605,000
Rescission				$0
2015	$2,987,685,000			$2,997,870,000
Rescission				$0
2016	$3,071,906,000	$3,035,062,000	$3,135,519,000	$3,115,538,000
Rescission				$0
2017[1]	$3,113,533,000			

[1]Includes mandatory financing.

Justification of Budget Request

National Heart, Lung, and Blood Institute

Authorizing Legislation: Section 301 and title IV of the Public Health Service Act, as amended.
Budget Authority (BA):

	FY 2015 Actual	FY 2016 Enacted	FY 2017 President's Budget	FY 2017 +/- FY 2016
BA	$2,995,865,000	$3,113,533,000	$3,113,533,000	+$0
FTE	917	926	926	0

Program funds are allocated as follows: Competitive Grants/Cooperative Agreements; Contracts; Direct Federal/Intramural and Other.

Director's Overview

For more than 60 years, long-term investments in biomedical research by the National Heart, Lung, and Blood Institute (NHLBI) have led to broad-based interventions that have contributed to a 71 percent decrease in death rates due to cardiovascular disease, improved the quality of life for patients with asthma and chronic obstructive pulmonary disease, and increased life expectancy for people born with sickle cell disease (SCD).[1] It is important to recognize that these life-saving interventions are the result of a sustained commitment to investments in fundamental discovery science. Taking advantage of emerging technologies and scientific opportunities as they arise, researchers have advanced our understanding of the molecular pathways and biological systems that sustain human health. These investments have laid the foundation for translating basic research into a new era of precision medicine that uses patient-specific strategies to further reduce the burden of heart, lung, blood, and sleep disorders (HLBS).

Foundation for Discoveries: Basic Research
Scientific discovery is fundamental to advancing human health. Many modern clinical advances only exist because of earlier basic science discoveries with anticipated or unanticipated clinical applications. For example, the Nobel Prize winning discovery of telomerase as the enzyme that makes telomeres – the chromosomal structures that protect our DNA – has opened the door to new scientific areas with direct relevance to disease. Individuals with mutations in telomerase genes develop a rare syndrome characterized by 'accelerated aging' and fibrotic scarring of the skin and major organs. A recent NHLBI-funded study discovered new mutations associated with familial pulmonary fibrosis, a late-onset lung disorder associated with a life expectancy of 2-3 years. The newly identified mutations in the genes PARN and RTEL1 were associated with shortened telomeres.[2] Together, PARN and RTEL1 account for about 7 percent of familial pulmonary fibrosis.[3] These findings illustrate the power of fundamental discovery science that

[1] National Center for Health Statistics, CDC WONDER. Compressed Mortality File 1968-1978 and Multiple Cause of Death File 2013
[2] Telomeres are the ends of a chromosome. Each time a cell divides, the telomeres lose a small amount of DNA and become shorter. Over time, the chromosomes become damaged and the cells die. (http://www.cancer.gov/publications/dictionaries/cancer-terms?cdrid=643091).
[3] http://www.nature.com/ng/journal/v47/n5/full/ng.3278.html

advanced our understanding of the intrinsic mechanisms that prevent premature aging to provide important new insights into clinical syndromes such as pulmonary fibrosis.

The Promise of Precision Medicine

Ever more sophisticated technologies now are allowing for a closer look not only at the genetics underlying HLBS disorders but also how genes interact with other factors that influence risk. NHLBI recently initiated the Trans-Omics for Precision Medicine (TOPMed) program to uncover the various factors that may affect individual risk for HLBS disorders. This program will combine whole-genome sequencing and measurements of varying types of molecular substances, such as metabolites, proteins, and RNA with behavioral, imaging, environmental, and clinical data from ethnically diverse patient populations. TOPMed is examining diseases that span the NHLBI portfolio, such as atrial fibrillation, cardiometabolic disorders, asthma, SCD, and venous thrombosis. It also capitalizes on existing investments in population studies. For example, the Women's Health Initiative (WHI) is participating in TOPMed to investigate genetic contributions to venous thrombosis, blood clots in veins that can break off, travel to the lung, and become life-threatening. WHI is uniquely positioned to address this issue given its finding that women on postmenopausal hormone therapy had double the risk of venous thrombosis compared to those taking placebo. NHLBI also will support the development of a novel web-based portal, the GenPort data commons, to provide the research community with access to integrated genomic and phenotypic information and the bioinformatics and computational tools necessary to analyze these data. In this way, NHLBI will maximize the utility of these rich data sets cultivated through the TOPMed program.

Translating Discovery into Health – Preempting and Preventing HLBS

Precision medicine-related research, such as TOPMed, strive to identify risk factors for disease and potential intervention strategies, which can be translated into clinical applications to improve health. One of the most fundamental differences that can contribute to improved detection, prevention, and treatment of diseases is sex. Some diseases affect men and women to different degrees; some affect one sex exclusively; and some affect men and women equally but have differential consequences for each sex. For example, obstructive sleep apnea (OSA) is more common in men than women. Yet, a recent study that followed men and women with OSA for 13 years found that it was associated with the development of heart failure and death only among women.[4] Because OSA is more prevalent in men, it often goes undetected in women. Research such as this demonstrates the importance of inclusion of women to identify more effective ways to improve health among all individuals.

Collectively, these examples illustrate the importance of an integrated approach that leverages basic science discoveries, population-level studies, translational research, and clinical studies to inform the development of new prevention and treatment strategies.

Stewardship to Inspire Public Trust

To fully realize the promise of scientific innovation and the integrative nature of science, NHLBI recently launched a Strategic Visioning process to shape its research priorities for the coming decade. NHLBI used a crowdsourcing platform to seek the perspectives of people who are working every day to alleviate the burden of HLBS disorders, including those doing research,

[4] http://circ.ahajournals.org/content/early/2015/08/29/CIRCULATIONAHA.115.016985.long

treating patients, or seeking to improve their lives or the lives of their loved ones. NHLBI also convened interested groups to ensure their voices were heard. For example, NHLBI convened stakeholders interested in cardiovascular research – basic and clinical scientists, epidemiologists, patient advocates, Federal officials, and others – to help shape the scientific priorities for research on cardiovascular health in women. Through the Strategic Visioning process, more than 1,000 ideas were submitted and 42,000 votes were cast by 4,000 members of the community from all 50 states and 42 countries around the world. The strength of this ongoing, iterative Strategic Visioning process rests in the collective input of the entire HLBS community to ensure that the research NHLBI supports continues to address the most important and timely scientific and public health questions related to HLBS disorders.

Program Descriptions and Accomplishments

Cardiovascular Diseases: This program supports research on the causes, diagnosis, treatment, and prevention of heart and vascular diseases, including coronary artery disease, myocardial infarction and ischemia, heart failure, arrhythmia, sudden cardiac death, congenital heart disease in adults and children, vascular dementia, cardiovascular disease complications of diabetes and obesity, and hypertension. The program's efforts span the full spectrum of basic, translational, clinical, epidemiological, behavioral, comparative effectiveness, and health services research.

NHLBI has a long history of groundbreaking research in hypertension, or high blood pressure, for example. High blood pressure is a common condition that increases the risk for heart disease and stroke, two of the leading causes of death for Americans. Understanding how best to control high blood pressure could greatly benefit the estimated one in three people in the United States who suffer from high blood pressure and the millions of others worldwide. Beginning in the early 1990s, NHLBI-supported research showed the benefit of anti-hypertensive medications in reducing stroke and other cardiovascular events and has been instrumental in the development and testing of the high blood pressure medications that are routinely used today. More recently, a landmark NHLBI study found that more intensive management of high blood pressure in people 50 years and older to achieve a target systolic pressure of 120 millimeters of mercury or less, rather than 140 mm Hg as is currently recommended, reduces cardiovascular events by almost one quarter and reduces the risk of death from such events by a little more than a quarter.[5]

While there are medications to treat high blood pressure, the cause of hypertension in most individuals remains unknown, suggesting that additional contributing factors have yet to be discovered. Recent studies are providing new insights in this regard. A recent NHLBI-funded study identified a critical protein (PCSK-6 or proprotein convertase subtilisin/kexin-6) that activates corin, a protein critical for maintaining normal blood pressure.[6] Another recent study used gene editing in rodents to discover how the gene Nr2f2 affects blood pressure. Editing the gene produced a protein that more strongly interacted with another protein, Fog2. This increased interaction led to significantly lower blood pressure in rodents.[7] These studies point to potential

[5] http://www.nhlbi.nih.gov/news/press-releases/2015/landmark-nih-study-shows-intensive-blood-pressure-management-may-save-lives
[6] http://www.nature.com/nm/journal/v21/n9/full/nm.3920.html
[7] http://www.nature.com/ncomms/2015/150217/ncomms7252/full/ncomms7252.html?WT.ec_id=NCOMMS-20150218

avenues for the development of additional intervention strategies that could be more effective in treating high blood pressure.

Budget Policy:
The FY 2017 budget estimate for the Heart and Vascular Diseases program is $1,739.591 million, a decrease of 3.399 million or 0.2 percent compared to the FY 2016 Enacted level.

Program Portrait: Bench to Bassinet – Transforming Care for Patients with Congenital Heart Disease

FY 2016 Level: $11.1 million
FY 2017 Level: $11.1 million
Change: $0.0 million

Congenital heart disease (CHD) is the most common birth defect, occurring in approximately one percent of births. Advances in diagnosis and care of children with CHD have dramatically increased survival rates. In the 1950s, a majority of children with CHD died. Today, 90 percent survive and their life expectancy has been extended from adolescence into middle age. Yet, they continue to suffer from the effects of their disease. Therefore, we need to know how to effectively care for these individuals not only during their childhood but also into adulthood. The ultimate goal is to transition from the current state where children undergo repeated surgeries that patch over defects toward a future where biology-driven therapies target the underlying molecular and developmental pathways so that a normal heart structure can be restored.

NHLBI's Bench to Bassinet Program (B2B) is helping us get closer to that goal by identifying genetic and epigenetic causes of CHD to help personalize treatment for children and adults. B2B fosters translation of basic research findings in heart development and genetics into improved treatment of CHDs. This program consists of three consortia that span the translation spectrum from basic science research to characterize the molecular networks and pathways that control heart development (the Cardiovascular Development Consortium-CvDC) to genomics research to identify the genetic causes of CHD (the Pediatric Cardiac Genomics Consortium-PCGC) to clinical research to improve evidence-based treatments for patients with CHD and pediatric acquired heart disease (the Pediatric Heart Network-PHN).

B2B was designed to yield more efficient and effective science by helping scientists work together and share data. For example, investigators from PCGC are using samples from PHN trials to explore how specific genetic changes relating to CHD affect brain development and body growth. A recent study identified spontaneous mutations among patients with CHDs and other congenital defects and neurodevelopmental disorders (NDDs) by examining the protein-coding regions of the genomes of more than 1,200 parent-child trios.[8] Understanding the shared genetic contributions to CHD, NDD, and other congenital defects provides insight into the related causes of these diseases and provides opportunities to identify CHD patients at high risk for NDDs, thereby allowing for earlier interventions. B2B was recently renewed so that it could build upon these and other successes, as well as adapt to new scientific opportunities as they emerge.

Lung Diseases: This program supports research on the causes, diagnosis, treatment, and prevention of lung diseases. Research areas include asthma, chronic obstructive pulmonary disease (COPD), cystic fibrosis, critical care and acute lung injury, sleep-disordered breathing, developmental biology and pediatric pulmonary diseases, immunology and fibrosis, lung cell and vascular biology, and pulmonary complications of AIDS and tuberculosis. The research portfolio is designed to support science that yields an integrated understanding at the molecular, cellular, and systems level to prevent and treat lung disease.

[8] Homsy et al. Genetic Causes for Congenital Heart Disease with Neurodevelopmental Disorders and Congenital Anomalies. Science (in press).

COPD is a progressive lung disease that is known to affect nearly 15 million people in the United States.[9] COPD is now the third most common cause of death in the United States. Research supported by NHLBI has shown that certain treatments and lifestyle changes – such as quitting smoking – can help people with COPD stay more active and slow disease progression. Although there is no cure for COPD, early treatment can markedly improve people's quality of life. By the time the disease is identified, however, irreversible damage has already occurred. For example, a recent study showed that standard diagnostics are not effective at early stages of disease. Examining computed tomography (CT) scans of patients initially classified as disease-free using conventional diagnostic technologies, the investigators discovered that 42 percent of patients had emphysema or airway thickening. NHLBI currently supports a clinical trial through its Pulmonary Trials Cooperative to determine whether such patients with mild COPD may benefit from inhaled bronchodilator therapy. Understanding the potential value of existing therapies for a broader population will inform the development of a National Action Plan to more rapidly reduce the burden of COPD.

Research is also underway to develop new drugs that target pathways that may be responsible for disease progression. For example, a recent study used existing genetic databases to identify genetic variants that affect lung function. Many of these genetic signatures affect the expression of genes involved in developmental and inflammatory pathways, which may affect how people respond to environmental contributors to COPD such as tobacco smoke. Researchers identified lung function genes that were differentially expressed between control and COPD cases, which allowed them to identify possible new COPD drugs based on the drug's known ability to alter the expression of these same genes. Findings such as this could lead to the development of medications that can reverse the genetic COPD signature in some patients to prevent disease progression.[10]

Budget Policy:

The FY 2017 budget estimate for the Lung Diseases program is $663.130 million, a decrease of $1.296 million or 0.2 percent compared to the FY 2016 Enacted level.

[9] Unpublished NHLBI tabulation from CDC/NCHS 2014 NHIS data set
[10] http://www.sciencedirect.com/science/article/pii/S221326001500380X

Program Portrait: Reducing Childhood Asthma Disparities

FY 2016 Level: $0.0 million
FY 2017 Level: $3.0 million
Change: +$3.0 million

Asthma, which affects 24 million people in the United States, including about six million children can be a debilitating condition.[11] As a result of NHLBI-supported research, people with asthma now have available more and better treatment and prevention options than they have ever had before. NHLBI-funded trials have evaluated promising treatments, including newer bronchodilators called long-acting β agonists and leukotriene receptor antagonists, provided better information on treatments for different levels of asthma severity, and discovered important individual asthma characteristics that can enable healthcare providers to make better predictions regarding response to treatment and disease progression. However, minority and economically disadvantaged children who have asthma have significantly worse outcomes than white and wealthier children. Black children are nearly twice as likely to have asthma and are three times as likely to die due to asthma as white children.[12,13]

Multiple risk factors contribute to this disparity and these may vary between communities. Therefore, reducing these disparities may require a tailored, multi-pronged approach. NHLBI has recently funded seven pilot projects to inform the development and testing of new research models that integrate interventions involving all sectors that influence and manage a patient's asthma: medical care; individual/family systems (e.g., asthma self-management behaviors and family and cultural perceptions of disease and health care seeking); home (e.g., exposures in the home and surrounding environments); and community (e.g., school/day care environments and programs and policies that support asthma self-management). In this first phase, investigators are conducting a needs assessment and forming critical partnerships in each of these sectors that will enable the development and testing of comprehensive care paradigms that meet that community's needs. In FY 2017, NHLBI will fund trials designed to assess whether these paradigms improve asthma outcomes, are sustainable over time, and what processes allowed for successful implementation. Effective multi-sector programs will help close the disparity gap and reduce the costs to society of uncontrolled asthma and health inequities.

Blood Diseases and Resources: This program supports research and research training on the use of blood and blood components for transfusion and cellular therapeutics. About five million Americans receive whole or red blood cell transfusions each year. Therefore, maintaining a strong blood supply is a national priority. NHLBI supports the development of optimized or novel blood products, new technologies that improve blood safety, and research on blood storage safety. In fact, a recent NHLBI-funded study found that red blood cell units stored for longer periods (21 or more days) were as effective and safe for transfusion in patients undergoing complex cardiac surgery as those stored for shorter periods (up to 10 days).[14] These findings support current red blood cell transfusion guidelines in adults going through complex cardiac surgical procedures.

The Blood Diseases and Resources program is also responsible for research on the causes, prevention, and treatment of nonmalignant blood diseases, including anemias, such as SCD and thalassemia; premalignant processes, such as myelodysplasia and myeloproliferative disorders; abnormalities of hemostasis and thrombosis, such as hemophilia; and immune dysfunction.

SCD is a serious genetic disorder in which red blood cells contain abnormal hemoglobin that causes them to develop a sickle, or crescent, shape. Sickle cells are stiff and sticky, and block

[11] National Health Interview Survey, Centers for Disease Control and Prevention, 2014
[12] National Health Interview Survey, Centers for Disease Control and Prevention, 2014
[13] National Center for Health Statistics, CDC WONDER.
[14] National Center for Health Statistics, CDC WONDER.

blood flow in the blood vessels of the limbs and organs causing pain and organ damage. Before 1970, it was uncommon for children with SCD to live beyond age 10, whereas many individuals now live into their fifth decade. SCD has no widely available cure; however, the results of NHLBI-supported clinical trials have led to the use of penicillin to prevent fatal infections, chronic blood transfusion to reduce stroke risk, and hydroxyurea to reduce pain, which collectively have significantly increased the lifespan of patients.

Nevertheless, this disease still causes debilitating effects in many patients. NHLBI has a comprehensive strategy from basic science through clinical trials to implementation research to further reduce the burden of this devastating illness and improve patient outcomes. NHLBI's ultimate goal is to find a widely available cure. Emerging gene-editing tools, which can remove specific DNA sequences, provide hope that this goal is within reach. Hydroxyurea is a mainstay treatment for SCD. This drug is known to reactivate fetal hemoglobin, which counters the effects of sickle hemoglobin in red blood cells. The gene BCL11a is known to control fetal hemoglobin expression and there is a small stretch of DNA called the enhancer that controls BCL11a expression only in red blood cells. In a recent NHLBI-funded study, researchers used gene editing to cut out tiny sections of DNA from the enhancer region of BCL11a in blood stem cells from human donors to identify the specific location within the enhancer that when cut leads to increased fetal hemoglobin production.[15] If developed and validated for human intervention, this strategy one day may allow patients with SCD to undergo genetic modification to permanently reactivate fetal hemoglobin expression in all of their red blood cells, essentially curing the disease.

Yet, even as work progresses towards finding a cure, the fact remains that many people with SCD do not receive the treatments that currently exist. Therefore, NHLBI also is developing a Sickle Cell Disease Implementation Consortium to improve the health and well-being of adolescents and adults with SCD in the United States through the development of multi-modal, multi-sector interventions aimed at improving the rate at which patients with SCD receive routine primary care. A comprehensive approach such as this one is the best hope for relieving the suffering of patients with this disease.

Budget Policy:
The FY 2017 budget estimate for the Blood Diseases and Resources program is $372.922 million, a decrease of $0.729 million or 0.2 percent c ompared to the FY 2016 Enacted level.

[15] http://www.nature.com/nature/journal/vaop/ncurrent/abs/nature15521.html

Program Portrait: Stimulating Private Sector Research and Development

FY 2016 Level: $5.6 million
FY 2017 Level: $5.7 million
Change: +$0.1 million

NHLBI-supported science cannot alleviate the burden of all HLBS disorders alone. NHLBI relies on partnerships with patient groups, pharmaceutical companies, and small businesses. In fact, the NHLBI has several programs designed to specifically stimulate private sector research and development – the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. A notable success story is that of HemoShear, a drug development company based in Charlottesville, Virginia. The story began in 2001, when a postdoctoral student was supported by an NHLBI Training Grant to conduct research that led to the young investigator's first research grant in 2006. In 2008, this investigator co-founded a company called HemoShear with another NHLBI grantee. In 2010, these investigators received SBIR Phase I funding and, in 2011, they received SBIR Phase II funding to create a predictive vascular system for early phase drug development. Today, HemoShear has more than 40 employees, has received $32 million in follow-on funding, and their product is used for cardiovascular drug discovery by major pharmaceutical companies throughout the Nation.

While an impressive example of how NHLBI funding can be leveraged to create a successful company to help stimulate the development of an effective medical product, HemoShear's story is not the norm. To facilitate more such success stories in the transition of NHLBI-supported innovative research into the commercial sector, NHLBI established the Office of Translational Alliances and Coordination (OTAC). OTAC created the NIH Centers for Accelerated Innovations (NCAI) Program, a $31.5 million, seven-year initiative intended to rapidly move breakthrough innovations to products that have health, economic, and societal impact by addressing the gap in the commercialization pipeline between scientific discovery and company formation. To accomplish their goals, NCAIs support proof-of-concept studies, educate academics on the technology development process, and provide early access to the scientific and business expertise needed for commercialization. NCAIs provide early mentoring to innovators to develop key business elements (legal, business development, regulatory, reimbursement, access to partners and capital), which are often not well understood by academic scientists and are critical for commercial success of developed technologies. Innovator response to the program has been robust, and the Centers received a wide range of applications to develop devices, therapeutics, diagnostics, and tools to address a broad spectrum of HLBS disorders.

Over the past year, the NCAI model was scaled across NIH through a new, three-year, trans-NIH $9 million Research Evaluation and Commercialization Hub program (REACH). Working together, the NCAI and REACH programs will enable development of self-sustaining biomedical technology development ecosystems that encourage the conversion of laboratory discoveries into products and services and disseminate best practices for technology development to other agencies, institutions, and regions across the Nation. By moving innovative technologies into the private sector for patient benefit, this network will enhance the commercial outcomes of federally-funded research for health, societal, and economic benefit.

Intramural Research: The Division of Intramural Research (DIR) program conducts basic, translational, clinical, and population research into HLBS and kidney disorders. This program has made numerous high-impact, fundamental discoveries that lay the foundation for many of tomorrow's medical breakthroughs.

In fact, a recent study has overturned longstanding scientific ideas regarding how energy for powering movement is distributed within muscles. Scientists have long believed that mitochondria, the cell's "powerhouses," distribute energy to muscle cells mainly by the slow spread of chemical energy through cells. However, recent genetic studies suggest that diffusion alone does not fully support the distribution of energy in heart and skeletal muscle cells. Researchers have suspected that a faster, more efficient energy pathway might exist but have found little proof of its existence – until now. Scientists from NHLBI DIR reported the first clear evidence that muscle cells distribute energy primarily by the rapid conduction of electrical charges through a vast, interconnected network of mitochondria in a way that resembles the wire grid that distributes power throughout a city. These findings could spark new avenues of scientific and medical research. This new information may lead to a better understanding of many diseases linked to energy utilization in the heart and skeletal muscle such as heart disease, mitochondrial diseases, and muscular dystrophy. In the future, scientists may be able to use muscle biopsies or sophisticated non-invasive imaging techniques to determine how defects in mitochondrial networks impact different diseases.[16]

Another recent finding is changing how scientists can fine tune immune system responses, with potential benefit in a range of situations, including transplantation and autoimmune diseases. The scientists developed altered forms of interleukin-2 (IL-2), a substance known as a cytokine that plays key roles in regulating immune system responses. These altered forms can be tuned to either boost or block immune responses depending on the desired therapeutic application. In laboratory studies, treatment with one type of modified IL-2 prolonged survival in a mouse model of graft-versus-host disease and blocked the growth *in vitro* of T-cells from a patient with chronic/smoldering adult T-cell leukemia, a rare form of cancer. A similar approach could potentially be used to engineer other immune system cytokines to generate new molecules with therapeutic potential.[17]

Budget Policy:
The FY 2017 President's Budget estimate for the Intramural Research program is $207.032 million, an increase of $3.421 million, or 1.7 percent compared to the FY 2016 Enacted level.

Research Management and Support (RMS): RMS activities provide administrative, budgetary, logistical, and scientific support in the review, awarding, and monitoring of research grants, training awards, and research and development contracts. RMS activities also include strategic planning, trans-NHLBI coordination, and evaluation of the Institute's programs, as well as regulatory compliance, international coordination, interactions with other Federal agencies and Congress, and dissemination of research findings to the public.

A prime example of how RMS activities support the functions of the Institute, play a role in strategic planning, and are critical to NHLBI's commitment to engage diverse stakeholders was NHLBI's Sickle Cell Disease Forum, *Engaging the Community: Developing Solutions*, held on June 25-26, 2015.[18] More than 450 people registered for the event. Participants included people living with SCD, their family members, health professionals (including hematologists),

[16] http://www.nature.com/nature/journal/v523/n7562/full/nature14614.html
[17] http://www.sciencedirect.com/science/article/pii/S1074761315001788
[18] https://www.nhlbi.nih.gov/news/events/sickle-cell-disease-forum

researchers, and advocates. In addition, many engaged through social media and viewed the presentations online via webcast. The event addressed a variety of important topics, which were informed by a listening session and planning group of individuals living with SCD, as well as organizations and professionals representing these individuals. Focus areas included ongoing research efforts toward finding a widely available cure and alleviating the pain caused by the disease; the resources available to patients, such as experimental procedures and clinical trials; and the groups at the national and local levels devoted to raising awareness about SCD. Participants in the forum shared their experiences with SCD, and presenters highlighted the science that aims to enhance the quality of life of SCD patients. These perspectives are critical in shaping the NHLBI research priorities to fulfill its commitment to the American people.

Budget Policy:
The FY 2017 President's Budget estimate for Research Management and Support is $130.857 million, an increase of $2.003 million or 1.5 percent compared to the FY 2016 Enacted level.

NATIONAL INSTITUTES OF HEALTH

National Heart, Lung, and Blood Institute

Budget Authority by Object Class[1]

(Dollars in Thousands)

Total compensable work years:	**FY 2016 Enacted**	**FY 2017 President's Budget[2]**	**FY 2017 +/- FY 2016**
Full-time employment	926	926	0
Full-time equivalent of overtime and holiday hours	1	1	0
Average ES salary	$174	$176	$3
Average GM/GS grade	12.5	12.5	0.0
Average GM/GS salary	$105	$111	$6
Average salary, grade established by act of July 1, 1944 (42 U.S.C. 207)	$0	$0	$0
Average salary of ungraded positions	$139	$146	$7

	OBJECT CLASSES	**FY 2016 Enacted**	**FY 2017 President's Budget[2]**	**FY 2017 +/- FY 2016**
	Personnel Compensation	-	-	-
11.1	Full-Time Permanent	$66,729	$67,238	$508
11.3	Other Than Full-Time Permanent	33,082	33,334	252
11.5	Other Personnel Compensation	4,529	4,563	34
11.7	Military Personnel	1,161	1,170	9
11.8	Special Personnel Services Payments	8,738	8,805	67
11.9	**Subtotal Personnel Compensation**	**$114,239**	**$115,109**	**$870**
12.1	Civilian Personnel Benefits	$33,660	$34,327	$667
12.2	Military Personnel Benefits	851	858	6
13.0	Benefits to Former Personnel	0	0	0
	Subtotal Pay Costs	**$148,750**	**$150,293**	**$1,543**
21.0	Travel & Transportation of Persons	$2,653	$2,700	$48
22.0	Transportation of Things	233	237	4
23.1	Rental Payments to GSA	0	0	0
23.2	Rental Payments to Others	0	0	0
23.3	Communications, Utilities & Misc. Charges	1,182	1,203	21
24.0	Printing & Reproduction	46	47	1
25.1	Consulting Services	$632	$633	$2
25.2	Other Services	91,436	93,082	1,646
25.3	Purchase of goods and services from government accounts	225,237	230,005	4,768
25.4	Operation & Maintenance of Facilities	$4,281	$4,358	$77
25.5	R&D Contracts	181,596	179,542	-2,054
25.6	Medical Care	1,266	1,300	34
25.7	Operation & Maintenance of Equipment	9,562	9,656	93
25.8	Subsistence & Support of Persons	0	0	0
25.0	**Subtotal Other Contractual Services**	**$514,010**	**$518,576**	**$4,566**
26.0	Supplies & Materials	$15,111	$15,376	$265
31.0	Equipment	10,913	11,064	151
32.0	Land and Structures	0	0	0
33.0	Investments & Loans	0	0	0
41.0	Grants, Subsidies & Contributions	2,420,632	2,414,032	-6,599
42.0	Insurance Claims & Indemnities	0	0	0
43.0	Interest & Dividends	3	3	0
44.0	Refunds	0	0	0
	Subtotal Non-Pay Costs	**$2,964,783**	**$2,963,240**	**-$1,543**
	Total Budget Authority by Object Class	**$3,113,533**	**$3,113,533**	**$0**

[1]Includes FTEs whose payroll obligations are supported by the NIH Common Fund.

[2]Includes mandatory financing.

NATIONAL INSTITUTES OF HEALTH
National Heart, Lung, and Blood Institute

Salaries and Expenses
(Dollars in Thousands)

OBJECT CLASSES	FY 2016 Enacted	FY 2017 President's Budget	FY 2017 +/- FY 2016
Personnel Compensation			
Full-Time Permanent (11.1)	$66,729	$67,238	$508
Other Than Full-Time Permanent (11.3)	33,082	33,334	252
Other Personnel Compensation (11.5)	4,529	4,563	34
Military Personnel (11.7)	1,161	1,170	9
Special Personnel Services Payments (11.8)	8,738	8,805	67
Subtotal Personnel Compensation (11.9)	**$114,239**	**$115,109**	**$870**
Civilian Personnel Benefits (12.1)	$33,660	$34,327	$667
Military Personnel Benefits (12.2)	851	858	6
Benefits to Former Personnel (13.0)	0	0	0
Subtotal Pay Costs	**$148,750**	**$150,293**	**$1,543**
Travel & Transportation of Persons (21.0)	$2,653	$2,700	$48
Transportation of Things (22.0)	233	237	4
Rental Payments to Others (23.2)	0	0	0
Communications, Utilities & Misc. Charges (23.3)	1,182	1,203	21
Printing & Reproduction (24.0)	46	47	1
Other Contractual Services:			
Consultant Services (25.1)	98	100	2
Other Services (25.2)	91,113	92,753	1,640
Purchases from government accounts (25.3)	138,159	141,359	3,201
Operation & Maintenance of Facilities (25.4)	4,281	4,358	77
Operation & Maintenance of Equipment (25.7)	9,562	9,656	93
Subsistence & Support of Persons (25.8)	0	0	0
Subtotal Other Contractual Services	**$243,214**	**$248,226**	**$5,013**
Supplies & Materials (26.0)	$15,111	$15,376	$265
Subtotal Non-Pay Costs	**$262,438**	**$267,790**	**$5,352**
Total Administrative Costs	**$411,189**	**$418,084**	**$6,895**

NATIONAL INSTITUTES OF HEALTH

National Heart, Lung, and Blood Institute

Detail of Full-Time Equivalent Employment (FTE)

OFFICE/DIVISION	FY 2015 Actual Civilian	FY 2015 Actual Military	FY 2015 Actual Total	FY 2016 Est. Civilian	FY 2016 Est. Military	FY 2016 Est. Total	FY 2017 Est. Civilian	FY 2017 Est. Military	FY 2017 Est. Total
Center for Translation Research and Implementation Science									
Direct:	14	2	16	15	2	17	15	2	17
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	14	2	16	15	2	17	15	2	17
Division of Blood and Resources									
Direct:	28	-	28	29	-	29	29	-	29
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	28	-	28	29	-	29	29	-	29
Division of Cardiovascular Sciences									
Direct:	123	1	124	123	1	124	123	1	124
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	123	1	124	123	1	124	123	1	124
Division of Extramural Research Activities									
Direct:	98	-	98	98	-	98	98	-	98
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	98	-	98	98	-	98	98	-	98
Division of Intramural Research									
Direct:	422	7	429	427	7	434	427	7	434
Reimbursable:	38	1	39	38	1	39	38	1	39
Total:	460	8	468	465	8	473	465	8	473
Division of Lung Diseases									
Direct:	31	-	31	32	-	32	32	-	32
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	31	-	31	32	-	32	32	-	32
Office of the Director									
Direct:	139	1	140	140	1	141	140	1	141
Reimbursable:	12	-	12	12	-	12	12	-	12
Total:	151	1	152	152	1	153	152	1	153
Total	**905**	**12**	**917**	**914**	**12**	**926**	**914**	**12**	**926**
Includes FTEs whose payroll obligations are supported by the NIH Common Fund.									
FTEs supported by funds from Cooperative Research and Development agreements.	0	0	0	0	0	0	0	0	0

FISCAL YEAR	Average GS Grade
2013	12.5
2014	12.4
2015	12.5
2016	12.5
2017	12.5

NATIONAL INSTITUTES OF HEALTH

National Heart, Lung, and Blood Institute

Detail of Positions[1]

GRADE	FY 2015 Actual	FY 2016 Enacted	FY 2017 President's Budget
Total, ES Positions	2	2	2
Total, ES Salary	343,288	347,510	352,827
GM/GS-15	96	97	97
GM/GS-14	151	155	155
GM/GS-13	196	200	200
GS-12	72	72	72
GS-11	52	52	52
GS-10	0	0	0
GS-9	44	44	44
GS-8	21	21	21
GS-7	18	18	18
GS-6	6	6	6
GS-5	1	1	1
GS-4	1	1	1
GS-3	4	4	4
GS-2	0	0	0
GS-1	3	3	3
Subtotal	665	674	674
Grades established by Act of July 1, 1944 (42 U.S.C. 207)	0	0	0
Assistant Surgeon General	1	1	1
Director Grade	5	5	5
Senior Grade	3	3	3
Full Grade	2	2	2
Senior Assistant Grade	1	1	1
Assistant Grade	0	0	0
Subtotal	12	12	12
Ungraded	260	260	260
Total permanent positions	673	673	673
Total positions, end of year	949	949	949
Total full-time equivalent (FTE) employment, end of year	917	926	926
Average ES salary	171,644	173,755	176,414
Average GM/GS grade	12.5	12.5	12.5
Average GM/GS salary	102,613	104,973	110,537

[1]Includes FTEs whose payroll obligations are supported by the NIH Common Fund.