DEPARTMENT OF HEALTH AND HUMAN SERVICES

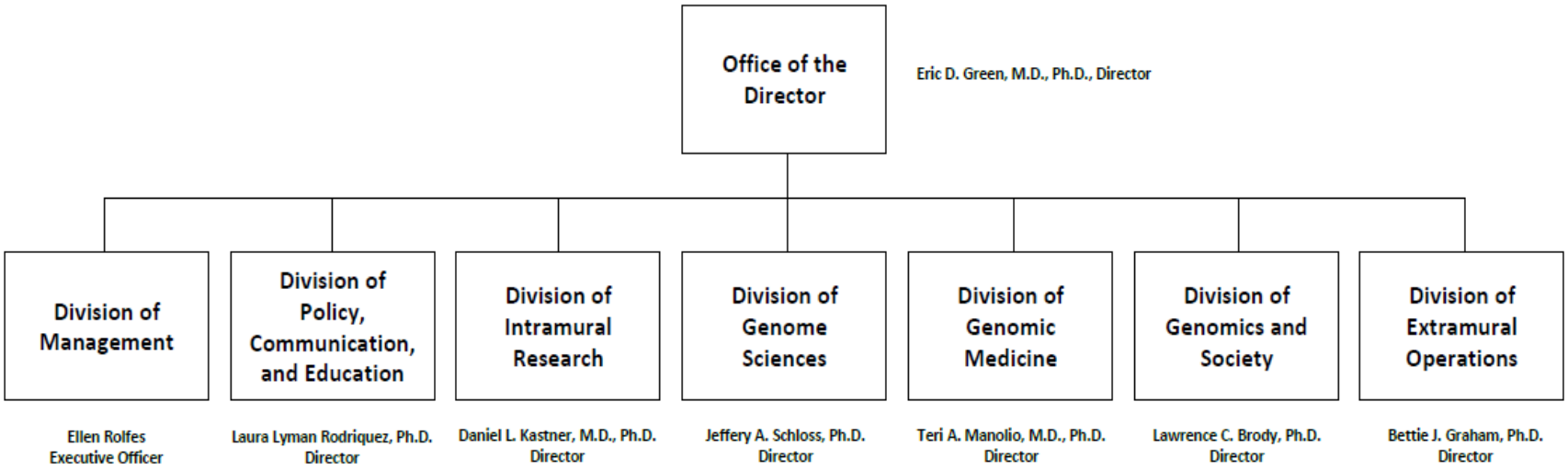
NATIONAL INSTITUTES OF HEALTH

National Human Genome Research Institute (NHGRI)

FY 2017 Budget — Page No.

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

NATIONAL HUMAN GENOME RESEARCH INSTITUTE
Organizational Structure



NATIONAL INSTITUTES OF HEALTH

National Human Genome Research Institute

For carrying out section 301 and title IV of the PHS Act with respect to human genome research, [$518,956,000]*$509,762,000*.

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Amounts Available for Obligation[1]
(Dollars in Thousands)

Source of Funding	FY 2015 Actual	FY 2016 Enacted	FY 2017 President's Budget
Appropriation	$499,356	$518,956	$513,227
Mandatory Appropriation: (non-add)			
Type 1 Diabetes	*(0)*	*(0)*	*(0)*
Other Mandatory financing	*(0)*	*(0)*	*(3,465)*
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	$499,356	$518,956	$513,227
OAR HIV/AIDS Transfers	-679	-5,729	0
National Children's Study Transfers	0	0	0
Subtotal, adjusted budget authority	$498,677	$513,227	$513,227
Unobligated balance, start of year	0	0	0
Unobligated balance, end of year	0	0	0
Subtotal, adjusted budget authority	$498,677	$513,227	$513,227
Unobligated balance lapsing	-29	0	0
Total obligations	$498,648	$513,227	$513,227

[1] Excludes the following amounts for reimbursable activities carried out by this account:
FY 2015 - $26,905 FY 2016 - $27,588 FY 2017 - $27,588

NATIONAL INSTITUTES OF HEALTH
FY 2017 Congressional Justification
NHGRI
Budget Mechanism - Total[1]

(Dollars in Thousands)

MECHANISM	FY 2015 Actual		FY 2016 Enacted		FY 2017 President's Budget[3]		FY 2017 +/- FY 2016	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Research Projects:								
Noncompeting	147	$91,344	152	$105,829	150	$191,907	-2	$86,078
Administrative Supplements	*(36)*	5,916	*(56)*	13,989	*(2)*	2,000	*(-54)*	-11,989
Competing:								
Renewal	6	3,431	20	26,250	18	44,500	-2	18,250
New	54	42,817	44	102,783	23	27,008	-21	-75,775
Supplements								
Subtotal, Competing	60	$46,248	64	$129,033	41	$71,508	-23	-$57,525
Subtotal, RPGs	207	$143,508	216	$248,851	191	$265,415	-25	$16,564
SBIR/STTR	30	12,138	32	13,309	34	14,072	2	763
Research Project Grants	237	$155,647	248	$262,160	225	$279,487	-23	$17,327
Research Centers:								
Specialized/Comprehensive	22	$119,674	16	$20,279	17	$21,583	1	$1,304
Clinical Research								
Biotechnology	24	61,151	23	58,826	13	39,434	-10	-19,392
Comparative Medicine								
Research Centers in Minority Institutions								
Research Centers	46	$180,825	39	$79,105	30	$61,017	-9	-$18,088
Other Research:								
Research Careers	18	$2,250	20	$2,485	20	$2,485		0
Cancer Education								
Cooperative Clinical Research		332						
Biomedical Research Support								
Minority Biomedical Research Support		400		400		400		0
Other	24	4,050	32	5,839	23	5,839	-9	0
Other Research	42	$7,031	52	$8,724	43	$8,724	-9	0
Total Research Grants	325	$343,503	339	$349,989	298	$349,228	-41	-$761
Ruth L Kirchstein Training Awards:	FTTPs		FTTPs		FTTPs		FTTPs	
Individual Awards	6	$223	20	$760	19	$760	-1	
Institutional Awards	151	6,431	214	9,337	192	8,575	-22	0
Total Research Training	157	$6,653	234	$10,097	211	$9,335	-23	-$762
Research & Develop. Contracts	11	$17,095	11	$17,895	11	$19,418		$1,523
(SBIR/STTR) (non-add)[2]		*(102)*		*(102)*		*(102)*		
Intramural Research	224	$103,103	226	$106,122	226	$106,122		0
Res. Management & Support	108	28,323	109	29,124	109	29,124		0
Res. Management & Support (SBIR Admin) (non-add)[2]								
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		0		0		-3,465		-3,465
Subtotal, Labor/HHS Budget Authority		**$498,677**		**$513,227**		**$509,762**		**-$3,465**
Interior Appropriation for Superfund Res.								
Total, NIH Discretionary B.A.		**$498,677**		**$513,227**		**$509,762**		**-$3,465**
Type 1 Diabetes								
Proposed Law Funding								
Cancer Initiative Mandatory Financing								
Other Mandatory Financing		0		0		3,465		3,465
Total, NIH Budget Authority		**$498,677**		**$513,227**		**$513,227**		**0**
Program Evaluation Financing								
Total, Program Level		**$498,677**		**$513,227**		**$513,227**		**0**

[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 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 mechanism and activity detail, and these highlights will not sum to the total change for the FY 2017 President's Budget request for NHGRI, which is the same as the same as the FY 2016 Enacted level, is $513.227 million.

Research Centers (-$18.008 million, total $61.017 million):
This decrease represents the movement of several large ongoing NHGRI initiatives from the Research Centers budget mechanism line to the RPG mechanism. There is a balancing increase in the funding for RPGs.

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Summary of Changes

(Dollars in Thousands)

FY 2016 Enacted	$513,227
FY 2017 President's Budget	$513,227
Net change	$0

CHANGES	FY 2017 President's Budget[1]		Change from FY 2016	
	FTEs	Budget Authority	FTEs	Budget Authority
A. Built-in:				
1. Intramural Research:				
a. Annualization of January 2016 pay increase & benefits		$38,897		$154
b. January FY 2017 pay increase & benefits		38,897		548
c. Two less days of pay		38,897		-308
d. Differences attributable to change in FTE		38,897		0
e. Payment for centrally furnished services		16,630		406
f. Increased cost of laboratory supplies, materials, other expenses, and non-recurring costs		50,595		348
Subtotal				$1,147
2. Research Management and Support:				
a. Annualization of January 2016 pay increase & benefits		$13,140		$51
b. January FY 2017 pay increase & benefits		13,140		187
c. Two less days of pay		13,140		-104
d. Differences attributable to change in FTE		13,140		0
e. Payment for centrally furnished services		1,946		47
f. Increased cost of laboratory supplies, materials, other expenses, and non-recurring costs		14,039		86
Subtotal				$267
Subtotal, Built-in				$1,415

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Summary of Changes - Continued

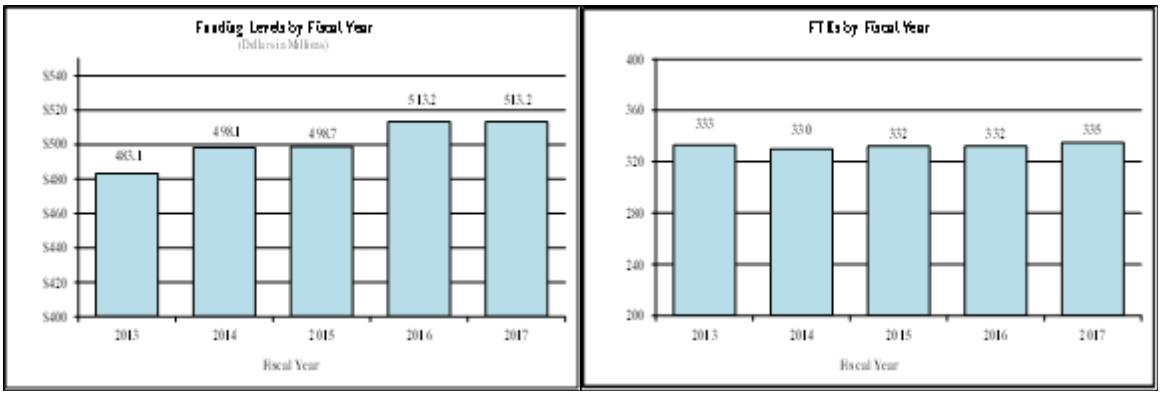
(Dollars in Thousands)

CHANGES	FY 2017 President's Budget		Change from FY 2016	
	No.	Amount	No.	Amount
B. Program:				
1. Research Project Grants:				
a. Noncompeting	150	$193,907	-2	$74,089
b. Competing	41	71,508	-23	-57,525
c. SBIR/STTR	34	14,072	2	763
Subtotal, RPGs	225	$279,487	-23	$17,327
2. Research Centers	30	$61,017	-9	-$18,088
3. Other Research	43	8,724	-9	0
4. Research Training	211	9,335	-23	-762
5. Research and development contracts	11	19,418	0	1,523
Subtotal, Extramural		$377,981		$0
	FTEs		FTEs	
6. Intramural Research	226	$106,122	0	-$1,147
7. Research Management and Support	109	29,124	0	-267
8. Construction		0		0
9. Buildings and Facilities		0		0
Subtotal, Program	335	$513,227	0	-$1,415
Total changes				$0

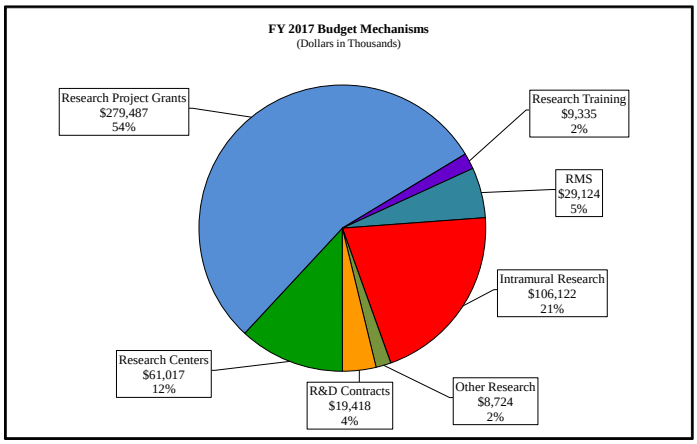
[1] Includes mandatory financing.

Fiscal Year 2017 Budget Graphs

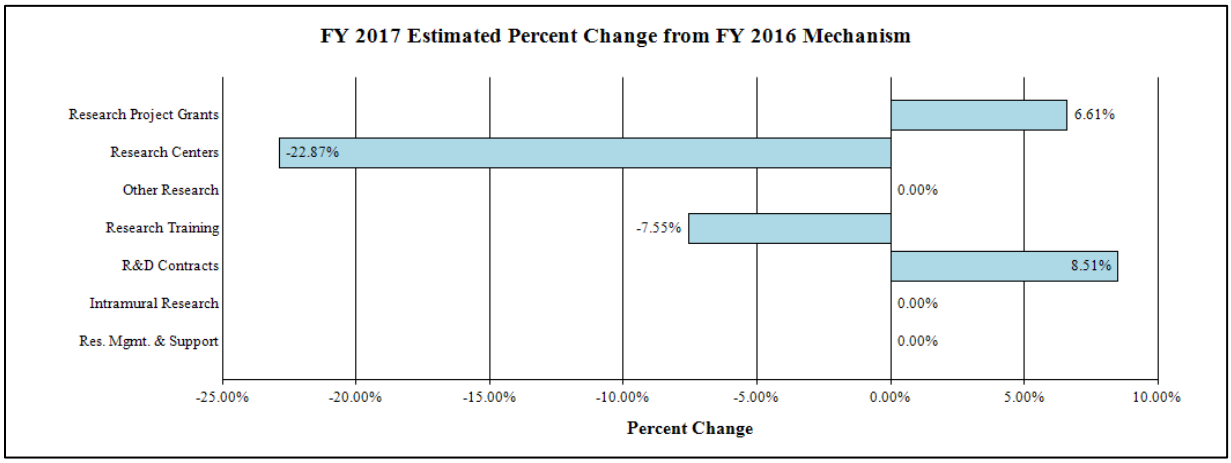
History of Budget Authority and FTEs:



Distribution by Mechanism:



Change by Selected Mechanisms:



NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Budget Authority by Activity[1]

(Dollars in Thousands)

	FY 2015 Actual		FY 2016 Enacted		FY 2017 President's Budget[2]		FY 2017 +/- FY2016	
Extramural Research	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**
Detail								
Understanding the Structure of Genomes		$33,250		$34,221		$34,221		$0
Understanding the Biology of Genomes		82,683		85,100		85,100		0
Using Genomics to Understand the Biology of Disease		132,134		135,997		135,997		0
Using Genomics to Advance Medical Science		25,727		26,480		26,480		0
Using Genomics to Improve the Effectiveness of Healthcare		14,503		14,927		14,927		0
Bioinformatics and Computational Biology		119,538		123,031		123,031		0
Education and Training		19,506		20,076		20,076		0
Genomics and Society		43,013		44,270		44,270		0
Subtotal, Program Activity*		**$470,354**		**$484,103**		**$484,103**		**$0**
Extramural Research (non-add)	*(0)*	*(367,251)*	*(0)*	*(377,981)*	*(0)*	*(377,981)*	*(0)*	*(0)*
Intramural Research (non-add)	**224**	*(103,103)*	**226**	*(106,122)*	**226**	*(106,122)*	**0**	*(0)*
Research Management & Support	**108**	**$28,323**	**109**	**$29,124**	**109**	**$29,124**	**0**	**$0**
TOTAL	**332**	**$498,677**	**335**	**$513,227**	**335**	**$513,227**	**0**	**$0**

[1] Includes FTEs whose payroll obligations are supported by the NIH Common Fund.
[2] Includes mandatory financing.
* The detail programs listed above include both Extramural and Intramural funding.

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research 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	$513,227,000	Indefinite	$509,762,000
National Human Genome Research Institute	Section 401(a)	42§281	Indefinite		Indefinite	
Total, Budget Authority				$513,227,000		$509,762,000

[1]Excludes mandatory financing.

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Appropriations History

Fiscal Year	Budget Estimate to Congress	House Allowance	Senate Allowance	Appropriation
2007	$482,942,000	$482,942,000	$486,315,000	$486,491,000
Rescission				$0
2008	$484,436,000	$493,996,000	$497,031,000	$495,434,000
Rescission				$8,655,000
Supplemental				$2,589,000
2009	$487,878,000	$504,603,000	$501,411,000	$502,367,000
Rescission				$0
2010	$509,594,000	$520,311,000	$511,007,000	$516,028,000
Rescission				$0
2011	$533,959,000		$533,127,000	$516,028,000
Rescission				$4,531,033
2012	$524,807,000	$524,807,000	$505,783,000	$513,844,000
Rescission				$971,165
2013	$511,370,000		$512,920,000	$512,872,835
Rescission				$1,025,746
Sequestration				($25,742,690)
2014	$517,319,000		$513,881,000	$497,813,000
Rescission				$0
2015	$498,451,000			$499,356,000
Rescission				$0
2016	$515,491,000	$505,551,000	$526,166,000	$518,956,000
Rescission				$0
2017[1]	$513,227,000			

[1] Includes mandatory financing.

Justification of Budget Request

National Human Genome Research 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	$498,648,000	$513,227,000	$513,227,000	$0
FTE	332	335	335	0

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

Director's Overview

Twenty-five years ago this past October, an international effort was mobilized to pursue the audacious goal of elucidating the complete sequence of the human genome – and the Human Genome Project (HGP) was underway. The project aimed to establish the order of the approximately three billion 'letters' (i.e., bases) in the human genome in 15 years at a projected cost of nearly $3 billion, or for about one dollar per base. The National Human Genome Research Institute (NHGRI) was specifically created to provide the U.S. leadership for this effort. NHGRI played a critical role in guiding the project to its successful conclusion two years ahead of schedule and, notably, under budget. The scientific and managerial lessons learned from HGP and the many important follow-on genomics projects have led to great advances in basic knowledge about how genomes operate, while concurrently leading to exciting opportunities to apply genomic approaches to translational and clinical research programs.

The overarching design for the research portfolio supported and led by NHGRI was laid out in a February 2011 strategic vision published in *Nature*, "Charting a Course for Genomic Medicine from Base Pairs to Bedside."[1] That document defines an arc from basic research aiming to understand the structure and function of genomes to applied research aiming to advance medical science and improve the effectiveness of healthcare. Over the past few years, NHGRI has fostered research along this path, enabling important genomic medicine advances to reach the clinic in areas such as oncology, and laying the foundation for transformational efforts now being launched in precision medicine. In particular, the proposed U.S. Precision Medicine Initiative, a bold new enterprise announced by President Obama in January 2015 to revolutionize medicine and generate the scientific evidence needed to better tailor the prevention, diagnosis, and treatment of diseases to individual care, will include genomic studies as a core element, aiming to integrate analyses of participants' genomes with other critical data (e.g., that related to lifestyle, environment, and previous medical care).

[1] Green E.D. and Guyer M.S. *Nature.* 470: 204-213, 2011.

In FY 2017, NHGRI's Genome Sequencing Program (GSP), a centerpiece component of the Institute's research portfolio, will begin an exciting new phase in its continuing evolution. This generation of GSP will be enhanced by additional components, allowing the program to progress and address current needs of the scientific community. In genomics, as in many fields today, data analysis is the rate-limiting factor. NHGRI recognizes the need to build infrastructure and increase the capacity to analyze thoroughly all of the genomic data being generated. To this end, dedicated data analysis centers will be added to the arsenal of groups involved in the NHGRI GSP.

The GSP utilizes the power of its broad scope and large scale to study a spectrum of diseases, from those rarely seen to more commonly recognized disorders. The Centers for Mendelian Genomics was highly successful in its first iteration, discovering more than 1,500 genes that, when mutated, cause a rare human disease.[2] This program will employ its continued funding to accelerate discovering the genomic underpinnings of the complicated and devastating disorders that collectively affect thousands of Americans and their families. A newly established GSP program, the Centers for Common Disease Genomics (CCDG), has a focus on more common diseases, ones whose underlying genomics are far more complicated. The goals of the CCDG program are extremely ambitious, requiring the sequencing and analysis of up to 250,000 human genomes over four years, with evaluations of progress and study designs at regular intervals to ensure that the approach is optimal and resources are being utilized appropriately.

By their very nature all of NHGRI's major genomics research programs generate 'Big Data' – a buzzword in common use today. The NIH Big Data to Knowledge (BD2K) Initiative aims to address the opportunities and challenges facing biomedical researchers in accessing, managing, analyzing, and integrating large amounts of data. NHGRI has been and will continue to be deeply involved in BD2K activities through both funding support and leadership of BD2K components. In FY 2017, NHGRI's own strategic data science efforts will synergize with the broader BD2K efforts, so as to ensure that all areas of genomics and genomic medicine effectively capitalize on the resulting advances.

The NHGRI Population Architecture using Genomics and Epidemiology (PAGE) program, now in its second phase, is addressing the fact that there has been insufficient population diversity in genomic research studies, with too heavy of an emphasis on research participants of European descent. This trend risks the effective and equitable realization of benefits from genomic and precision medicine approaches across the U.S. population. PAGE answers this need through its focused examination of genomic variants associated with common diseases in non-European populations, including African Americans, Asian Americans, American Indians, Hispanic Americans, and Native Hawaiians. FY 2017 funding for the PAGE program will help to advance methods for analyzing genomic variants in non-European populations and to generate additional genomic information on thousands of new samples from an array of diverse populations.

[2] http://www.ncbi.nlm.nih.gov/pubmed/26166479

The promise of genomic and precision medicine is also embodied in the NIH Undiagnosed Diseases Program (UDP) and the now-broader NIH Common Fund Undiagnosed Disease Network (UDN) launched in 2013. Under NHGRI's leadership, both programs aim to help patients (and their families) facing diagnostic odysseys and to discover the basis for extremely rare disorders. The value in UDN is not only the care and intensive analyses provided to its patients (nearly 800 to date through the UDP at NIH), but also in the development of common protocols for disease characterization, standards for clinical and laboratory data that can be systematically collected and shared, and a collaborative community of clinicians and researchers. The September 2015 launch of an online patient application portal, known as the UDN Gateway, sets the stage for FY 2017 funds to support an expansion in patient enrollment and disease studies.

As NHGRI leads the field of genomics into its next quarter-century, the Institute will continue to examine the issues at the intersections of genomics and society. The societal issues raised by the ongoing advances in genomic and precision medicine make attention to the ethical, legal, and social implications (ELSI) of genomics even more important today. NHGRI is also actively engaged across Federal agencies to create partnerships to ensure genomic science is effectively and efficiently translated into innovative clinical tools. Further, NHGRI will utilize its leadership across the spectrum of genomics inquiry to promote genomic advances from bench to bedside and back again, thereby ensuring a complete cycle of knowledge able to be translated and exploited for maximum public benefit improving human health and promoting quality of life for every American.

Overall Budget Policy:
The FY 2017 President's Budget request for NHGRI is $513.227 million, which is the same as the FY 2016 Enacted level.

Program Descriptions and Accomplishments

Understanding the Structure of Genomes: During the past few decades, NHGRI has nurtured a vibrant ecosystem of basic research and technology-development initiatives that aim to characterize and understand the structure of genomes. Extending our knowledge of genome structure and how it relates to function – in combination with the Institute's extramural Genome Technology Program's (GTP) efforts to develop new methods, technologies, and instruments that enable rapid, low-cost determination of DNA sequence – provides a robust framework for stimulating advances in genomics. In particular, GTP has a strong track record of cultivating groundbreaking technologies through its support of high-risk, high-reward research; for example, the program is responsible for many of the key innovations that have led to the current ability to generate a human genome sequence in just a matter of days for close to $1,000.[3] GTP also supports and coordinates the transfer of technologies from developers to users, and promotes collaborative, multidisciplinary programs that closely integrate research projects at academic and private-sector laboratories.[4]

[3] http://www.genome.gov/sequencingcosts
[4] http://www.nature.com/news/technology-the-1-000-genome-1.14901

Recently, NHGRI engaged in a rigorous dialogue with academic and industry stakeholders to explore future opportunities for NHGRI to nurture continued technology innovations in genomics. Informed by these discussions, the FY 2017 incarnation of GTP will stimulate technological development and engage with the scientific community through even more dynamic interactions than those used to date. Funds will support projects to address specific shortcomings of current genome-sequencing technologies, develop novel technologies that will enable new approaches for DNA and direct RNA sequencing, and advance new methodologies with the potential to significantly propel the field of genomics forward.

Budget Policy:
The FY 2017 President's Budget request for Understanding the Structure of Genomes is $34.221 million, which is the same as the FY 2016 Enacted level. NHGRI will continue to support technology development in areas that will improve the quality of human genome sequence data for use in research and in clinical settings; in addition, efforts to drive down the costs of genome sequencing will continue. As in the past, the Institute will also fund meritorious investigator-initiated research that applies these and other technologies for advancing our understanding of genome structure.

Understanding the Biology of Genomes: Deciphering the genomic underpinnings of biology continues to require the assembly of comprehensive sets of genomic data and the development of new research tools and methodologies. Lynchpins in the NHGRI portfolio that aim to understand the biology of genomes include the Centers of Excellence in Genomic Science (CEGS), the Encyclopedia of DNA Elements (ENCODE) program, and the Genomics of Gene Regulation (GGR) program (highlighted in the Program Portrait below).

The CEGS program supports multi-investigator, interdisciplinary research teams that conduct highly innovative research to develop new concepts, methods, technologies, and ways to analyze data that will substantially advance the state-of-the-art in genomic approaches to the study of biology. Examples of work that will utilize FY 2017 funds include efforts to combine genome-editing technologies and tissue-engineering methods to develop improved models of complex tissues, and efforts to develop revolutionary technologies that enable the direct visualization and functional profiling of gene-regulatory regions in the human genome.

ENCODE (ENCyclopedia Of DNA Elements) has long-term goals of identifying all of the sequence-based functional elements in the human genome and sharing catalogs of these elements freely with the research community in a readily accessible and interpretable manner. To date, ENCODE data resources have been used by researchers outside of ENCODE in studies detailed in more than 1,400 publications that report findings related to basic biology and the genomic bases of disease.[5] Anticipated new ENCODE awards in FY 2017 will address the following specific goals: expanding the catalog of functional elements; moving beyond cataloging towards understanding the functional role of genomic elements in specific biological contexts; developing strategies to apply such studies to disease; increasing the number of scientists from the research community contributing to the creation of the encyclopedia of functional genomic

[5] https://www.encodeproject.org/search/?type=publication&published_by=community

elements; developing analytical tools to enhance the utility of the data; and, making the data, tools, analyses, and assembled encyclopedia freely available to the research community.

Program Portrait: Genomics of Gene Regulation (GGR)

FY 2016 Level: $8.4 million
FY 2017 Level: $9.2 million
Change: +$0.8 million

Since the human genome sequence was first unveiled roughly 13 years ago, a key research focus has been characterizing the roughly 20,000 genes in the human genome and understanding how they are regulated. Gene sequences (areas in the genome that encode for proteins) only account for about one percent of the approximately three billion bases in the human genome. Other specific regions of the genome (called regulatory sequences) work together as 'switches' to determine when, where, and how much genes are 'turned on' to produce their encoded proteins. About 90 percent of genomic variants associated with human disease lie outside of genes themselves, highlighting the importance of regulatory sequences. Yet, our understanding of regulatory regions and their functions remains limited.

All of the trillions of cells in the human body have the same genome (or blueprint), yet different cell types perform different functions, such as making our bodies move or think. The differences among cells are determined by which genes are active (or inactive), which in turn is controlled by the gene-regulatory network of that cell. Today, we do not understand how the information to coordinate these network signals is encoded in our genomes beyond a few well-studied examples. The long-term aim is to eventually be able to predict gene activity of a given type of cell by reading a DNA sequence.

The GGR program builds on the success of NGHRI's ENCODE, which has been cataloging all of the functional elements in the human genome (including regulatory sequences). GGR aims to determine how these regulatory elements work in concert, functioning within gene-regulatory networks. GGR grant recipients are exploring gene-regulatory networks based on genomic data that they are generating from studies of skin, the immune system, and the lungs; these biological systems were chosen for their diversity. It is anticipated that in FY 2017, most projects will be focused on developing and refining models for individual gene-regulatory networks. The computer-based models will be developed from genomic data collected by the projects in the first two years; the research groups may also attempt to compare different computer-based modeling approaches utilized by different projects. The collective goal of these projects is to develop a generalizable method to analyze gene-regulatory networks in order to better understand genome function in any specialized cell.

Budget Policy:
The FY 2017 President's Budget request for Understanding the Biology of Genomes is $85.100 million, which is the same as the FY 2016 Enacted level. The knowledge generated by this area of research will aid the scientific community in determining the root causes of disease. Additionally, the Institute will continue to fund meritorious investigator-initiated applications to develop better tools, models, and insights into the relationship between genome structure and biology.

Using Genomics to Understand the Biology of Disease: A common thread between the research programs in this area of NHGRI's research portfolio and the Precision Medicine Initiative is the shared aim of understanding how an individual's genome is associated with their health and propensity to develop disease(s). As the National Cancer Institute (NCI) and others

advance the genomic approaches for disease studies developed by The Cancer Genome Atlas, which was jointly led by NCI and NHGRI, the NHGRI Genome Sequencing Program will aggressively pursue genomic approaches for characterizing common diseases more generally. An important aspect of NHGRI's Centers for Common Disease Genomics program will be substantial partnerships with other NIH ICs and non-federal funding sources as a means to leverage the Institute's investment in this priority area.

Another strategic emphasis in FY 2017 will be enabling synergy across NHGRI investments to maximize stewardship of resources. An illustration of this is seen with the rare disease initiatives within the Undiagnosed Diseases Network (UDN) and the second phase of the Centers for Mendelian Genomics. Both programs are structured through national consortia that bring together leading experts and create great potential to gain insights about basic biological pathways that not only lead to rare disease when perturbed, but that also contribute to common diseases. Utilizing the discoveries from rare disease studies should propel forward our understanding of common diseases, revealing insights about fundamental aspects of disease mechanisms and about potential new treatments.

Another source of discoveries related to understanding the biology of disease is the Electronic Medical Records and Genomics (eMERGE) Network, now in its third phase. This program brings together researchers with a wide range of expertise in genomics, statistics, ethics, informatics, and clinical medicine from leading medical research institutions across the country. The goals of eMERGE center on developing, disseminating, and applying approaches to research that combine the use of DNA biorepositories with electronic medical record systems for large-scale, high-throughput genomics research. To date, this program has emphasized research focused on understanding fundamental aspects of human disease, but it is now morphing to include more clinically focused research pursuits described in the following section.

Budget Policy:
The FY 2017 President's Budget request for Using Genomics to Understand the Biology of Disease is $135.997 million, which is the same as the FY 2016 Enacted level. NHGRI's genomics programs should yield important advances in the study of rare and common diseases. The Institute will continue to fund meritorious investigator-initiated applications that will utilize genomics to enhance understanding of disease etiology and pathogenesis as well as differences in responses to environmental exposures.

Using Genomics to Advance Medical Science: A key priority within the NHGRI research portfolio is to look ahead to clinical research opportunities and the need to facilitate the realization of genomic medicine. Prototypic NHGRI efforts in this area include the newer, more clinically oriented aspects of eMERGE (introduced above) and the Clinical Genome Resource (ClinGen). Both are yielding leading-edge insights to inform the conception and early planning for the Precision Medicine Initiative, and will continue to do so going forward. More information for ClinGen is provided in the Program Portrait below.

Program Portrait: Clinical Genome Resource (ClinGen)

FY 2016 Level: $7.5 million
FY 2017 Level: $9.5 million
Change: +$2.0 million

With the expanding use of genome sequencing in clinical research, there are increasing numbers of genomic variants being discovered that appear to play a role in health and disease. Individual efforts to evaluate tests, review scientific and clinical literature, and assess evidence have historically been used to determine the clinical validity and clinical utility of genomic variants. However, such an approach has led to duplicative work and is generally inefficient for disseminating research and clinical findings. ClinGen is building an authoritative central data resource of clinically relevant genes and genomic variants for use in genomic medicine and research, this user-friendly database is also intended to stimulate further research, and could serve as a basis for the development of genomics-oriented practice guidelines by relevant professional societies.

ClinGen's clinical and research experts are working to develop standard approaches for data sharing and clinical characterization of genomic variants. It is also developing machine-learning algorithms to improve the throughput of genomic variant interpretation, and researchers are working to disseminate the collective knowledge and ensure interoperability of the resulting information within electronic health records. A patient registry, GenomeConnect, has been created to help individuals share their genomic and health information with researchers and connect to other patients with similar disorders.

In FY 2017, ClinGen experts will tackle high-priority diseases in areas such as pulmonology, endocrinology, and neurology, and disseminate the results through the ClinGen data portal (www.clinicalgenome.org). Furthermore, existing curation interfaces will be expanded to include genome sequence and structural variant curation, as well as clinical actionability. Lastly, ClinGen will continue to collaborate with the Food and Drug Administration as they explore approaches under the auspices of the Precision Medicine Initiative for using high-quality, well-curated databases (such as ClinGen) to aid in the clinical interpretation of variants and to support regulatory decision-making for genome sequencing tests.[6]

In FY 2017, eMERGE will continue expanding its focus on the integration of available genomic information within clinical processes to improve risk assessment, diagnosis, treatment, and possibly disease prevention. This work will include a greater focus on effective and scalable informed consent methods, patient and healthcare provider education, regulatory issues confronting genomic medicine techniques as they enter the clinic, and issues pertaining to community engagement. These latter focus areas demonstrate NHGRI's commitment to addressing the ELSI issues stemming from the bench and clinical research it supports. This area of research is fundamental to the sustainment of public trust in the genomics research enterprise, and in the potential for genomic and precision medicine to be viewed as a valuable pursuit for the Nation.

Also advancing medical science through genomics research is the NHGRI Clinical Sequencing Exploratory Research program. In FY 2017, this now-mature program will continue its pursuit of exploring the use of genome sequence information as a clinical tool. Meanwhile, the Newborn Sequencing in Genomic Medicine and Public Health (NSIGHT) program, launched and managed in partnership with the *Eunice Kennedy Shriver* National Institute for Child Health and Human Development, is also a cutting-edge program designed to anticipate scientific

[6] http://www.fda.gov/downloads/MedicalDevices/NewsEvents/WorkshopsConferences/UCM427869.pdf

opportunities and promote consideration of the responsible application of genomic technologies in various healthcare domains. This program is described in the Program Portrait below.

Program Portrait: Newborn Screening in Genomic Medicine and Public Health (NSIGHT)

FY 2016 Level: $10.0 million
FY 2017 Level: $10.0 million
Change: $0 million

Newborn screening is an extremely successful public health program that has saved the lives of countless children. Four million babies are screened each year for life threatening and debilitating conditions, with the intent of identifying and treating the infants before they are symptomatic. Screening involves the collection of several drops of heel-stick blood from babies soon after birth. The bloodspots are then screened using various technologies to identify specific disorders. Currently, newborn DNA is used for primary analysis for only one of these disorders. However, new and cost-effective testing methods may enable the expansion of newborn screening in the future to include DNA sequencing.

Newborn Screening in Genomic Medicine and Public Health (NSIGHT), which began in 2013, was established to explore, in a limited but deliberate manner, the implications, challenges and opportunities associated with the possible use of genomic sequence information in the newborn period. The NSIGHT program consists of components that address the technical challenges of performing genome sequencing of large numbers of individuals; explore the value added of genome sequence information to the clinical care of newborns; and evaluate the ethical, legal, and social implications of genomic sequencing in the newborn period.

In FY 2017, the program will continue efforts to effectively reduce the turnaround time required for genome sequencing results to be generated in the newborn period, and will explore a comparison of newborn screening results obtained through current methodologies with those obtained through genome sequencing. Other components of the program will compare the attitudes of parents with sick newborns to parents of healthy newborns with respect to views about genome sequencing. The program will also evaluate an electronic decision aid tool developed to help parents make informed decisions when receiving genomic information about their newborn. Collectively, the results of this program will help clinicians, families, and policy makers better understand how and when the use of genome sequencing is most beneficial for the infant.

Budget Policy:
The FY 2017 President's Budget request for Using Genomics to Advance Medical Science is $26.480 million, which is the same as the FY 2016 Enacted level. Understanding the means necessary to effectively implement genomics in the clinical setting and ensuring such an approach is accessible to all Americans is a goal for FY 2017 funding. Additionally, NHGRI will expand its genome sequencing efforts for newborns and the diseases specific to this population.

Using Genomics to Improve the Effectiveness of Healthcare: In order to maximize the impact of funds invested in genomic medicine and initiatives such as the Precision Medicine Initiative, research efforts that move into the healthcare delivery arena are imperative. To that end, NHGRI's Implementing Genomics in Practice (IGNITE) program is an innovative effort that seeks to incorporate genomics into baseline clinician activities across different types of healthcare settings. Highlights of the IGNITE program to date include the development of tools that clinicians can use in decision making and the expansion of genomic interventions from specialized clinical centers to community settings, such as those that serve veterans, the military, and traditionally underserved communities. In FY 2017, IGNITE goals include understanding

how to code and implement genomic testing in the clinical setting, effectively using family health history and other online tools to integrate genomic information into electronic health records, and the pursuit of other mechanisms through which to incorporate genomic information in the primary care setting.

In addition to the pursuit of specific research programs, a Working Group of the National Advisory Council for Human Genome Research has held a series of workshops to bring experts together to focus on specific challenges to the implementation of genomic medicine in healthcare.[7] Efforts of this Working Group will continue to inform NHGRI on areas related to genomic medicine implementation, including issues related to infrastructure, to ensure the Institute's investments address the critical opportunities necessary to achieve public benefit.

Budget Policy:
The FY 2017 President's Budget request for Using Genomics to Improve the Effectiveness of Healthcare is $14.927 million, which is the same as the FY 2016 Enacted level. IGNITE's continued efforts in FY 2017 will work to diffuse innovations throughout the community.

Bioinformatics, Computational Biology, and Data Science: NHGRI remains committed to supporting research related genomics aspects of bioinformatics, computational biology, and data science. This will include the development of new computational approaches, algorithms, and analysis tools that maximize the integration of 'big data' (like genomics data) into biomedical research. In FY 2017, NHGRI's Computational Genomics and Data Science Program will enable the development of new methods for associating genomic variation with disease phenotypes and traits, and for predicting the functional effects of genomic variants. To further facilitate the interpretation of the gene-disease and gene-function relationship, the program will continue funding highly curated and broadly used resources of genomic variants, both for human and model organisms. NHGRI will also support web-based informatics platforms and computing resources (including cloud-based solutions) that enable the management, integration, analysis, and visualization of genomic data. Clinical decision-support systems that utilize genomic data to enhance the capabilities of electronic health records will also be refined. The goal of these tools is improving the diagnosis, treatment, and prevention of diseases.

Recognizing that 'big data' is not an Institute-specific challenge, and following in NHGRI's tradition of bringing genomic expertise to broader biomedical needs, the BD2K initiative will remain an area of deep collaboration and engagement for the Institute in FY 2017. Over time, the Precision Medicine Initiative will inevitably generate more genomic and other data than ever could have been anticipated a quarter century ago, as the field of genomics was beginning. NHGRI is working to ensure the rapidly accumulating genomic data are organized and useful in their entirety. However, as in other industries, the emergence of 'big data' has necessitated improved data-management and -analysis tools, as well as enhanced computing power. NHRGI will continue development of an appropriate infrastructure as well as analytical tools to harness and interpret the available data, as the amount of data being generated requires fundamentally new approaches as well as creative solutions.

[7] http://www.genome.gov/27549220

Budget Policy:
The FY 2017 President's Budget request for Bioinformatics and Computational Biology is $123.031 million, which is the same as the FY 2016 Enacted level. NHGRI is committed to continue its investment in analysis tools and methods that will allow for incorporation of an increasing quantity of diverse data, as well as bringing more researchers into the fold. Continued funding of this effort will enhance our knowledge and ability to translate reams of data into meaningful information. The Institute also will continue to fund meritorious investigator-initiated applications that explore new concepts and develop innovative tools for gathering, analyzing, and storing genomic data.

Education and Training: A well-rounded and diverse scientific workforce, one well-versed in genomics, is a vital element of this Nation's future. Realizing this, NHGRI launched its career training and development programs at the outset of the Human Genome Project. As a discipline, genomics is constantly advancing and evolving. To keep pace with these changes, it is necessary for NHGRI to lay the groundwork for training tomorrow's scientists in continuously innovative ways.

NHGRI will continue to fund investigators beginning their genomics career, as well as expand training opportunities in the general area of genomic medicine. NHGRI also provides support for several genomics education initiatives. In addition, specific NHGRI programs (e.g., CEGS) are required to have a training component that leverages its strengths in training the next generation of interdisciplinary scientists, who will bring imaginative approaches to studying biological problems through a genomics approach. This component of the program includes a specific focus on engaging the talents of individuals from underrepresented groups.

Budget Policy:
The FY 2017 President's Budget request for Education and Training is $20.076 million, which is the same as the FY 2016 Enacted level. In FY 2017, NHGRI will continue its support for training the next generation of genomics researchers, as well as programs aimed at bringing genomics to healthcare professionals and the general public. NHGRI is dedicated to mentoring young scientists and clinicians, and to providing our mentees with meaningful professional opportunities. NHGRI also plans to increase its support for training in the following areas: bioinformatics, data science, and genomic medicine.

Genomics and Society: Since the inception of the Human Genome Project, NHGRI has funded research to examine the ELSI issues related to genomic advances and the increasing accessibility of genomic information and technologies within society. Each year, approximately five percent of NHGRI's funding is dedicated to ELSI research studies and programs. Led by NHGRI's Division of Genomics and Society, this research will remain a vital component of the Institute's strategic vision in the coming fiscal year. FY 2017 will see continued attention to focused ELSI research as well as integrated ELSI questions within broader genomics initiatives, especially those that are piloting genomic applications in the clinic. NHGRI remains a leader in bioethics research at NIH and, indeed, in the world. Funding of extramural programs, such as the multi-disciplinary Centers of Excellence in ELSI Research (CEERs), together with the Institute's

intramural social and behavioral research efforts, have placed NHGRI at the forefront of bioethics research and training.
In FY 2017, NHGRI-funded ELSI researchers will continue to study issues the public is concerned about related to the increasing presence of genomics in everyday life. Building trust within communities is one of the pillars of the ELSI program. This work will be continued as projects look into methods to enhance informed consent for research and genomic medicine. In addition, ELSI questions related to biobanking, clinical genome sequencing, and broad data sharing, all issues of great relevance to the Precision Medicine Initiative, will be pursued. A particular focus will be placed on how these types of research issues affect studies involving vulnerable or underrepresented populations. Further, genomic privacy and discrimination as well as the return of genomic research results are issues that will be explored, as they bear weight on best practices for integrating genomics within clinical care.

Budget Policy:
The FY 2017 President's Budget request for Genomics and Society is $44.270 million, which is the same as the FY 2016 Enacted level. In FY 2017, NHGRI will continue to support the extramural ELSI Research Program, and the intramural Social and Behavioral Research Branch to study, analyze, and anticipate the social, behavioral, ethical, and legal issues that may result from the use of new genome-sequencing technologies and the generated genomic information. Several major NHGRI research programs incorporate ELSI research aims (including CSER, eMERGE, NSIGHT, and ClinGen), as do individual investigator-initiated research projects.

Research Management and Support (RMS): RMS funds are utilized by most of the NHGRI Divisions. As an example, NHGRI's Division of Policy, Communications, and Education (DPCE) uses these funds to promote educational opportunities for healthcare professionals and the general public about genomics. In FY 2017, NHGRI will continue to stimulate and support these activities in conjunction with the NHGRI-Smithsonian exhibition *Unlocking Life's Code* as it continues its tour of the United States and Canada.[8] In addition, the research divisions within the NHGRI Extramural Research Program will utilize FY 2017 RMS funds to maintain ongoing and interactive discussions with public and private stakeholders in the research community on the future challenges and the most promising genomics opportunities to ensure that the Institute's stewardship of the Federal genomics investment continues to lead the field in exciting, innovative, and forward-looking directions.

Budget Policy:
The FY 2017 President's Budget estimate for the Research Management and Support program is $29.124 million, which is the same as the FY 2016 Enacted level. In FY 2017, NHGRI will continue to implement outreach and communication to expand public and practitioner understanding of genomics. The Institute will continue to contribute and lead collaborative activities across NIH and the federal government to identify best practices and effective strategies to manage the genomics research portfolio and realize the promise of genomic and precision medicine.

[8] https://unlockinglifescode.org/

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Budget Authority by Object Class[1]
(Dollars in Thousands)

		FY 2016 Enacted	FY 2017 President's Budget	FY 2017 +/- FY 2016
Total compensable workyears:				
	Full-time employment	335	335	0
	Full-time equivalent of overtime and holiday hours	0	0	0
	Average ES salary	$177	$178	$2
	Average GM/GS grade	12.5	12.5	0.0
	Average GM/GS salary	$108	$109	$1
	Average salary, grade established by act of July 1, 1944 (42 U.S.C. 207)	$108	$109	$1
	Average salary of ungraded positions	$182	$183	$2
OBJECT CLASSES		**FY 2016 Enacted**	**FY 2017 President's Budget**	**FY 2017 +/- FY 2016**
	Personnel Compensation			
11.1	Full-Time Permanent	$17,429	$17,561	$133
11.3	Other Than Full-Time Permanent	16,450	16,576	125
11.5	Other Personnel Compensation	548	552	4
11.7	Military Personnel	1,000	1,008	8
11.8	Special Personnel Services Payments	4,237	4,269	32
11.9	**Subtotal Personnel Compensation**	**$39,664**	**$39,966**	**$302**
12.1	Civilian Personnel Benefits	$11,123	$11,344	$220
12.2	Military Personnel Benefits	721	727	5
13.0	Benefits to Former Personnel	0	0	0
	Subtotal Pay Costs	**$51,508**	**$52,036**	**$528**
21.0	Travel & Transportation of Persons	$2,130	$2,131	$0
22.0	Transportation of Things	179	179	0
23.1	Rental Payments to GSA	0	0	0
23.2	Rental Payments to Others	0	0	0
23.3	Communications, Utilities & Misc. Charges	507	507	0
24.0	Printing & Reproduction	2	2	0
25.1	Consulting Services	268	267	-1
25.2	Other Services	14,129	13,506	-624
25.3	Purchase of goods and services from government accounts	63,470	66,349	2,879
25.4	Operation & Maintenance of Facilities	881	871	-10
25.5	R&D Contracts	1,641	1,663	22
25.6	Medical Care	7,371	7,109	-262
25.7	Operation & Maintenance of Equipment	1,944	1,865	-79
25.8	Subsistence & Support of Persons	0	0	0
25.0	**Subtotal Other Contractual Services**	**$89,705**	**$91,630**	**$1,925**
26.0	Supplies & Materials	$7,216	$6,610	-$605
31.0	Equipment	1,894	1,569	-325
32.0	Land and Structures	0	0	0
33.0	Investments & Loans	0	0	0
41.0	Grants, Subsidies & Contributions	360,086	358,563	-1,523
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	**$461,719**	**$461,191**	**-$528**
	Total Budget Authority by Object Class	**$513,227**	**$513,227**	**$0**

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

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research 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)	$17,429	$17,561	$133
Other Than Full-Time Permanent (11.3)	16,450	16,576	125
Other Personnel Compensation (11.5)	548	552	4
Military Personnel (11.7)	1,000	1,008	8
Special Personnel Services Payments (11.8)	4,237	4,269	32
Subtotal Personnel Compensation (11.9)	**$39,664**	**$39,966**	**$302**
Civilian Personnel Benefits (12.1)	$11,123	$11,344	$221
Military Personnel Benefits (12.2)	721	727	5
Benefits to Former Personnel (13.0)	0	0	0
Subtotal Pay Costs	**$51,508**	**$52,036**	**$528**
Travel & Transportation of Persons (21.0)	$2,130	$2,131	$0
Transportation of Things (22.0)	179	179	0
Rental Payments to Others (23.2)	0	0	0
Communications, Utilities & Misc. Charges (23.3)	507	507	0
Printing & Reproduction (24.0)	2	2	0
Other Contractual Services:			
Consultant Services (25.1)	268	267	-1
Other Services (25.2)	14,129	13,506	-624
Purchases from government accounts (25.3)	49,379	50,296	918
Operation & Maintenance of Facilities (25.4)	881	871	-10
Operation & Maintenance of Equipment (25.7)	1,944	1,865	-79
Subsistence & Support of Persons (25.8)	0	0	0
Subtotal Other Contractual Services	**$66,601**	**$66,805**	**$204**
Supplies & Materials (26.0)	$7,216	$6,610	-$605
Subtotal Non-Pay Costs	**$76,636**	**$76,234**	**-$402**
Total Administrative Costs	**$128,144**	**$128,270**	**$128**

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Detail of Full-Time Equivalent Employment (FTE)

OFFICE/DIVISION	FY 2015 Actual			FY 2016 Est.			FY 2017 Est.		
	Civilian	Military	Total	Civilian	Military	Total	Civilian	Military	Total
Division of Extramural Operations									
Direct:	14	-	14	14	-	14	14	-	14
Reimbursable:	2	-	2	2	-	2	2	-	2
Total:	16	-	16	16	-	16	16	-	16
Division of Genome Sciences									
Direct:	15	-	15	16	-	16	16	-	16
Reimbursable:	1	-	1	1	-	1	1	-	1
Total:	16	-	16	17	-	17	17	-	17
Division of Genomic Medicine									
Direct:	10	-	10	10	-	10	10	-	10
Reimbursable:	1		1	1		1	1		1
Total:	11	-	11	11	-	11	11	-	11
Division of Genomics and Society									
Direct:	4	-	4	4	-	4	4	-	4
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	4	-	4	4	-	4	4	-	4
Division of Intramural Research									
Direct:	191	8	199	193	8	201	193	8	201
Reimbursable:	22	3	25	22	3	25	22	3	25
Total:	213	11	224	215	11	226	215	11	226
Division of Management									
Direct:	42	-	42	42	-	42	42	-	42
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	42	-	42	42	-	42	42	-	42
Division of Policy, Communications and Education									
Direct:	13	-	13	13	-	13	13	-	13
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	13	-	13	13	-	13	13	-	13
Office of the Director									
Direct:	6	-	6	6	-	6	6	-	6
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	6	-	6	6	-	6	6	-	6
Total	321	11	332	324	11	335	324	11	335
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	12.3
2014	12.3
2015	12.5
2016	12.5
2017	12.5

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National Human Genome Research 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	346,710	353,298	356,831
GM/GS-15	35	35	35
GM/GS-14	27	29	29
GM/GS-13	64	65	65
GS-12	42	42	42
GS-11	14	14	14
GS-10	1	1	1
GS-9	4	4	4
GS-8	16	16	16
GS-7	1	1	1
GS-6	0	0	0
GS-5	0	0	0
GS-4	0	0	0
GS-3	1	1	1
GS-2	1	1	1
GS-1	0	0	0
Subtotal	206	209	209
Grades established by Act of July 1, 1944 (42 U.S.C. 207)	0	0	0
Assistant Surgeon General	0	0	0
Director Grade	5	5	5
Senior Grade	5	5	5
Full Grade	1	1	1
Senior Assistant Grade	0	0	0
Assistant Grade	0	0	0
Subtotal	11	11	11
Ungraded	126	126	126
Total permanent positions	219	222	222
Total positions, end of year	345	348	348
Total full-time equivalent (FTE) employment, end of year	332	335	335
Average ES salary	173,355	176,649	178,416
Average GM/GS grade	12.5	12.5	12.5
Average GM/GS salary	105,807	107,817	108,896

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