National Human Genome Research Institute

CONGRESSIONAL JUSTIFICATION
FY 2023

Department of Health and Human Services
National Institutes of Health

NIH National Human Genome Research Institute

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DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTES OF HEALTH

National Human Genome Research Institute

FY 2023 Budget Table of Contents

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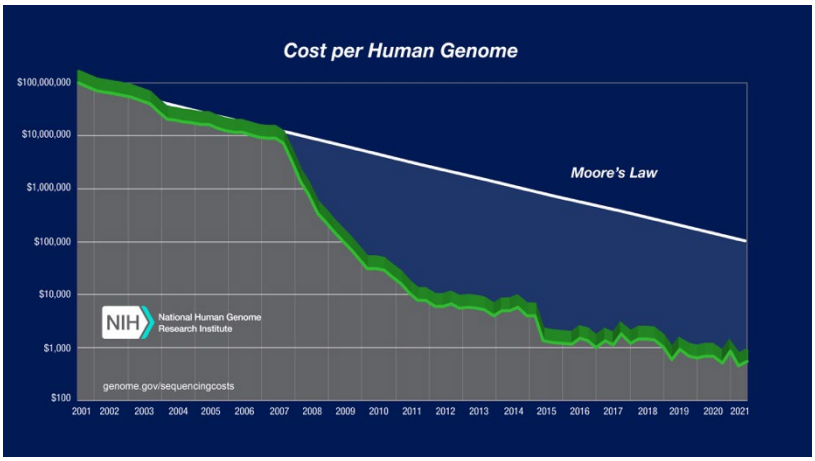
Director's Overview

Eric D. Green, M.D., Ph.D., Director, NHGRI

Starting with the Human Genome Project (1990-2003), the field of genomics has catalyzed revolutionary advances in biomedicine, which has positioned it to play a central role in the new era of digital biology. The integration of genomics into virtually all areas of biomedical research and healthcare has come by harnessing the power of large, interdisciplinary research consortia and big data to drive cutting-edge discoveries. As the Institute responsible for leading genomics research at the National Institutes of Health (NIH), the National Human Genome Research Institute (NHGRI) is uniquely poised to continue these efforts at *The Forefront of Genomics*.[1]

Over the last three decades, genomics has grown from an emerging field to a well-established discipline, with the tools of genomics now routinely and broadly used throughout the biomedical research enterprise. Consequently, there is a robust foundation for conducting genomic-based studies; maintaining and improving that foundation is something that NHGRI embraces as a core part of its mission. Beginning with the Human Genome Project, NHGRI has supported research to reduce the cost of DNA sequencing, helping to realize the million-fold reduction in the cost of sequencing a human genome achieved over the last ~18 years. This foundational work in technology development has made cheap and rapid DNA-sequencing methods widely available, enabling their rapid adoption for use in coronavirus disease 2019 (COVID-19) diagnostics and the deployment of COVID-19 testing early in the pandemic. Additionally, NHGRI has long supported research into the development of technologies for creating synthetic RNA and DNA. Once the severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) viral genome sequence became known, these technologies were instrumental in creating messenger RNA (mRNA)-based COVID-19 vaccines. Another



To illustrate the nature of the reductions in DNA sequencing costs, this graph also shows hypothetical data reflecting Moore's Law, which describes a long-term trend in the computer hardware industry that involves the doubling of "computing power" every two years. Technology improvements that "keep up" with Moore's Law are widely regarded to be doing exceedingly well, making it useful for comparison.

[1] Green, E.D., Gunter, C., Biesecker, L.G. *et al.* Strategic vision for improving human health at The Forefront of Genomics. *Nature* **586,** 683–692 (2020). https://doi.org/10.1038/s41586-020-2817-4

component of the foundation for genomics is the establishment of standards and approaches for open and rapid data sharing, an ethos that was quickly adopted in the global response to the COVID-19 pandemic.

A major challenge in human genomics, especially as genomics becomes increasingly integrated into medicine, is establishing a more complete understanding of how genomic variation influences human health and disease. While variants can now be readily identified in a person's genome, our ability to rapidly establish the biological and clinical relevance of such variants needs to be substantially improved. Towards that end, NHGRI has committed $185 million over five years to support the work of the Impact of Genomic Variation on Function (IGVF) Consortium, which includes world leaders in experimental and computational approaches for predicting the impact of variants on genome function. As the functional consequences of more and more human genomic variants are determined, collecting, curating, and disseminating the resulting information are essential for advancing genomic medicine – this is the signature work of the Clinical Genome Resource (ClinGen), which was renewed in August 2021 for an additional five years,with co-funding from the National Cancer Institute (NCI). In its current phase, ClinGen aims to increase the scale and impact of its tools and expand the diversity of its curation workforce, as it continues to disseminate information about human genomic variants to researchers and clinicians worldwide.

New challenges continually arise in efforts to interrogate the human genome and use the resulting information for improving the practice of medicine. Since FY 2001, NHGRI has funded the Centers of Excellence in Genomic Science (CEGS) Program to develop new transformative genomic approaches to address such challenges. In FY 2021, Congress appropriated $12.5 million to NHGRI to support a complementary "emerging Centers of Excellence in Genomic Science" (eCEGS) Program, targeting institutions which had not previously received a CEGS award. In FY 2023 and beyond, NHGRI plans to continue to engage in outreach efforts at eligible institutions to increase the applicant pool for the eCEGS program and continue to build capacity in genomics research across the country.

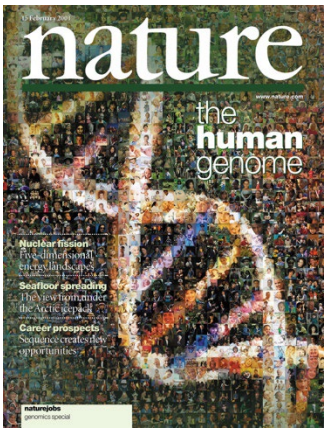
Data science is now a central component of genomics. As such, NHGRI invests in a range of data resources, infrastructure, and technologies that strengthen the computational and data foundation for advancing genomics research. Some of these efforts involve developing robust approaches for handling the prodigious number of human genomes sequences now being generated and made available to the research community every month. This includes support for data browsers, portals, and visualization tools that allow the research and medical communities to share, analyze, and utilize the increasingly complex and heterogenous data types (e.g., sequence, environmental, lifestyle, social, medical, and more) that are now used for genomic medicine and precision medicine research. A prototype program in this area is NHGRI's Genomic Analysis, Visualization, and Informatics Lab-space (AnVIL), a rapidly maturing cloud-based environment for housing and analyzing large complex datasets. NHGRI is now a leader in genomic data science, attracting data scientists to the genomics research community through the support of training, research experiences, and career development. To this end, NHGRI is appointing a Chief Data Science Strategist who will report to the NHGRI Director and provide critical leadership in data science and computational-related efforts in genomics.

NHGRI is dedicated to ensuring that genomics improves human health by building on discoveries made through genetics research and applying them in clinical settings. For example, the Institute is committed to building the infrastructure and technologies to improve understanding, diagnosis, and treatment of genetic disorders. In the summer of 2021, NHGRI launched the Genomics Research Elucidates Genetics of Rare Disease (GREGoR) Consortium, which will be supported by nearly $80 million over five years to help researchers identify the genetic causes of rare genetic diseases that have to date eluded complete characterization (including identifying the causative gene). Complementing such a disease-gene discovery program, the Implementing Genomics in Practice (IGNITE) Network, established in 2013 and currently in its second phase, works to develop methods for incorporating genomic information into clinical care and assess approaches for real-world application of genomic medicine in diverse clinical settings.

NHGRI strives for global diversity in all aspects of genomics research and is committed to the systematic inclusion of ancestrally diverse and underrepresented individuals in all of its studies. The Institute also aims to maximize the utility of genomics for all members of the public, including the ability to access genomics in healthcare. In addition to IGNITE's clinical trial efforts, NHGRI and NCI are partnering to fund grants totaling $38 million over five years to establish and support the Polygenic Risk MEthods in Diverse populations (PRIMED) Consortium, which will work to improve methods by which people can learn about their genetic risk for developing a disease by studying much larger numbers of non-European individuals, with the long-term aim of improving genomic-based prediction methods in all populations. Additionally, NHGRI is taking a leadership role in the research community in efforts to move beyond population descriptors based on historical social constructs such as race in genomic studies – one of the Bold Predictions in the 2020 NHGRI Strategic Vision.

NHGRI cannot successfully complete its mission of accelerating scientific and medical breakthroughs that improve human health for all populations without attracting, developing, and retaining a diverse genomics workforce, including individuals from groups currently underrepresented in the genomics enterprise. This is an Institute-wide priority and central to the 2020 NHGRI Strategic Vision. Vence L. Bonham Jr., J.D., recently appointed the acting deputy director of the Institute, will lead programmatic activities to advance our work related to diversity, inclusion, health equity, anti-racism, and social justice. In late 2021, NHGRI established the Training, Diversity, and Health Equity (TiDHE) Office, which will develop, support, and lead the Institute's efforts in genomics training and workforce development, workforce diversity, and research initiatives aimed at addressing health disparities and inequities.

The field of genomics has routinely benefited from a willingness and matched desire to articulate ambitious – often audacious – research efforts that aim to address challenges and acquire knowledge that may seem out of reach. Such boldness has served the genomics community well by pushing its scientists to adapt to an ever-changing world, as exemplified by the unexpected circumstances presented by the COVID-19 pandemic. NHGRI is committed to training the next generation of scientists and clinicians who can bring genomics expertise to the next set of unanticipated challenges that present themselves to the research, medical, and public health communities. Towards that end, NHGRI's Training and Career Development Program has developed several initiatives focused on facilitating the work and maturation of early career researchers, with an emphasis on attracting new investigators from diverse backgrounds.



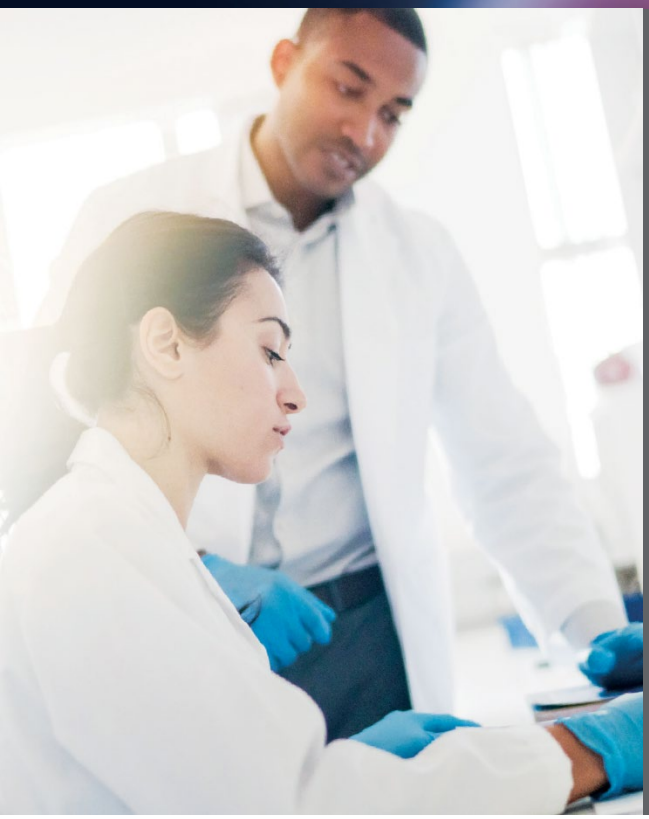
Roughly 18 years after completion of the Human Genome Project, genomic researchers finally generated a 100 percent complete reference of the ~3-billion-base human genome sequence. This historic achievement is a reflection of the foundational and ongoing investments in technology development and the values that undergird international and interdisciplinary collaborations, all lessons learned from the Human Genome Project. NHGRI remains committed to these values, which are deeply embedded in the bedrock of our Institute and allow us to continue to be a productive force at *The Forefront of Genomics*.

The Forefront of Genomics®

genome.gov

National Human Genome Research Institute

NHGRI conducts and funds world-class genomics research, trains the next generation of genomics experts, and collaborates with diverse communities to improve human health.



Empowering the Biomedical Research Community

Building on our leadership role in sequencing the human genome, NHGRI uses a "team science" approach to tackle increasingly complex biological problems. As one of the smaller institutes at the National Institutes of Health (NIH), we make every dollar we spend impactful. We assemble interdisciplinary research teams consisting of scientists, clinicians, ethicists, and other experts, and we ensure they have the funding and resources to advance genomics. This approach has stimulated a cultural change across biomedical research toward enhanced data sharing, increased collaboration in the scientific and medical communities, and a heightened appreciation for the impact of genomics on society.

Research Funding Areas:

- Structure and Biology of the Genome
- Biology of Disease
- Genomic Medicine
- Data Science
- Early Career Training
- Ethical, Legal, and Social Implications of Genomics
- Small Business Innovation

Our Institute

375 FTEs
FY 2022

$615,780,000
FY 2022 CR Budget
(1.4% of the total NIH budget)

$629,154,000
FY 2023 President's Budget Request

5% of NHGRI's research budget is dedicated to studying the ethical, legal, and social implications of genomics

From Bench to Bedside: Transforming Patient Care

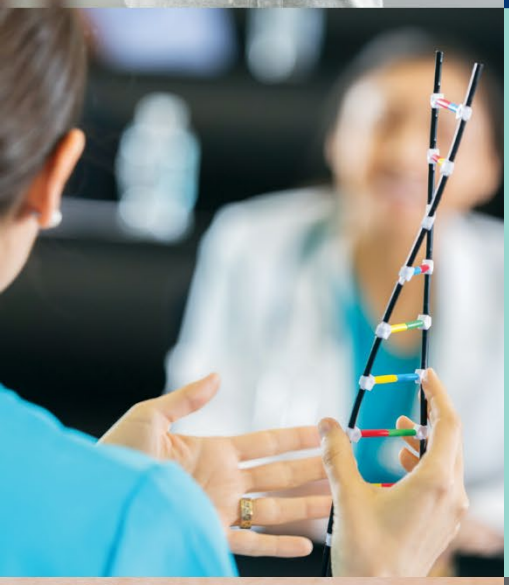
By catalyzing new technologies and building translational programs, our experts help understand, diagnose, and treat both rare and common diseases in sophisticated new ways.

Genomic Technologies

The research we fund paves the way for precision medicine and therapeutic interventions. NHGRI-funded investigators and consortia are developing new genomic and data analysis tools to transform the study of human biology and disease. One such center, the Center for Genome Editing and Recording led by 2020 Nobel Prize winner Dr. Jennifer Doudna, employs CRISPR/Cas9 genome-editing technology to understand how genomic variation contributes to disease and uncover new therapeutic targets.

Genomic Medicine

We are enabling healthcare professionals to use their patients' genomic information for personalized care. NHGRI is implementing genomic medicine across different clinical settings and in diverse populations as part of the Implementing Genomics in Practice (IGNITE) Pragmatic Trials Network (PTN). By integrating genomic data into electronic medical records and clinical decision making, NHGRI is piloting new approaches for personalized treatments that will be available to everyone in the future.



Driving Responsible Use of Genomics

NHGRI is committed to advancing genomic knowledge and ensuring that genomics benefits the health of all humans. We consider the ethical, legal, and social implications (ELSI) of genomics in all aspects of our work. The ELSI Research Program supports transdisciplinary Centers of Excellence in ELSI Research (CEER) that examine cutting-edge questions in ELSI research and translate this scholarship into practice and policy.

Our teams:

- Explore privacy concerns and how to communicate study results to research participants and their providers.
- Strive to increase participation of underrepresented populations in research.
- Engage with diverse communities to increase genomic literacy.
- Work with policymakers to inform policy decisions for a future in which genomics is part of daily life.

A 2020 Vision for Genomics

In October 2020, NHGRI published a strategic vision for the next decade that aims to expand genomics into new frontiers and enable novel applications to human health and disease. Through a multi-year process of strategic engagement, NHGRI collected input from diverse stakeholders at over 50 events. The anticipated advances in technology development, biological insights, and clinical applications will integrate genomics into virtually all areas of biomedical research, mainstream medical and public-health practices, and everyday life. NHGRI's strategic vision highlights research opportunities and priorities that are at *The Forefront of Genomics*:

I. Providing a socially responsible and highly ethical framework for conducting human genomics research by establishing and adhering to guiding principles and values.

II. Facilitating genomic advances by sustaining and improving a robust foundation for genomics research.

III. Breaking down barriers in genomics through advances that create new research opportunities and improve clinical care.

IV. Defining and leading the pursuit of bold and compelling genomics research projects focused on elucidating genome function, understanding human disease, studying the societal implications of genomics, and improving human health.

Major Changes in Fiscal Year 2023 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 2023 President's Budget request for NHGRI, which is $629.2 million, an increase of $13.4 million from the FY 2022 Continuing Resolution (CR) level. Within this request level, NHGRI will pursue its highest research priorities through strategic investments and careful stewardship of appropriated funds.

Research Project Grants (RPGs) (+$7.9 million, total $320.4 million):
NHGRI will support a total of 414 Research Project Grant (RPG) awards in FY 2023, including SBIR/STTR awards. Costs for non-competing RPGs will increase by $23.2 million, supporting 33 more awards than in the FY 2022 CR level. Funding for competing RPGs will decline by $17.4 million relative to the FY 2022 CR level, with 28 fewer awards.

Research Centers (-$1.6 million, total $6.4 million):
This decrease relative to the FY 2022 CR level represents completion of and the movement of ongoing NHGRI initiatives from the Research Centers budget mechanism line to the Other Research mechanism. Several of these programs are part of the NHGRI Genomic Community Resource Program which facilitates genomic research and the dissemination of its products, and supports resources that are crucial for disease studies, model organism studies, and other biomedical research

Research and Development Contracts (+$2.0 million, total $24.3 million):
This increase relative to the FY 2022 CR level represents additional support for NIH infrastructure and research support and an increase to strengthen NIH-wide cybersecurity.

Budget Mechanism Table

NATIONAL INSTITUTES OF HEALTH

National Human Genome Research Institute

Budget Mechanism *

(Dollars in Thousands)

Mechanism	FY 2021 Final		FY 2022 CR		FY 2023 President's Budget		FY 2023 +/- FY 2022	
	Number	Amount	Number	Amount	Number	Amount	Number	Amount
Research Projects:								
Noncompeting	203	$141,694	281	$220,935	314	$244,120	33	$23,185
Administrative Supplements	*(41)*	$40,711	*(5)*	$4,968	*(5)*	$6,215	0	$1,247
Competing:								
Renewal	12	$9,214	15	$11,305	11	$7,764	-4	-$3,541
New	128	$98,891	89	$59,130	65	$45,260	-24	-$13,870
Supplements	0	$0	0	$0	0	$0	0	$0
Subtotal, Competing	**140**	**$108,104**	**104**	**$70,435**	**76**	**$53,024**	**-28**	**-$17,411**
Subtotal, RPGs	343	$290,510	385	$296,338	390	$303,359	5	$7,021
SBIR/STTR	25	$16,449	23	$16,210	24	$17,040	1	$830
Research Project Grants	368	$306,959	408	$312,548	414	$320,398	6	$7,851
Research Centers								
Specialized/Comprehensive	1	$2,114	1	$555	0	$34	-1	-$521
Clinical Research	0	$373	0	$0	0	$0	0	$0
Biotechnology	11	$22,179	3	$7,456	3	$6,341	0	-$1,115
Comparative Medicine	0	$0	0	$0	0	$0	0	$0
Research Centers in Minority Institutions	0	$0	0	$0	0	$0	0	$0
Research Centers	**12**	**$24,667**	**4**	**$8,011**	**3**	**$6,375**	**-1**	**-$1,636**
Other Research:								
Research Careers	34	$4,974	41	$5,870	40	$5,839	-1	-$31
Cancer Education	0	$0	0	$0	0	$0	0	$0
Cooperative Clinical Research	0	$0	0	$0	0	$0	0	$0
Biomedical Research Support	0	$0	0	$0	0	$0	0	$0
Minority Biomedical Research Support	0	$345	0	$345	0	$345	0	-$0
Other	78	$83,406	94	$89,832	95	$91,088	1	$1,256
Other Research	**112**	**$88,724**	**135**	**$96,047**	**135**	**$97,272**	**0**	**$1,225**
Total Research Grants	492	$420,350	547	$416,606	552	$424,045	5	$7,440
Ruth L Kirschstein Training Awards:	FTTPs		FTTPs		FTTPs		FTTPs	
Individual Awards	29	$1,242	29	$1,259	29	$1,283	0	$24
Institutional Awards	171	$10,013	171	$10,580	171	$10,782	0	$201
Total Research Training	**200**	**$11,254**	**200**	**$11,839**	**200**	**$12,064**	**0**	**$225**
Research & Develop. Contracts	11	$22,246	11	$22,246	11	$24,282	0	$2,036
SBIR/STTR (non-add)	*(0)*	*($173)*	*(0)*	*($173)*	*(0)*	*($175)*	*(0)*	*($2)*
Intramural Research	239	$123,768	251	$126,448	258	$128,977	7	$2,529
Res. Management & Support	108	$36,545	124	$38,641	127	$39,786	3	$1,145
SBIR Admin. (non-add)	*(0)*	*($50)*	*(0)*	*($50)*	*(0)*	*($50)*	*(0)*	*($0)*
Construction		$0		$0		$0		$0
Buildings and Facilities		$0		$0		$0		$0
Total, NHGRI	**347**	**$614,163**	**375**	**$615,780**	**385**	**$629,154**	**10**	**$13,374**

* All items in italics and brackets are non-add entries.

Appropriations Language

NATIONAL HUMAN GENOME RESEARCH INSTITUTE

For carrying out section 301 and title IV of the PHS Act with respect to human genome research, $629,154,000.

Summary of Changes

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Summary of Changes
(Dollars in Thousands)

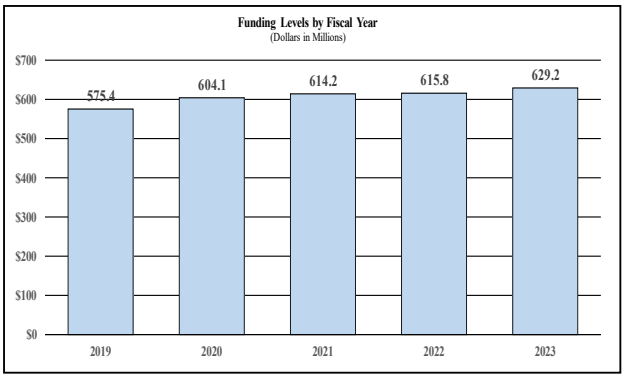
FY 2022 CR	$615,780
FY 2023 President's Budget	$629,154
Net change	$13,374

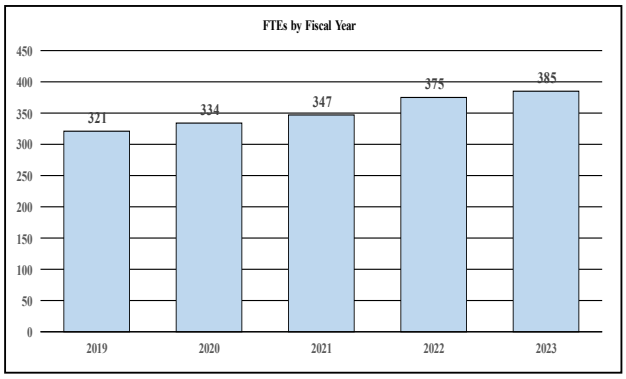
CHANGES	FY 2022 CR FTEs	FY 2022 CR Budget Authority	FY 2023 President's Budget FTEs	FY 2023 President's Budget Budget Authority	Built-In Change from FY 2022 CR FTEs	Built-In Change from FY 2022 CR Budget Authority
A. Built-in:						
1. Intramural Research:						
a. Annualization of January 2022 pay increase & benefits		$48,352		$51,352		$321
b. January FY 2023 pay increase & benefits		$48,352		$51,352		$1,637
c. Paid days adjustment		$48,352		$51,352		-$184
d. Differences attributable to change in FTE		$48,352		$51,352		$1,228
e. Payment for centrally furnished services		$21,422		$21,850		$428
f. Cost of laboratory supplies, materials, other expenses, and non-recurring costs		$56,675		$55,775		$1,234
Subtotal						$4,664
2. Research Management and Support:						
a. Annualization of January 2022 pay increase & benefits		$19,542		$20,751		$129
b. January FY 2023 pay increase & benefits		$19,542		$20,751		$661
c. Paid days adjustment		$19,542		$20,751		-$74
d. Differences attributable to change in FTE		$19,542		$20,751		$493
e. Payment for centrally furnished services		$1,492		$1,522		$30
f. Cost of laboratory supplies, materials, other expenses, and non-recurring costs		$17,607		$17,513		$384
Subtotal						$1,623
Subtotal, Built-in						$6,287

CHANGES	FY 2022 CR No.	FY 2022 CR Amount	FY 2023 President's Budget No.	FY 2023 President's Budget Amount	Program Change from FY 2022 CR No.	Program Change from FY 2022 CR Amount
B. Program:						
1. Research Project Grants:						
a. Noncompeting	281	$225,903	314	$250,335	33	$24,432
b. Competing	104	$70,435	76	$53,024	-28	-$17,411
c. SBIR/STTR	23	$16,210	24	$17,040	1	$830
Subtotal, RPGs	408	$312,548	414	$320,398	6	$7,851
2. Research Centers	4	$8,011	3	$6,375	-1	-$1,636
3. Other Research	135	$96,047	135	$97,272	0	$1,225
4. Research Training	200	$11,839	200	$12,064	0	$225
5. Research and development contracts	11	$22,246	11	$24,282	0	$2,036
Subtotal, Extramural		$450,691		$460,391		$9,700
6. Intramural Research	251	$126,448	258	$128,977	7	-$2,135
7. Research Management and Support	124	$38,641	127	$39,786	3	-$479
8. Construction		$0		$0		$0
9. Buildings and Facilities		$0		$0		$0
Subtotal, Program	375	$615,780	385	$629,154	10	$7,087
Total built-in and program changes						$13,374

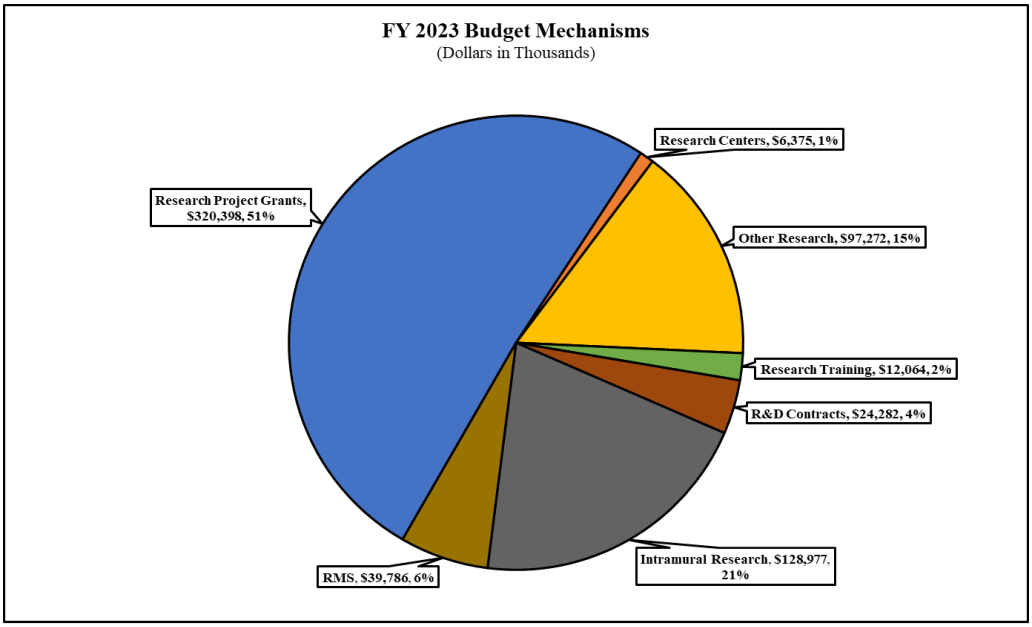
Fiscal Year 2023 Budget Graphs

History of Budget Authority and FTEs:

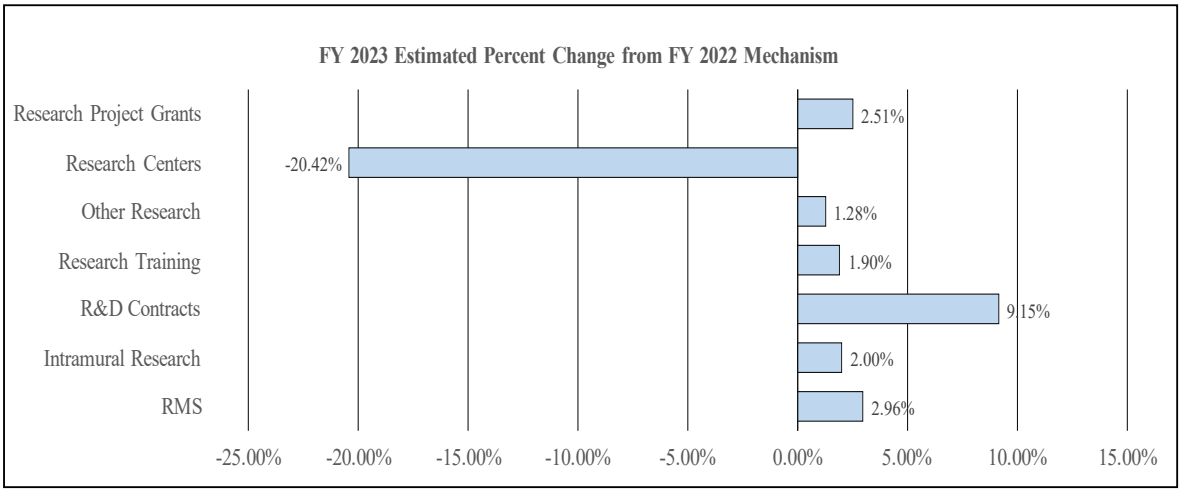




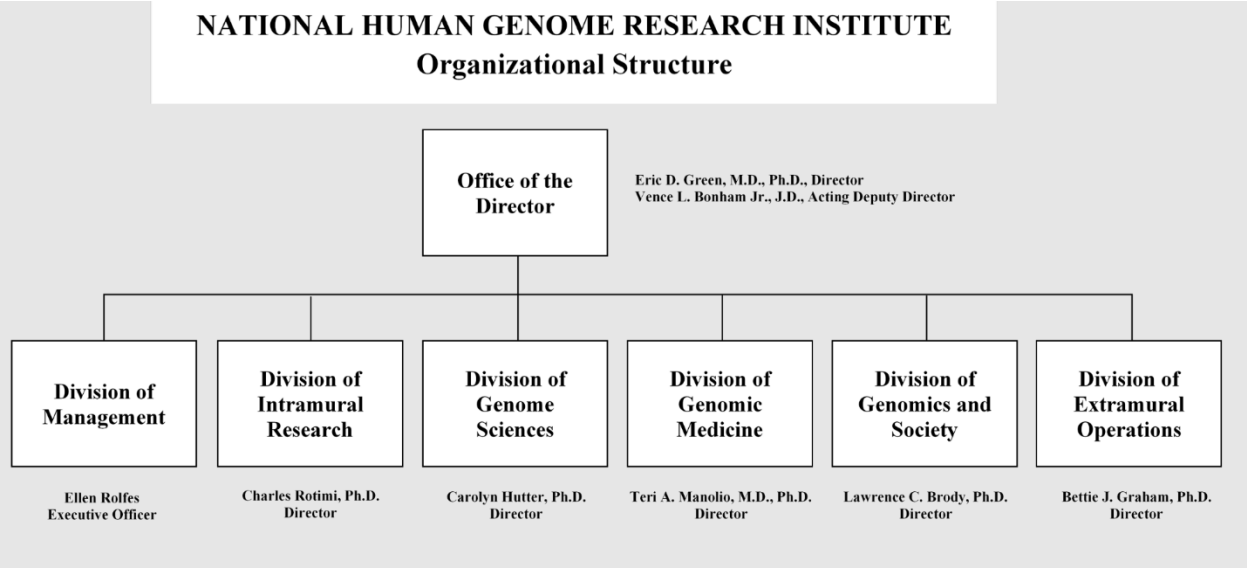
Distribution by Mechanism:



Change by Selected Mechanisms:



Organization Chart



Budget Authority by Activity Table

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

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

Program Activity	FY 2021 Final FTE	FY 2021 Final Amount	FY 2022 CR FTE	FY 2022 CR Amount	FY 2023 President's Budget FTE	FY 2023 President's Budget Amount	FY 2023 +/- FY 2022 CR FTE	FY 2023 +/- FY 2022 CR Amount
Detail								
Understanding the Structure of Genomes		$44,903		$44,679		$45,636		$957
Understanding the Biology of Genomes		107,084		106,817		109,090		2,273
Using Genomics to Understand the Biology of Disease		118,424		118,856		121,346		2,490
Using Genomics to Advance Medical Science		23,992		24,374		24,869		495
Using Genomics to Improve the Effectiveness of Healthcare		14,506		14,617		14,921		303
Bioinformatics, Computational Biology, and Data Science		185,644		184,777		188,731		3,954
Education and Training		28,445		28,566		29,164		597
Genomics and Society		54,620		54,452		55,613		1,160
Subtotal, Program Activity*		**$577,618**		**$577,139**		**$589,368**		**$12,229**
Extramural Research (non-add)		*(453,850)*		*(450,691)*		*(460,391)*		*(9,700)*
Intramural Research (non-add)	**239**	*(123,768)*	**251**	*(126,448)*	**258**	*(128,977)*	**7**	*(2,529)*
Research Management & Support	**108**	**$36,545**	**124**	**$38,641**	**127**	**$39,786**	**3**	**$1,145**
TOTAL	**347**	**$614,163**	**375**	**$615,780**	**385**	**$629,154**	**10**	**$13,374**

[1] Includes FTEs whose payroll obligations are supported by the NIH
* The detail programs listed above include both Extramural and Intramural Funding

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 2021 Final	FY 2022 CR	FY 2023 President's Budget	FY 2023 +/- FY 2022
BA	$614,163,000	$615,780,000	$629,154,000	$13,374,000
FTE	347	375	385	10

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

Overall Budget Policy: The FY 2023 President's Budget request for NHGRI is $629.2 million, an increase of $13.4 million compared with the FY 2022 CR level. This increase is distributed across all programmatic areas of basic, translational, and clinical research.

Program Descriptions

Understanding the Structure of Genomes: The recent generation of a 100 percent complete reference of the roughly 3-billion-base human genome sequence, made possible by an international collaborative effort that includes funding from NHGRI, the National Library of Medicine (NLM), the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), the National Institute of General Medical Sciences (NIGMS), the NIH Common Fund, the Wellcome Trust, universities across the globe, and other partners, represents a key milestone in genomics. The gapless, comprehensive view of the human genome, now openly accessible via the National Center for Biotechnology Information website and other sources, provides a foundation for future efforts to answer even more complex questions about the interplay of our DNA with health and disease than were previously possible.

NHGRI's Genome Technology Development Program has played a leading role in supporting research that has reduced the cost of DNA sequencing by over a million-fold since the Human Genome Project. These efforts have not only revolutionized the study of human genomic variation by facilitating the sequencing of hundreds of thousands of human genomes, but they also laid the foundation for the rapid sequencing of the SARS-CoV-2 genomes in the research and diagnostic settings as well as the development of mRNA-based COVID-19 vaccines. The current focus of the Genome Technology Development Program has shifted to address the

scientific and technical challenges that remain in developing genomic technologies for a wide set of applications. Current and future awards will continue to support developing both novel nucleic acid sequencing methods and other genomic technologies, such as approaches for the large-scale synthesis of DNA.

These technological advances in DNA sequencing are leading to new opportunities to improve the human genome reference sequence. To this end, NHGRI created and supports the multi-component Human Genome Reference Program (HGRP), which aims to improve the human genome reference sequence that is used widely by the research community and to foster its ongoing improvement and long-term sustainability. As the HGRP investigators are working to generate and release the first pangenome reference sequence, they are addressing important questions, such as how to choose the most appropriate human populations for study, how to effectively produce a complete genome sequence, how to represent a pangenome sequence in a readily understandable fashion, and how to develop tools for productively using the pangenome reference sequence. In the second year of the program, the HGRP conducted extensive outreach to the scientific community in an effort to address these questions.

As DNA sequencing technologies improve, the genomics community continues to glean valuable new insights by comparing the human genome to the genomes of various non-human organisms. NHGRI's Comparative Genomics Program involves research projects that are sequencing genomes from species across the tree of life in order to characterize the genomic similarities and differences that have emerged throughout evolution. NHGRI recognizes the importance of partnerships in this area of science, with the Comparative Genomics Program signing on to the National Science Foundation-led Enabling Discovery through GEnomics (EDGE) Program. In addition, comparative genomics will contribute to our understanding of tissue-specific gene expression at distinct developmental stages through the Non-Human Primate Developmental Genotype-Tissue Expression (NHP dGTEx) Project that is being conducted in collaboration with the National Institute of Mental Health and the Office of Research Infrastructure Programs. NHGRI staff will also continue to be involved in the Inter-Agency Comparative Genomics Interest Group and aims to continue developing other trans-agency partnerships in FY 2023 and beyond.

Budget Policy: The FY 2023 President's Budget request for Understanding the Structure of Genomes is $45.6 million, an increase of $1.0 million or 2.1 percent from the FY 2022 CR level. With these funds, NHGRI will continue to support the development of novel nucleic acid sequencing technologies and data-analysis methods. NHGRI will also continue to fund the efforts of the Human Genome Reference Program to produce a "pangenome" reference sequence that is more representative of the genomic variation that exists across humanity.

Understanding the Biology of Genomes: In order to unlock the potential for scientific discovery that will come with a detailed understanding of the human genome, efforts to detect and characterize all functional elements in human DNA become critically important. NHGRI continues to be a leader in this rapidly advancing area of genomics. As the well-regarded Encyclopedia of DNA Elements (ENCODE) project, launched in 2003, finishes its final phase,

Understanding the Impact of Genomic Variation on Function

The completion of the Human Genome Project in 2003 marked the beginning of efforts to comprehensively determine the function of the human genome's roughly 3-billion letters. An initial first step involved identifying the ~20,000 genes in the human genome, although much work remains for understanding how most of these genes function. Beyond the genes are numerous other elements in the human genome involved in choreographing various biological functions.

Spelling differences among people's genomes (genomic variation) can influence genome function, and in fact, account for much of the differences seen among people, including those related to their health. Humans are 99.9 percent identical to one another in terms of their genome sequences, with the small remaining 0.1 percent of genomic variation being critically important to understand, especially as genomics becomes increasingly used in medicine.

A 2019 NHGRI workshop and the 2020 NHGRI Strategic Vision highlighted the importance of improving our understanding of the interplay between genomic variation and biological function. This led to the creation of the Impact of Genomic Variation on Function (IGVF) Consortium, which aims to determine how human genomic variation contributes to differences in various traits and disease risk. NHGRI plans to provide the IGVF Consortium $185 million over 5 years to fund 26 awards throughout the United States. The awardees will work together to accomplish the goals of the program, conducting experimental studies and computational-based predictive modeling that will provide insights about the impact of genomic variants on human health and disease. This includes generating a data resource and new methods for use by the research community.

In forming the IGVF Consortium, NHGRI worked to include experienced investigators who are new to the field, those from demographic groups or institutions that are generally underrepresented in genomics, and those new to NHGRI consortia. NHGRI is committed to increasing diversity in genomics, and the IGVF Consortium provides an opportunity for conscious inclusion of historically underrepresented populations to ensure everyone benefits from the ultimate health implications of these studies.

NHGRI recently launched a new program called the Impact of Genomic Variation on Function (IGVF) that seeks to build on ENCODE's successes by systematically examining the impact of genomic variation on genome function and phenotypes (see Program Portrait nearby). NHGRI has committed $185 million over five years to IGVF, and, in FY 2023, the program will continue to develop innovative predictive models, identify and characterize functional genomic elements, and build a catalog of variant effects that will be shared with the research community.

Gaining a fundamental understanding of how genomic variation influences human biology at different times in life will be important for using genomics in medicine. NHGRI is a key contributor to NIH Common Fund efforts, such as the Human BioMolecular Atlas Program (HuBMAP) and the 4D Nucleome (4DN) program, that seek to understand how genomes operate across time and space. The 4DN program has made 30 awards to support 6 initiatives in its second stage, which will facilitate research on the three-dimensional organization of the nucleus and how it changes over time. Researchers supported by HuBMAP utilize the power of genomics to understand the spatial organization and specialization of the roughly 37 trillion cells in the adult human body. During the production phase of HuBMAP (FY 2022-2026), this collaborative effort will develop a widely accessible framework for comprehensively mapping the human body at single-cell resolution.

In order to ensure that investigators throughout the research community have access to the technologies that allow for robust genomic analyses, NHGRI continues to support, in partnership with other NIH institutes and centers, the Center for Inherited Disease Research (CIDR), which was

established in 1996 and remains a valuable resource for the research community. In FY 2023, CIDR will continue its mission to provide cutting-edge genomic services to NIH-funded investigators, including large consortia such as the OncoArray Network, Population Architecture Using Genomics and Epidemiology (PAGE), and Human Heredity and Health in Africa (H3Africa). CIDR continues to have a sustained focus on research and development, including that related to developing new statistical, informatics, and laboratory methods for advancing high-throughput genotyping and sequencing studies.

Budget Policy: The FY 2023 President's Budget request for Understanding the Biology of Genomes is $109.1 million, an increase of $2.3 million or 2.1 percent from the FY 2022 CR level. NHGRI will continue to fund programs that seek to understand the biology of genomes as a key step towards advancing the use of genomics in clinical care and disease prevention. CIDR will continue to support numerous investigators in pursuing their genomics-based research objectives.

Using Genomics to Understand the Biology of Disease: The path to realizing the promise of genomic medicine requires understanding not only how variation in the genome influences biological function, but how these effects eventually contribute to human disease. The 2020 NHGRI Strategic Vision laid out a set of "bold predictions for human genomics by 2030" that included: "The biological function(s) of every human gene will be known; for non-coding elements in the human genome, such knowledge will be the rule, rather than the exception." A powerful way to understand the function of a gene is to study what happens when it is inactivated or "knocked out." Aiming to make progress towards this prediction, NHGRI established the Molecular Phenotypes of Null Alleles in Cells (MorPhiC) program to develop a catalog of molecular and cellular phenotypes that result by inactivating each human gene. This work will help to elucidate the roles and relationships of genes in pathways and networks and inform our understanding of how genes contribute to health and disease.

NHGRI's Centers of Excellence in Genomic Science (CEGS) program, established in FY 2001, aims to develop transformative approaches that address important biological and biomedical research problems and advance genomic science. Each CEGS engages a team of interdisciplinary scientists, ranging from basic and clinical scientists to engineers and ethicists, to develop novel approaches and concepts that improve the ability of researchers to produce, analyze, integrate, and use genomic data. In FY 2020, the NHGRI budget included an additional $10 million allocation for "emerging Centers of Excellence in Genomic Science" (eCEGS), targeting institutions which had not previously received a CEGS award. In FY 2021, this funding increased to $12.5 million per year. These funds will be used to develop scientific infrastructure through funding CEGS at institutions that have not previously received a CEGS award, continuing to expand and diversify the genomics enterprise.

NHGRI has always been and remains committed to responsible, open data sharing and the development and maintenance of resources that benefit the genomics community. The Genomic Community Resources are a collection of awards that NHGRI supports to enable data integration, comparison of methods, and a widening scope of genomics research. Open sharing of genomic data and accessible resources are crucial to collaborative, interdisciplinary efforts to elucidating the genomic bases of disease. In FY 2023, NHGRI will continue to support efforts to

ensure that shared genomic databases and resources meet the needs of the research community and realize the promise of genomics for all populations and communities.

Budget Policy: The FY 2023 President's Budget request for Using Genomics to Understand the Biology of Disease is $121.3 million, an increase of $2.5 million or 2.1 percent from the FY 2022 CR level. These funds will support the CEGS/eCEGS program's efforts in human genomics, as well as the maintenance and expanded capacity of critical genomic databases, catalogs, and knowledgebases that facilitate the use of genomics for studying human disease.

Using Genomics to Advance Medical Science: As genomic variation is increasingly being associated with human phenotypes (including diseases), the resulting knowledge can be applied in clinical care to diagnose inherited disorders, some of which will be previously unknown, and to inform treatment. The NHGRI-funded Centers for Mendelian Genomics (CMG) have led the way in discovering the genomic bases of rare diseases, reporting a total of 3,617 gene-disease pairs since the program's inception in FY 2011. In FY 2021, NHGRI committed $80 million over five years to the new Genomics Research Elucidates Genetics of Rare Disease (GREGoR) Consortium, which will aim to identify the genomic bases for rare diseases for which the cause is still unknown – building on NHGRI's already successful efforts in the area of disease-gene discovery. The GREGoR Consortium will include five clinical sites and one data coordination center, which will apply novel analytical approaches fueled by cutting-edge genome-sequencing technologies to expand the set of rare diseases for which the underlying cause is known.

To achieve effective integration of genomics into clinical care, clinicians and researchers must have access to expertly curated information about the relationship between genomic variants and human disease. The Clinical Genome Resource (ClinGen) aims to collect that information, develop consensus approaches to genomic variant interpretation and classification, and disseminate the resulting information to the genomics and medical communities. In FY 2021, ClinGen was renewed for an additional five years, with co-funding from the National Cancer Institute. The third phase of ClinGen will emphasize three overarching themes: (1) engaging patients, healthcare systems, scientific experts, and genetics professionals; (2) increasing the scale of the consortium's work and its applications; and (3) embracing diversity in all regards, from the diversity of the genomics workforce to the diversity of the patients and population databases. In FY 2023, ClinGen will continue to provide, and improve upon, this essential resource for the research and clinical communities.

Budget Policy: The FY 2023 President's Budget request for Using Genomics to Advance Medical Science is $24.9 million, an increase of $0.5 million or 2.0 percent from the FY 2022 CR level. In FY 2023, GREGoR and ClinGen will utilize these funds to continue to advance the implementation of genomic medicine by supporting the successful integration of genomics into clinical decision making and care.

Using Genomics to Improve the Effectiveness of Healthcare: NHGRI is dedicated to ensuring that genomics improves human health by building on discoveries made through genomic studies and applying them in real-world clinical settings. The Implementing Genomics in Practice (IGNITE) Pragmatic Trials Network (PTN), building on the successful genomic medicine projects of the initial phase of IGNITE (IGNITE I), works to actively implement genomic

medicine in clinical settings with diverse populations. IGNITE PTN (or IGNITE II) supports a network of multi-site Clinical Groups, conducting two pragmatic clinical trials of genomic medicine interventions: Genetic Testing to Understand and Address Renal Disease Disparities Across the United States (GUARDD-US) and A Depression and Opioid Pragmatic Trial in Pharmacogenetics (ADOPT-PGx). GUARDD-US began enrollment in July 2020 and has enrolled over 3,800 patients as of February 2022. ADOPT-PGx is comparing genotype-guided drug therapy versus conventional approaches to drug therapy selection for acute post-surgical pain, chronic pain, and depression via changes in patient-reported outcomes representing pain and depression control. ADOPT-PGx began enrollment in February 2021 and has accrued over 1,000 patients as of February 2022. The information generated from these trials will contribute to the growing knowledge of utilizing genomic information in patient care.

Improving Genomics-based Disease Risk Calculations in Diverse Populations

Genomic medicine provides the opportunity for more personalized healthcare based on an individual's unique genomic makeup. Realizing such an opportunity is particularly challenging for common diseases, such as cancer, cardiovascular disease, and mental illness, which most often are influenced by variants in multiple genes (that is, such diseases are considered polygenic in nature).

An emerging tool for estimating a patient's risk for developing such common diseases involves calculating a polygenic risk score (PRS) for a specific disorder, which involves accounting the number and characteristics of disease-associated genomic variants present in a patient's genome. The use of PRSs in genomic medicine represents an active and exciting area of research. However, because of the historical over-representation of people of European ancestry in genomics research, it is difficult to currently perform PRS studies in non-European populations.

NHGRI recently launched the **P**olygenic **Ri**sk **Me**thods in **D**iverse populations (PRIMED) Consortium, which aims to improve the application of PRSs to predict health and disease risk across diverse populations. The PRIMED Consortium will develop improved methods and more comprehensively analyze existing genomic and associated disease information from datasets from around the world, including those from large numbers of non-European individuals. The PRIMED Consortium includes 8 study sites, each of which will take a unique approach to improving PRS development and collaborate using 120 datasets from over 40 different countries. The overall goal of the program is to collectively develop methods that are widely available to the biomedical research community and build a robust foundation for the large-scale use of PRSs in clinical practice.

Although rare monogenic disorders collectively represent a significant public health burden, the most common diseases afflicting the United States and worldwide population (such as heart disease and diabetes) are caused by complex interactions involving many genomic variants and the physical and social environments. Realizing the promise of genomic medicine for these common diseases requires the integration of many data types and improved methods for risk prediction that apply for all populations. The Consensus Measures for Phenotypes and eXposures (PhenX) Toolkit – a collaborative effort between NHGRI and seven other NIH offices, institutes, and centers – provides researchers with standard measures related to complex diseases, phenotypic traits, and environmental exposures in order to facilitate combining data across multiple studies. In response to the COVID-19 pandemic, PhenX worked with DR2 (NIH Public Health Emergency and Disaster Research Response) to curate COVID-19-related protocols and organize them by topic. PhenX was awarded a supplement to advance its COVID-19 collection. The COVID-19 Research Collections were released in October 2020 and consist

of six specialty collections. Moving forward, PhenX aims to expand its recently published social determinants of health collection.

Another way to accelerate the use of genomics in medicine is to better understand who is at an increased risk of having a certain disease. Such knowledge would allow for focusing resources, such as early detection and preventative interventions. One way to identify individuals at increased risk of a disease is to use a polygenic risk score (PRS). PRSs are calculated based on the total number of disease-associated genomic variants that a person harbors. The use of PRSs is intensively being studied for a broad range of diseases, ranging from cancer to heart disease to mental illness. However, at present, these scores perform more poorly in non-European individuals due to the dearth of genomic data for these populations. The Polygenic Risk MEthods in Diverse populations (PRIMED) Consortium is conducting a new initiative funded by NHGRI and NCI that will work to improve the use of PRSs by studying much larger numbers of non-European individuals (see Program Portrait nearby). NHGRI and NCI have committed $38 million over five years to establish and support the PRIMED Consortium, continuing to lead in the effort to improve genomic risk prediction for all populations in FY 2023 and beyond.

Budget Policy: The FY 2023 President's Budget request for Using Genomics to Improve the Effectiveness of Healthcare is $14.9 million, an increase of $0.3 million or 2.1 percent from the FY 2023 CR level. Using FY 2023 funds, IGNITE will continue to pioneer and study real-world applications of genomics in healthcare to improve patient outcomes, and PRIMED will work to improve the predictive ability and responsible use of PRSs to assess disease risk in diverse populations.

Bioinformatics, Computational Biology, and Data Science: The field of genomics is fueled by innovations in the approaches used for assimilating and analyzing data. Supporting these innovations is an integral part of NHGRI's mission, and NHGRI's commitment to bioinformatics, computational genomics, and data science is a key component of the 2020 NHGRI Strategic Vision. NHGRI's Computational Genomics and Data Science (CGDS) Program supports the development of improved computational approaches, innovative data analysis tools, and data resources that provide scientific utility to the research community. In keeping with the NIH Strategic Plan for Data Science, the CGDS Program is supporting a number of new trans-NIH activities in collaboration with the NIH Division of Program, Coordination, Planning, and Strategic Initiatives (DPCPSI) and its Office of Data Science Strategy (ODSS) . The CGDS Program has elicited a robust response from the research community (15 funded applications) in response to three FY 2021 funding opportunity announcements soliciting investigator-initiated and small business research in computational genomics, data science, statistics, and bioinformatics relevant to genomics. In April 2021, the NHGRI Genomic Data Science Working Group (GDSWG) of the National Advisory Council for Human Genome Research, with support from CGDS Program staff, hosted a Machine Learning in Genomics Workshop to identify key areas of potential investment by NHGRI in this increasingly important field in FY 2023 and beyond.

The Genomic Data Science Analysis, Visualization, and Informatics Lab-space (AnVIL), funded by NHGRI in 2018, provides the genomics community with cloud-based computing infrastructure and specialized expertise necessary to store, curate, analyze, and share large

genomic datasets and associated phenotypic information. AnVIL investigators are in the process of onboarding additional, high-value NHGRI consortia datasets including those from the CMGs and the Clinical Sequencing Evidence-Generating Research (CSER) consortia. To date, AnVIL has onboarded almost four petabytes of data and that number will only continue to grow in FY 2023 and beyond. AnVIL will also serve as the data sharing platform for the recently awarded Polygenic Risk Methods in Diverse Populations (PRIMED) consortium, as well as for other NHGRI programs that are currently being established. Since early in the COVID-19 pandemic, AnVIL has been collaborating with the European Genome-Phenome Archive (EGA) to facilitate access by researchers to datasets from international COVID-19 host genetics studies. In line with the international genomic data sharing standards set forth by the Global Alliance for Genomics and Health (GA4GH), AnVIL is conducting a pilot of the Data Use Oversight System (DUOS) to semi-automate and efficiently manage the sharing of human subject data in compliance with the data use restrictions. The feasibility of using a DUOS-based approach for managing data access is currently being tested by a few NIH Data Access Committees, including NHGRI's. The AnVIL is also one of the founding members of the NIH Cloud Platform Interoperability (NCPI) project, together with other NIH platforms including the NHLBI BioData Catalyst, the NCI Cancer Research Data Commons and the Common Fund Kids First Data Resource Center. Collectively these platforms host data from 176 studies representing about 690,000 participants and almost 11 petabytes of data. The NCPI members have worked collaboratively to leverage the interoperability standards of the NIH Researcher Auth Service (RAS) and the Fast Healthcare Interoperability Resources (FHIR), as well as GA4GH DRS standards to address real world scientific use cases that utilize data from all these systems.

In a demonstration of its growing commitment to data science, NHGRI is in the process of appointing a Chief Data Strategist within the Office of the Director, who will provide leadership for the Institute's computational and data science efforts.

Budget Policy: The FY 2023 President's Budget request for Bioinformatics, Computational Biology, and Data Science is $188.7 million, an increase of $4.0 million or 2.1 percent from the FY 2022 CR level. With FY 2023 funds, NHGRI will continue to push the frontiers of data-analyses technologies. AnVIL will continue to provide a cutting-edge resource for the storage, analysis, and sharing of genomic data.

Education and Training: Attracting, developing, and retaining a diverse genomics workforce is a top priority for NHGRI and is necessary to utilize the power of genomics to meet the challenges faced by the research and clinical communities, both now and in the future. NHGRI recently established the Training, Diversity, and Health Equity (TiDHE) Office, which will bring together the Institute's training and workforce development efforts with its research initiatives in health disparities and health inequities (see Program Portrait nearby). In addition to overseeing the implementation of the NHGRI Action Agenda for Genomics Workforce Diversity, the TiDHE Office will participate in NIH-wide efforts, such as UNITE, and partner with professional societies, the National Academies of Sciences, Engineering, and Medicine, and industry to promote diversity in the genomics workforce.

NHGRI's Research Training and Career Development Program continues to support training opportunities for scientists at all stages of their careers. New genomics training initiatives in FY 2023 and beyond will focus on training medical professionals, such as physicians, genetic counselors, and other clinicians. Additionally, as the computational challenges in genomics continue to grow, there are efforts to increase genomic data science training for both PhD scientists as well undergraduates and masters-level trainees. NHGRI is committed to increasing the diversity of the genomics workforce by creating funding opportunities specifically targeted for individuals who are currently underrepresented in genomics. For example, the AnVIL program is offering training opportunities for researchers and students of underrepresented backgrounds interested in data science applications to genomic research.

Building a More Diverse Genomics Workforce

Although the United States population is incredibly diverse, the genomics and biomedical research workforce falls short of reflecting the same diversity. The promise of genomics cannot be fully realized without successfully attracting, developing, and retaining a diverse workforce that more closely resembles the country's population. A recent report by the U.S. Government Accountability Office further underscored the need to increase the size and diversity of the clinical genomics workforce (e.g., genetic counselors and medical geneticists) as the demands of the field are quickly outpacing the availability of trained professionals, especially if we hope to close the gap in healthcare disparities.

NHGRI is deeply committed to enhancing the diversity of the genomics workforce by 2030. The 2020 NHGRI Strategic Vision and the resulting "Building a Diverse Genomics Workforce: An NHGRI Action Agenda" outline an ambitious set of goals and objectives towards establishing a more inclusive genomics workforce. The Action Agenda has four major goals: (1) develop and support initiatives that provide early exposure and access to careers in genomics; (2) develop and support training programs and networks that connect undergraduate and graduate education to careers in genomics; (3) develop and support training, career development, and research transition programs that lead to independent research and clinical careers in genomics; and (4) evaluate progress towards achieving greater diversity in the genomics workforce.

Like the monumental challenge of sequencing the human genome for the first time, NHGRI stands ready to tackle these Herculean tasks. Towards that end, NHGRI recently established the Training, Diversity, and Health Equity (TiDHE) Office, which will coordinate NHGRI training programs that prepare individuals for genomics careers and develop and support programs for building a more diverse genomics workforce, such as those described in the new Action Agenda.

NHGRI is partnering with academic institutions, professional societies, private industry, non-profits, and other groups to support new opportunities to enhance the diversity of the genomics workforce. These partnerships strive to expand participation and diversity in genomics training and biomedical research, including a focus on developing partnerships with Minority Serving Institutions. NHGRI acknowledges its role to provide responsible stewardship in this area as a leader at the forefront of human genomics. A diverse genomics workforce is an urgent priority, and the above efforts will provide a strong foundation for NHGRI's long-term commitment to this priority.

NHGRI also continues to fund the Genomic Innovator Awards and – in partnership with the American Society of Human Genetics – the Human Genetics Scholars Initiative (HGI), with both programs supporting early career researchers. In FY 2021, 11 early career genomics investigators who are part of consortia or other team-science efforts received Genomic Innovator Awards. HGI provides crucial mentorship and funds to early-career scientists from underrepresented backgrounds; in FY 2023, the third class of eight HGI scholars will begin their second year of the program and the fourth class will begin the program.

In addition to supporting summer interns, post-baccalaureate fellows, graduate students, and postdoctoral fellows of all backgrounds, the NHGRI Intramural Research Program participates in the NIH Office of Intramural Training and Education's High School Scientific Training and Enrichment Program 2.0 (HiSTEP 2.0), offered to high school seniors who have little to no research experience, providing them an opportunity to spend a summer performing biomedical research at NIH. NHGRI's Education and Community Involvement Branch provides genomics education and training resources for healthcare providers, tribal colleges, high school teachers, and other professionals and will continue to do so in FY 2023 and beyond.

Budget Policy: The FY 2023 President's Budget request for Education and Training is $29.1 million, an increase of $0.6 million or 2.1 percent from the FY 2022 CR level. These funds will be used by NHGRI to continue supporting diverse trainees in genomics at all stages of their careers and to aid in the development of early-stage investigators.

Genomics and Society: The 2020 NHGRI Strategic Vision outlined a set of principles and values for human genomics, which have been informed by ethical, legal, and social implications (ELSI) research, to which NHGRI dedicates at least 5 percent of its annual research budget. ELSI research emerged at the beginning of the Human Genome Project to ensure that the negative uses of genetics did not resurface (such as with eugenics), but this area of research has since grown to include a large portfolio of studies that examine the intersection of genomics, law, ethics, philosophy, and society. ELSI research is embedded in many larger genomics research projects funded by NHGRI, such as the Human Pangenome Reference Consortium and the Developmental Genotype-Tissue Expression Initiative (dGTEX), but the NHGRI ELSI Research Program funds its own standalone research studies, training opportunities, and workshops on salient topics, such as human germline genome editing.

In addition to its three currently active Program Announcements, the ELSI Research Program participates in several training and career development programs. It also supports the Centers of Excellence in ELSI Research (CEER) program, which currently supports four research centers at universities across the country, and the Center for ELSI Resources and Analysis (CERA), which assists in developing a more integrated ELSI research community. The ELSI Research Program is continuing to engage with the ELSI research and genomics communities to disseminate relevant work products and inform genetic and genomics research. CERA hosts the ESLIhub – the leading public resource for ELSI research and analysis. In July 2019, the ELSI Research Program issued a conference grant to support the biennial ELSI Research Congress. An ELSI Congress is expected to be held every two years, with the next Congress in 2024.

The ELSI Research Program is working to solicit more applications from diverse disciplines, with special attention being paid to work that uses analytical and conceptual approaches to address issues raised by emerging technologies. It is also strengthening partnerships with other NIH institutes, centers, and the *All of Us* Research Program to address these goals and to better coordinate ELSI research across the NIH.

Budget Policy: The FY 2023 President's Budget request for the NHGRI Genomics and Society is $55.6 million, an increase of $1.2 million or 2.1 percent from the FY 2022 CR level. In FY 2023, NHGRI will continue to fund ELSI research that is critical for ensuring ethical and successful advances in genomics.

Research Management and Support (RMS): Within NHGRI's Division of Genomics and Society and alongside the ELSI Research Program, the Policy and Program Analysis Branch (PPAB) and the Education and Community Involvement Branch (ECIB) use RMS funds to support NHGRI's mission of furthering genetics and genomics research by engaging with policymakers, stakeholders, educators, researchers, and clinicians.

PPAB supports NHGRI in a broad range of activities, including Congressional relations; program and portfolio analysis; policy tracking, dissemination, analysis and development; stakeholder engagement; and resource development for both scientific and lay audiences. In FY 2023 PPAB will continue to focus its portfolio to address emerging policy issues in genomics, such as data sharing, human subjects research, legal and regulatory landscapes, the implementation of genomic medicine, and other salient issues.

ECIB's education programs include those that inform the public of the latest advances in genomics as well as those that support the dissemination of information to teachers, students, consumers, and clinicians. ECIB spearheads NHGRI's educational activities for National DNA Day – an annual celebration of the discovery of DNA's double helix in 1953 and the successful completion of the Human Genome Project in 2003. ECIB continues to disseminate the *Genome: Unlocking Life's Code* newsletter in partnership with the Smithsonian National Museum of Natural History, which provides vital resources for educators, students, and parents. ECIB also aims to improve genomic literacy among healthcare providers via the Inter-Society Coordinating Committee for Practitioner Education in Genomics (ISCC-PEG), which includes over 200 representatives from societies, professional organizations, NIH institutes, industry, and individuals with expertise in medical education. New initiatives include the ISCC-PEG Scholars Program, a mentorship opportunity between ISCC-PEG members and students interested in genomics education, as well as new efforts to improve genomic literacy, including the "LGBTQI+ Issues in Genomics Project Group." In FY 2021, ECIB offered its annual NHGRI Short Course in Genomics for middle and high school teachers, community college instructors, and Tribal college faculty that teach science, technology, engineering, and math (STEM) courses.

NHGRI's Communications and Public Liaison Branch (CPLB), within the Office of the Director, creates media in the form of written articles, videos, graphics, and social media posts to provide high-quality and timely genomics information to the general public. Throughout FY 2021 and FY 2022, CPLB hosted a virtual lecture series featuring science communicators from all forms

of media, which emphasized the challenges in covering genomics in a rapidly changing world. Upon the announcement of a 100 percent complete, gapless human genome reference sequence in 2021, CPLB created an infographic explaining why it was so difficult for researchers to fill in those final gaps in the human genome sequence. During the COVID-19 pandemic, CPLB has also created easy-to-understand fact sheets about COVID-19 mRNA vaccines and COVID-19 PCR testing in collaboration with PPAB.

In FY 2023, PPAB, ECIB, and CPLB will continue to work in concert to promote sound policy, perform outreach and stakeholder engagement, and keep the public informed about the latest in genomics and genomic medicine.

Budget Policy: The FY 2023 President's Budget request for Research Management and Support is $39.8 million, an increase of $1.1 million or 3.0 percent from the FY 2022 CR level. These funds will be used to support a number of outreach, education, and stakeholder-engagement initiatives in FY 2023.

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Appropriations History

Fiscal Year	Budget Estimate to Congress	House Allowance	Senate Allowance	Appropriation
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	$531,438,000	$534,516,000	$528,566,000
Rescission				$0
2018	$399,622,000	$536,774,000	$546,934,000	$556,881,000
Rescission				$0
2019	$512,979,000	$563,531,000	$575,882,000	$575,579,000
Rescission				$0
2020	$495,448,000	$603,710,000	$607,999,000	$606,349,000
Rescission				$0
2021	$550,116,000	$611,564,000	$623,862,000	$615,780,000
Rescission				$0
2022	$632,973,000	$646,295,000	$634,598,000	$615,780,000
Rescission				$0
2023	$629,154,000			

[1] Budget Estimate to Congress includes mandatory financing.

Authorizing Legislation

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Authorizing Legislation

	PHS Act/ Other Citation	U.S. Code Citation	2022 Amount Authorized	FY 2022 CR	2023 Amount Authorized	FY 2023 President's Budget
Research and Investigation	Section 301	42§241	Indefinite	$615,780,000	Indefinite	$629,154,000
National Human Genome Research Institute	Section 401(a)	42§281	Indefinite		Indefinite	
Total, Budget Authority				$615,780,000		$629,154,000

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

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

Source of Funding	FY 2021 Final	FY 2022 CR	FY 2023 President's Budget
Appropriation	$615,780	$615,780	$629,154
Secretary's Transfer	-$1,849	$0	$0
OAR HIV/AIDS Transfers	$232	$0	$0
Subtotal, adjusted budget authority	$614,163	$615,780	$629,154
Unobligated balance, start of year	$0	$0	$0
Unobligated balance, end of year (carryover)	$0	$0	$0
Subtotal, adjusted budget authority	**$614,163**	**$615,780**	**$629,154**
Unobligated balance lapsing	-$32	$0	$0
Total obligations	$614,131	$615,780	$629,154

[1] Excludes the following amounts (in thousands) for reimbursable activities carried out by this account:
FY 2021 - $28,605 FY 2022 - $30,002 FY 2023 - $31,175

Budget Authority by Object Class

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

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

		FY 2022 CR	FY 2023 President's Budget	FY 2023 +/- FY 2022
Total compensable workyears:				
	Full-time equivalent	375	385	10
	Full-time equivalent of overtime and holiday hours	0	0	0
	Average ES salary	$204	$211	$8
	Average GM/GS grade	12.8	12.8	0.0
	Average GM/GS salary	$126	$131	$5
	Average salary, Commissioned Corps (42 U.S.C. 207)	$132	$137	$5
	Average salary of ungraded positions	$163	$169	$6
	OBJECT CLASSES	**FY 2022 CR**	**FY 2023 President's Budget**	**FY 2023 +/- FY 2022**
	Personnel Compensation			
11.1	Full-Time Permanent	$23,699	$25,485	$1,786
11.3	Other Than Full-Time Permanent	$20,199	$21,287	$1,088
11.5	Other Personnel Compensation	$1,085	$1,126	$41
11.7	Military Personnel	$224	$233	$8
11.8	Special Personnel Services Payments	$5,995	$6,219	$224
11.9	**Subtotal Personnel Compensation**	**$51,202**	**$54,350**	**$3,148**
12.1	Civilian Personnel Benefits	$16,502	$17,557	$1,055
12.2	Military Personnel Benefits	$189	$196	$7
13.0	Benefits to Former Personnel	$0	$0	$0
	Subtotal Pay Costs	**$67,894**	**$72,103**	**$4,209**
21.0	Travel & Transportation of Persons	$155	$185	$30
22.0	Transportation of Things	$148	$151	$3
23.1	Rental Payments to GSA	$0	$0	$0
23.2	Rental Payments to Others	$0	$0	$0
23.3	Communications, Utilities & Misc. Charges	$156	$160	$3
24.0	Printing & Reproduction	$8	$8	$0
25.1	Consulting Services	$24,648	$25,131	$483
25.2	Other Services	$24,917	$23,744	-$1,173
25.3	Purchase of Goods and Services from Government Accounts	$55,181	$57,921	$2,739
25.4	Operation & Maintenance of Facilities	$180	$180	$0
25.5	R&D Contracts	$2,025	$2,070	$45
25.6	Medical Care	$456	$474	$19
25.7	Operation & Maintenance of Equipment	$1,845	$1,886	$41
25.8	Subsistence & Support of Persons	$0	$0	$0
25.0	**Subtotal Other Contractual Services**	**$109,252**	**$111,405**	**$2,153**
26.0	Supplies & Materials	$6,282	$6,420	$138
31.0	Equipment	$2,556	$2,613	$56
32.0	Land and Structures	$884	$0	-$884
33.0	Investments & Loans	$0	$0	$0
41.0	Grants, Subsidies & Contributions	$428,445	$436,109	$7,665
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	**$547,886**	**$557,051**	**$9,165**
	Total Budget Authority by Object Class	**$615,780**	**$629,154**	**$13,374**

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

Salaries and Expenses

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Salaries and Expenses
(Dollars in Thousands)

Object Classes	FY 2022 CR	FY 2023 President's Budget	FY 2023 +/- FY 2022
Personnel Compensation			
Full-Time Permanent (11.1)	$23,699	$25,485	$1,786
Other Than Full-Time Permanent (11.3)	$20,199	$21,287	$1,088
Other Personnel Compensation (11.5)	$1,085	$1,126	$41
Military Personnel (11.7)	$224	$233	$8
Special Personnel Services Payments (11.8)	$5,995	$6,219	$224
Subtotal, Personnel Compensation (11.9)	**$51,202**	**$54,350**	**$3,148**
Civilian Personnel Benefits (12.1)	$16,502	$17,557	$1,055
Military Personnel Benefits (12.2)	$189	$196	$7
Benefits to Former Personnel (13.0)	$0	$0	$0
Subtotal Pay Costs	**$67,894**	**$72,103**	**$4,209**
Travel & Transportation of Persons (21.0)	$155	$185	$30
Transportation of Things (22.0)	$148	$151	$3
Rental Payments to Others (23.2)	$0	$0	$0
Communications, Utilities & Misc. Charges (23.3)	$156	$160	$3
Printing & Reproduction (24.0)	$8	$8	$0
Other Contractual Services			
Consultant Services (25.1)	$24,648	$25,131	$483
Other Services (25.2)	$24,917	$23,744	-$1,173
Purchase of Goods and Services from Government Accounts (25.3)	$38,737	$41,117	$2,381
Operation & Maintenance of Facilities (25.4)	$180	$180	$0
Operation & Maintenance of Equipment (25.7)	$1,845	$1,886	$41
Subsistence & Support of Persons (25.8)	$0	$0	$0
Subtotal Other Contractual Services	**$90,326**	**$92,058**	**$1,731**
Supplies & Materials (26.0)	$6,282	$6,420	$138
Subtotal Non-Pay Costs	**$97,075**	**$98,982**	**$1,906**
Total Administrative Costs	**$164,969**	**$171,084**	**$6,116**

Detail of Full-Time Equivalent Employment (FTE)

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Detail of Full-Time Equivalent Employment (FTE)

Office	FY 2021 Final			FY 2022 CR			FY 2023 President's Budget		
	Civilian	Military	Total	Civilian	Military	Total	Civilian	Military	Total
Division of Intramural Research									
Direct:	201	1	202	212	1	213	218	1	219
Reimbursable:	34	3	37	36	2	38	37	2	39
Total:	235	4	239	248	3	251	255	3	258
Office of the Director									
Direct:	10	-	10	15	-	15	17	-	17
Total:	10	-	10	15	-	15	17	-	17
Division of Management									
Direct:	42	-	42	48	-	48	48	-	48
Total:	42	-	42	48	-	48	48	-	48
Division of Genome Sciences									
Direct:	12	-	12	13	-	13	13	-	13
Reimbursable:	3	-	3	3	-	3	3	-	3
Total:	15	-	15	16	-	16	16	-	16
Division of Genomic Medicine									
Direct:	13	-	13	14	-	14	14	-	14
Reimbursable:	1	-	1	1	-	1	1	-	1
Total:	14	-	14	15	-	15	15	-	15
Division of Genomics and Society									
Direct:	10	-	10	13	-	13	13	-	13
Total:	10	-	10	13	-	13	13	-	13
Division of Extramural Operations									
Direct:	15	-	15	15	-	15	15	-	15
Reimbursable:	2	-	2	2	-	2	3	-	3
Total:	17	-	17	17	-	17	18	-	18
Total	343	4	347	372	3	375	382	3	385
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**								
2019	12.7								
2020	12.6								
2021	12.7								
2022	12.8								
2023	12.8								

Detail of Positions

NATIONAL INSTITUTES OF HEALTH
National Human Genome Research Institute

Detail of Positions[1]

GRADE	FY 2021 Final	FY 2022 CR	FY 2023 President's Budget
Total, ES Positions	2	2	2
Total, ES Salary	$398,600	$407,669	$422,924
General Schedule			
GM/GS-15	37	42	43
GM/GS-14	31	35	36
GM/GS-13	69	82	85
GS-12	34	39	40
GS-11	20	21	22
GS-10	0	0	0
GS-9	2	3	3
GS-8	12	12	12
GS-7	0	0	0
GS-6	0	0	0
GS-5	0	0	0
GS-4	0	0	0
GS-3	2	2	2
GS-2	0	0	0
GS-1	0	0	0
Subtotal	207	236	243
Commissioned Corps (42 U.S.C. 207)			
Assistant Surgeon General	0	0	0
Director Grade	2	2	2
Senior Grade	2	1	1
Full Grade	0	0	0
Senior Assistant Grade	0	0	0
Assistant Grade	0	0	0
Subtotal	4	3	3
Ungraded	145	147	151
Total permanent positions	213	241	248
Total positions, end of year	358	388	399
Total full-time equivalent (FTE) employment, end of year	347	375	385
Average ES salary	$199,300	$203,834	$211,462
Average GM/GS grade	12.7	12.8	12.8
Average GM/GS salary	$122,601	$125,849	$130,558

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