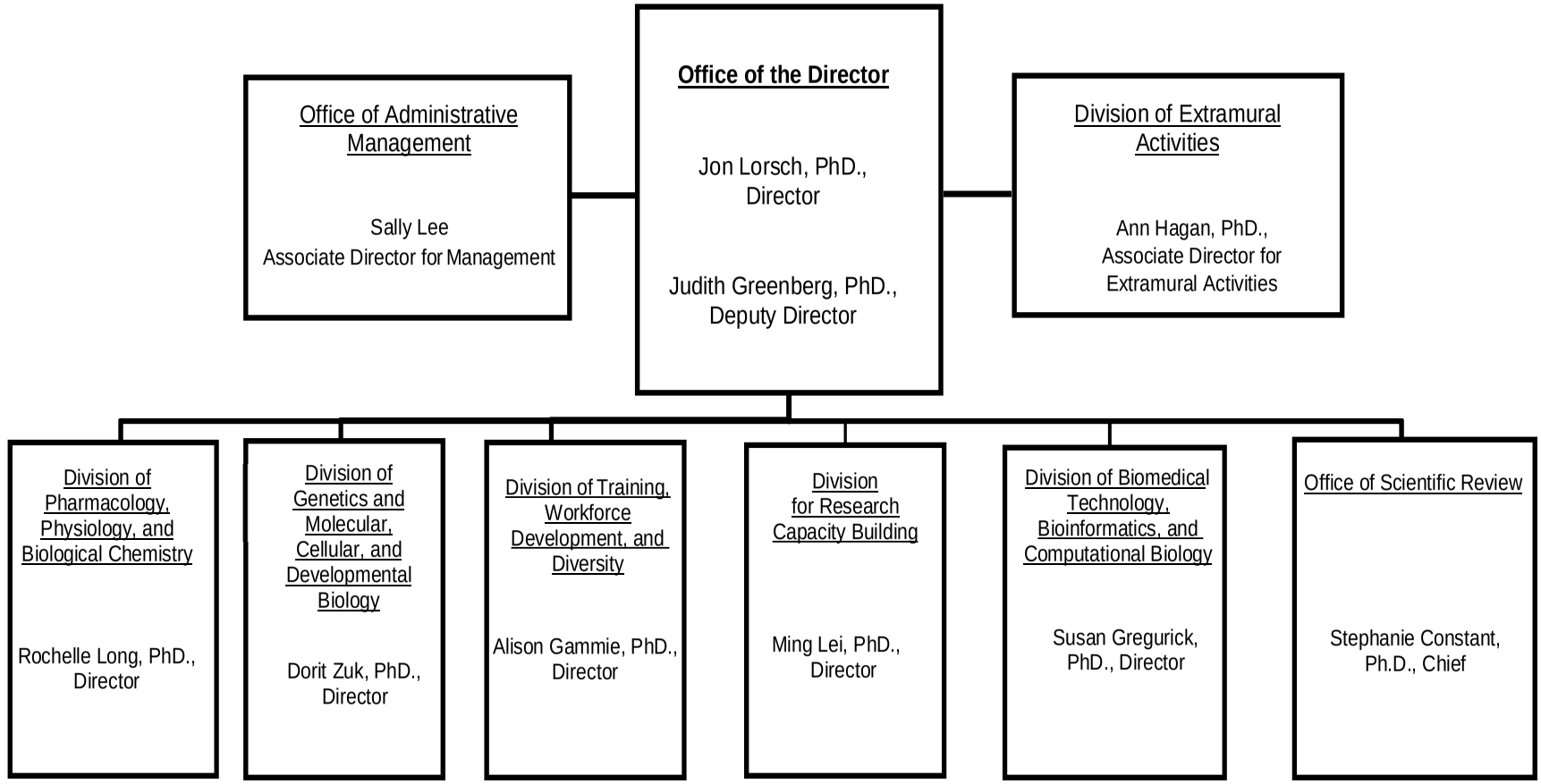
DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTES OF HEALTH

National Institute of General Medical Sciences (NIGMS)

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

Organization Structure



NATIONAL INSTITUTES OF HEALTH

NATIONAL INSTITUTE OF GENERAL MEDICAL SCIENCES

For carrying out section 301 and title IV of the PHS Act with respect to general medical sciences, **[**$2,872,780,000**]***$2,472,838,000*, of which **[**$1,146,821,000**]***$741,000,000* shall be from funds available under section 241 of the PHS Act: *Provided*, That not less than **[**$361,573,000**]***$311,236,000* is provided for the Institutional Development Awards program.

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

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

Source of Funding	FY 2018 Final	FY 2019 Enacted	FY 2020 President's Budget
Appropriation	$2,785,400	$2,872,780	$2,472,838
Mandatory Appropriation: (non-add)			
Type 1 Diabetes	*(0)*	*(0)*	*(0)*
Other Mandatory financing	*(0)*	*(0)*	*(0)*
Rescission	0	0	0
Sequestration	0	0	0
Secretary's Transfer	-4,376	0	0
Subtotal, adjusted appropriation	$2,781,024	$2,872,780	$2,472,838
OAR HIV/AIDS Transfers	0	0	0
Subtotal, adjusted budget authority	$2,781,024	$2,872,780	$2,472,838
Unobligated balance, start of year	0	0	0
Unobligated balance, end of year	0	0	0
Subtotal, adjusted budget authority	$2,781,024	$2,872,780	$2,472,838
Unobligated balance lapsing	-70	0	0
Total obligations	$2,780,954	$2,872,780	$2,472,838

[1] Excludes the following amounts (in thousands) for reimbursable activities carried out by this account:
FY 2018 - $1,282 FY 2019 - $5,000 FY 2020 - $5,000

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

Budget Mechanism - Total[1]

(Dollars in Thousands)

MECHANISM	FY 2018 Final		FY 2019 Enacted		FY 2020 President's Budget		FY 2020 +/- FY 2019 Enacted	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Research Projects:								
Noncompeting	3,098	$1,229,467	3,216	$1,267,709	3,510	$1,338,796	294	$71,087
Administrative Supplements	*(664)*	64,455	*(690)*	67,000	*(521)*	50,569	*(-169)*	-16,431
Competing:								
Renewal	239	93,473	245	94,935	82	30,647	-163	-64,288
New	876	338,852	921	357,133	307	115,288	-614	-241,845
Supplements	3	411	3	425	3	366	0	-59
Subtotal, Competing	1,118	$432,736	1,169	$452,493	392	$146,301	-777	-$306,192
Subtotal, RPGs	4,216	$1,726,658	4,385	$1,787,202	3,902	$1,535,666	-483	-$251,536
SBIR/STTR	195	89,848	202	92,843	173	79,604	-29	-13,239
Research Project Grants	4,411	$1,816,506	4,587	$1,880,045	4,075	$1,615,270	-512	-$264,775
Research Centers:								
Specialized/Comprehensive	160	$388,563	165	$400,608	142	$344,836	-23	-$55,772
Clinical Research	0	0	0	0	0	0	0	0
Biotechnology	34	64,193	35	66,183	30	56,969	-5	-9,214
Comparative Medicine	1	3,312	1	3,312	1	2,851	0	-461
Research Centers in Minority Institutions	0	0	0	0	0	0	0	0
Research Centers	195	$456,067	201	$470,103	173	$404,656	-28	-$65,447
Other Research:								
Research Careers	105	$28,145	108	$29,017	93	$24,978	-15	-$4,039
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	7,865	0	0	0	0	0	0
Minority Biomedical Research Support	282	97,183	291	100,196	226	77,895	-65	-22,301
Other	214	63,948	221	74,039	174	58,393	-47	-15,646
Other Research	601	$197,142	620	$203,252	493	$161,266	-127	-$41,986
Total Research Grants	5,207	$2,469,715	5,408	$2,553,400	4,741	$2,181,192	-667	-$372,208
Ruth L Kirchstein Training Awards:	FTTPs		FTTPs		FTTPs		FTTPs	
Individual Awards	341	$17,784	358	$20,075	307	$17,280	-51	-$2,795
Institutional Awards	3,901	187,948	3,905	190,218	3,581	177,426	-324	-12,792
Total Research Training	4,242	$205,731	4,263	$210,293	3,888	$194,706	-375	-$15,587
Research & Develop. Contracts	23	$26,737	24	$27,566	21	$23,728	-3	-$3,838
(SBIR/STTR) (non-add)	*(0)*	*(180)*	*(0)*	*(186)*	*(0)*	*(160)*	*(0)*	*(-26)*
Intramural Research	0	3,588	0	3,976	0	3,422	0	-554
Res. Management & Support	173	75,254	184	77,545	184	69,790	0	-7,755
Res. Management & Support (SBIR Admin) (non-add)	*(0)*	*(0)*	*(0)*	*(0)*	*(0)*	*(0)*	*(0)*	*(0)*
Construction		0		0		0		0
Buildings and Facilities		0		0		0		0
Total, NIGMS	173	$2,781,024	184	$2,872,780	184	$2,472,838	0	-$399,942

[1] All items in italics and brackets are non-add entries.

Major Changes in the Fiscal Year 2020 Budget Request

Major changes by budget mechanism and/or budget activity detail are briefly described below. The FY 2020 President's Budget reflects the Administration's fiscal policy goals for the Federal Government. Within this framework, NIGMS will pursue its highest research priorities through strategic investments and careful stewardship of appropriated funds:

Research Project Grants (-$264.8 million; total $1,615.3 million):

In FY 2020, the balanced funding of new and early stage investigators compared to established investigators will remain a high priority. NIGMS will continue to prioritize the support of investigator-initiated Research Project Grants (RPGs). Due to an increase in the number of RPG commitments projected in FY 2020 from the ramping up of competing grants in previous years, the institute plans to reduce noncompeting awards by 3.5 percent. Additionally, the competing grants will be given a similar 3.5 percent reduction to average cost. This budget represents a 14 percent reduction to the overall RPG mechanism.

Research Center Grants (-$65.447 million; total $404.656 million):

In FY 2020, NIGMS will continue to maintain its research center grant portfolio. An overall 14 percent reduction to the center mechanism along with a 3.5 percent reduction to committed levels will be applied.

Other Research (-$41.986 million; total $161.266 million):

This budget represents nearly a 21 percent decrease due to the overall sub-mechanisms and programs being reduced nearly 14 percent (consistent with the overall decrease for the institute) along with the first year of transitioning programs from Other Research and Minority Biomedical Research Support Program (MBRS) into Institutional Training awards. The transition includes moving the Initiative for Maximizing Student Development (IMSD) and the Research Initiative for Scientific Enhancement (RISE), from the MBRS sub-mechanism as well as Bridges to the Baccalaureate and Bridges to the Doctoral, from the Other sub-mechanism, to new programs under the Training mechanism. These new programs, the Graduate Research Training Initiative for Student Enhancement (G-RISE), the Undergraduate Research Training Initiative for Student Enhancement (U-RISE) and the Bridges Programs are similar to their predecessors. By moving these trainees and students to these innovative programs NIGMS will be better equipped to assist and track these fellows along the various stages of their career. This will result in nearly $16 million moving from MBRS and Other Research into Training.

Ruth L. Kirchstein Training Awards (-$15.587 million; total $194.706 million):

Under this budget, Individual Fellowships receives a 14 percent reduction, similar to the overall NIGMS decrease. Institutional Training sees roughly a 7 percent decrease due to roughly $14 million transitioning from Other Research, as described above.

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

Summary of Changes

(Dollars in Thousands)

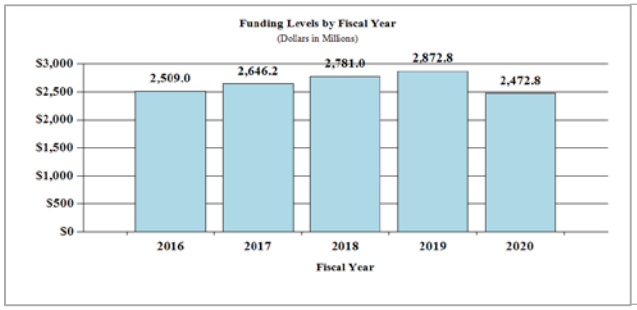
FY 2019 Enacted	$2,872,780
FY 2020 President's Budget	$2,472,838
Net change	-$399,942

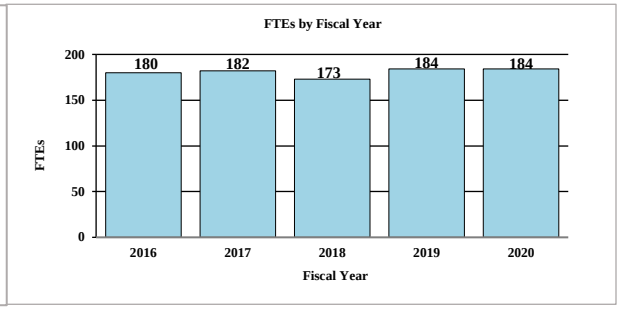
CHANGES	FY 2020 President's Budget FTEs	FY 2020 President's Budget Budget Authority	Change from FY 2019 Enacted FTEs	Change from FY 2019 Enacted Budget Authority
A. Built-in:				
1. Intramural Research:				
a. Annualization of January 2019 pay increase & benefits		$1,761		$331
b. January FY 2020 pay increase & benefits		1,761		8
c. Paid days adjustment		1,761		7
d. Differences attributable to change in FTE		1,761		0
e. Payment for centrally furnished services		122		0
f. Cost of laboratory supplies, materials, other expenses, and non-recurring costs		1,539		0
Subtotal				$346
2. Research Management and Support:				
a. Annualization of January 2019 pay increase & benefits		$28,013		$250
b. January FY 2020 pay increase & benefits		28,013		101
c. Paid days adjustment		28,013		106
d. Differences attributable to change in FTE		28,013		0
e. Payment for centrally furnished services		8,796		0
f. Cost of laboratory supplies, materials, other expenses, and non-recurring costs		32,981		0
Subtotal				$457
Subtotal, Built-in				$803

CHANGES	FY 2020 President's Budget No.	FY 2020 President's Budget Amount	Change from FY 2019 Enacted No.	Change from FY 2019 Enacted Amount
B. Program:				
1. Research Project Grants:				
a. Noncompeting	3,510	$1,389,365	294	$54,656
b. Competing	392	146,301	-777	-306,192
c. SBIR/STTR	173	79,604	-29	-13,239
Subtotal, RPGs	4,075	$1,615,270	-512	-$264,775
2. Research Centers	173	$404,656	-28	-$65,447
3. Other Research	493	161,266	-127	-41,986
4. Research Training	3,888	194,706	-375	-15,587
5. Research and development contracts	21	23,728	-3	-3,838
Subtotal, Extramural		$2,399,626		-$391,633
	FTEs		FTEs	
6. Intramural Research	0	$3,422	0	-$900
7. Research Management and Support	184	69,790	0	-8,212
8. Construction		0		0
9. Buildings and Facilities		0		0
Subtotal, Program	184	$2,472,838	0	-$400,745
Total changes				-$399,942

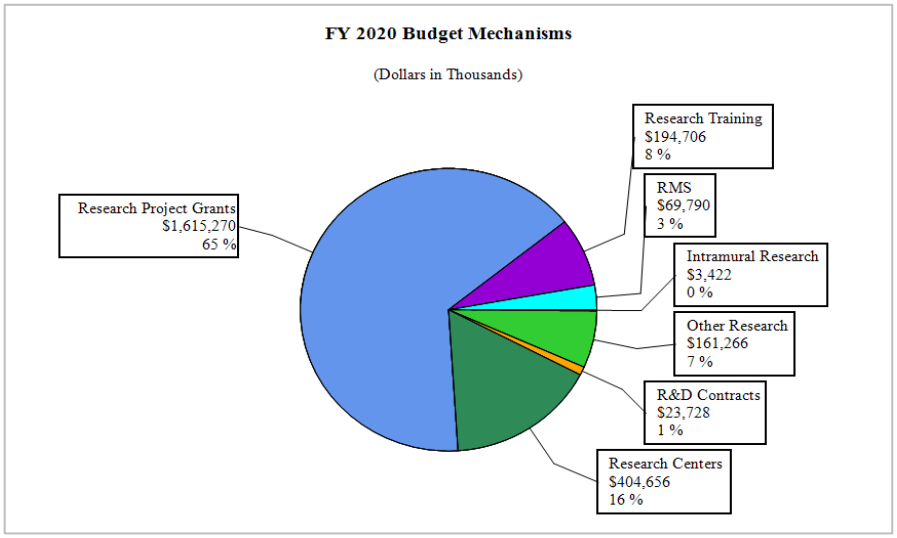
Fiscal Year 2020 Budget Graphs

History of Budget Authority and FTEs:

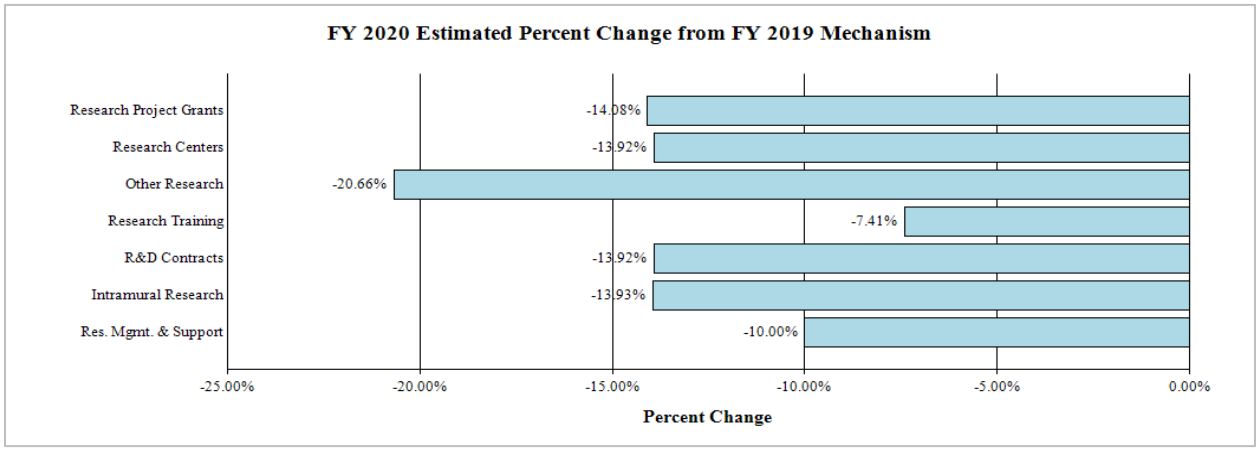




Distribution by Mechanism:



Change by Selected Mechanism:



NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

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

	FY 2018 Final		FY 2019 Enacted		FY 2020 President's Budget		FY 2020 +/- FY2019	
Extramural Research	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**
Detail								
Biophysics, Biomedical Technology, and Computational		522,123		539,334		463,662		-75,672
Genetics and Molecular, Cellular, and Developmental		833,115		860,578		739,833		-120,745
Pharmacology, Physiology and Biological Chemistry		599,478		619,240		532,356		-86,884
Training, Workforce Development and Diversity		320,212		330,767		284,358		-46,409
Division for Research Capacity Building		427,256		441,340		379,417		-61,923
Institutional Development Award (IDeA)		*(350,575)*		*(361,573)*		*(311,236)*		*(-50,337)*
Subtotal, Extramural		**$2,702,183**		**$2,791,259**		**$2,399,626**		**-$391,633**
Intramural Research	**0**	**$3,588**	**0**	**$3,976**	**0**	**$3,422**	**0**	**-$554**
Research Management & Support	**173**	**$75,254**	**184**	**$77,545**	**184**	**$69,790**	**0**	**-$7,755**
TOTAL	**173**	**$2,781,024**	**184**	**$2,872,780**	**184**	**$2,472,838**	**0**	**-$399,942**

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

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

Authorizing Legislation

	PHS Act/ Other Citation	U.S. Code Citation	2019 Amount Authorized	FY 2019 Enacted	2020 Amount Authorized	FY 2020 President's Budget
Research and Investigation	Section 301	42§241	Indefinite	$2,872,780,000	Indefinite	$2,472,838,000
National Institute of General Medical Sciences	Section 401(a)	42§281	Indefinite		Indefinite	
Total, Budget Authority				$2,872,780,000		$2,472,838,000

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

Appropriations History

Fiscal Year	Budget Estimate to Congress	House Allowance	Senate Allowance	Appropriation
2011	$2,125,090,000		$2,121,783,000	$2,051,798,000
Rescission				$18,016,009
2012	$2,102,300,000	$2,102,300,000	$2,347,309,000	$2,434,637,000
Rescission				$4,601,464
2013	$2,378,835,000		$2,387,112,000	$2,430,035,536
Rescission				$4,860,071
Sequestration				($121,971,075)
2014	$2,401,011,000		$2,435,570,000	$2,364,147,000
Rescission				$0
2015	$2,368,877,000			$2,371,476,000
Rescission				$0
2016	$2,433,780,000	$2,439,437,000	$2,511,431,000	$2,512,073,000
Rescission				$0
2017[1]	$2,512,437,000	$2,538,851,000	$2,633,755,000	$2,650,838,000
Rescission				$0
2018	$2,185,509,000	$2,713,775,000	$2,887,194,000	$2,785,400,000
Rescission				$0
2019	$2,572,669,000	$2,818,667,000	$2,874,292,000	$2,872,780,000
Rescission				$0
2020	$2,472,838,000			

[1] Budget Estimate to Congress includes mandatory financing.

Justification of Budget Request

National Institute of General Medical Sciences

Authorizing Legislation: Section 301 and Title IV of the Public Health Service Act, as amended.

Budget Authority (BA):

	FY 2018 Actual	FY 2019 Enacted	FY 2020 PB	FY 2020 + / - FY 2019
BA	$ 2,781,024,000	$2,872,780,000	$2,472,838,000	-399,942,000
FTE	173	184	184	0

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

Director's Overview

The National Institute of General Medical Sciences (NIGMS) supports fundamental research that increases our understanding of biological processes and drives advances in disease diagnosis, treatment, and prevention. NIGMS-funded scientists investigate how living systems work at a wide range of levels, from individual molecules and cells to tissues, organs, research organisms, humans, and even whole populations. Additionally, to ensure the vitality and continued productivity of the research enterprise, NIGMS provides robust opportunities in training the next generation of scientists, enhancing the diversity of the scientific workforce, and developing biomedical research capacity throughout the country.

The importance of the NIGMS mission was made clear again this year by the receipt of the 2018 Nobel Prize in Chemistry by two long-time NIGMS grantees. One component of this prestigious award was made for work on the directed evolution of enzymes. Enzymes produced through this process are used to manufacture everything from biofuels to pharmaceuticals. The second component of the award was made for work done on phage display of peptides and antibodies. In phage display, a virus that infects bacteria can be used to evolve proteins with new functions, making it a fundamental technology used for drug discovery.[1] The award of this year's Nobel Prize to NIGMS grantees clearly demonstrates the importance of investments in basic biomedical research and is a testament to how studies of seemingly abstract biological principles can have profound implications for both technology and medicine.

Promoting Creative and Ambitious Research: The Maximizing Investigators' Research Award (MIRA)

As part of NIGMS' efforts to promote creative and ambitious research as documented in Goal 1 of its 2015-2020 Strategic Plan, the Institute developed the Maximizing Investigators' Research Award (MIRA) (R35 award mechanism) and launched it as a pilot program in 2015.[2] MIRA grants support an entire program of research for a particular investigator, rather than a specific

[1] NIH News Releases, *NIH grantees win 2018 Nobel Prize in Chemistry*, October 3, 2018. www.nih.gov/news-events/news-releases/nih-grantees-win-2018-nobel-prize-chemistry

[2] Maximizing Investigators' Research Award (MIRA) (R35) www.nigms.nih.gov/Research/mechanisms/MIRA/Pages/default.aspx

project. Among the program's aims is to increase the stability of funding for NIGMS investigators and enhance their flexibility to follow promising research directions. Due to the overwhelming amount of interest in the program from both established investigators (EIs) and early-stage investigators (ESIs),[3] NIGMS is advancing the MIRA program from a pilot phase to a mainstay of the Institute's research portfolio. To achieve this objective, NIGMS will soon be issuing a new funding opportunity announcement (FOA) for MIRA that will support renewal applications from existing MIRA awardees. As was done in previous rounds of the program, the review process will ensure that EI and ESI applicants are evaluated separately (i.e., relative to each group's peers) and thus equitably. In FY 2018, NIGMS funded 228 additional investigators under the MIRA program, of which 115 are EIs and 113 are ESIs. This support represents an increase of 19 and 14 investigators, respectively, from the number funded in FY 2017. Overall, NIGMS is currently supporting 344 EIs and 304 ESIs through MIRA grants, which represents 16 percent of the investigators supported by the Institute through R01 (research project grant)-equivalent mechanisms.

Supporting the Next Generation of Biomedical Research Scientists

Sustaining a diverse pool of talented investigators is a central goal of both NIGMS and NIH. NIGMS remains committed to training scientists and students from a wide variety of professional and academic backgrounds, including groups that have been historically underrepresented in the biomedical research enterprise. The Institute supports this pool of talent through an array of fellowships, career development awards, institutional training grants, and student development programs that span multiple career stages. This year, NIGMS funded 204 ESIs, exceeding the goal set for the Institute by NIH's Next Generation Researchers Initiative (NGRI)[4].

Because an increasing body of evidence indicates that career transitions from the postdoctoral training period to independent faculty positions are a key exit point of talent within the NIH-funded research workforce,[5] NIGMS has undertaken efforts to facilitate the career transition of postdoctoral scientists into independent academic positions. Such efforts include the Institutional Research and Academic Career Development Awards[6] and provision of research supplements to promote re-entry into biomedical and behavioral research careers.[7] Despite these efforts, there remains a compelling need to develop additional strategies to promote transitions to independent faculty positions. Thus, commensurate with Goal 4 of its Strategic Plan, NIGMS recently sought input from key stakeholders on strategies to enhance postdoctoral career

[3] A Program Director / Principal Investigator (PD/PI) who has completed their terminal research degree or end of post-graduate clinical training, whichever date is later, within the past 10 years and who has not previously competed successfully as PD/PI for a substantial NIH independent research award.

[4] NIH Next Generation Researchers Initiative, grants.nih.gov/ngri.htm

[5] Gibbs et al, eLife 2016, www.ncbi.nlm.nih.gov/pubmed/27852433; Meyers et al, PLOS One 2018, www.ncbi.nlm.nih.gov/pubmed/29338019

[6] Institutional Research and Academic Career Development Awards (IRACDA) (K12), www.nigms.nih.gov/Training/CareerDev/Pages/TWDInstRes.aspx

[7] Research Supplements to Promote Re-entry into Biomedical and Behavioral Research Careers, www.nigms.nih.gov/Research/Mechanisms/Pages/PromoteReentry.aspx

transitions and to promote faculty diversity, specifically within research-intensive institutions.[8] As a result of the feedback received from these outreach efforts, NIGMS intends to issue two new FOAs in 2019 that will utilize a mentored cohort approach to enhancing career transitions for postdoctoral fellows from diverse backgrounds into faculty positions at research-intensive universities.

Contributing to a 21st Century Workforce by Improving Graduate Education and Training

NIGMS has been working to catalyze the modernization of biomedical research training to keep pace with the increasing complexity and interdisciplinarity of the research enterprise. To meet this goal, the Institute issued two new FOAs in 2018 – an NIGMS-specific predoctoral training program in basic biomedical sciences[9] and a medical scientist training program (MSTP)[10], both using the T32 (training program) award mechanism. The NIGMS-specific T32 FOA is intended to allow the scientific community to develop and implement evidence-based approaches to biomedical research training and mentoring that will effectively train future generations of outstanding biomedical scientists to conduct rigorous, responsible and reproducible research. Similarly, areas of particular importance in the MSTP FOA are the continuous evaluation and improvement of MSTP training, fostering the persistence of MSTP alumni in research careers, and enhancing the diversity of the physician-scientist workforce.

Expanding Geographic and Scientific Frontiers: Building Research Capacity in Underserved States, Regions, and Institutions

One of NIGMS' major programs is the Institutional Development Award (IDeA), which builds research capacities at academic institutions located in states that have historically received a lower aggregate level of NIH funding. By building organizational and workforce-related capacities in these states, the program enhances the ability of investigators to compete successfully for additional research funding while also addressing the specific needs of medically underserved communities. In addition to well-established and widely-known components of the IDeA program such as the Centers of Biomedical Research Excellence (COBRE), the IDeA Clinical and Translational Research (CTR) Network, and the IDeA-State Networks of Biomedical Research Excellence (INBRE), NIGMS recently added Regional Technology Transfer Accelerator Hubs for IDeA states in each of the 4 IDeA regions (central, northeast, southeast, and western regions). The goal of the accelerators is to provide consulting and skills development in entrepreneurship, technology transfer, management, small business finance, and other areas needed to transform important discoveries made in the lab into commercial products that address human health. Awards for each of the four accelerators were made in September 2018 (see Program Portrait below for additional details).

An important aspect of the IDeA program is being able to support research related to the health needs of unique populations in IDeA states. For example, the IDeA States Pediatric Clinical Trials Network (ISPCTN) will build the capacity to perform pediatric clinical trials in IDeA

[8] Request for Information (RFI): Strategies for Enhancing Postdoctoral Career Transitions to Promote Faculty Diversity, May 2018, grants.nih.gov/grants/guide/notice-files/NOT-GM-18-034.html

[9] National Institute of General Medical Sciences Ruth L. Kirschstein National Research Service Award (NRSA) Predoctoral Institutional Research Training Grant (T32), grants.nih.gov/grants/guide/pa-files/PAR-17-341.html

[10] Medical Scientist Training Program (T32), grants.nih.gov/grants/guide/pa-files/par-19-036.html

states and provide medically underserved and rural populations with access to state-of-the-art pediatric clinical trials. The ISPCTN is a collaborative effort involving multiple NIH offices, Institutes, and Centers, including the Environmental Influences on Child Health Outcomes program, the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, and NIGMS.

NIGMS is proud to continue to serve the American Indian and Alaska Native (AI/AN) community through the Native American Research Centers for Health (NARCH) program. NARCH provides research, research training, and faculty development opportunities designed to meet the specific needs of AI/AN communities. It also provides opportunities for tribes and tribal organizations to build research infrastructure and capacity that address the historical health disparities prevalent in AI/AN communities and in so doing, increases the trust for research within these communities.

Part of NIGMS' efforts for building research capacity is focused on outreach and education, including during the earliest years in the educational process. Investing in both educators and educational activities at the pre-kindergarten to grade 12 level ensures that the nation's biomedical research needs continue to be met. Through the Science Education Partnership Award (SEPA), NIGMS provides opportunities for both students and teachers from various communities (including historically underserved communities) to consider careers in scientific education, research, and practice. Twelve of the 17 SEPAs in IDeA states are currently in partnerships with IDeA COBREs or INBREs.

Ensuring Access to Transformational Tools, Technologies, and Resources

Whether utilized by single investigators or teams of scientists, cutting-edge technologies are critical enablers of biomedical research. The ability to accurately and robustly interrogate molecules, cells, tissues, and living systems is directly dependent upon the tools and technologies that scientists have at their disposal. Because of the central role of technology in biomedical research, NIGMS has continued to place a high level of importance on the development of new technologies and on ensuring access to them, commensurate with Goal 3 of its Strategic Plan. Thus, NIGMS has created a multi-stage pipeline to robustly support technology development efforts. A grant to support the initial proof-of-concept phase, for instance, can be followed by a second grant to enable the prototype refinement phase. These phases can, in turn, lead to commercialization of the technology through small business innovation research or small business technology transfer (SBIR/STTR) grants, application of the technology to specific scientific questions through incorporation into NIH-funded research grants (e.g., R01s and R35 MIRAs), or expansion and further development of the technology through support provided by the Institute's Biomedical Technology Research Resources (BTRR) program.

The importance of technology development, dissemination, and access is demonstrated through NIGMS' leadership (along with the National Eye Institute) of the new Common Fund Transformative Cryo-electron Microscopy (cryoEM) initiative. CryoEM is an exciting method used to image frozen biological molecules without the use of structure-altering dyes or fixatives or the need for crystallization. It provides a three-dimensional picture of individual molecules and therefore a greater understanding of biological function. Three national cryoEM service centers with state-of-the-art equipment, technical support, and training for the production and analysis of high-resolution data have been funded, and online and computer-based cryoEM instructional material is being developed. By increasing access to cryoEM technology and the

detailed information it provides about viruses, proteins, and other important biomolecules, NIH hopes to accelerate the development of vaccines and drugs that can effectively combat serious diseases, from Alzheimer's to Zika.

Advancing Sepsis Research

NIGMS supports a substantial portfolio of sepsis research that includes both fundamental and clinical studies and that emphasizes the host's response to sepsis rather than its initial triggers (e.g., infection or injury). In an effort to optimize NIGMS' sepsis research portfolio, the Institute has sought input from key stakeholders on novel ideas and strategies by which to address the challenges and opportunities inherent in this evolving field. In addition, it has convened a working group of its Advisory Council to help guide the Institute on how to accelerate advances in both the rapid detection and treatment of this condition.[11]

[11] Request for Information (RFI): Strategies for Advancing Sepsis Research Supported by NIGMS, July 2018, grants.nih.gov/grants/guide/notice-files/NOT-GM-18-039.html

Program Portrait on Artificial Intelligence and Deep Learning in Biomedical Science

FY 2019 level: $26.2 million

FY 2020 level: $22.5 million

Change: -$3.7 million

Computers far surpass humans in their ability to sift through vast amounts of data with speed, accuracy, and neutrality. As software and hardware become increasingly sophisticated, computers are better able to mimic the way human brains work. With this functionality, called artificial intelligence (AI), computers can make logical decisions about data, such as organizing it into categories, or determining how closely it matches an idealized standard. AI computers can even "learn," meaning that they can progressively improve on a specific task without being explicitly programmed. All they need is the appropriate hardware, software, input data, and a set of guidelines. The data can be in any form, such as images, genome sequences, sounds, machine signals, video, speech, or written words.

Although AI technology is already used in a variety of applications, such as voice recognition software and Google image searches, it is also the focus of intense research. With one type of AI, called deep learning, computers are not only able to organize and analyze information, but also reveal new insights and recognize patterns that would be impossible for humans to detect amidst the mountains of data. Deep learning provides a new way of predicting unknown results, based on patterns in the available data.

Increasingly, biomedical researchers are using AI—and deep learning in particular—as a tool to enhance their ongoing efforts to better understand biology and find new ways to prevent, detect, diagnose, and treat diseases. Deep learning is already helping scientists better predict the effectiveness—and possible side effects—of medications. It is also finding uses in basic biomedical research in a variety of ways.

A team led by a MIRA-funded researcher developed a machine learning software called CellProfiler. Paired with microscopy, the image analysis software has advanced biomedical work ranging from counting cells to analyzing human tissue samples. For example, the software makes it possible to detect changes in the appearance of cells that are imperceptible to the human eye. Some of these changes might indicate the early stage of a disease, or help scientists understand normal cellular processes and identify the causes and possible treatments for a wide range of conditions. Every year, the opensource software is launched more than 125,000 times by researchers worldwide. It has been cited in more than 3,400 papers from more than 1,000 laboratories.

Another NIGMS grantee is using deep learning to advance structure-based drug design. The idea is to find small molecules (potential drugs) that can bind to disease-related proteins (drug targets) and have a therapeutic effect. Computers can efficiently sift through enormous amounts of data on the 3D structures of proteins and can predict which small molecules might bind to those proteins and produce a desired effect. Using AI to find potential drug candidates has the potential to significantly speed up the drug discovery process.

Program Portrait on STTR Regional Technology Transfer Accelerator Hubs for Institutional Development Award (IDeA) States

FY 2019 level: $5.1 million

FY 2020 level: $4.4 million

Change: -$0.7 million

Under this new program, small businesses and academic institutions in IDeA states partner to create regional “hubs” to accelerate technology transfer—the commercialization of scientific results from academic laboratory to marketplace. Each hub serves one of the four IDeA regions (central, northeastern, southeastern, and western). The overarching goal of the hubs is to promote a sustainable culture of biomedical entrepreneurship at institutions in the region. Each hub will provide infrastructure to facilitate professional collaborations, mentoring relationships, and the sharing of expertise, information, and business practices. The effort will produce educational tools, such as curricula, texts, and webinars, that can be licensed or sold to other institutions.

Program Portrait on Rare Research Organisms

FY 2019 level: $8.0 million

FY 2020 level: $6.9 million

Change: -$1.1 million

Fruit flies have revealed insights about genetics and neuroscience for more than a century, including the NIGMS-funded work on circadian rhythms that was awarded the Nobel Prize in Physiology or Medicine in 2017. Mice—low-maintenance mammals available by mail order in thousands of different genetic varieties—have been a research lab mainstay for decades. However, recent advances such as the decreasing cost of genome sequencing and the development of the CRISPR system for genomic modification now make it possible to use an expanded range of research organisms, many of which are particularly well suited for a specific type of investigation. For example, the Australian songbird zebra finch (*Taeniopygia guttata*) sings a simple, easily analyzed tune, and has become a go-to organism for studies on the neurobiological basis of learning and memory. It is inexpensive, easy to raise in the lab, and widely available.

Other research organisms that NIGMS-funded scientists have begun to explore include:

African spiny mice (*Acomys kempi* and *Acomys percivali)*, the only mammal known to heal without scarring, for studies of tissue healing. In humans and other mammals, organ and tissue damage typically results in thickening, stiffening, and reduced mobility in the affected areas. When it occurs in internal organs such as the heart or lungs, this scarring (fibrosis) can lead to organ failure and death. It is a major public health problem in the U.S. A MIRA grantee is working to uncover the mechanical and cellular processes that cause scarring—and how African spiny mice circumvent them. A better understanding of how and why scar tissues form could lead to treatments that help humans better heal after heart attacks, spinal cord injury, severe burns, and other injuries and tissue-damaging diseases.

Hawaiian bobtail squid (*Euprymna scolopes*), for studies of bacterial infection and microbial symbiosis (how microorganisms live together and benefit from each other). Some species of bacteria can form a close-knit community known as a biofilm, where they are protected from immune system defenses and antibiotic medications. Biofilms cause a range of medical problems, including diabetic foot ulcers, urinary tract infections, middle ear infections, and life-threatening lung infections in people with cystic fibrosis. Biofilm infections are especially problematic with implanted medical devices, such as artificial joints, heart valves, pacemakers, and dialysis catheters. Although biofilms are common in the environment, it has been difficult to study them in living organisms. One NIGMS-funded researcher is helping to overcome that issue by studying the mutually beneficial relationship between bobtail squid and the bacterium *Vibrio fischeri*. By revealing how these squid encourage biofilm formation within their bodies, this work might lead to new ways for humans to combat unwelcome infections.

Carolina anole (*Anolis carolinensis*), the first reptile to have its genome sequenced, for studies on regeneration and development. An NIGMS grantee is comparing tissue healing in Mexican salamanders (*Ambystoma mexicanum*) with that in anole lizards. He identified cellular reasons why the salamanders are able to completely regrow a severed tail, while the lizards cannot (just as humans cannot regrow lost limbs). The long-term goal of such research is to find ways to improve wound healing and regrowth of human tissues.

Program Descriptions and Accomplishments

Genetics and Molecular, Cellular, and Developmental Biology (GMCDB): The GMCDB division supports research to understand the structure and function of cells and cellular components, and the cellular and molecular mechanisms that underlie inheritance, gene expression, and development. The results of this research form the foundation for advances in diagnosing, preventing, treating, and curing a wide variety of diseases. Most of the projects supported by the division make use of research organisms, which advance the general understanding of biological processes. To complement GMCDB's large investment in research that is performed in a wide variety of research organisms, GMCDB will also employ FY 2020

funds to bolster human research studies aimed at revealing the generalizable principles of the genetics of human biology and human disease.

Budget Policy: The FY 2020 President's Budget request for the GMCDB program is $739.833 million, a decrease of $120.745 million or 14 percent compared to the FY 2019 Enacted level. GMCDB expenditures will support individual investigators seeking fundamental knowledge about biological processes. GMCDB will continue its support for collaborative research on cellular, molecular, and genomic studies in animal models, as well as research into specific genetic variants within complex disorders.

Pharmacology, Physiology, and Biological Chemistry (PPBC): The PPBC division supports a broad spectrum of research aimed at improving the molecular-level understanding of fundamental biological processes and discovering approaches to their control. Research supported by the division takes a multifaceted approach to problems in pharmacology, physiology, biochemistry, and biological chemistry that are very basic in nature. The goals of supported research include an improved understanding of drug action and of anesthesia; mechanisms underlying responses to drugs; new methods and targets for drug discovery; advances in natural products synthesis; an enhanced understanding of biological catalysis; knowledge of metabolic regulation and fundamental physiological processes; and the integration and application of basic physiological, pharmacological, and biochemical research to clinical issues in anesthesia, clinical pharmacology, and trauma and burn injury. The division works to ensure that research approaches are state-of-the-art and employ the optimal research organisms for the problems being addressed.

Budget Policy: The FY 2020 President's Budget request for the PPBC program is $532.356 million, a decrease of $86.884 million or 14 percent compared to the FY 2019 Enacted level. PPBC will continue to emphasize the support of investigator-initiated research grants related to basic pharmacology, biochemistry, and chemistry that inform knowledge of how small molecules influence human health.

Biophysics, Biomedical Technology, and Computational Biosciences (BBCB): The BBCB division facilitates advances in basic biomedical research by supporting the technology and computational research infrastructures and the development and application of biophysical and computational methods and tools for understanding basic biological questions. Computational approaches include analytical methods, mathematical modeling, and simulations. This year a major new effort in BBCB is the support of data science and artificial intelligence (e.g., machine learning) approaches to address fundamental research questions. BBCB also supports biophysical techniques and studies, derived from the physical and engineering sciences, to develop and improve measurement and analysis of macromolecular, cellular, and organelle processes and function. Another major new effort in BBCB is to support technology development through all the stages from high-risk, high-reward emerging concepts to established biomedical resources. Technology resources, supported by BBCB, impact basic biomedical research on living systems, from molecules and cells to tissues, organs, and organisms, and are used by thousands of NIH-supported scientists each year.

Budget Policy: The FY 2020 President's Budget request for the BBCB program is $463.662 million, a decrease of $75.672 million or 14 percent compared to the FY 2019 Enacted level.

BBCB plans to fund investigator-initiated approaches to enable the development of new and emerging biomedical technologies.

Division of Training, Workforce Development, and Diversity (TWD): The TWD division supports programs that foster the development of a strong and diverse biomedical research workforce. The division funds research training, student development, and career development activities through a variety of programs ranging from the undergraduate level to the doctorate and beyond. TWD also administers the Common Fund Diversity Program Consortium, including the Coordination and Evaluation Center, Building Infrastructure Leading to Diversity, and the National Research Mentoring Network. TWD funded initiatives include the Diversity Supplement Program, Bridges to the Baccalaureate, Maximizing Access to Research Careers, Research Initiative for Scientific Enhancement, Initiative for Maximizing Student Development, Post-baccalaureate Research Education, Bridges to the Doctorate, National Research Service Award fellowships and training grants, Pathway to Independence Awards, Career Awards, Institutional Research and Academic Career Development Awards, Innovative Programs to Enhance Research Training, Support for Research Training Conferences, the Research on Interventions Program, and the Science of Science Policy Awards. Collectively, these programs are designed to ensure that future generations of researchers will be drawn from the entire pool of talented individuals, bringing different aptitudes, perspectives, interests, and experiences to address complex scientific problems. NIGMS seeks to enhance the diversity of the biomedical research workforce by supporting individuals from a variety of backgrounds at multiple training and career stages in a variety of institutions and educational settings across the country.

Budget Policy: The FY 2020 President's Budget request for the TWD program is $284.358 million, a decrease of $46.409 million or 14 percent compared to the FY 2019 Enacted level. TWD will continue to support Individual and Institutional Training awards and maintain the same stipend levels as FY 2019.

Division for Research Capacity Building (DRCB): DRCB supports research, research infrastructure improvement, faculty development, and research training in states and institutions that have been historically underrepresented in NIH funding. DRCB administers four major programs. The Institutional Development Award (IDeA) program broadens the geographic distribution of NIH funding for biomedical research in 23 states and Puerto Rico through five initiatives: (1) the COBRE initiative aims to develop thematic, multidisciplinary centers; (2) the INBRE initiative supports the establishment of statewide networks for expanding research access and capabilities; (3) the IDeA CTR initiative promotes the advancement of clinical and translational research that addresses regional health concerns; (4) the IDeA co-funding initiative aims to increase the pool of NIH funded investigators; and (5) the Regional Technology Transfer Accelerator Hubs for IDeA States (STTR) program supports the commercialization of innovative technologies and methodologies and aims to strengthen skills needed to move discoveries and technologies out of the lab and into commercial products that address human health. The Support of Competitive Research (SCORE) program seeks to increase the research competitiveness of faculty at institutions that have an explicitly stated historical mission focused on serving students from underrepresented groups. The NARCH program supports partnerships between American Indian/Alaska Native tribes or tribally-based organizations and institutions that conduct intensive biomedical research. The SEPA program invests in educational activities

that complement or enhance the training of a workforce to meet the nation's biomedical, biobehavioral, and clinical research needs.

Budget Policy: The FY 2020 President's Budget request for the DRCB program is $379.417 million, a decrease of $61.923 million or 14 percent compared to the FY 2019 Enacted level. DRCB will continue to support new and continuing awards in these three programs. DRCB also supports the use of SBIR/STTR funds to initiate small business and technology transfer activities in IDeA states.

Intramural: NIGMS has a small but unique intramural research training program, the NIGMS Postdoctoral Research Associate (PRAT) Program. PRAT postdoctoral research fellows are supported for up to three years. They pursue independent research in intramural NIH laboratories under the guidance of tenured/tenure-track investigators, and they receive specialized training and career mentoring from NIGMS staff. Fellows in this highly regarded program have received numerous honors and awards for their innovative research in areas ranging from cell and molecular biology to pharmacology and genetics.

Budget Policy: The FY 2020 President's Budget request for the Intramural Research program is $3.422 million, a decrease of $0.6 million or 14 percent compared to the FY 2019 Enacted level.

Research Management and Support (RMS): RMS provides administrative, budgetary, logistical, and scientific support toward the review, award, and monitoring of research grants, training awards, and research and development contracts. The program also encompasses strategic planning, coordination, and evaluation of NIGMS programs; regulatory compliance; and coordination and liaison with other Federal agencies, Congress, and the public. RMS funds improvements in information technology tools to facilitate the paylist process where grant applications are discussed and prioritized for possible funding. RMS funds also support IT system enhancements to facilitate business processes in the areas of grants program management and internal grant application referral. In response to Congressional reporting requirements, RMS was used to enhance IT systems that capture data on the careers of NIGMS-funded trainees and provide information on NIGMS training program outcomes. Funds were allocated to migrate and develop NIGMS services and systems to the "cloud." Development in a cloud environment results in reduced resource dependencies, significant cost savings, enhanced information technology security and disaster recovery, as well as ensures compliance with the Federal Information Technology Acquisition Reform Act.

Budget Policy: The FY 2020 President's Budget request for RMS is $69.790 million, a decrease of $7.755 million or 10 percent compared to the FY 2019 Enacted level.

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

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

		FY 2019 Enacted	FY 2020 President's Budget	FY 2020 +/- FY 2019
Total compensable workyears:				
	Full-time equivalent	184	184	0
	Full-time equivalent of overtime and holiday hours	0	0	0
	Average ES salary	$178	$178	$0
	Average GM/GS grade	12.9	12.9	0.0
	Average GM/GS salary	$124	$124	$0
	Average salary, grade established by act of July 1, 1944 (42 U.S.C. 207)	$0	$0	$0
	Average salary of ungraded positions	$185	$185	$0
	OBJECT CLASSES	**FY 2019 Enacted**	**FY 2020 President's Budget**	**FY 2020 +/- FY 2019**
	Personnel Compensation			
11.1	Full-Time Permanent	17,903	17,971	68
11.3	Other Than Full-Time Permanent	2,723	2,734	10
11.5	Other Personnel Compensation	487	489	2
11.7	Military Personnel	0	0	0
11.8	Special Personnel Services Payments	1,233	1,238	5
11.9	**Subtotal Personnel Compensation**	**$22,346**	**$22,431**	**$85**
12.1	Civilian Personnel Benefits	7,207	7,343	136
12.2	Military Personnel Benefits	0	0	0
13.0	Benefits to Former Personnel	0	0	0
	Subtotal Pay Costs	**$29,553**	**$29,774**	**$221**
21.0	Travel & Transportation of Persons	398	332	-66
22.0	Transportation of Things	4	3	-1
23.1	Rental Payments to GSA	0	0	0
23.2	Rental Payments to Others	31	26	-5
23.3	Communications, Utilities & Misc. Charges	180	153	-27
24.0	Printing & Reproduction	0	0	0
25.1	Consulting Services	420	363	-57
25.2	Other Services	6,923	5,963	-960
25.3	Purchase of goods and services from government accounts	97,323	91,405	-5,918
25.4	Operation & Maintenance of Facilities	86	72	-14
25.5	R&D Contracts	752	752	0
25.6	Medical Care	0	0	0
25.7	Operation & Maintenance of Equipment	8,878	7,457	-1,420
25.8	Subsistence & Support of Persons	2	2	0
25.0	**Subtotal Other Contractual Services**	**$114,383**	**$106,014**	**-$8,369**
26.0	Supplies & Materials	164	138	-26
31.0	Equipment	229	192	-37
32.0	Land and Structures	0	0	0
33.0	Investments & Loans	0	0	0
41.0	Grants, Subsidies & Contributions	1,581,016	1,595,204	14,188
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	**$1,696,406**	**$1,702,064**	**$5,658**
	Total Budget Authority by Object Class	**$1,725,959**	**$1,731,838**	**$5,879**

[1] Includes FTEs whose payroll obligations are supported by the NIH Common Fund. Excludes reimbursable obligations funded by program evaluation financing under Section 241 of the PHS Act.

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

Salaries and Expenses
(Dollars in Thousands)

OBJECT CLASSES	FY 2019 Enacted	FY 2020 President's Budget	FY 2020 +/- FY 2019
Personnel Compensation			
Full-Time Permanent (11.1)	$17,903	$17,971	$68
Other Than Full-Time Permanent (11.3)	2,723	2,734	10
Other Personnel Compensation (11.5)	487	489	2
Military Personnel (11.7)	0	0	0
Special Personnel Services Payments (11.8)	1,233	1,565	332
Subtotal Personnel Compensation (11.9)	**$22,346**	**$22,759**	**$412**
Civilian Personnel Benefits (12.1)	$7,207	$7,016	-$190
Military Personnel Benefits (12.2)	0	0	0
Benefits to Former Personnel (13.0)	0	0	0
Subtotal Pay Costs	**$29,553**	**$29,775**	**$222**
Travel & Transportation of Persons (21.0)	$398	$332	-$66
Transportation of Things (22.0)	4	3	-1
Rental Payments to Others (23.2)	31	26	-5
Communications, Utilities & Misc. Charges (23.3)	180	153	-27
Printing & Reproduction (24.0)	0	0	0
Other Contractual Services:			
Consultant Services (25.1)	66	66	0
Other Services (25.2)	6,923	5,963	-960
Purchases from government accounts (25.3)	75,428	69,509	-5,919
Operation & Maintenance of Facilities (25.4)	86	72	-14
Operation & Maintenance of Equipment (25.7)	8,878	7,457	-1,420
Subsistence & Support of Persons (25.8)	2	2	0
Subtotal Other Contractual Services	**$91,383**	**$83,070**	**-$8,313**
Supplies & Materials (26.0)	$164	$138	-$26
Subtotal Non-Pay Costs	**$92,160**	**$83,722**	**-$8,437**
Total Administrative Costs	**$121,713**	**$113,497**	**-$8,216**

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

Detail of Full-Time Equivalent Employment (FTE)

OFFICE/DIVISION	FY 2018 Final			FY 2019 Enacted			FY 2020 President's Budget		
	Civilian	Military	Total	Civilian	Military	Total	Civilian	Military	Total
Division for Research Capacity Building									
Direct:	10	-	10	11	-	11	11	-	11
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	10	-	10	11	-	11	11	-	11
Division of Biophysics, Biomedical Technology, and Computational Biosciences									
Direct:	14	-	14	14	-	14	14	-	14
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	14	-	14	14	-	14	14	-	14
Division of Genetics and Molecular, Cellular, and Developmental Biology									
Direct:	16	-	16	18	-	18	18	-	18
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	16	-	16	18	-	18	18	-	18
Division of Pharmacology, Physiology and Biological Chemistry									
Direct:	11	-	11	12	-	12	12	-	12
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	11	-	11	12	-	12	12	-	12
Division of Training, Workforce Development and Diversity									
Direct:	10	-	10	12	-	12	12	-	12
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	10	-	10	12	-	12	12	-	12
Office of Administrative Management									
Direct:	32	-	32	32	-	32	32	-	32
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	32	-	32	32	-	32	32	-	32
Office of Extramural Activities									
Direct:	51	-	51	52	-	52	52	-	52
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	51	-	51	52	-	52	52	-	52
Office of Scientific Review									
Direct:	14	-	14	14	-	14	14	-	14
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	14	-	14	14	-	14	14	-	14
Office of the Director									
Direct:	15	-	15	19	-	19	19	-	19
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	15	-	15	19	-	19	19	-	19
Total	173	-	173	184	-	184	184	-	184
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
2016	12.7
2017	12.7
2018	12.8
2019	12.9
2020	12.9

NATIONAL INSTITUTES OF HEALTH
National Institute of General Medical Sciences

Detail of Positions[1]

GRADE	FY 2018 Final	FY 2019 Enacted	FY 2020 President's Budget
Total, ES Positions	1	1	1
Total, ES Salary	178,479	178,479	178,479
GM/GS-15	20	20	20
GM/GS-14	61	66	66
GM/GS-13	45	47	47
GS-12	11	16	16
GS-11	3	4	4
GS-10	0	0	0
GS-9	3	3	3
GS-8	5	5	5
GS-7	13	12	12
GS-6	0	0	0
GS-5	0	1	1
GS-4	1	0	0
GS-3	0	0	0
GS-2	0	0	0
GS-1	0	0	0
Subtotal	162	174	174
Grades established by Act of July 1, 1944 (42 U.S.C. 207)	0	0	0
Assistant Surgeon General	0	0	0
Director Grade	0	0	0
Senior Grade	0	0	0
Full Grade	0	0	0
Senior Assistant Grade	0	0	0
Assistant Grade	0	0	0
Subtotal	0	0	0
Ungraded	21	21	21
Total permanent positions	163	175	175
Total positions, end of year	176	196	196
Total full-time equivalent (FTE) employment, end of year	173	184	184
Average ES salary	178,479	178,479	178,479
Average GM/GS grade	12.8	12.9	12.9
Average GM/GS salary	120,443	123,695	123,695

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