DEPARTMENT OF HEALTH AND HUMAN SERVICES

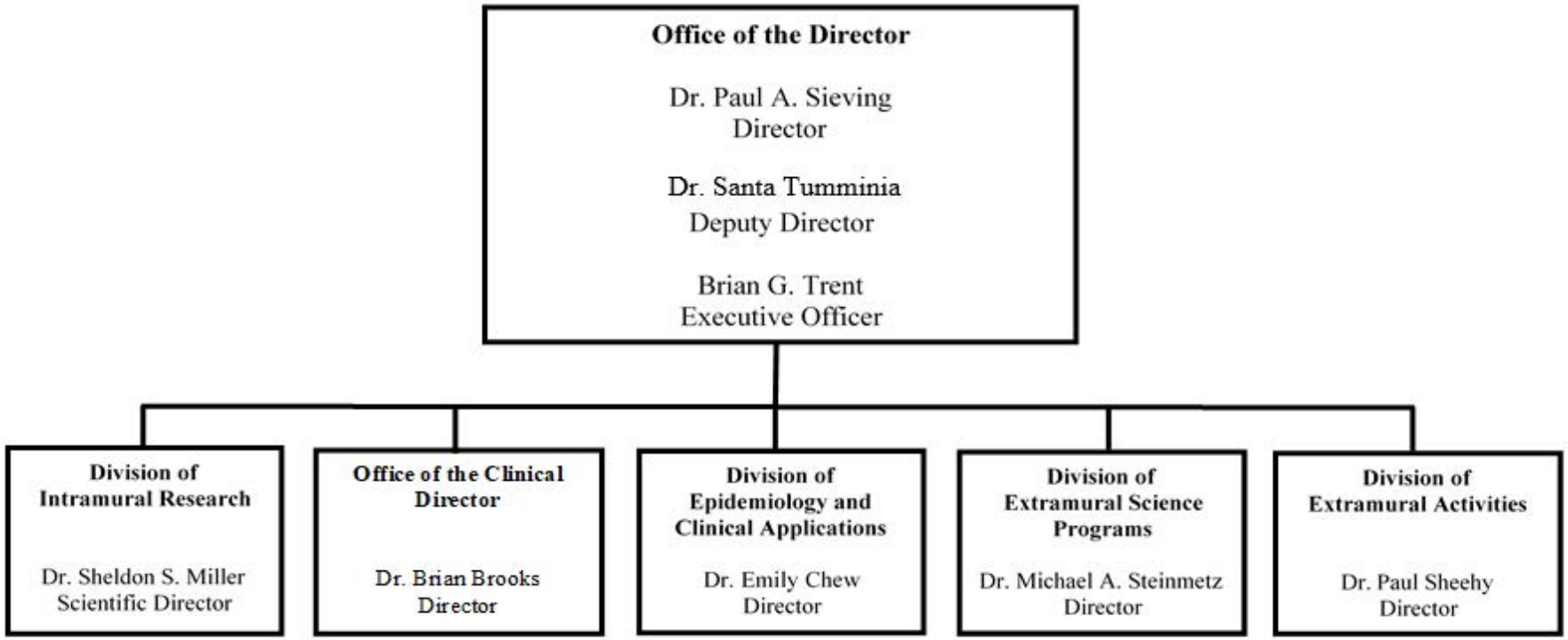
NATIONAL INSTITUTES OF HEALTH

National Eye Institute (NEI)

NATIONAL INSTITUTES OF HEALTH

National Eye Institute

Organization Chart



NATIONAL INSTITUTES OF HEALTH

National Eye Institute

For carrying out section 301 and title IV of the PHS Act with respect to eye diseases and visual disorders, **[**$796,536,000**]** *$685,644,000*.

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

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

Source of Funding	FY 2018 Final	FY 2019 Enacted	FY 2020 President's Budget
Appropriation	$772,317	$796,536	$685,644
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	-1,815	0	0
Subtotal, adjusted appropriation	$770,502	$796,536	$685,644
OAR HIV/AIDS Transfers	-9	0	0
Subtotal, adjusted budget authority	$770,493	$796,536	$685,644
Unobligated balance, start of year	0	0	0
Unobligated balance, end of year	0	0	0
Subtotal, adjusted budget authority	$770,493	$796,536	$685,644
Unobligated balance lapsing	-10	0	0
Total obligations	$770,483	$796,536	$685,644

[1] Excludes the following amounts (in thousands) for reimbursable activities carried out by this account:
FY 2018 - $17,240 FY 2019 - $25,100 FY 2020 - $21,500

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

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	827	$348,491	878	$362,049	854	$340,529	-24	-$21,520
Administrative Supplements	*(74)*	7,526	*(36)*	3,667	*(6)*	2,090	*(-30)*	-1,577
Competing:								
Renewal	95	41,633	97	39,990	65	25,183	-32	-14,807
New	215	83,372	218	89,010	145	56,052	-73	-32,958
Supplements	0	0	0	0	0	0	0	0
Subtotal, Competing	310	$125,004	315	$129,000	210	$81,234	-105	-$47,766
Subtotal, RPGs	1,137	$481,021	1,193	$494,716	1,064	$423,853	-129	-$70,863
SBIR/STTR	47	24,092	55	24,876	47	21,321	-8	-3,555
Research Project Grants	1,184	$505,113	1,248	$519,592	1,111	$445,175	-137	-$74,418
Research Centers:								
Specialized/Comprehensive	42	$27,167	42	$27,167	36	$23,255	-6	-$3,912
Clinical Research	0	0	0	0	0	0	0	0
Biotechnology	0	0	0	0	0	0	0	0
Comparative Medicine	1	144	1	160	0	137	-1	-23
Research Centers in Minority Institutions	0	0	0	0	0	0	0	0
Research Centers	43	$27,310	43	$27,327	36	$23,392	-7	-$3,935
Other Research:								
Research Careers	97	$18,832	97	$18,832	83	$16,120	-14	-$2,712
Cancer Education	0	0	0	0	0	0	0	0
Cooperative Clinical Research	51	37,538	54	39,814	46	34,081	-8	-5,733
Biomedical Research Support	0	0	0	0	0	0	0	0
Minority Biomedical Research Support	0	0	0	0	0	0	0	0
Other	24	14,542	28	15,700	24	13,439	-4	-2,261
Other Research	172	$70,912	179	$74,346	153	$63,640	-26	-$10,706
Total Research Grants	1,399	$603,335	1,470	$621,265	1,300	$532,207	-170	-$89,059
Ruth L Kirchstein Training Awards:	FTTPs		FTTPs		FTTPs		FTTPs	
Individual Awards	99	$4,551	99	$4,741	99	$4,741	0	$0
Institutional Awards	164	7,067	164	7,373	164	7,373	0	0
Total Research Training	263	$11,618	263	$12,114	263	$12,114	0	$0
Research & Develop. Contracts	41	$38,928	41	$42,353	37	$36,564	-4	-$5,789
(SBIR/STTR) (non-add)	*(0)*	*(48)*	*(0)*	*(48)*	*(0)*	*(238)*	*(0)*	*(190)*
Intramural Research	177	86,866	183	90,089	183	77,116	0	-12,973
Res. Management & Support	82	29,745	90	30,715	90	27,643	0	-3,071
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, NEI	259	$770,493	273	$796,536	273	$685,644	0	-$110,892

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

Major Changes in the Fiscal Year 2020 President's Budget Request

Major changes by budget mechanism and/or budget detail are briefly described below. Note that there may be overlap between budget mechanisms and activity detail and these highlights will not sum to the total change for the FY 2020 President's Budget. The FY 2020 President's Budget for NEI is $685.6 million, a decrease of $110.9 million from FY 2019 Enacted level.

Research Project Grants (RPGs) (-$74.4 million; total $445.2 million):
NEI will reduce funding for Non-competing RPGs by 5.9 percent, which is a $17.9 million decrease from their full funding level. Competing RPGs are expected to decrease by 33.3 percent or 105 grants compared to the FY 2019 enacted level of 315 awards, and the amount to support competing awards will be reduced by $47.8 million from FY 2019. These reductions are distributed across all programmatic areas and basic, translational or clinical research.

Research Centers (-$3.9 million; total $23.4 million):
NEI will reduce funding for Research Centers by 14.4 percent, resulting in 7 fewer awards.

Other Research (-$10.7 million; total $63.6 million):
NEI will reduce funding for Other Research mechanisms by 14.4 percent. Research Careers are expected to decrease by 14.4 percent or 14 grants compared to the FY 2019 enacted level of 97 awards. Cooperative Clinical Research is expected to decrease by 14.4 percent resulting in 8 fewer awards.

R&D Contracts (-$5.8 million; total $36.6 million):
NEI will reduce funding for R&D Contracts by 13.7 percent, which is a $5.8 million decrease from the full funding level. These reductions are distributed across all existing research contracts and R&D related Interagency Agreements.

Intramural Research (-$13.0 million; total $77.1 million):
NEI will reduce funding for intramural research RPGs by 14.4 percent, which is a $13.0 million decrease from its full funding level. These reductions are distributed across all programmatic areas and basic, translational or clinical research.

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

Summary of Changes

(Dollars in Thousands)

FY 2019 Enacted	$796,536
FY 2020 President's Budget	$685,644
Net change	-$110,892

CHANGES	FY 2020 President's Budget		Change from FY 2019 Enacted	
	FTEs	Budget Authority	FTEs	Budget Authority
A. Built-in:				
1. Intramural Research:				
a. Annualization of January 2019 pay increase & benefits		$33,655		$17
b. January FY 2020 pay increase & benefits		33,655		51
c. Paid days adjustment		33,655		127
d. Differences attributable to change in FTE		33,655		0
e. Payment for centrally furnished services		11,878		-1,934
f. Cost of laboratory supplies, materials, other expenses, and non-recurring costs		31,583		0
Subtotal				-$1,738
2. Research Management and Support:				
a. Annualization of January 2019 pay increase & benefits		$14,360		$8
b. January FY 2020 pay increase & benefits		14,360		25
c. Paid days adjustment		14,360		54
d. Differences attributable to change in FTE		14,360		0
e. Payment for centrally furnished services		3,777		-429
f. Cost of laboratory supplies, materials, other expenses, and non-recurring costs		9,506		0
Subtotal				-$342
Subtotal, Built-in				-$2,079

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

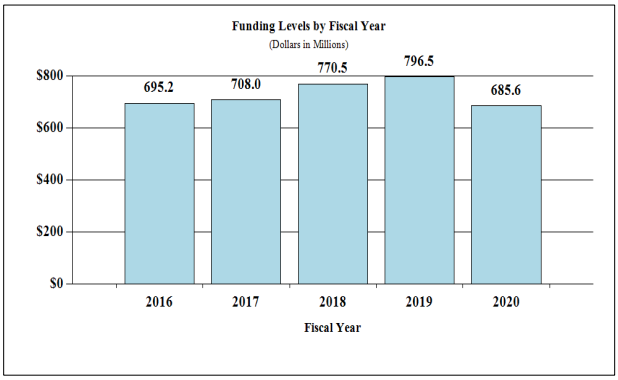
Summary of Changes - Continued

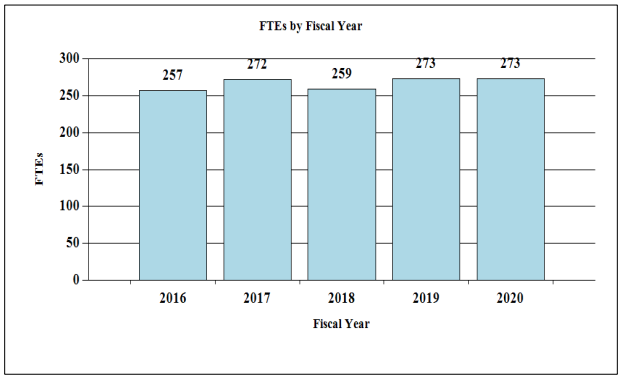
(Dollars in Thousands)

CHANGES	FY 2020 President's Budget		Change from FY 2019 Enacted	
	No.	Amount	No.	Amount
B. Program:				
1. Research Project Grants:				
a. Noncompeting	854	$342,619	-24	-$23,097
b. Competing	210	81,234	-105	-47,766
c. SBIR/STTR	47	21,321	-8	-3,555
Subtotal, RPGs	1,111	$445,175	-137	-$74,418
2. Research Centers	36	$23,392	-7	-$3,935
3. Other Research	153	63,640	-26	-10,706
4. Research Training	263	12,114	0	0
5. Research and development contracts	37	36,564	-4	-5,789
Subtotal, Extramural		$580,885		-$94,848
	FTEs		FTEs	
6. Intramural Research	183	$77,116	0	-$11,235
7. Research Management and Support	90	27,643	0	-2,730
8. Construction		0		0
9. Buildings and Facilities		0		0
Subtotal, Program	273	$685,644	0	-$108,813
Total changes				-$110,892

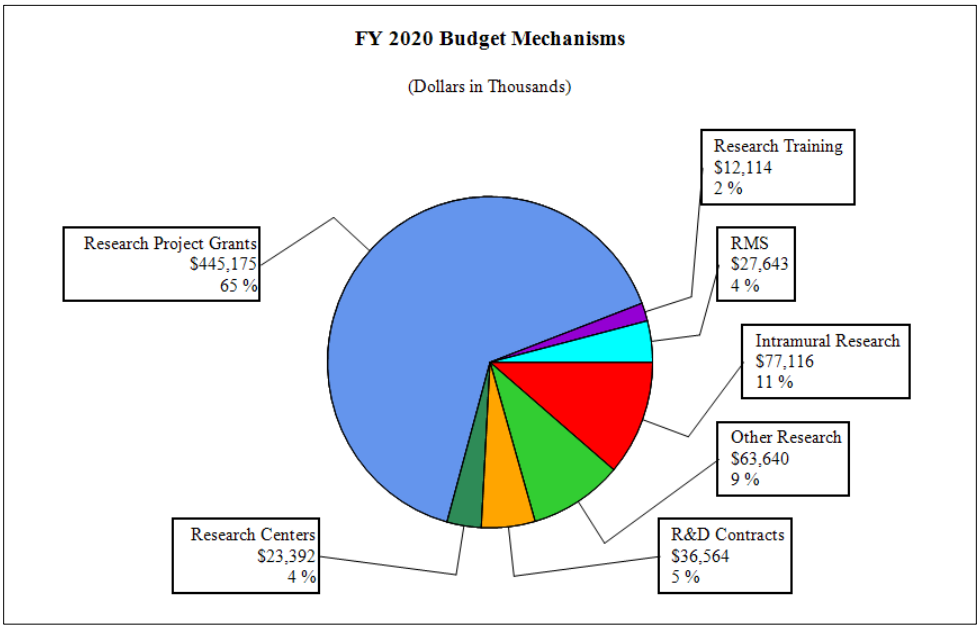
Fiscal Year 2020 Budget Graphs

History of Budget Authority and FTEs:

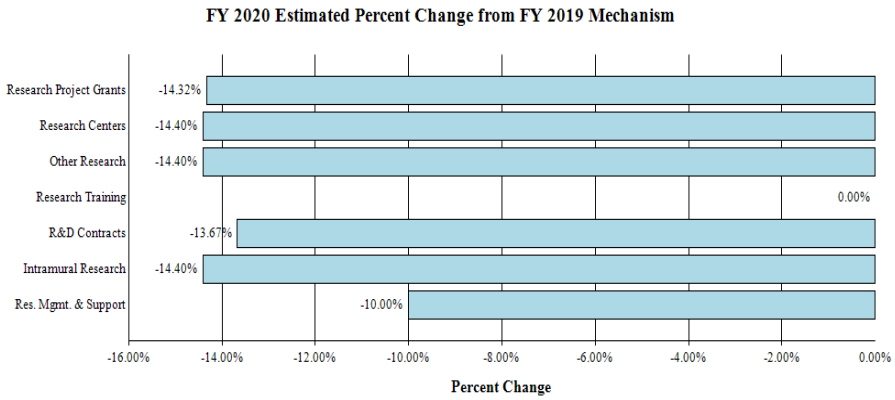




Distributed by Mechanism:



Change by Selected Mechanism:



NATIONAL INSTITUTES OF HEALTH
National Eye Institute

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

	FY 2018 Final		FY 2019 Enacted		FY 2020 President's Budget		FY 2020 +/- FY2019 CR	
Extramural Research	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**
Detail								
Retinal Diseases Research		$303,355		$313,492		$269,489		-$44,003
Corneal Diseases, Cataract, and Glaucoma Research		208,048		215,000		184,822		-30,178
Sensorimotor Disorders, Visual Processing, and Rehabilitation Research		142,479		147,240		126,573		-20,667
Subtotal, Extramural		**$653,882**		**$675,733**		**$580,885**		**-$94,848**
Intramural Research	**177**	**$86,866**	**183**	**$90,089**	**183**	**$77,116**	**0**	**-$12,973**
Research Management & Support	**82**	**$29,745**	**90**	**$30,715**	**90**	**$27,643**	**0**	**-$3,071**
TOTAL	**259**	**$770,493**	**273**	**$796,536**	**273**	**$685,644**	**0**	**-$110,892**

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

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

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	$796,536,000	Indefinite	$685,644,000
National Eye Institute	Section 401(a)	42§281	Indefinite		Indefinite	
Total, Budget Authority				$796,536,000		$685,644,000

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

Appropriations History

Fiscal Year	Budget Estimate to Congress	House Allowance	Senate Allowance	Appropriation
2011	$724,360,000		$723,220,000	$707,036,000
Rescission				$6,208,198
2012	$719,059,000	$719,059,000	$692,938,000	$704,043,000
Rescission				$1,330,641
2013	$693,015,000		$695,115,000	$702,712,359
Rescission				$1,405,425
Sequestration				($35,271,328)
2014	$699,216,000		$701,407,000	$682,077,000
Rescission				$0
2015	$675,168,000			$684,191,000
Rescission				$0
2016	$695,154,000	$698,108,000	$709,549,000	$715,903,000
Rescission				$0
2017[1]	$707,998,000	$735,576,000	$740,826,000	$732,618,000
Rescission				$0
2018	$549,847,000	$743,881,000	$758,552,000	$772,317,000
Rescission				$0
2019	$711,015,000	$781,540,000	$796,955,000	$796,536,000
Rescission				$0
2020	$685,644,000			

[1] Budget Estimate to Congress includes mandatory financing.

Justification of Budget Request

National Eye Institute

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

Budget Authority (BA):

	FY 2018 Final	FY 2019 Enacted	FY 2020 President's Budget	FY 2020 +/- FY 2019
BA	$770,493,000	$796,536,000	$685,644,000	-110,892,000
FTE	259	273	273	0

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

Director's Overview

Eye diseases that lead to blindness, such as age-related macular degeneration (AMD), diabetic retinopathy (DR), and glaucoma, affect millions of Americans of all ages and ethnicities. These and other less common diseases disable productive careers and rob people of their mobility and independence. The National Eye Institute (NEI) supports vision and ocular health research through approximately 1,500 research grants and training awards made to scientists at more than 250 medical centers, hospitals, and universities across 44 states and around the world. NEI also conducts laboratory and patient-oriented research in facilities located on the NIH campus in Bethesda, Maryland.

2020 Vision

The vision for the NEI FY 2020 Budget is to help more Americans achieve 20/20 vision. As NEI celebrated its 50th anniversary in 2018, it also celebrated NEI research achievements which led to Food and Drug Administration (FDA) approvals of new drugs for glaucoma and the first approved gene therapy for a form of childhood blindness. Vision science continues to break new ground: the NEI Audacious Goal Initiative (AGI) is pioneering regenerative medicine to restore vision loss due to injury or degenerative disease; artificial intelligence is becoming a transformative tool for diagnosing and predicting eye disease.

In recent years, NEI's top priority has been to strengthen the capacity to conduct high quality vision research in a balanced portfolio including diseases of the retina and cornea, cataract, glaucoma, vision processing in the brain, and low vision/blindness rehabilitation. To help achieve this, the Institute cultivates a robust scientific workforce that nurtures early and mid-career investigators who are particularly vulnerable in the current hypercompetitive environment. The Institute has paid special attention to talented investigators who rely on NEI as their only source of funding, while also solidifying the next generation of vision researchers through early

career awards. Regenerative medicine is another priority: NEI applied new funds to start stem cell clinical trials in 2018 in the retina and cornea (*see program portrait*). Also, NEI expanded the successful Diabetic Retinopathy Clinical Research network (DRCR.net) to encompass other retinal diseases, adding a network chair to focus on AMD and hereditary retinal degenerations, while augmenting the robust diabetes portfolio. DRCR.net has extensive infrastructure involving academic centers and community clinics to rapidly recruit patients and implement trial protocols. Data science is another priority, with an emphasis on data sharing. Platforms, such as the NEI Data Commons, allow researchers to share data. The NEI AGI requires grantees to work together in scientific consortia to share data and methods.

Building on Basic Science: New Therapies for Eye Disease

The FDA recently approved two new drugs for glaucoma, the first new drugs in nearly 18 years. Glaucoma is a leading cause of blindness particularly in African American and Hispanic populations and is often caused by a build-up of fluid pressure, resulting in the death of neurons that carry vision information from the eye to the brain. Aqueous humor is a clear fluid that nourishes tissues. It continuously flows in and out of a healthy eye through two routes, a spongy layer called the trabecular meshwork (TM), and an alternative pathway, which handles about one third of the fluid. When these pathways become clogged, fluid accumulates, ultimately leading to glaucoma. Current drugs mainly act on the alternative pathway, but drugs that increase TM flow remained elusive for decades. In basic research starting in the 1990s, NEI scientists discovered that drugs that inhibited an enzyme called rho kinase relaxed the TM and increased fluid flow. Trials are currently underway to test a combination therapy involving existing and new drugs to powerfully prevent glaucoma in patients with high ocular pressure.

NEI has also endeavored to understand the molecular causes of glaucoma—it is known to be strongly hereditary, but until recently, only genes for rare forms of glaucoma had been identified. As a complex disease, there is no obvious singular gene that explains the risk; instead, many genes and environmental factors together contribute risks in aggregate. NEI has assembled the NEI Glaucoma Human Genetics CollaBORation (NEIGHBOR) to collect and compare DNA from 4,000 glaucoma patients and 30,000 people without glaucoma. NEIGHBOR and its international partners created the Heritable Overall Operational Database (NEIGHBORHOOD), which applied new genomics techniques and data analysis to identify 133 genetic variants, 68 of which were new, that predict with 75 percent accuracy the risk for developing glaucoma related to elevated pressure in the eye. Future genetic tests could identify high-risk individuals who would benefit from early interventions aimed at preventing vision loss. Furthermore, other NEI scientists expanded the use of an imaging tool, optical coherence tomography (OCT), which has already revolutionized diagnosis and treatment decisions for retinal diseases like age-related macular degeneration (AMD) and diabetic retinopathy (DR). In a study, OCT detected glaucoma in 60 percent of 356 patients with suspected glaucoma compared to 27 percent with standard-of-care vision tests. OCT significantly improved detection for cases of mild glaucoma.

The NEI AGI is designing transformational tools and technologies, with the goal of restoring vision through regeneration of neurons and neural connections in the eye and visual system. AGI seeks to catalyze new treatments for blinding conditions like AMD, glaucoma, retinitis pigmentosa, and other degenerative eye diseases. One AGI scientific consortium is developing new imaging technologies that not only visualize individual living cells in patients but also

indicate if they function correctly. A second, discovery-based AGI consortium is looking at animals such as newts that have the natural capacity to regenerate their nerves, to identify and test factors that may promote regeneration in mammals. In a recent advance, a team that included AGI investigators studied Müller glia cells (MG), which can regenerate into retinal neurons after injury in zebrafish, but not in mammals. Damage triggers increased production of a protein, Ascl1, which in turn controls gene expression to make other proteins that convert the cell into a neuron. While this doesn't happen naturally in mammals, scientists artificially increased Ascl1 in mouse MGs after inducing damage. In very young mice, MGs turned into neurons. However, they found the MG DNA in older mice was inaccessible—to prevent inappropriate gene expression, mature cells block some regions of DNA with a protein structure called chromatin. Normally this prevents mature cells from converting from one cell type to another. If the team added a factor that remodeled chromatin structure, the hidden genes became accessible and they could reprogram older mouse MGs into neurons. Furthermore, these neurons were functional, responding to light and forming connections with the other neurons. A separate NEI team also succeeded in converting mouse MGs into neurons, in this case the light-sensitive rod cells. Their method, which does not involve injuring the retina to reprogram MGs, is a two-step process. First, they inject a gene to stimulate MGs to proliferate into a large pool of MG cells. After several weeks, they use a protocol to reprogram MGs to rods. They were able to rescue a congenitally blind strain of mice, born without rods; MG-derived rods allowed the mice to detect light and the neurons integrated in the mouse retina.

In September 2018, AGI funded five projects to form a new consortium to develop cell and animal models that closely match human biology and eye disease. Models are needed to test new treatments like gene therapy or stem cell-based tissue replacement, and then to translate therapies to the clinic. Leaping from inspiration to innovation, NEI launched a 3-D Retina Organoid Challenge competition (3D-ROC) in two phases to develop functional retina organoids for use in disease modeling or drug screening. Organoids are mini-organs grown in a culture dish, derived from human stem cells. In 2017, phase I: Ideation, NEI awarded a prize to a design proposing a screen printing method to juxtapose retina cell layers. In February 2018, NEI announced $1 million in prizes for the competition to deliver organoids meeting specific functional requirements by 2020.

Exploring the Next Frontier: Artificial Intelligence (AI) as a Diagnosis Tool

An experienced doctor can look at photograph of the retina and diagnose a patient with diabetic retinopathy (DR) or AMD by looking carefully at specific features, such as the shape of the blood vessels, plaques, or spots that indicate cell death. Machine learning also relies on experience: feeding thousands of images, along with the "ground truth" clinical information such as disease state, the AI algorithm iteratively trains itself to recognize which image features are important for diagnosis, while ignoring artifacts, like a spurious shadow. Numerous reports by NEI scientists in the past year demonstrated that not only can AI reliably classify disease with higher accuracy than many doctors, but these algorithms can also successfully predict the patient's age, gender, whether he/she smokes, and the likelihood of developing disease in the next five years. In the future, one can envision some routine medical diagnostics handled by AI, at a substantial cost savings and benefit to patients. NEI funds small business grants to develop AI tools to screen rural and underserved communities for DR and AMD, and to screen premature, low birthweight infants at risk for retinopathy-of-prematurity (ROP), a condition in

which prompt intervention can prevent lifelong blindness. Microperimetry is a visual field test that maps the ability of subject to perceive light at discrete points on the retina. With microperimetry plus imaging, AI allows doctors to predict sensitivity of the retina at locations between measurement points. Beyond diagnosis, AI optimizes manufacturing of cell therapy products. NEI researchers developed a way to convert patient-derived stem cells into replacement retina cells for use in an AMD clinical trial. However, the researchers needed to test the clinical grade product to verify which cells function appropriately and which should be discarded. Thus, they developed an AI characterization platform to non-invasively predict cell therapy function based on shape and texture features of single cells.

While current prosthetics turn images into electrical impulses delivered to the retina providing blind users the ability to see bright lights and high contrast edges, the next generation prosthetic takes advantage of the visual processing already performed by the retina. An NEI team is constructing a prosthetic using a camera mounted on glasses that sends processed images to the retina using its own neural code representation of the 3-D world. The brain is better able to interpret the pre-processed visual information. AI models have shown that this coded information excels at feature detection and can successfully steer a robot through the real world.

50 Years of Progress in Treating Eye Diseases

NEI celebrated the 50th anniversary since Congress created the Institute in 1968, with a Congressional reception in March, community events, and four scientific symposia, covering vision and neuroscience, immunology, rehabilitation, and the future of vision research. These events are archived online[1], along with "Then and Now" videos and a booklet highlighting the progress in the past 50 years. As NEI looked forward to the remarkable research on the horizon, the Institute also had the opportunity to recognize its accomplishments in saving the vision of millions of Americans. NEI played a pivotal role in standardizing clinical trial methodology while advancing vision-saving treatments for DR, AMD, uveitis, amblyopia, and glaucoma. The Institute has identified dietary supplements that slow AMD progression. Clinicians can now detect and prevent vision loss in ROP, and a recent NEI clinical trial demonstrated that telemedicine can expand access to ROP specialists in rural and underserved communities. Infectious eye diseases have largely been eradicated in the U.S., and anti-retroviral treatments for HIV now prevent serious vision loss associated with AIDS. NEI has funded 9 Nobel laureates, including research that discovered how brain circuits form and self-organize, and how the retina detects light at the molecular level. Vision research has led cutting-edge biomedical research in genomics, gene therapy, and now regenerative medicine. Last year, the FDA approved the first gene therapy for a rare genetic form of blindness that strikes in childhood. The gene was discovered by an NEI scientist in 1993, before the field of gene therapy had been developed. NEI funded years of research developing safe viral vectors to deliver the gene into the appropriate cells, and then testing the therapy in animal models, followed by clinical trials. Following this pioneering work, dozens of gene therapies for other previously incurable genetic diseases are in pre-clinical or clinical trials and may soon be available. As NIH invests in next-generation technologies, the future of vision research is very bright.

[1] www.nei.nih.gov/**NEI**at**50**

Overall Budget Policy:
The FY 2020 President's Budget request is $685.6 million, a decrease of $110.9 million or 13.9 percent compared with the FY 2019 Enacted level.

Program Descriptions and Accomplishments

Retinal Diseases Research: The retina is the light-sensitive neural tissue that lines the inside of the eye and sends visual messages through the optic nerve to the brain. Damage to the retina through disease or retinal detachment can lead to severe vision loss. The goals of this program are to increase the understanding of disease mechanisms that cause vision loss and to develop improved methods of prevention, diagnosis, and treatment. To meet these goals, NEI supports research on the cell biology, physiology, neuroscience, and immunology of the retina. Major areas addressed within the Retina Program include:

- **Age-related Macular Degeneration.** A leading cause of vision loss, AMD is a disease that blurs the sharp, central vision required for reading, driving, and face recognition. There are two forms of advanced AMD: geographic atrophy ("dry") AMD, a gradual breakdown of light sensing photoreceptor neurons; and neovascular ("wet") AMD, when abnormal blood vessels grow underneath the retina.
- **Retinopathy.** Diabetic retinopathy is a complication of diabetes in which abnormal blood vessels grow on the surface of the retina and may swell and leak fluid. Retinopathy of Prematurity is a potentially blinding disorder that affects premature infants with very low birthweight.
- **Retinal monogenic disorders.** Some retinal degenerative diseases are caused by single genetic mutations, including retinitis pigmentosa, Usher syndrome, and ocular albinism.
- **Uveitis.** Inflammatory diseases that produce swelling and destroy eye tissue, sometimes leading to severe vision loss.

Recent program accomplishments include regenerative medicine breakthroughs deriving neurons from stem cells, elucidating neuronal circuitry, and exploring molecules involved in healthy and disease functions. For example, inflammation plays a role in triggering the dry form of AMD, but the molecular pathway had not been worked out. As one team pieced the puzzle together, they recognized non-canonical interactions of certain proteins, including a complex known as the inflammasome—opening the door to potential drug targets for AMD. In another advance, infants whose mothers had Zika virus infections during pregnancy were evaluated for eye developmental abnormalities. Researchers found that Zika impacted gene regulation in the retina differently than other viruses, such as Dengue virus, which may help direct therapeutic strategies.

Budget Policy:
The FY 2020 President's Budget request is $269.5 million, a decrease of $44.0 million or 14.0 percent compared with the FY 2019 Enacted level. The Retina Program seeks to balance a portfolio of basic and clinical research on fundamental retinal processes, retinal neuroscience, and retinal diseases. The expansion of the DRCR network to cover retinal diseases other than diabetic retinopathy will expedite development of protocols in AMD and retinal degenerations.

Program Portrait: Natural History Study of AMD Progression
FY 2019 level: $1.500 million
FY 2020 level: $1.500 million
Change: $0.000 million

In 2018, NEI launched a clinical study to follow 500 people over five years to learn more about the natural history of early age-related macular degeneration (AMD). By using the latest technologies to visualize structures within the eye and measure their function, researchers hope to identify biomarkers of disease progression, well before it advances to late-stage disease and causes vision loss. AMD is the leading cause of vision impairment and blindness among people age 50 and older in the United States. Only about 10 to 20 percent of people with early AMD progress to late-stage disease within five years. It is difficult to predict who will progress because AMD is a complex, multifactorial disease influenced by a combination of age, family history, genetic and health behavioral factors. A diet rich in green leafy vegetables and fish may reduce the risk, while smoking cigarettes increases it. The AMD Ryan Initiative Study (ARIS) will track the eye health of 200 people who have bilateral early AMD, defined by the presence of medium-size drusen, yellowish deposits that accumulate under the retina. In addition, ARIS will include 200 people with early, reticular pseudodrusen, a type of lesion that causes the retina to have a giraffe-like macular pattern. The composition and location of the reticular pseudodrusen differ from that of typical drusen. Some data suggest reticular pseudodrusen are associated with a higher than usual risk for progression to late disease, but more research is needed about this group. For comparison, the study will enroll 100 age-matched, drusen-free control participants. Private partners, such as the Beckman Institute, are co-funding this trial.
This study builds on recent NEI studies including the Age-Related Eye Disease Studies (AREDS I & II), as well as genomics studies which have identified 52 independent genetic variants associated with AMD. People with early AMD typically do not have daylight vision loss. As it progresses, AMD causes cells in the retina to die. Much of the damage occurs in the macula, an area of the retina responsible for sharp, central vision. Treatments that halt the disease at its early stage would have an enormous public health impact.

Corneal Diseases, Cataract, and Glaucoma Research: Corneal diseases, cataracts, and glaucoma cause more visits to ophthalmologists a year than any other vision disorders. NEI supports research to address these conditions that originate in the front of the eye.

- **Corneal disease research.** Corneal injuries, infections, and diseases can be extremely painful and require immediate medical attention. In FY 2018 results from the Cornea Preservation Time Study indicated that transplantation success was unaffected for donor corneas preserved for 11 days, expanding the pool of tissue available for transplantation.
- **Cataract research.** Cataracts, a clouding of the lens in the eye that affects vision, are the leading cause of blindness worldwide. NEI researchers investigate strategies to prevent cataract formation and progression through research to understand the physiological basis of how the lens in the eye remains transparent at the cellular and molecular levels. Although cataract surgery is effective, up to 12 percent of surgery patients develop secondary cataract. A 2018 study on cataract surgery showed that a protein called vimentin was implicated in the process in which wound healing can lead to scarring.
- **Glaucoma research.** Glaucoma is a group of blinding diseases that result from damage to the optic nerve, the bundle of fibers that transmit signals from the eyes to the brain. Current therapies focus on reducing excessive fluid pressure in the eye, which causes nerve damage in the most common form of glaucoma. Recent research suggests repetitive strain from eye movement may play a role in glaucoma, possibly explaining why glaucoma can develop in people without the risk factor of elevated ocular pressure.

Budget Policy:

The FY 2020 President's Budget request is $184.8 million, a decrease of $30.2 million or 14.0 percent compared with the FY 2019 Enacted level. While anterior eye diseases (affecting the front of the eye) can lead to vision loss in patients at any age, NEI places additional priority on research exploring the impact of aging and environmental factors on conditions such as corneal dysfunction, glaucoma, and cataract formation. Anterior eye research also includes ocular pain, ocular infection, inflammation, and immunology.

Sensorimotor Disorders, Visual Processing, and Rehabilitation Research: NEI funds basic and applied brain research, and research on rehabilitation for individuals with low vision. NEI neuroscientists have made remarkable progress in understanding what goes on in the face-processing areas in the brain.

- **Sensorimotor disorders and visual processing research.** Strabismus (misalignment of the eyes) and amblyopia (commonly known as "lazy eye") are common disorders that develop during childhood. Program goals center on gaining a better understanding of the neuromuscular control of gaze and the development of the visual system in children at high risk for these disorders. Neuroscientists working in vision research seek to understand how the brain processes the visual information that floods our eyes, how neural activity is related to visual perception, and how the visual system interacts with cognitive and motor systems.
- **Refractive errors.** Refractive errors, such as nearsightedness, farsightedness, and astigmatism, are commonly correctable with eye glasses or contact lenses in the U.S. but remain a tremendous economic and personal burden globally. The major goals of this program are to discover the biochemical pathways that govern eye growth and to uncover the risk factors associated with refractive errors.
- **Rehabilitation research.** Low vision is the term used to describe chronic visual conditions that are not correctable by eye glasses or contact lenses. NEI supports rehabilitation research to improve the quality of life for people with visual impairments by helping them maximize the use of remaining vision and by devising improved aids and strategies to assist those without useful vision.

It has long been accepted that in roughly one-third of stroke patients who end up with low vision, the blindness is irreversible. However, recent studies suggest that vision training after nerve or brain damage can improve vision. Brain imaging indicated that the mechanism of rehabilitation involved circuits in the brain linked to attention. Another recent study used brain imaging to compare sighted individuals with people congenitally blind from birth. In people with sight, part of visual brain cortex called the visual word form area is involved in reading letters and words and has strong connectivity with language networks. While people who are born blind do not read letters and words, this same part of the brain was specifically recruited for higher-order language processing, active during grammatical processing of spoken sentences in blind Braille readers, but not sighted readers of print. This provides insights into brain organization and how it develops; even in the absence of vision, the visual word form area is deeply connected to language.

Budget Policy:

The FY 2020 President's Budget request is $126.6 million, a decrease of $20.7 million or 14.0 percent compared with the FY 2019 Enacted level. NEI conducts pediatric clinical studies for strabismus, amblyopia, and refractive error. Interventions for these conditions, as well as low vision and blindness rehabilitation are most effective when introduced at early stages.

Intramural Research: NEI clinical studies are focused on the cause, prevention, and treatment of eye diseases and vision disorders; cellular and molecular mechanisms of eye development, infectious diseases of the eye; inflammatory and immunological responses; mechanisms of visual perception by the brain; and sensory control of movements. A recent program accomplishment demonstrated that immune cells called microglia can completely repopulate themselves in the retina after being nearly eliminated in mouse eyes. The cells also re-establish their normal organization and function. The findings point to potential therapies for controlling inflammation and slowing progression of retinal diseases. Also, scientists studying hibernation in ground squirrels developed a model "hibernation in a dish" from reprogrammed stem cells, which retained their intrinsic ability to adapt to the cold. The team discovered genes and other molecules that allow the animals to hibernate, which could be a step toward extending storage of human donor tissues awaiting transplantation and protecting traumatic brain injury patients who undergo induced hypothermia.

Program Portrait: Stem Cell Therapy Clinical Trials

FY 2019 level:	$0.600 million
FY 2020 level:	$2.400 million
Change:	$1.800 million

Stem cells have the remarkable potential to divide essentially without limit to create copies of themselves and to develop into many different cell types in the body during early life and growth. The promise of stem cell-based therapies to repair or replace damaged cells, tissues, or organs has captured the imagination of scientists, patients, and the public: in the 21st Century Cures Act, Congress established the Regenerative Medicine Program (RMP) to support clinical research using adult stem cells. NEI has invested deeply in basic stem cell research, resulting in protocols for converting stem cells into many different types of cells in the eye. This investment is paying off: NEI launched three stem cell clinical trials in the last year. RMP is supporting an NEI project to treat Limbal Stem Cell Deficiency (LSCD). Corneal limbal cells are responsible for renewing the front layer of the transparent cornea. In thousands of patients with LSCD, loss of these cells causes visual impairment from chronic inflammation, abnormal blood vessel growth, and opaque corneas. Researchers identified a limbal cell marker, *ABCB5*, which has allowed them to isolate, purify and expand limbal stem cells in the lab in sufficient quantities for transplantation. The second trial treats patients with retinal vein occlusion, in which the vessels draining blood from retinal tissue become clotted, leading to leaking and bleeding and ultimately starving the neurons of oxygen. The trial will test the safety, feasibility and efficacy of injecting stem cells derived from the patient's own bone marrow into their eyes. Induced pluripotent stem cells (iPSCs) are adult cells that have been genetically reprogrammed to an embryonic state, meaning they can be turned into any cell type in the body. In the first trial of its kind, NEI scientists are treating patients with the dry form of AMD using iPSC-based therapies derived from their own cells. In dry AMD, there is a gradual breakdown of the light-sensitive retina neurons, and of the supporting tissue beneath these cells. These changes cause vision loss. Blood cells taken from AMD patients are manipulated in the lab for 180 days to become this supporting tissue, then surgically implanted back into the same patients, thereby minimizing rejection of foreign tissue that affects many types of transplant therapies. In pre-clinical studies in animal models, light-sensing function was rescued, suggesting that the tissue grafts are successful in regenerating neurons.

Budget Policy:

The FY 2020 President's Budget request is $77.1 million, a decrease of $13.0 million or 14.0 percent compared with the FY 2019 Enacted level. In a joint Intramural/Extramural cross-disciplinary initiative, research teams are creating a scientific resource to help predict AMD disease progression and develop potential new treatments. NEI is building a database to integrate disparate patient data from the Age-related Eye Disease Study, including clinical metrics on disease progression, eye imaging data, and genomic sequence data. These rich data sources feed into artificial intelligence (AI) based models. Furthermore, patients' blood samples will be converted into stem cells, and subsequently transformed into retinal cells to enable researchers to study disease mechanism pathways using molecular cell biology.

Research Management and Support (RMS): RMS supports, provides essential services, and monitors the budgets of research programs. Included in these funds is personnel to carry out leadership and management functions, human resource support, training, travel, purchasing, facilities, budget, planning, information technology, and extramural grant award and management. NEI currently oversees more than 1,500 grants and contracts, including research project grants, core center grants, research career development awards, cooperative clinical research agreements, and research and development contracts.

Budget Policy:
The FY 2020 President's Budget request is $27.6 million, a decrease of $3.1 million or 10.0 percent compared with the FY 2019 Enacted level.

Program Portrait: Collaborative Vision Research Program with Department of Defense

FY 2019 level:	$0.000 million
FY 2020 level:	$2.000 million
Change:	$2.000 million

NEI will collaborate with the Department of Defense (DoD) Vision Research Program (VRP). VRP was established by Congress in FY 2009 to fund impactful military-relevant vision research that has the potential to significantly improve the health care and wellbeing of service members, veterans, their family members and caregivers, and the public. The focus of the VRP is eye injury, burns, and visual dysfunction resulting from battlefield trauma (including visual processing related to traumatic brain injury). Similarly, the NEI mission focuses on vision research in health and disease, and as such NEI program officials have served as advisors to VRP since program inception. Despite a common interest in vision research, the research applicant pool between DoD and NEI are generally non-overlapping, each offering unique perspectives and approaches. The VRP receives more qualified applications than it can fund each year, opening an opportunity for cross-governmental collaboration to fund more projects.
In FY 2019, NEI and DoD signed an Memorandum of Understanding to formally partner and expedite application sharing. The collaboration is modeled on the successful Collaborative Research in Computational Neuroscience (CRCNS), a partnership between NIH, the National Science Foundation, and international funding agencies. CRCNS promotes collaborative science and engineering projects through a common grant application process that expedites review across agencies—matching projects with the most appropriate funding agency. NEI and DoD will align their review criteria such that a single review of grant applications will satisfy both funding agencies. Qualified projects not funded by the VRP will be automatically reformatted for NIH and considered competitively for funding provided the research is relevant to the NEI program mission. The DoD-NEI collaboration increases the chances of funding for more qualified projects, while also enhancing the NEI scientific workforce into new areas of expertise.

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

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	273	273	0
	Full-time equivalent of overtime and holiday hours	0	0	0
	Average ES salary	$190	$190	$0
	Average GM/GS grade	12.4	12.4	0.0
	Average GM/GS salary	$110	$110	$0
	Average salary, grade established by act of July 1, 1944 (42 U.S.C. 207)	$119	$123	$4
	Average salary of ungraded positions	$133	$133	$0
	OBJECT CLASSES	**FY 2019 Enacted**	**FY 2020 President's Budget**	**FY 2020 +/- FY 2019**
	Personnel Compensation			
11.1	Full-Time Permanent	18,687	18,758	71
11.3	Other Than Full-Time Permanent	11,501	11,543	42
11.5	Other Personnel Compensation	1,449	1,454	6
11.7	Military Personnel	243	251	8
11.8	Special Personnel Services Payments	5,113	5,132	19
11.9	**Subtotal Personnel Compensation**	**$36,992**	**$37,138**	**$146**
12.1	Civilian Personnel Benefits	10,597	10,729	132
12.2	Military Personnel Benefits	142	147	5
13.0	Benefits to Former Personnel	0	0	0
	Subtotal Pay Costs	**$47,732**	**$48,015**	**$283**
21.0	Travel & Transportation of Persons	901	647	-254
22.0	Transportation of Things	77	55	-23
23.1	Rental Payments to GSA	0	0	0
23.2	Rental Payments to Others	14	10	-3
23.3	Communications, Utilities & Misc. Charges	452	336	-115
24.0	Printing & Reproduction	6	5	-2
25.1	Consulting Services	349	249	-100
25.2	Other Services	23,779	16,241	-7,537
25.3	Purchase of goods and services from government accounts	69,055	58,994	-10,061
25.4	Operation & Maintenance of Facilities	153	119	-34
25.5	R&D Contracts	9,448	8,461	-987
25.6	Medical Care	215	150	-64
25.7	Operation & Maintenance of Equipment	2,622	1,882	-740
25.8	Subsistence & Support of Persons	1,021	1,021	0
25.0	**Subtotal Other Contractual Services**	**$106,641**	**$87,119**	**-$19,523**
26.0	Supplies & Materials	4,812	3,338	-1,474
31.0	Equipment	2,512	1,795	-717
32.0	Land and Structures	0	0	0
33.0	Investments & Loans	0	0	0
41.0	Grants, Subsidies & Contributions	633,385	544,321	-89,065
42.0	Insurance Claims & Indemnities	0	0	0
43.0	Interest & Dividends	4	4	0
44.0	Refunds	0	0	0
	Subtotal Non-Pay Costs	**$748,804**	**$637,629**	**-$111,175**
	Total Budget Authority by Object Class	**$796,536**	**$685,644**	**-$110,892**

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

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

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)	$18,687	$18,758	$71
Other Than Full-Time Permanent (11.3)	11,501	11,543	42
Other Personnel Compensation (11.5)	1,449	1,454	6
Military Personnel (11.7)	243	251	8
Special Personnel Services Payments (11.8)	5,113	5,132	19
Subtotal Personnel Compensation (11.9)	**$36,992**	**$37,138**	**$146**
Civilian Personnel Benefits (12.1)	$10,597	$10,729	$132
Military Personnel Benefits (12.2)	142	147	5
Benefits to Former Personnel (13.0)	0	0	0
Subtotal Pay Costs	**$47,732**	**$48,015**	**$283**
Travel & Transportation of Persons (21.0)	$901	$647	-$254
Transportation of Things (22.0)	77	55	-23
Rental Payments to Others (23.2)	14	10	-3
Communications, Utilities & Misc. Charges (23.3)	452	336	-115
Printing & Reproduction (24.0)	6	5	-2
Other Contractual Services:			
Consultant Services (25.1)	349	249	-100
Other Services (25.2)	23,779	16,241	-7,537
Purchases from government accounts (25.3)	47,795	38,223	-9,573
Operation & Maintenance of Facilities (25.4)	153	119	-34
Operation & Maintenance of Equipment (25.7)	2,622	1,882	-740
Subsistence & Support of Persons (25.8)	1,021	1,021	0
Subtotal Other Contractual Services	**$75,720**	**$57,736**	**-$17,983**
Supplies & Materials (26.0)	$4,812	$3,338	-$1,474
Subtotal Non-Pay Costs	**$81,981**	**$62,127**	**-$19,854**
Total Administrative Costs	**$129,713**	**$110,142**	**-$19,571**

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

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 of Epidemiology and Clinical Applications									
Direct:	10	-	10	10	-	10	10	-	10
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	10	-	10	10	-	10	10	-	10
Division of Extramural Activities									
Direct:	15	-	15	17	-	17	17	-	17
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	15	-	15	17	-	17	17	-	17
Division of Extramural Science									
Direct:	16	-	16	16	-	16	16	-	16
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	16	-	16	16	-	16	16	-	16
Division of Intramural Research									
Direct:	132	-	132	144	-	144	144	-	144
Reimbursable:	3	-	3	3	-	3	3	-	3
Total:	135	-	135	147	-	147	147	-	147
Office of the Director									
Direct:	81	2	83	81	2	83	81	2	83
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	81	2	83	81	2	83	81	2	83
Total	257	2	259	271	2	273	271	2	273
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	12.3
2017	12.4
2018	12.4
2019	12.4
2020	12.4

NATIONAL INSTITUTES OF HEALTH
National Eye Institute

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	189,600	189,600	189,600
GM/GS-15	34	34	34
GM/GS-14	18	18	18
GM/GS-13	41	41	41
GS-12	39	39	39
GS-11	28	28	28
GS-10	1	1	1
GS-9	6	6	6
GS-8	1	1	1
GS-7	3	3	3
GS-6	2	2	2
GS-5	1	1	1
GS-4	1	1	1
GS-3	1	1	1
GS-2	0	0	0
GS-1	0	0	0
Subtotal	176	176	176
Grades established by Act of July 1, 1944 (42 U.S.C. 207)	0	0	0
Assistant Surgeon General	0	0	0
Director Grade	1	1	1
Senior Grade	1	1	1
Full Grade	0	0	0
Senior Assistant Grade	0	0	0
Assistant Grade	0	0	0
Subtotal	2	2	2
Ungraded	81	95	95
Total permanent positions	177	177	177
Total positions, end of year	259	273	273
Total full-time equivalent (FTE) employment, end of year	259	273	273
Average ES salary	189,600	189,600	189,600
Average GM/GS grade	12.4	12.4	12.4
Average GM/GS salary	110,388	110,388	110,388

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