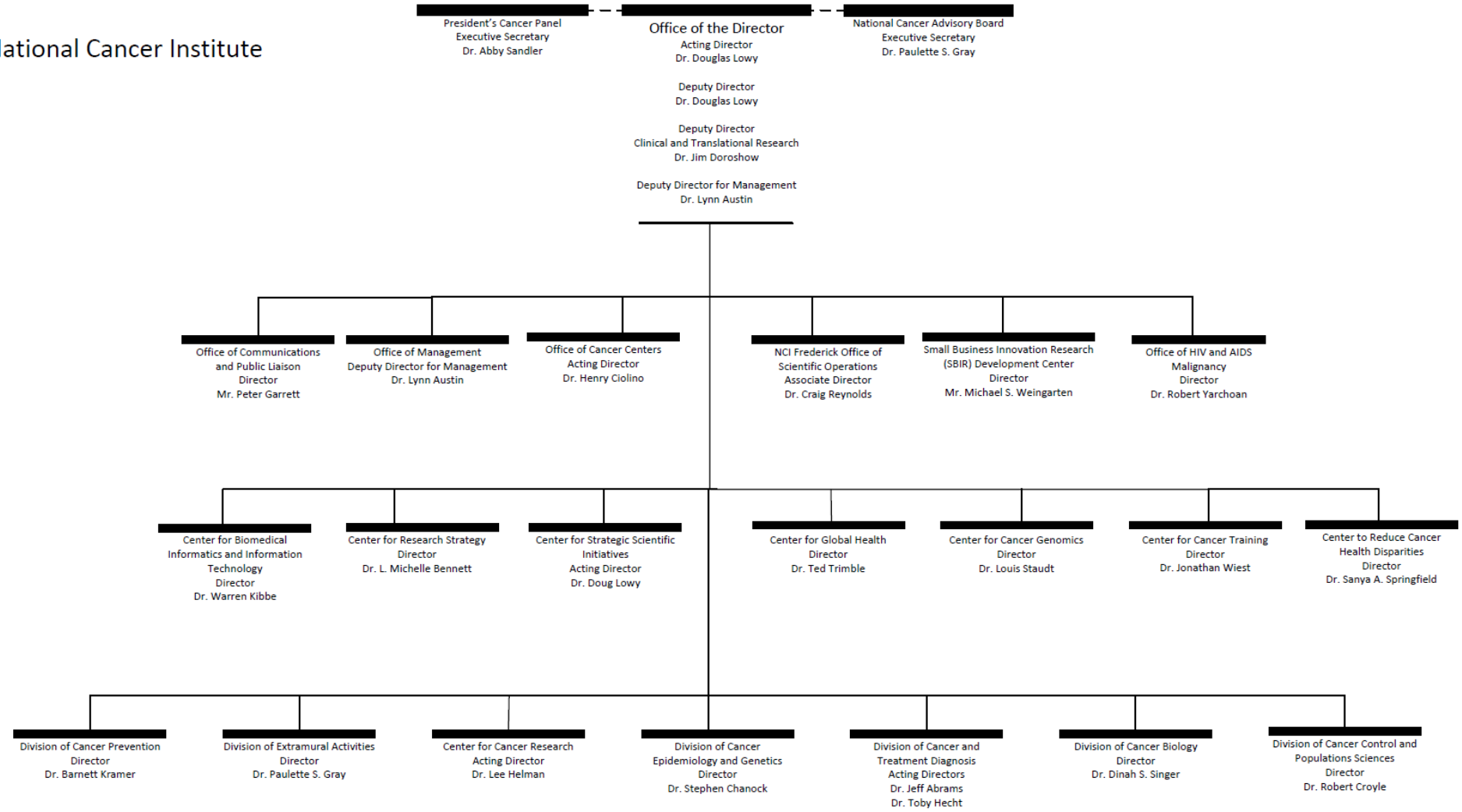
DEPARTMENT OF HEALTH AND HUMAN

SERVICES NATIONAL INSTITUTES OF HEALTH

National Cancer Institute (NCI)

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

National Cancer Institute



NATIONAL INSTITUTES OF HEALTH

National Cancer Institute

For carrying out section 301 and title IV of the PHS Act with respect to cancer, [$5,214,701,000]*$5,097,287,000*, of which up to [$16,000,000]*$50,000,000* may be used for facilities repairs and improvements at the National Cancer Institute—Frederick Federally Funded Research and Development Center in Frederick, Maryland.

NATIONAL INSTITUTES OF HEALTH

National Cancer Institute

Amounts Available for Obligation[1]

(Dollars in Thousands)

Source of Funding	FY 2015 Actual	FY 2016 Enacted	FY 2017 President's Budget
Appropriation	$4,950,396	$5,214,701	$5,893,509
Mandatory Appropriation: (non-add)			
Type 1 Diabetes	*(0)*	*(0)*	*(0)*
Other Mandatory financing	*(0)*	*(0)*	*(796,222)*
Rescission	0	0	0
Sequestration	0	0	0
FY 2015 First Secretary's Transfer	0	0	0
FY 2015 Second Secretary's Transfer	0	0	0
Subtotal, adjusted appropriation	$4,950,396	$5,214,701	$5,893,509
OAR HIV/AIDS Transfers	2,632	-1,192	0
National Children's Study Transfers	0	0	0
Subtotal, adjusted budget authority	$4,953,028	$5,213,509	$5,893,509
Unobligated balance, start of year	0	0	0
Unobligated balance, end of year	0	0	0
Subtotal, adjusted budget authority	$4,953,028	$5,213,509	$5,893,509
Unobligated balance lapsing	-435	0	0
Total obligations	$4,952,593	$5,213,509	$5,893,509

[1] Excludes the following amounts for reimbursable activities carried out by this account:
FY 2015 - $23,085 FY 2016 - $30,000 FY 2017 - $60,000

NATIONAL INSTITUTES OF HEALTH
National Cancer Institute
Budget Mechanism - Total[1]

(Dollars in Thousands)

MECHANISM	FY 2015 Actual		FY 2016 Enacted		FY 2017 President's Budget[3]		FY 2017 +/- FY 2016	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Research Projects:								
Noncompeting	3,337	$1,471,436	3,237	$1,523,644	3,302	$1,614,336	65	$90,692
Administrative Supplements	*(226)*	20,475	*(295)*	34,000	*(382)*	44,000	*(87)*	10,000
Competing:								
Renewal	146	90,955	151	91,173	204	126,822	53	35,649
New	1,089	416,796	1,086	416,481	1,518	581,156	432	164,675
Supplements	1	375	3	846	1	522	-2	-324
Subtotal, Competing	1,236	$508,126	1,240	$508,500	1,723	$708,500	483	$200,000
Subtotal, RPGs	4,573	$2,000,037	4,477	$2,066,144	5,025	$2,366,836	548	$300,692
SBIR/STTR	194	92,598	160	93,500	241	115,000	81	21,500
Research Project Grants	4,767	$2,092,635	4,637	$2,159,644	5,266	$2,481,836	629	$322,192
Research Centers:								
Specialized/Comprehensive	249	$509,475	271	$554,162	284	$580,662	13	$26,500
Clinical Research								
Biotechnology								
Comparative Medicine								
Research Centers in Minority Institutions								
Research Centers	249	$509,475	271	$554,162	284	$580,662	13	$26,500
Other Research:								
Research Careers	401	$68,821	409	$70,221	427	$73,221	18	$3,000
Cancer Education	85	28,026	87	28,626	91	29,876	4	1,250
Cooperative Clinical Research	102	250,837	105	261,837	111	273,837	6	12,000
Biomedical Research Support								
Minority Biomedical Research Support	2	240	2	240	2	240		
Other	89	62,172	121	84,839	179	124,839	58	40,000
Other Research	679	$410,096	724	$445,763	810	$502,013	86	$56,250
Total Research Grants	5,695	$3,012,205	5,632	$3,159,568	6,360	$3,564,511	728	$404,942
Ruth L Kirchstein Training Awards:	FTTPs		FTTPs		FTTPs		FTTPs	
Individual Awards	538	$21,714	540	$22,149	578	$23,342	38	$1,193
Institutional Awards	893	48,089	876	49,051	957	51,532	81	2,481
Total Research Training	1,431	$69,803	1,416	$71,200	1,535	$74,874	119	$3,674
Research & Develop. Contracts	430	$597,386	435	$671,305	450	$897,447	15	$226,142
(SBIR/STTR) (non-add)[2]	*(44)*	*(29,257)*	*(63)*	*(40,000)*	*(80)*	*(50,000)*	*(17)*	*(10,000)*
Intramural Research	1,767	$843,162	1,785	$867,652	1,785	$875,201		$7,549
Res. Management & Support	1,231	422,471	1,244	427,784	1,244	431,476		3,692
Res. Management & Support (SBIR Admin) (non-add)[2]		*(1,868)*		*(2,500)*				*(-2,500)*
Office of the Director - Appropriation[2]								
Office of the Director - Other								
ORIP/SEPA (non-add)[2]								
Common Fund (non-add)[2]								
Buildings and Facilities		8,000		16,000		50,000		34,000
Appropriation								
Type 1 Diabetes								
Program Evaluation Financing								
Cancer Initiative Mandatory Financing						-680,000		-680,000
Other Mandatory Financing						-116,222		-116,222
Subtotal, Labor/HHS Budget Authority		**$4,953,028**		**$5,213,509**		**$5,097,287**		**-$116,222**
Interior Appropriation for Superfund Res.								
Total, NIH Discretionary B.A.		**$4,953,028**		**$5,213,509**		**$5,097,287**		**-$116,222**
Type 1 Diabetes								
Proposed Law Funding								
Cancer Initiative Mandatory Financing						680,000		680,000
Other Mandatory Financing						116,222		116,222
Total, NIH Budget Authority		**$4,953,028**		**$5,213,509**		**$5,893,509**		**$680,000**
Program Evaluation Financing								
Total, Program Level		**$4,953,028**		**$5,213,509**		**$5,893,509**		**$680,000**

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

Major Changes in the Fiscal Year 2016 President's Budget Request

Major changes by budget mechanism and/or budget activity detail are briefly described below. Note that there may be overlap between budget mechanisms and activity detail, and these highlights will not sum to the total change for the FY 2017 President's Budget for NCI, which is $680.000 million more than the FY 2016 Enacted level, for a total of $5,893.509 million.

Research Project Grants (RPGs: +$300.192 million; total $2,481.836 million): During FY 2017, NCI will continue to support its established commitment base for non-competing Research Project Grants (RPGs). In addition to the commitment base, NCI will support an increased number of competing RPGs and SBIR/STTR awards, including additional awards to increase discoveries in the areas of immunology, cancer prevention and screening, and other promising research opportunities. NCI will also use funding in this mechanism to increase investments in pediatric cancer research, including research on rare pediatric cancers. The NCI FY 2017 increase in this mechanism also includes amounts to support supplements for these and other areas of cancer research.

Other Research (+$56.250 million; total $502.013 million): NCI will invest in enhanced and early detection research to stimulate the development of technologies that can capture and analyze circulating bio markers using minimally invasive methods. NCI will also support expanding participation in community clinical trials to accelerate the pace of immunotherapy research.

R&D Contracts (+$226.142 million; total $897.447 million): During FY 2017, NCI will use this mechanism to significantly increase investments that target cancer prevention and treatment, including research on new vaccines to prevent cancer-causing infections. The additional funding in this mechanism will also allow NCI to expand its support for the NCI Cancer Immunotherapy Trial Network and add capacity to more quickly test new investigational immunotherapeutic drugs or drug combinations to treat cancer. The increase in this mechanism will also allow NCI to support partnerships and collaborations with others that are developing cancer therapies and to support open access to data that can accelerate cancer discovery and new treatments. Finally, NCI will fund other promising opportunities to prevent, diagnose and treat cancer and thereby advance scientific discovery and reduce the burden of cancer.

Buildings and Facilities (+$34.000 million; total $50.000 million): During FY 2017, NCI will increase spending to commence priority repair and improvement projects and thereby strengthen the operations of its Federally Funded Research and Development Center (FFRDC). NCI faces a backlog of projects to repair and renovate facilities on the Fort Detrick, Maryland campus where the FFRDC is primarily located.

NATIONAL INSTITUTES OF HEALTH
National Cancer Institute

Summary of Changes

(Dollars in Thousands)

FY 2016 Enacted				$5,213,509
FY 2017 President's Budget				$5,893,509
Net change				$680,000
CHANGES	**FY 2017 President's Budget[1]**		**Change from FY 2016**	
	FTEs	**Budget Authority**	**FTEs**	**Budget Authority**
A. Built-in:				
1. Intramural Research:				
a. Annualization of January 2016 pay increase & benefits		$315,214		$1,323
b. January FY 2017 pay increase & benefits		315,214		3,969
c. Two less days of pay		315,214		-2,522
d. Differences attributable to change in FTE		315,214		0
e. Payment for centrally furnished services		135,053		3,294
f. Increased cost of laboratory supplies, materials, other expenses, and non-recurring costs		424,934		0
Subtotal				$6,064
2. Research Management and Support:				
a. Annualization of January 2016 pay increase & benefits		$198,337		$838
b. January FY 2017 pay increase & benefits		198,337		2,513
c. Two less days of pay		198,337		-1,587
d. Differences attributable to change in FTE		198,337		0
e. Payment for centrally furnished services		32,169		785
f. Increased cost of laboratory supplies, materials, other expenses, and non-recurring costs		200,970		0
Subtotal				$2,548
Subtotal, Built-in				$8,612

NATIONAL INSTITUTES OF HEALTH
National Cancer Institute

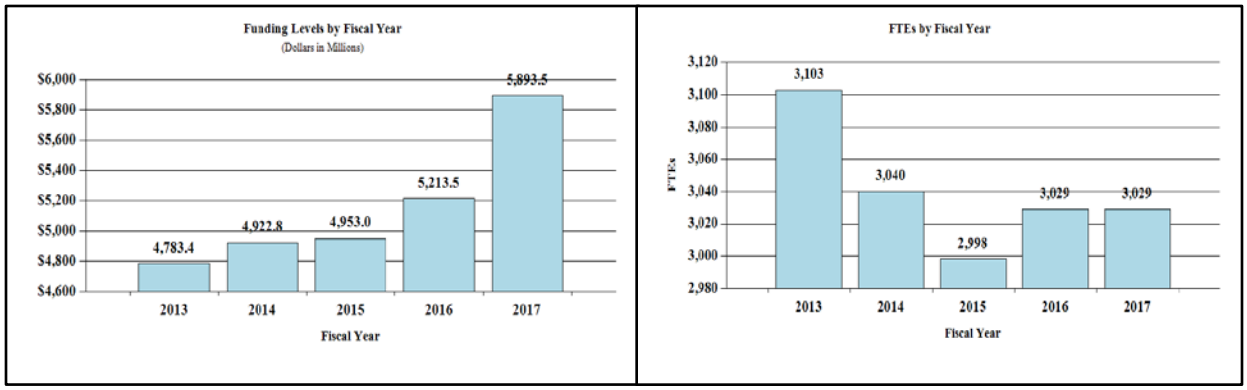
Summary of Changes - Continued

CHANGES	FY 2017 President's Budget[1]		Change from FY 2016	
	No.	Amount	No.	Amount
B. Program:				
1. Research Project Grants:				
a. Noncompeting	3,302	$1,658,336	65	$100,692
b. Competing	1,723	708,500	483	200,000
c. SBIR/STTR	241	115,000	81	21,500
Subtotal, RPGs	5,266	$2,481,836	629	$322,192
2. Research Centers	284	$580,662	13	$26,500
3. Other Research	810	502,013	86	56,250
4. Research Training	1,535	74,874	119	3,674
5. Research and development contracts	450	897,447	15	226,142
Subtotal, Extramural		$4,536,832		$634,759
	FTEs		FTEs	
6. Intramural Research	1,785	$875,201	0	$1,485
7. Research Management and Support	1,244	431,476	0	1,144
8. Construction		0		0
9. Buildings and Facilities		50,000		34,000
Subtotal, Program	3,029	$5,893,509	0	$671,388
Total changes				$680,000

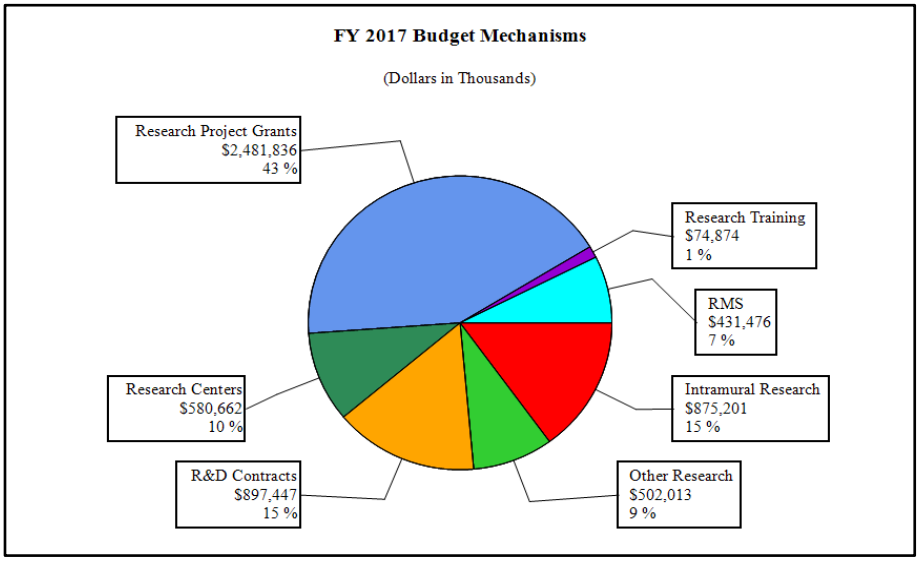
[1] Includes mandatory financing.

Fiscal Year 2017 Budget Graphs

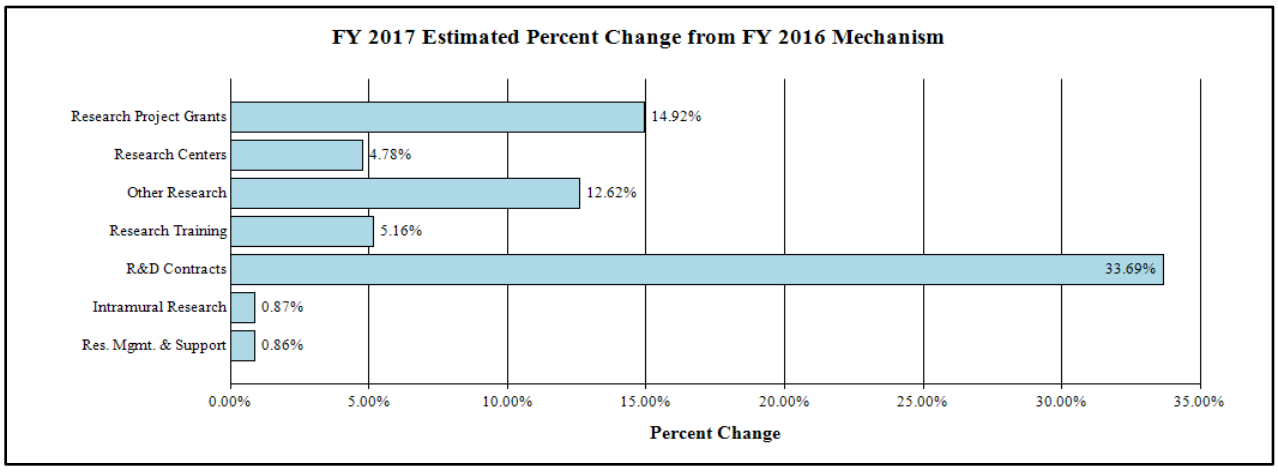
History of Budget Authority and FTEs:



Distribution by Mechanism:



Change by Selected Mechanism:



NATIONAL INSTITUTES OF HEALTH

National Cancer Institute

Budget Authority by Activity[1]

(Dollars in Thousands)

	FY 2015 Actual		FY 2016 Enacted		FY 2017 President's Budget[2]		FY 2017 +/- FY2016	
Extramural Research	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**
Detail								
Understanding the Mechanisms of Cancer		$733,251		$773,326		$877,467		$104,141
Understanding the Causes of Cancer		1,273,378		1,343,022		1,524,033		181,011
Improve Early Detection and Diagnosis		462,554		487,874		553,698		65,825
Develop Effective and Efficient Treatments		1,190,452		1,255,503		1,424,541		169,039
Cancer Prevention and Control		194,493		205,079		232,558		27,479
Cancer Centers		501,786		529,177		600,337		71,160
Research Workforce Development		166,642		175,745		199,398		23,653
Buildings and Facilities		8,000		16,000		50,000		34,000
Subtotal, Extramural		**$4,530,557**		**$4,785,725**		**$5,462,033**		**$676,307**
Intramural Research	**1,767**	***$843,162***	**1,785**	***$867,652***	**1,785**	***$875,201***	**0**	***$7,549***
Research Management & Support	**1,231**	**$422,471**	**1,244**	**$427,784**	**1,244**	**$431,476**	**0**	**$3,692**
TOTAL	**2,998**	**$4,953,028**	**3,029**	**$5,213,509**	**3,029**	**$5,893,509**	**0**	**$680,000**

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

NATIONAL INSTITUTES OF HEALTH
National Cancer Institute

Authorizing Legislation

	PHS Act/ Other Citation	U.S. Code Citation	2016 Amount Authorized	FY 2016 Enacted	2017 Amount Authorized	FY 2017 President's Budget[1]
Research and Investigation	Section 301	42§241	Indefinite	$5,213,509,000	Indefinite	$5,097,287,000
National Cancer Institute	Section 401(a)	42§281	Indefinite		Indefinite	
Total, Budget Authority				$5,213,509,000		$5,097,287,000

[1]Excludes mandatory financing.

NATIONAL INSTITUTES OF HEALTH
National Cancer Institute

Appropriations History

Fiscal Year	Budget Estimate to Congress	House Allowance	Senate Allowance	Appropriation
2007	$4,753,609,000	$4,753,609,000	$4,799,063,000	$4,797,639,000
Rescission				$0
2008	$4,782,114,000	$4,870,382,000	$4,910,160,000	$4,890,525,000
Rescission				$85,437,000
Supplemental				$25,559,000
2009	$4,809,819,000	$4,975,039,000	$4,958,594,000	$4,968,973,000
Rescission				$0
2010	$5,150,170,000	$5,150,170,000	$5,054,099,000	$5,103,388,000
Rescission				$0
2011	$5,264,643,000		$5,256,409,000	$5,103,388,000
Rescission				$44,810,787
2012	$5,196,136,000	$5,196,136,000	$5,001,623,000	$5,081,788,000
Rescission				$9,604,579
2013	$5,068,864,000		$5,084,227,000	$5,072,183,421
Rescission				$10,144,367
Sequestration				($254,588,730)
2014	$5,125,951,000		$5,091,885,000	$4,923,238,000
Rescission				$0
2015	$4,930,715,000			$4,950,396,000
Rescission				$0
2016	$5,098,479,000	$5,081,812,000	$5,204,058,000	$5,214,701,000
Rescission				$0
2017[1]	$5,893,509,000			

[1] Includes mandatory financing.

Justification of Budget Request

National Cancer Institute

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

	FY 2015 Actual	FY 2016 Enacted	FY 2017 President's Budget	FY 2017 + /- FY 2016
BA	$4,952,593,189	$5,213,509,000	$5,893,509,000	+$680,000,000
FTE	2,998	3,029	3,029	0

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

Director's Overview

For FY 2017, the budget includes an increase of $680 million for NCI to launch a bold and promising cancer research initiative to make broad advances across a range of exciting opportunities to prevent, diagnose, and treat cancer.

In January of 2016, the Administration announced goals and priorities for this research initiative. Known as the Vice President's Cancer Moonshot, the initiative is a multi-year enterprise designed to substantially accelerate progress throughout the field of cancer prevention, treatment and discovery.[1] In addition to the $680 million for FY 2017, NCI will also begin the initial work on many components of this effort during FY 2016. The initiative has many important facets, including broad engagement across the cancer research and oncology community, and engagement with many other partners and stakeholders to make progress against all forms of cancer.

Decades of research investments by Congress have given us the knowledge that cancers are fundamentally diseases of the genome and that understanding cancer begins by identifying the genes and proteins that drive abnormalities and trigger the risk of developing cancer. These research investments, and the wealth of scientific results flowing from them, have brought us to the threshold of a new era in oncology.

Given the speed at which we are gaining new insights into the causes of cancer, we are now poised to dramatically increase our ability to translate these discoveries throughout cancer clinical practice. With the resources in this initiative, NCI will further accelerate the pace of discovery in ways that produce tangible benefits for patients with all types of cancer, for those at risk of cancer, and for the growing population of cancer survivors.

[1] https://www.whitehouse.gov/the-press-office/2016/01/28/memorandum-white-house-cancer-moonshot-task-force)

The elements of the FY 2017 Cancer Research Initiative include:

- developing new techniques to detect cancer earlier
- developing new vaccines to prevent cancer-causing infections and vaccines to target genetic changes that can cause cancer
- expanding recent successes in cancer immunotherapy to a much wider range of tumor types
- expanding research on mutations that drive cancer and determine how cells respond to cancer
- accelerating progress on detecting and treating childhood cancers
- fostering enhanced data sharing to speed discovery and verify treatment response
- funding other promising opportunities in cancer discovery, prevention, and treatment.

With the resources in the FY 2017 budget, NCI will capitalize on these promising opportunities as we also continue to support core, ongoing biomedical research to advance scientific discovery and to reduce the burden of cancer.

The research portfolio of the National Cancer Institute spans the science continuum and addresses a broad range of priorities that contribute to preventing, diagnosing, and treating cancer. This overview briefly highlights a few prominent ongoing areas of science directly linked to NCI's new FY 2017 cancer research initiative – precision oncology, immunotherapy, prevention, and cancer disparities research – while the pages that follow this overview offer a more in-depth perspective on the wide scope and significant accomplishments of NCI research.

Precision Oncology: The FY 2016 budget that Congress enacted for NCI reflects a genuine understanding that this is a transformational moment for cancer patients and cancer research, and that the era of precision oncology is within reach. Thanks to prior investments by Congress in research at NCI, we have the knowledge that cancers are fundamentally diseases of the genome and that understanding cancer begins by identifying the abnormal genes and proteins that confer the risk of developing cancer, identifying the mechanisms that drive these abnormalities, and thereby achieving a deeper understanding the underlying causes of cancer.

The budget that Congress appropriated for FY 2016 will allow NCI to harness and build on this important knowledge. It will foster a new era of medical practice where detailed genetic and other molecular information about a patient's cancer is routinely used to deploy effective, patient-specific remedies to treat it.

During FY 2017 and beyond, precision oncology will remain a core focus for NCI. The Budget requests $70 million for precision oncology in FY 2017, the same as the FY 2016 Enacted level. NCI will build on what has already been learned, to accelerate the pace of discovery and deliver important benefits to patients. For example, a central component of precision oncology involves new and expanded clinical trials where drug therapies are selected and targeted based on the patient's specific molecular abnormalities rather than the site of tumor. NCI is testing this approach in the Molecular Analysis for Therapy Choice (NCI-MATCH) clinical trial, launched in August 2015 for participants with a range of cancers.

In FY 2016, NCI plans to launch a similar trial, Pediatric MATCH, and apply this approach to identify better therapies for children with cancer. The resources in this FY 2017 budget will allow NCI to expand the reach of precision oncology to all aspects of cancer – diagnostics and therapeutics, prevention and screening, and molecular analysis and imaging used to monitor tumors –

to achieve a deeper understanding of the causes of cancer and to deliver important results for cancer patients.

Immunotherapy: Immunotherapy is a promising opportunity that focuses on activating the immune system to attack the cancer cell. During the past few years, some remarkable successes using immune therapy to treat several types of adult cancers have revolutionized thinking about the prospects for immunotherapy.

In the past, scientists have developed and deployed passively administered monoclonal antibodies to treat lymphomas, leukemia, and breast and colorectal cancer. For some cancers, these therapies have become standard treatments. Other scientists have developed immunotoxins through genetic engineering by fusing antibodies with parts of bacterial toxins to selectively kill cancer cells. Several immunotoxins developed by NCI have induced remission in patients with late-stage cases of mesothelioma, ovarian, triple-negative breast cancer, and other cancers. Most recently, the clinical application of immune checkpoint inhibitors has ushered in the first, but certainly not the last, scalable approach that harnesses the power of the patient's own immune system to successfully combat their cancer.

NCI's Cancer Immunology Initiative seeks to extend these early successes in cancer immunotherapy to virtually all tumors, especially epithelial tumors that have thus far been the most resistant to cure. All cancers have mutations; the average cancer has 70-100 mutant proteins. The immune system, if properly primed, should be able to search and destroy those cancer cells. During FY 2017, NCI will provide increased support to promising immunotherapy research that offers the potential for new therapies that employ the cells of the immune system to attack cancer.

Prevention: Preventing cancer and screening for cancer have long been central priorities for NCI. Prevention takes many forms, such as controlling tobacco use, vaccinating against cancer-causing infectious agents such as human hepatitis B virus and papillomaviruses, limiting exposure to sunlight, and limiting exposure to asbestos and other carcinogens. These priorities have contributed to reducing the incidence and mortality rates for many cancers. Population-wide screening for certain cancers can substantially reduce mortality, and NCI continues to support research on this priority.

The experience with lung cancer – the most common cause of death due to cancer in the United States – serves as a good example of the benefits of prevention and screening. Between 2001 and 2010, there was a 25 percent decrease in male death rates and an eight percent decrease in female death rates from lung cancer, primarily due to decreased tobacco consumption.

In the area of screening, the National Lung Screening Trial (NLST), which studied more than 50,000 patients who were current heavy smokers or former heavy smokers, found that a form of screening known as helical computed tomography (CT) could reduce lung cancer mortality for these patients. This knowledge led the U.S. Prevention Services Task Force and the Centers for Medicare and Medicaid Services to endorse helical CT screening for patients with smoking histories similar to those who participated in NLST.

NCI is also focusing on other promising opportunities in screening and prevention. For example, the most recent report of the President's Cancer Panel emphasize that increased use of HPV vaccines could dramatically reduce the incidence and mortality of cervical, anal, oropharyngeal, and other cancers. NCI continues to invest heavily in cancer screening and prevention because we know that

much more progress is possible for those at risk of cancer.

Cancer Health Disparities: Cancer health disparities are differences in cancer incidence, prevalence, treatment response, and mortality among different population groups. The consequences of cancer disparities are far-reaching, and include lost productivity, increased medical costs, increased morbidity, premature death, undue stress for families and caregivers, and broader, community-wide effects.

Reducing and eliminating cancer health disparities require a deeper understanding of the complex interplay among a range of factors – biological, behavioral, environmental, and socioeconomic – that may contribute to the unequal burden of disease. With this in mind, NCI is engaged in a multi-pronged approach to address cancer health disparities. For example, NCI is conducting basic research on the underlying biology of disparities, fostering community-level programs to overcome barriers to cancer care, and supporting population-based registries to document the scope of the problem and identify areas that require further study. NCI is also training the next generation of scientists who will contribute their expertise to unraveling the complexities of cancer health disparities. NCI will also make understanding and addressing cancer disparities a priority within many elements of the FY 2017 cancer research initiative.

The NCI effort to gain a deeper understanding of the biological differences that contribute to cancer health disparities is closely linked to NCI's Precision Medicine Initiative for Oncology. Both share the goal of identifying and understanding genetic factors that contribute to the risk of developing cancer in individuals and sub-populations. And, both aim to intervene as early as possible in the disease process as a means of ensuring better outcomes for patients.

Conclusion: Despite progress in these and other areas, too many Americans face a cancer diagnosis and far too many die from the disease. There will be more than 1.6 million new cases of cancer in the United Stated during 2016, and more than 600,000 will die from cancer. In addition, our progress in preventing, diagnosing, and treating cancers is not uniform for all populations and all forms of the disease. Although mortality rates for many cancers have decreased, rates for some cancers have increased. To cite one example, death rates from liver cancer increased by about 20 percent between 2001 and 2010. As these statistics demonstrate, much work remains to meet the needs of those suffering from cancer, those at risk of cancer, and the growing population of cancer survivors. Meeting those needs is a central element of our mission at the National Cancer Institute.

Overall Budget Policy:
The FY 2017 President's Budget request is $5,893.509 million, an increase of $680 million or 13.0 percent compared with the FY 2016 Enacted level. The increase will allow NCI to commence a bold and promising cancer research initiative designed to substantially accelerate progress throughout the field of cancer prevention, treatment, and discovery. With these resources, NCI expects to make broad advances across a range of promising research opportunities and thereby reduce the burden of cancer in the United States. The Budget proposes to include $5,097.287 million in discretionary funding and $796.222 million in mandatory funding for FY 2017.

Program Descriptions and Accomplishments

NCI conducts basic and applied research activities that advance five broad scientific goals:

- Understanding the Causes of Cancer
- Understanding the Mechanisms of Cancer
- Improving Early Detection and Diagnosis
- Developing and Improving Effective and Efficient Treatments
- Improving Cancer Prevention and Control.

To pursue these goals, NCI issues grants to support investigator-initiated research, conducts clinical trials, and finances many other cancer research programs. NCI selects and provides support to cancer centers, conducts basic, clinical, and population research through its intramural programs, issues and manages research contracts, including a Federal Funded Research and Development Center (FFRDC), and operates research facilities to support its intramural and FFRDC activities.

NCI uses these various mechanisms to support cancer research as it pursues the five major scientific goals. In particular, the investigator-initiated research project grants that NCI awards constitute a large portion of the research investment for all five of the NCI scientific goals. During FY 2015, NCI issued 5,695 new and non-competing grant awards across all grant mechanisms, including 3,403 traditional (R01) grants and 648 exploratory (R21) grants to support research that advances its cancer research goals.

In addition to its five scientific goals, NCI also supports more than 100 specialized centers for cancer research, including 69 NCI-designated cancer centers, provides training and career development to maintain a strong workforce of cancer researchers, and provides essential management, administrative, infrastructure, and facilities support to advance the NCI cancer research mission.

The narratives that follow highlight some of NCI's programs and identify recent NCI progress and future plans within each scientific area. It is important to appreciate a few general points at the outset.

First, virtually all NCI research in one scientific goal area influences the approaches used to advance scientific goals in the remaining scientific areas. Furthermore, although NCI research is often identified by topic and theme, basic research remains a consistent priority across nearly all areas of science at NCI. We know that cancers are disorders of cell growth, cell survival, and other cell behaviors, fueled largely by changes in genes. Based on this understanding, NCI continues to make substantial investments in many fundamental aspects of cell biology and genetics, recognizing that basic biological science is essential to understanding cancer and reducing the incidence, morbidity, and mortality for all types of cancer.

Second, a driving force behind the FY 2016 NCI budget approved by Congress is the opportunity to make rapid progress in precision medicine. NCI research to advance and implement precision medicine in oncology will remain a high priority during FY 2017 and beyond. Although the concept of precision medicine is most simply illustrated by therapies developed based on an accurate account of the molecular and genetic alterations in a specific cancer, the concept of

precision medicine applies to most aspects of cancer research and cancer control, including epidemiology, prevention, screening, diagnosis, and risk assessment.

Third, the size and complexity of the NCI research program precludes a complete review of all NCI programs in this budget document. The examples chosen offer a meaningful overview of current NCI operations, but inevitably understate the vast amount of valuable work underway in all areas of cancer research.

I. Understanding the Causes of Cancer: Cancer develops through a complex interplay of genetic background, lifestyle, and environmental factors. These factors probably influence the likelihood of contracting almost all cancer. In some cases, however, cancer risk is most strongly influenced by inheriting a mutation (or a variant) of a single gene or a combination of genes. In other situations, cancer risk is determined principally by external factors, such as exposure to tobacco or infectious agents. Individual responses to these external factors are likely to differ depending on a person's genetic background. One task of precision medicine is to understand the relationships among these factors and to use that knowledge to improve the assessment of risk, the understanding of individual behaviors, and the means of preventing and detecting cancers.

NCI-funded studies of the causes of cancer range from small-scale laboratory-based research to large-scale studies that use population cohorts or case-controlled comparisons of subpopulations. The studies may also involve modeling to predict cancer risks within an individual or population. In addition, NCI also supports research to identify new causes of cancer.

Budget Policy:
The FY 2017 President's Budget request is $1,524.033 million, an increase of $181.011 million or 13.5 percent compared to the FY 2016 Enacted level.

Population Cohorts in Cancer Research: NCI investments in population studies – known as cohorts – provide an important framework for identifying factors associated with cancer risk. For example, NCI's Cohort Consortium – a large, international collaboration of cohorts that includes data on more than four million people – is evaluating the role of genetic susceptibility, lifestyle, environmental exposures, and gene-environment interactions for a range of cancers. The Cohort Consortium recently identified –

- a connection between light drinking and cancer
- the relationship between aspirin and NSAID use and the risk of colorectal cancer according to genetic variants
- the association between a vegetarian diet or a diet that includes fish and a reduced risk of colorectal cancer.

The Cohort Consortium also offers the promise of answering important questions related to cancer risks in African-Americans, Hispanics, and other racial and ethnic populations, as well as questions about the interaction between environmental exposures and genetics, and questions about how medical practices may affect cancer risks.

Studies on Obesity and Cancer Risk: In addition to its association with other health risks, obesity is associated with increased risks of cancers of the esophagus, breast (for postmenopausal women), endometrium (the lining of the uterus), colon and rectum, kidney, pancreas, thyroid,

gallbladder, and possibly other cancer types. Through the National Collaborative on Childhood Obesity Research (NCCOR), NCI is partnering with four NIH institutes, as well as the Centers for Disease Control and Prevention (CDC), the Robert Wood Johnson Foundation, and the U.S. Department of Agriculture to improve the efficiency, effectiveness, and application of childhood obesity research. Through NCCOR, NCI seeks to:

- increase surveillance of childhood obesity
- identify, design, and evaluate practical and sustainable interventions
- support coordination and collaboration to halt and reverse childhood obesity.

Since 2011, NCI has been operating two web-based NCCOR tools. Through the first tool, the Catalogue of Surveillance Systems, researchers and practitioners can assess a range of childhood obesity resources, identify possible gaps, and plan innovative multilevel obesity prevention research. The second tool, the Measures Registry, contains more than 1,000 measures and is an invaluable resource for researchers interested in using standard measures to describe, monitor, and evaluate interventions related to obesity and cancer risk.

Basic Research on Cancer Health Disparities: In the United States, several racial and ethnic populations demonstrate increased incidence and more aggressive disease progression for specific cancer types. These include prostate, breast, lung, cervical, liver, colorectal, kidney, and stomach cancers, as well as multiple myeloma and pediatric acute lymphoblastic leukemia. Even when accounting for socioeconomic and access to care factors, incidence and mortality differences persist. Recent studies indicate that biological factors may help explain some of the differences observed in cancer incidence, prevalence, and mortality rates. NCI supports research to investigate the biological basis for cancer health disparities and issues specific funding opportunities to invite research in this area. NCI accomplishments during the past year include:

- discovering differences in the physiological response to tobacco smoke carcinogens in different races, which may affect their susceptibility to disease
- improving the understanding of the aggressiveness and chemo-resistance of triple negative breast cancer.

Integrating Genomic, Proteomic, and Imaging Data to Improve Clinical Prediction: To gain a better understanding of cancer and the variation in treatment response, researchers use molecular-level analysis to gain a more comprehensive view of a patient's health. Performing genomic characterization of biopsies and other biological samples from cancer patients before they receive treatment can provide essential insights into the causes of cancer. These insights can become more meaningful when data from the genomic characterization is integrated with proteomics and imaging data derived from the same cancer patient.

At the same time, scientists and clinicians are using large multi-platform and multi-scale biomedical data repositories to achieve the data integration necessary to support more accurate decision-making for patients, and these repositories are an important cornerstone of precision medicine. For example, recent large-scale NCI characterization efforts generated volumes of integrated molecular-level data for colorectal, ovarian, and breast cancer. This effort involved the integration of The Cancer Genome Atlas (TCGA) data with Clinical Proteomic Tumor Analysis Consortium (CPTAC) data and will likely lead better methods to identify the grade and stage of a cancer, and to predict patient survival.

Research on Exposure to Therapeutic Radiation: Radiation exposure from medical sources in the United States has increased six-fold since 1980. Given this substantial increase, NCI conducts studies of cancer risks associated with established and emerging medical radiation sources, including diagnostic and screening radiation exposures (lower dose) and radiotherapy (high dose). During 2015, NCI published studies using new computational tools it developed to assess radiation dose to each organ in children and adults. Other studies are underway to identify cellular and molecular biomarkers of radiation effects and to assess whether there is a genetic component of risk in treatment-related cancers.

Studies on Inflammation and Immune Markers: Chronic inflammation due to persistent infection, harmful exposures, or obesity may increase cancer risk by directly damaging DNA or through the process of tissue remodeling and scarring. NCI investigators are conducting discovery and replication studies within well-characterized cohorts to identify associations between inflammation markers and various cancers. NCI researchers have discovered several markers associated with increased lung cancer risk that are independent of smoking and other markers that may play a role in early-stage lung cancer survival. In a 2015 study, NCI-supported researchers identified genetic variations in inflammation that are associated with developing colorectal, breast, lung, and ovarian cancers.

II. Understanding Mechanisms of Cancer: Cancer is driven by alterations of a cell's genome (DNA) and its associated proteins. As a consequence, abnormal kinds and amounts of proteins are made that cause a variety of molecular abnormalities and result in inappropriate tumor cell survival, inadequately controlled tumor growth, and other hallmarks of cancer. Precision medicine, in all of its forms, depends on a deeper understanding of the genetic and physiological changes that take place in cancer cells.

To better understand these mechanisms, NCI supports large-scale, high-throughput studies of the genes, proteins, and pathways altered in cancer. In addition, NCI supports studies of basic cell biology, cell interactions, angiogenesis, immune responses, and other essential research to understand the mechanisms of cancer. NCI also supports laboratory studies in model systems, including animal models, to investigate the functions of molecules within these systems.

Budget Policy:
The FY 2017 President's Budget request is $877.467 million, an increase of $104.141 million or 13.5 percent compared to the FY 2016 Enacted level.

Cloud Computing to Analyze Cancer Genomics: The NCI Center for Cancer Genomics and the Center for Biomedical Informatics and Information Technology are developing a new model for computational analysis and sharing very large data sets. This model, which relies on high-performance and cloud computing, will be a valuable tool to study the mechanisms of cancer.

In January 2016, three cloud pilots will be available to the cancer research community, providing the ability to analyze data from The Cancer Genome Atlas (TCGA) as well as to upload and co-analyze a researcher's own data. The Genomic Data Commons will be available in mid-2016 and will serve as the authoritative repository for all NCI cancer genomic data. These programs form the foundation of a Cancer Knowledge System to support NCI's Precision Medicine Initiative for Oncology. Activities planned for FY 2017 include:

- expanding the capabilities of the Genomic Data Commons and Cloud Pilots to accommodate active submissions from non-NCI cancer genomics projects
- enhancing data visualization tools
- other potential features, such as the ability to retrieve and display histologic, radiologic, and proteomics data.

The Cancer Target Discovery and Development (CTD2) Network: The CCTD2 Network is accelerating the use of molecular data to speed the translation of basic science findings to clinical trials. Through validation studies that rely on bioinformatics analysis of genomic data, high-throughput screening of small molecules, and research that involves cancer models or other tools, the CTD2 Network supports research to capitalize on a growing volume of data to identify new cancer vulnerabilities and treatments. Highlights of CTD2 progress during the past year include:

- discovering the mechanism of action of a compound that selectively inhibits the growth of breast cancer stem cells
- discovering novel, rare driver mutations in pancreatic cancer and confirming their importance through *in vitro* models.

The NCI Meta-Organism Initiative: Certain bacteria and viruses are linked to cancer development because they transform normal cells and / or induce inflammation. In fact, many tumors originate at sites of infection or chronic inflammation, and most established tumors induce cancer-associated inflammation. Moreover, antitumor immunity can profoundly affect tumor progression. All the elements of the meta-organism and its response to environmental stimuli contribute to the overall balance that favors or impedes tumor progression and response to therapy.

Experimental evidence also indicates that the composition of the microbiome (the microorganisms that inhabit the human body) can contribute to the response to cancer immunotherapy and chemotherapy as well as anticancer immune response associated with both types of therapy. Mapping efforts in diverse patient populations with different tumor progression pathologies offers the potential to identify important biomarkers. For example, epidemiological studies identify microbial markers for cancer susceptibility. Progression and comparative follow-up studies will generate prognostic markers. Based on these studies of the nature of the microbiota and its molecular interplay with the host, new drugs and other therapeutic approaches targeting the microbiome or its signaling be developed.

III. Improving Early Detection and Diagnosis: Many cancer deaths occur because cancers are diagnosed at late stages, when the disease is extensive and treatment may be less effective. This is often a consequence of a lack of screening tests to identify cancers earlier, when they may respond more effectively to treatment. NCI researchers are working to identify molecules – nucleic acids, proteins, glycans, metabolites, and other substances – and develop imaging methods to identify the presence of cancer cells earlier. Investigator-initiated research project grants are a primary mechanism that NCI relies on to support and improve early detection and diagnosis of cancer, but other larger research programs also play important roles.

These efforts are part of – or closely linked to – components of the Precision Medicine Initiative for Oncology, since they depend on the characterization and interpretation of cancer genomes and computationally-based methods to interpret and disseminate findings. Clinicians will increasingly be using this detailed, tumor-specific information to find tumors early and to guide how tumors are

categorized to support diagnosis as well as to select the best treatment for each patient. NCI also supports research to assess the risks associated with screening and early detection, and to ensure that the potential harms of screening do not outweigh the benefits.

Budget Policy:
The FY 2017 President's Budget request is $553.698 million, an increase of $65.825 million or 13.5 percent compared to the FY 2016 Enacted level.

Partnerships to Address Pancreatic Ductal Adenocarcinoma (PDAC): PDAC, which has an estimated 5-year survival of 7 percent, is usually detected at late stage. NCI is involved in several new efforts to better identify at-risk individuals, improve early detection, and identify appropriate biomarkers for better detection and diagnosis, with the long-term goal of improving the outcome for patients who develop PDAC.

NCI and the National Institute for Diabetes and Digestive and Kidney Diseases are developing a collaborative consortium to support research on the relationship between PDAC and chronic pancreatitis, pancreatogenic diabetes (Type 3c), and new-onset diabetes that will focus on methods to detect PDAC earlier. NCI has also initiated the Pancreatic Cancer Detection Consortium to identify and validate biomarkers for early detection of PDAC or its precursor lesions, determine which pancreatic cysts are likely to progress to cancer, develop molecular and imaging-based approaches to screen populations at high risk of PDAC, and collect longitudinal biospecimens to establish a biorepository. Finally, NCI recently developed partnerships with the Lustgarten Foundation and the Kenner Family Research Fund to leverage resources and expertise, and thereby accelerate methods of detecting PDAC earlier.

Developing the Next Generation of Nano-Enabled Interventions: As we develop a deeper understanding of molecular roles of genes and proteins in cancer initiation and progression, we encounter problems that require new tools and approaches to probe and execute actions at the nano- or micro-scales. For example, NCI has supported development of various nanoparticle-based *in vivo* imaging techniques and *in vitro* nano-scale devices to capture and analyze blood borne cells, vesicles, proteins and DNA/RNA. These new technologies are providing improved sensitivity and specificity of disease diagnosis and are generating greater understanding of disease progression and response to therapy. In addition to developing targeted funding opportunities, NCI plans to sponsor workshops to bring the imaging, assay, and device development communities together to correlate and integrate data from *in vivo* and *in vitro* approaches as a means of achieving more effective and less invasive disease staging and stratification.

Improving Cancer Screening Guidelines through Risk Modeling: NCI researchers are leveraging epidemiologic findings into practical cost-effective screening and clinical applications that have a direct impact on public health policy and medical practice. For example, NCI research helped the U.S. Preventive Services Task Force (USPSTF) and professional society guideline committees develop sound evidence-based cancer screening recommendations. NCI's research and screening-based risk calculations contributed to the new lung cancer screening guidelines and to new cervical cancer screening guidelines issued by the USPSTF, which now endorse HPV testing with Pap testing, with longer intervals between screenings.

By combining screening data from 1.5 million women, NCI researchers developed robust cervical cancer risk calculations to establish a new framework to optimize clinical care for women. The

framework incorporates HPV and Pap testing data so that a woman's care may be clinically managed in a consistent, evidence-based manner. In addition, NCI biostatisticians developed a risk-based lung cancer screening protocol using low dose CT based on results from NCI's National Lung Cancer Screening trial. The new protocol was cited in the recent lung cancer screening guidelines issued by the USPSTF. NCI is also supporting efforts through the Coding 4 Lung Screening Challenge to produce new computer algorithms to improve lung cancer screening accuracy. Finally, NCI researchers are working to enhance risk modeling for breast cancer by combining common genetic variation information into assessment algorithms.

IV. Developing and Improving Effective and Efficient Treatments: Research on cancer therapy has many facets that go beyond developing and testing drugs, radiotherapy, immunotherapy, and surgery. These other aspects include control of symptoms and palliation of fatal cancers. Still, developing new drugs, immune-based therapies, and the means to monitor cancers before and during treatment are central to efforts to advance the goals of effective and efficient treatment. Increasingly, progress is linked to new knowledge about the molecular fingerprints of tumors, about how cancer cells interact with the host environment and the immune system, and about the altered behaviors of cancer cells.

These elements are well-recognized components of precision medicine in oncology, because they are critical to the design of interventions that target specific molecules and signaling pathways. Although several successful applications of precision medicine to therapeutics have been documented, fully realizing the potential of precision medicine will require the wide use of combined therapies, an understanding of drug resistance, better models for pre-clinical testing, and a better integration of drug-based and immunologically-based approaches.

To develop effective and efficient cancer treatments, NCI invests in basic, translational, and clinical research. These investments have identified therapeutic targets and strategies, and commercial interests frequently validate many of these targets and develop interventions against them. NCI supports clinical research to develop and test interventions at many sites across the country and at the NIH Clinical Center, often through clinical research networks.

Budget Policy:
The FY 2017 President's Budget request is $1,424.541 million, an increase of $169.039 million or 13.5 percent compared to the FY 2016 Enacted level.

NCI-MATCH (Molecular Analysis for Therapy Choice): NCI-MATCH is a clinical trial for patients with refractory cancers, that is, cancers that are not responding to standard treatments. The MATCH clinical trial – which treats patients according the molecular abnormalities in their tumors, rather than according to the anatomical origin of the tumor – is a cornerstone of the NCI Precision Medicine Initiative in Oncology.

Upon entering the NCI-MATCH trial, the patient's tumors are biopsied and sequenced, and if an actionable mutation is found, patients are assigned or "matched" to a treatment that has been shown as effective for treating similar mutations. NCI MATCH opened in August 2015 with the first 10 treatments, and NCI has plans to expand the trial to 20-to-30 treatments during the spring of 2016. Nearly 800 patients registered for the NCI-MATCH trial during its first three months.

NCI has begun molecular testing of 500 of the first 800 patient tumor samples and will test the

additional tumor samples in the near future. NCI is also studying how to best deliver patient education about genomic tests, and will assess the effectiveness of remote genetic counseling for patients when tumor sequencing reveals a potentially harmful germline mutation.

Specialized Programs of Research Excellence (SPORE): The NCI SPORE program is developing vaccines as treatments for ovarian, melanoma, and brain cancers by targeting specific proteins on the tumor cells such as mutated receptors or enzymes that are not found on normal cells. The vaccines are administered in combination with treatments that increase the ability of the patient's immune system to amplify the response to the vaccine. For the ovarian and melanoma SPORE projects, in addition to administering the vaccine, lymphocytes or dendritic cells are isolated from the patient's blood. These cells are treated to increase their efficacy and specificity to generate an immune response and are re-injected into the patient to help eliminate residual tumor cells and attract immune cells. The vaccines used in the brain SPORE projects target specific mutations in brain tumors or a specific mutation found in low-grade brain tumors. The vaccines are administered with immune cell growth factors to help build antibodies against the tumor proteins.

Tumor Paints to Improve Cancer Resection: An SBIR grantee is developing the Tumor Paint™ technology, which allows surgeons to see tumors in real time during surgery because the product preferentially binds and is taken up by tumor cells. The ability to visualize tumor cells in real-time and at high resolution during surgery could allow surgeons to completely remove cancerous tissue while also potentially sparing the patient's normal tissue. This technology, if successful in clinical studies, has the potential to minimize repeat surgeries, reduce cancer recurrence, and limit other harmful side-effects, and could reduce health care costs associated with cancer surgery. The Tumor Paint product, BLZ-100, is derived from scorpion venom and a near-infrared fluorescent beacon. During surgery, near-infrared is visualized in real time and at high resolution. The SBIR grantee is currently accruing patients with soft tissue sarcoma to conduct a Phase I Study of BLZ-100.

The Cancer Imaging Archive (TCIA): NCI is expanding the TCIA resource of public, shared imaging data used to develop correlations between genomic data – such as data in The Cancer Genome Atlas (TCGA) – and imaging data. Developing correlations between proteomics and imaging features maximizes the usefulness of the major genomic and proteomic initiatives.

Clinical imaging that is used to diagnose and treat cancer, such as MRI, PET, and CT, is complementary to and powerfully leverages cancer genomic and proteomic data. A medical image visualizes an entire heterogeneous tumor before treatment begins and then repeatedly as a patient is treated. The emerging field of radiomics uses powerful computerized approaches to analyze images for subtle features and correlate them to genomic and other patient data. However, radiomics requires substantial curated data to develop the correlations. Collecting and analyzing medical scans of some of the patients in the TCGA database has led to promising results in brain and lung cancers. Expanding this research to other cancer types and to proteomics has the potential to refine a patient's therapy through sophisticated analysis of medical scans conducted over time.

Using the Quantitative Imaging Network (QIN) to Measure Therapy Response: Reliably measuring clinical response to therapies will foster more efficient clinical trials because fewer patients will be required to demonstrate effectiveness. The goal of the NCI-funded QIN is to develop and validate quantitative imaging methods for use in multi-center therapeutic clinical trials. This network has 26 funded multi-disciplinary teams, located at NCI-designated cancer centers. Progress to date has included developing consensus on:

- methods to reduce the measurement uncertainty in data collection and analysis across imaging platforms and sites
- an informatics infrastructure coupled with the NCI TCIA to evaluate software tools for clinical decision support
- approaches to integrate the quantitative imaging methods into clinical workflow.

Achieving consensus in these areas promotes the wider adoption of imaging techniques by the clinical trial community.

The NCI National Clinical Trials Network (NCTN): NCI focuses its cancer treatment trials on identifying the molecular alterations of each tumor type that require a specific treatment. This approach allows NCI to focus trials on patients whose tumors are most likely to respond to treatment, which results in smaller trials that in principle could be completed more rapidly. However, the molecular alterations often are infrequent, and they affect a small percent of the overall number of patients with the disease. Therefore, it is necessary to test tumors in many patients to identify patients with a molecular alteration that can be targeted in the trial. Hence, such trials often require a large, national trial network to be successful.

The NCTN, with more than 3,000 sites across the United States, is organized to conduct trials of this design. Examples of such trials include Lung-MAP, ALCHEMIST, NCI-MATCH and the ongoing, national studies of non-small cell lung cancer. NCI is using this approach to develop additional studies for papillary renal cell cancer and for pediatric cancers.

Studies of Exceptional Responders: NCI is focusing on patients identified as exceptional responders to treatment based on their strong and favorable response to investigational drugs or conventional chemotherapy. NCI seeks to understand the genomic and transcriptomic (that is, the entire RNA transcript produced by the genome at any one time) reasons for exceptional responses by certain patients to standard and investigational treatments. Since the fall of 2014, NCI reviewed 286 cases and accepted 135 to evaluate a patient's exceptional response. NCI is conducting genetic assessments of tumors from exceptional responders to understand the basis for their favorable response. NCI will conduct a workshop in 2016 to discuss results of our analysis, to identify lessons we have learned, and to consider more focused studies of exceptional responders.

Immunotherapeutics: Immunotherapy using checkpoint inhibitors has yielded profound benefits for many cancer patients. Coordinating effort in basic, translational, and clinical research is essential for immunotherapeutics to reach its full therapeutic potential. The NCI has a strong portfolio of immunotherapy agents and extensive immune-oncology expertise in the NCI clinical trial network.

For example, the NCI-sponsored phase III trial for the drug ipilimumab in adjuvant melanoma completed accrual this year. This trial will compare a less toxic and less costly dose of ipilimumab with higher dose. Recently, a phase II trial conducted through the Cancer Immunotherapy Trials Network reported a high response rate to anti-PD-1 in a viral associated tumor known as Merkel cell carcinoma. This is seen as an important development for standard of care in this rare cancer.

Rapidly evolving science and technology offers opportunities to accelerate development of human immunology and immunotherapies. NCI is ready to expand efforts in several areas including:

- preclinical studies for biology, mechanisms of action, and novel combinations
- clinical trials for rare tumors, new standards of care, novel combinations, and new agents
- expanded biomarker studies in genomics and cancer immune microenvironment.

V. Improving Cancer Prevention and Control: Cancer prevention research draws on knowledge of the mechanisms and causes of cancer, and is therefore closely associated with aspects of the precision medicine initiative for oncology. Prevention also depends on population-based surveys to obtain epidemiological information, such as the incidence of specific types of cancers and their association with possible causative factors. Through education, behavior modification, vaccination, and policies that limit exposures to known carcinogens, the risk of cancer can be reduced by one-third to one-half.

To improve cancer prevention and control, NCI supports research to understand the factors that influence cancer outcomes, quality of care, and quality of life. NCI also promotes studies in disadvantaged communities in the United States and globally to advance the goal of controlling cancer more effectively for all populations.

Budget Policy:
The FY 2017 President's Budget request is $232.558 million, an increase of $27.479 million or 13.4 percent compared to the FY 2016 Enacted level.

Developing the Next-Generation HPV Vaccine: The development and FDA approval of pediatric vaccines to prevent infection with human papilloma virus (HPV) and thereby prevent cervical and some other mucosal cancers represents an important achievement in cancer prevention. The most advanced vaccine can prevent HPV strains that account for about 90 percent of these cancers.

Building on this success, the PREVENT Cancer Preclinical Drug Development Program is supporting the current Good Manufacturing Practices production and toxicology testing of a new HPV vaccine that has an even broader spectrum of efficacy to prevent infection by a wider range of HPV types. The new vaccine is expected to be ready for toxicology testing in spring of 2016. The Consortia for Early Phase Prevention Clinical Trials is planning to evaluate the vaccine clinically for safety and immunogenicity.

Studies of HPV Infection and Cancer: NCI is conducting research to more fully understand HPV infection and disease progression. For example, researchers are working to develop and evaluate biomarkers that distinguish between the few women at highest risk of HPV-associated cancers from the majority with benign infections.

Although effective vaccines and screening strategies exist to prevent cervical cancer, additional research can define the optimum vaccination, screening, and clinical management approaches for HPV-related diseases. In 2015, data from a combined analysis of two independent trials of the HPV vaccine strengthened previous findings that one or two doses were equally protective against HPV infection four years after vaccination. Another 2015 study demonstrated the vaccine's effectiveness against infection at sites other than the cervix. These efforts will provide the data to inform changes in vaccine recommendations, screening protocols in the vaccine era, and clinical management of HPV-infected individuals. They will also contribute to reducing geographic,

ethnic, and socioeconomic disparities associated with this tumor.

Aspirin and Cancer: Aspirin has been used to treat pain and fever for centuries. It is an FDA-approved drug, and is often administered during a heart attack and prescribed to prevent stroke and a second heart attack. Based on evidence that it also prevents some cancers, the USPSTF is now proposing to recommend its use to prevent colorectal cancer in 50- to 59-year olds who are not at increased risk for bleeding. However, additional research is needed to recommend aspirin use to prevent other cancers and to recommend its use in older patients.

NCI is partially funding a large clinical trial in collaboration with the National Institute on Aging, *Aspirin in Reducing Events in Elderly (ASPREE)*, that is focused on patients who are older than 70. This trial will explore the effects of aspirin on cancer in addition to its primary goal of disability- and dementia-free survival. A number of NCI projects are exploring the possible mechanisms of action associated with aspirin's apparent cancer preventive effects. This includes investigating aspirin's effects on the immune response when taken alone and when taken in combination with vaccines. Understanding aspirin's mechanisms of action may identify new candidates for cancer prevention agents. Furthermore, gaining knowledge on the side effects of aspirin in population subsets can inform the development of more personalized approaches to cancer prevention.

Smoking Cessation: Despite the enormous progress in reducing the prevalence of tobacco use in the United States, national smoking rates continue to be substantially above public health targets. Analysis has repeatedly revealed that the large reduction in smoking rates are not consistent across the U.S. population, with progress in reducing smoking in some subpopulations lagging far behind the general population. Prioritizing smoking cessation in groups that continue to demonstrate elevated smoking prevalence is essential to achieving further progress in tobacco control.

In addition to maintaining a substantial investigator-initiated grant portfolio relating to smoking and tobacco control, NCI has partnered with other NIH institutes and centers to fund targeted research on smoking cessation. This includes an initiative with National Heart, Lung, and Blood Institute (NHLBI) that focuses on hospitalized patients and an initiative with the National Institute on Drug Abuse to conduct cessation interventions in people with schizophrenia. NCI also plans to fund new research, including grant awards during FY 2016, in response to a Funding Opportunity Announcement (FOA) on smoking cessation in the context of lung cancer screening. This initiative will test interventions at lung cancer screening sites that are designed to increase cessation rates among the population of current smokers who are undergoing lung cancer screening.

NCI also is developing a new FOA for FY 2017-2020 that calls for research to improve cessation rates in low-income populations. Low-income populations have less access to treatment and more obstacles to engaging in and maintaining behavioral change, which contribute to less success in quitting smoking. Future research under this FOA includes directly addressing smoking cessation in low-income populations through approaches targeted to individuals, systems, or populations.

Reducing the Effects of Toxicities in Cancer Treatment: The success of recent improvements in anti-cancer treatments has been tempered by a parallel rise in the incidence of treatment-related toxicities that lead to morbidity and mortality. To address this concern, NCI is focusing on key areas to improve treatments and reducing toxicity that include:

- understanding the molecular mechanisms of toxicities associated with cancer treatment

- collaborating with NHLBI on studies related to cardiotoxicity
- establishing common toxicity criteria for patients to report symptom adverse events.

By better understanding the underlying mechanisms of treatment toxicity, NCI seeks to identify more effective and less toxic treatments. Question 9 of the NCI Provocative Question Initiate targets this scientific gap. In addition, investigators in the NCI Community Oncology Research Program (NCORP) are also working to identify actionable targets for future clinical trials.

Chemotherapy and radiotherapy treatment can cause severe cardiovascular complications for patients such as heart failure, myocardial ischemia or infarction, hypertension, thromboembolism, and arrhythmias. In November 2015, NCI and NHLBI released a joint FOA that seeks to better understand and minimize cardiotoxicity. NCI and NHLBI are also working to achieve individualized cardio-oncology risk stratification, prevention, monitoring, and management plans for cancer treatment.

Finally, through the patient-reported outcome version of an initiative known as the Common Terminology Criteria for Adverse Events project, NCI is developing a robust, electronic system for patient self-reporting of symptom adverse events. The goal is to improve the accuracy and precision of grading for this class of adverse events, and eventually to develop sufficient evidence to support qualification by FDA of a tool to support the development of cancer treatments.

Community Clinical Trials and Cancer Care Delivery Research: The opportunity for individuals to join research studies in their local community allows them to stay close to family, friends, support systems, including local physicians and health organizations. Four NCI entities – Divisions of Cancer Prevention, Cancer Control and Population Sciences, Cancer Therapy and Diagnosis, and the Center to Reduce Cancer Health Disparities – provide support and scientific expertise for community-based research through the NCORP. NCORP seeks to add clinical practices to existing NCI community-based research programs in areas of geographic need and to broaden access to the NCI supported clinical studies, thus generating a broadly applicable evidence base that contributes to improved patient outcomes and reduces cancer disparities.

The NCI Surveillance, Epidemiology and End Results Program: Since 1973, the Surveillance, Epidemiology and End Results (SEER) program has been collecting data on cancer incidence, mortality, and prevalence. SEER is a cornerstone NCI program for improving cancer prevention and control. The registries that comprise SEER cover approximately 30 percent of the U.S. population within their catchment areas. The SEER database contains information on 5.7 million cancer cases, with more than 400,000 new cancer cases added each year. The SEER database is a critical resource for identifying cancer trends. It also serves as a powerful resource for researchers, and the database includes population data associated by age, sex, race, year of diagnosis, and geographic areas. SEER data is used to create the Annual Report to the Nation on the Status of Cancer, which is a collaboration among the NCI, the CDC, the American Cancer Society, and the North American Association of Central Cancer Registries.

The March 30, 2015 report revealed that overall cancer mortality rates for men and women continued to decline at an average rate of about 1.6 percent per year, after adjusting for age. It also described the prevalence and impact of comorbidities (other coexisting noncancerous diseases) in patients over 66 years of age with breast, prostate, lung, or colorectal cancer. Because comorbidities affect cancer care and survival, NCI has funded several grants that specifically

consider issues related to comorbidities in cancer patients.

VI. Cancer Centers: The NCI Cancer Centers program is an anchor of the nation's cancer research effort. The 69 NCI-designated Cancer Centers located in 35 states and the District of Columbia form the backbone of NCI programs for studying and controlling cancer.

Budget Policy:
The FY 2017 President's Budget request is $600.337 million, an increase of $71.160 million or 13.4 percent compared to the FY 2016 Enacted level.

The NCI-designated Cancer Centers are the nation's single most important source of new insights into the causes of cancer and into strategies to prevent, diagnosis, and treat cancer. Research proposals from Cancer Center investigators account for about three-quarters of the successful investigator-initiated grants that NCI awards.

At any given time, hundreds of research studies are under way at NCI Cancer Centers, ranging from basic laboratory research to clinical assessments of new treatments. Many of these studies are collaborative and involve several research centers and other partners in industry and the cancer research community. In addition to conducting meritorious basic and applied research, the cancer centers deliver quality cancer care to patients and their families, which included communities with underserved and understudied populations. In addition to 69 NCI-designated cancer centers, NCI supports more than 100 other more specialized centers for cancer research.

VII. Research Workforce Development: NCI has a long-standing commitment to training and developing a strong workforce of cancer researchers that spans the career continuum. NCI's investment in early-stage investigators helps attract strong talent and ensure the strength of future cancer research. In addition to NCI's direct support for training, our support for established investigators – scientists that have proven their ability to conduct robust science – also fosters mentoring for the next generation of cancer researchers.

Budget Policy:
The FY 2017 President's Budget request is $199.398 million, an increase of $ 23.653 million or 13.5 percent compared to the FY 2016 Enacted level.

NCI supports opportunities for training in basic, clinical, and behavioral research through formal training programs, individual fellowships, and career development awards. NCI training occurs at universities and other institutions across the country. In addition, NCI supports research experiences for high school, college, graduate and medical school students, and domestic and foreign post-doctoral fellows working in NCI intramural research programs. Recipients of training and career development grants span the career continuum and include pre-doctoral candidates, postdoctoral fellows, new faculty in independent research positions, and established midcareer investigators.

NCI is committed to enhancing diversity within the cancer research workforce. To support this objective, the NCI Center to Reduce Cancer Health Disparities coordinates diversity training at NCI.

Training the Next Generation of Clinical Research Scientists: Preventing cancer is one of the most important scientific and public health goals of the 21st Century. With the changing demographics in the United States and the growing cost of cancer treatment, there is an urgent need for a sufficient workforce of scientific and health professionals trained in the principles of clinical research to advance cancer prevention and control. These NCI training programs include:

- **Cancer Prevention Fellowship Program (CPFP):** Each year, CPFP provides state-of-the-art mentoring in cancer prevention and control research and leadership training for approximately 40 early career scientists and clinicians. In addition, the CPFP Summer Institute provides opportunities for short-term cancer prevention training to international scientists from low- and middle-income countries. A 2015 study found that CPFP alumni are three-to-five times more likely to achieve a research position and pursue other careers in cancer prevention compared to applicants who do not participate in the program.

- **Partnerships to Advance Cancer Health Equity (PACHE):** The PACHE program fosters collaboration among investigators at institutions that serve communities with cancer health disparities, including communities served by NCI Cancer Centers. PACHE seeks to achieve a greater understanding of the underlying causes of cancer health disparities and to train the next generation of investigators in cancer and health disparities research. To advance these goals, PACHE supports the training and education of individuals from populations that are underrepresented in cancer research and supports research across the cancer research continuum, including cancer health disparities research.

- **Continuing Umbrella of Research Experiences (CURE):** The CURE program funds a broad range of cancer research opportunities for under-represented individuals throughout the training continuum, from high school students to early stage investigators. The CURE program has successfully increased the participation of under-represented individuals in biomedical, behavioral, and clinical research. CURE's unique, holistic approach is intended to help individuals envision and achieve independence in a career in cancer research.

- **Partnering with the VA to Train Big Data Scientists:** The rapidly expanding volume of healthcare data has led to the urgent need to train a diverse pool of scientists with the capability to apply big data to cancer research. To address this need, NCI has partnered with the Veterans Health Administration at the U.S. Department of Veterans Affairs (VA), which is home to the largest integrated medical system in the United States. During FY 2015, this partnership led to the Big Data Scientist Training Enhancement Program (BD-STEP). BD-STEP is training a cadre of diverse junior-level physical scientists and engineers in clinical big data skills. BD-STEP will improve the treatment and care of cancer patients through an expanded ability to manipulate and analyze large-scale patient data sets and to construct new algorithms that advance patient-centered outcomes research.

VIII. Research Management and Support: NCI research management and support personnel fulfill a key and indispensable role by supporting and enabling the activities and success of all NCI-funded programs.

Budget Policy:
The FY 2017 President's Budget request is $431.5 million, an increase of $3.7 million or 0.9 percent compared to the FY 2016 Enacted level.

IX. Repairs and Improvements: Established in 1971 under the National Cancer Act, the NCI Frederick National Laboratory for Cancer Research is the only Federally-Funded Research and Development Center (FFRDC) dedicated to biomedical research. Located at Fort Detrick in Frederick, Maryland, this NCI enterprise is a national asset and a unique resource. It brings public and private partners together to address some of the most difficult cancer research challenges. Funding for Repairs and Improvements allows NCI to maintain its Frederick campus so that it can continue to perform world-class research to support the NCI national cancer mission.

Budget Policy:
The FY 2017 President's Budget request is $50 million, an increase of $34 million or 212.5 percent compared to the FY 2016 Enacted level.

The increased in funding for this account is required to modernize existing laboratory buildings and repair the core infrastructure that is vital to the NCI-Frederick research campus. The aging laboratories and associated facilities needed to be modernized when NCI inherited the Fort Detrick buildings. With these funds, NCI will commence the repairs and improvements necessary to upgrade laboratories and related facilities.

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

		FY 2016 Enacted	FY 2017 President's Budget[2]	FY 2017 +/- FY 2016
Total compensable workyears:				
	Full-time employment	3,029	3,029	0
	Full-time equivalent of overtime and holiday hours	2	2	0
	Average ES salary	$184	$187	$3
	Average GM/GS grade	12.3	12.3	0.0
	Average GM/GS salary	$104	$106	$1
	Average salary, grade established by act of July 1, 1944 (42 U.S.C. 207)	$102	$104	$2
	Average salary of ungraded positions	$140	$142	$2
	OBJECT CLASSES	**FY 2016 Enacted**	**FY 2017 President's Budget[2]**	**FY 2017 +/- FY 2016**
	Personnel Compensation			
11.1	Full-Time Permanent	$216,449	$218,040	$1,592
11.3	Other Than Full-Time Permanent	119,638	120,458	820
11.5	Other Personnel Compensation	9,706	9,780	74
11.7	Military Personnel	3,631	3,659	28
11.8	Special Personnel Services Payments	46,602	46,957	355
11.9	**Subtotal Personnel Compensation**	**$396,026**	**$398,894**	**$2,868**
12.1	Civilian Personnel Benefits	$110,800	$112,449	$1,649
12.2	Military Personnel Benefits	2,192	2,208	17
13.0	Benefits to Former Personnel	0	0	0
	Subtotal Pay Costs	**$509,018**	**$513,552**	**$4,534**
21.0	Travel & Transportation of Persons	$15,343	$15,618	$275
22.0	Transportation of Things	1,155	1,175	21
23.1	Rental Payments to GSA	22,438	22,797	359
23.2	Rental Payments to Others	6	6	0
23.3	Communications, Utilities & Misc. Charges	6,546	6,662	116
24.0	Printing & Reproduction	72	74	1
25.1	Consulting Services	$24,920	$33,368	$8,449
25.2	Other Services	475,586	555,773	80,187
25.3	Purchase of goods and services from government accounts	605,773	675,375	69,601
25.4	Operation & Maintenance of Facilities	$56,372	$67,387	$11,015
25.5	R&D Contracts	261,616	388,618	127,002
25.6	Medical Care	3,500	3,594	94
25.7	Operation & Maintenance of Equipment	20,092	20,435	343
25.8	Subsistence & Support of Persons	0	0	0
25.0	**Subtotal Other Contractual Services**	**$1,447,859**	**$1,744,550**	**$296,691**
26.0	Supplies & Materials	$34,676	$35,299	$623
31.0	Equipment	21,263	22,631	1,368
32.0	Land and Structures	6	6	0
33.0	Investments & Loans	0	0	0
41.0	Grants, Subsidies & Contributions	3,155,124	3,531,136	376,012
42.0	Insurance Claims & Indemnities	0	0	0
43.0	Interest & Dividends	2	2	0
44.0	Refunds	0	0	0
	Subtotal Non-Pay Costs	**$4,704,491**	**$5,379,957**	**$675,466**
	Total Budget Authority by Object Class	**$5,213,509**	**$5,893,509**	**$680,000**

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

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Salaries and Expenses

(Dollars in Thousands)

OBJECT CLASSES	FY 2016 Enacted	FY 2017 President's Budget	FY 2017 +/- FY 2016
Personnel Compensation			
Full-Time Permanent (11.1)	$216,449	$218,040	$1,592
Other Than Full-Time Permanent (11.3)	119,638	120,458	820
Other Personnel Compensation (11.5)	9,706	9,780	74
Military Personnel (11.7)	3,631	3,659	28
Special Personnel Services Payments (11.8)	46,602	46,957	355
Subtotal Personnel Compensation (11.9)	**$396,026**	**$398,894**	**$2,868**
Civilian Personnel Benefits (12.1)	$110,800	$112,449	$1,649
Military Personnel Benefits (12.2)	2,192	2,208	17
Benefits to Former Personnel (13.0)	0	0	0
Subtotal Pay Costs	**$509,018**	**$513,552**	**$4,534**
Travel & Transportation of Persons (21.0)	$15,343	$15,618	$275
Transportation of Things (22.0)	1,155	1,175	21
Rental Payments to Others (23.2)	6	6	0
Communications, Utilities & Misc. Charges (23.3)	6,546	6,662	116
Printing & Reproduction (24.0)	72	74	1
Other Contractual Services:			
Consultant Services (25.1)	12,803	13,034	230
Other Services (25.2)	475,586	555,773	80,187
Purchases from government accounts (25.3)	460,437	475,743	15,307
Operation & Maintenance of Facilities (25.4)	36,757	37,418	662
Operation & Maintenance of Equipment (25.7)	20,092	20,435	343
Subsistence & Support of Persons (25.8)	0	0	0
Subtotal Other Contractual Services	**$1,005,675**	**$1,102,404**	**$96,729**
Supplies & Materials (26.0)	$34,676	$35,299	$623
Subtotal Non-Pay Costs	**$1,063,473**	**$1,161,238**	**$97,765**
Total Administrative Costs	**$1,572,492**	**$1,674,790**	**$102,298**

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Detail of Full-Time Equivalent Employment (FTE)

OFFICE/DIVISION	FY 2015 Actual			FY 2016 Est.			FY 2017 Est.		
	Civilian	Military	Total	Civilian	Military	Total	Civilian	Military	Total
Center for Cancer Research									
Direct:	1,366	17	1,383	1,380	17	1,397	1,380	17	1,397
Reimbursable:	3	-	3	3	-	3	3	-	3
Total:	1,369	17	1,386	1,383	17	1,400	1,383	17	1,400
Division of Cancer Biology									
Direct:	51	-	51	52	-	52	52	-	52
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	51	-	51	52	-	52	52	-	52
Division of Cancer Control and Population Sciences									
Direct:	161	3	164	163	3	166	163	3	166
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	161	3	164	163	3	166	163	3	166
Division of Cancer Epidemiology and Genetics									
Direct:	149	4	153	151	4	155	151	4	155
Reimbursable:	2		2	2		2	2		2
Total:	151	4	155	153	4	157	153	4	157
Division of Cancer Prevention									
Direct:	96	1	97	97	1	98	97	1	98
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	96	1	97	97	1	98	97	1	98
Division of Cancer Treatment and Diagnosis									
Direct:	224	4	228	226	4	230	226	4	230
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	224	4	228	226	4	230	226	4	230
Division of Extramural Activities									
Direct:	100	-	100	101	-	101	101	-	101
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	100	-	100	101	-	101	101	-	101
Office of the Director									
Direct:	814	3	817	822	3	825	822	3	825
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	814	3	817	822	3	825	822	3	825
Total	2,966	32	2,998	2,997	32	3,029	2,997	32	3,029
Includes FTEs whose payroll obligations are supported by the NIH Common Fund.									
FTEs supported by funds from Cooperative Research and Development Agreements.	0	0	0	0	0	0	0	0	0
FISCAL YEAR	**Average GS Grade**								
2013	12.3								
2014	12.1								
2015	12.3								
2016	12.3								
2017	12.3								

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Detail of Positions[1]

GRADE	FY 2015 Actual	FY 2016 Enacted	FY 2017 President's Budget
Total, ES Positions	3	3	3
Total, ES Salary	544,500	552,831	561,288
GM/GS-15	270	273	273
GM/GS-14	474	479	479
GM/GS-13	427	431	431
GS-12	465	470	470
GS-11	200	202	202
GS-10	12	12	12
GS-9	125	126	126
GS-8	84	85	85
GS-7	55	56	56
GS-6	15	15	15
GS-5	5	5	5
GS-4	6	6	6
GS-3	7	7	7
GS-2	3	3	3
GS-1	1	1	1
Subtotal	2,149	2,171	2,171
Grades established by Act of July 1, 1944 (42 U.S.C. 207)	0	0	0
Assistant Surgeon General	0	0	0
Director Grade	15	15	15
Senior Grade	9	9	9
Full Grade	4	4	4
Senior Assistant Grade	2	2	2
Assistant Grade	0	0	0
Subtotal	30	30	30
Ungraded	865	874	874
Total permanent positions	2,146	2,168	2,168
Total positions, end of year	3,016	3,047	3,047
Total full-time equivalent (FTE) employment, end of year	2,998	3,029	3,029
Average ES salary	181,500	184,277	187,096
Average GM/GS grade	12.3	12.3	12.3
Average GM/GS salary	103,423	104,457	105,501

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