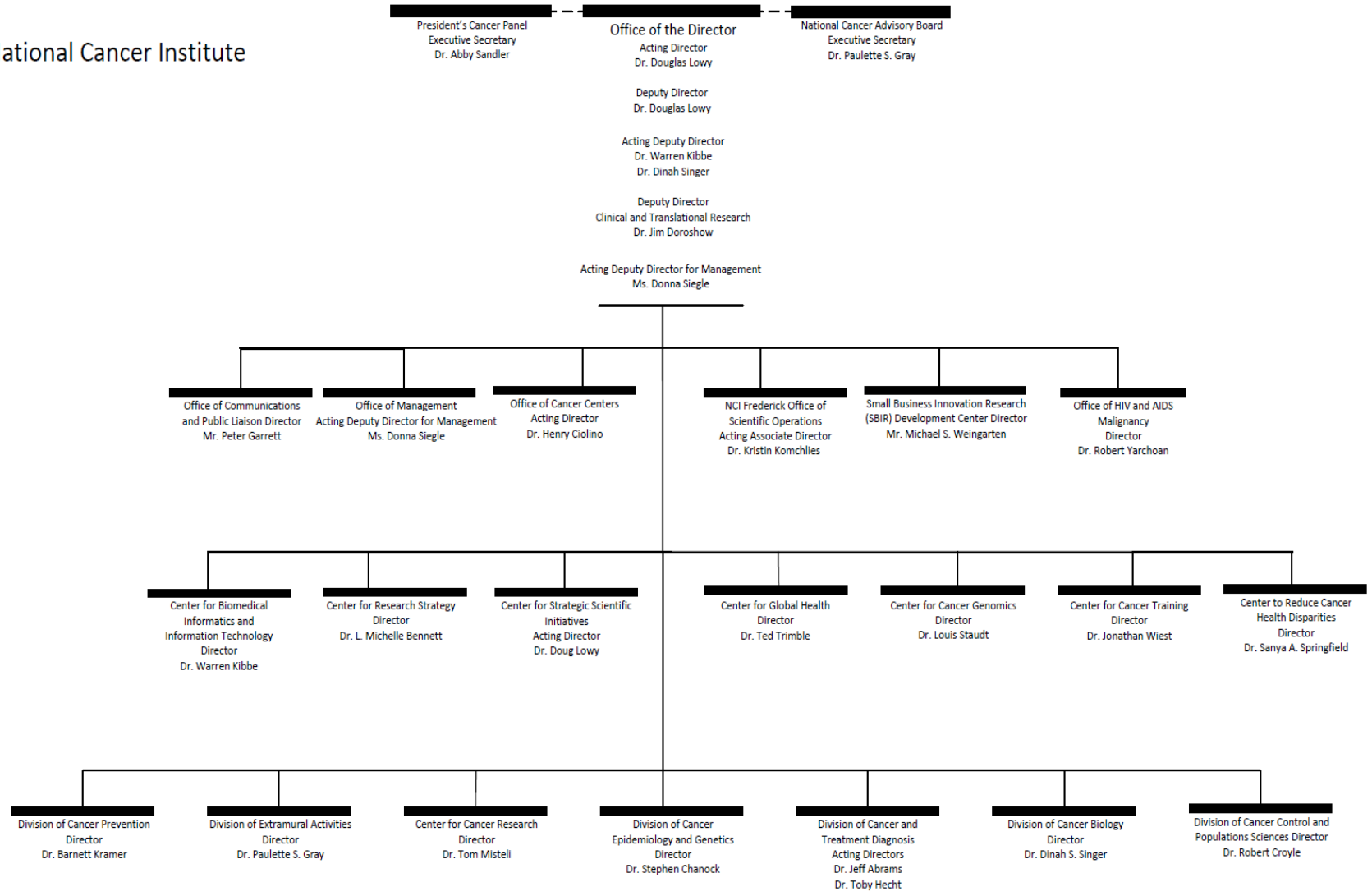
DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTES OF HEALTH

National Cancer Institute (NCI)

FY 2018 Budget | Page No.

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, $4,174,222,000 of which up to $10,000,000 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)

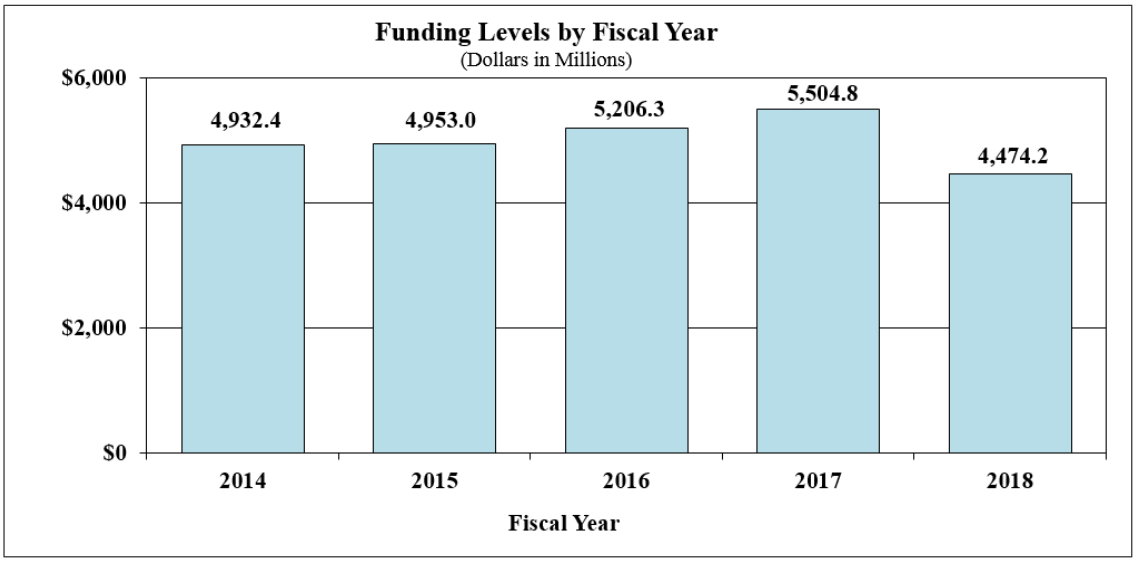
Source of Funding	FY 2016 Final	FY 2017 Annualized CR	FY 2018 President's Budget[2]
Appropriation	$5,214,701	$5,514,701	$4,474,222
Mandatory Appropriation: (non-add)			
Type 1 Diabetes	*(0)*	*(0)*	*(0)*
Other Mandatory financing	*(0)*	*(0)*	*(0)*
Rescission	0	-9,913	0
Sequestration	0	0	0
Zika Intra-NIH Transfer	-7,217	0	0
Subtotal, adjusted appropriation	$5,207,484	$5,504,788	$4,474,222
OAR HIV/AIDS Transfers	-1,192	0	0
Subtotal, adjusted budget authority	$5,206,292	$5,504,788	$4,474,222
Unobligated balance, start of year	0	0	0
Unobligated balance, end of year	0	0	0
Subtotal, adjusted budget authority	$5,206,292	$5,504,788	$4,474,222
Unobligated balance lapsing	-122	0	0
Total obligations	$5,206,169	$5,504,788	$4,474,222

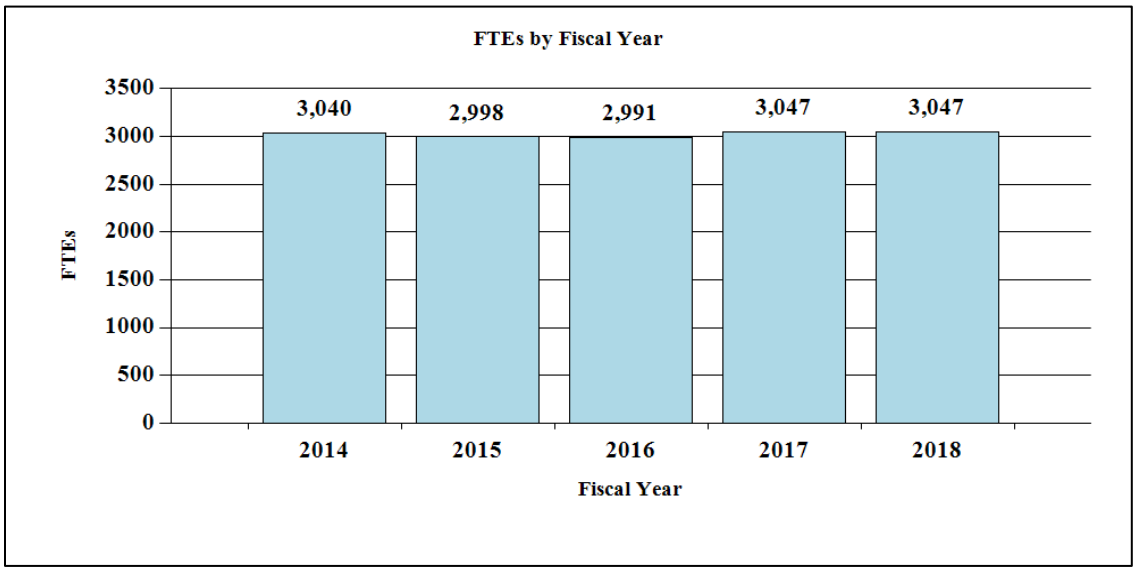
[1] Excludes the following amounts for reimbursable activities carried out by this account:
FY 2016 - $22,087 FY 2017 - $0 FY 2018 - $0

[2] Of which $300 million is derived by transfer from the NIH Innovation Account.

Fiscal Year 2018 Budget Graphs

History of Budget Authority and FTEs:





NATIONAL INSTITUTES OF HEALTH
National Cancer Institute

Authorizing Legislation

	PHS Act/ Other Citation	U.S. Code Citation	2017 Amount Authorized	FY 2017 Annualized CR	2018 Amount Authorized	FY 2018 President's Budget
Research and Investigation	Section 301	42§241	Indefinite	$5,504,788,000	Indefinite	$4,474,222,000
National Cancer Institute	Section 401(a)	42§281	Indefinite		Indefinite	
Total, Budget Authority				$5,504,788,000		$4,474,222,000

NATIONAL INSTITUTES OF HEALTH
National Cancer Institute

Appropriations History

Fiscal Year	Budget Estimate to Congress	House Allowance	Senate Allowance	Appropriation
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	$5,388,444,000	$5,429,769,000	$5,514,701,000
Rescission				$9,913,000
2018	$4,474,222,000			

[1] Budget Estimate to Congress includes mandatory financing.

FY 2018 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 2016 Actual	FY 2017 Annualized CR	FY 2018 President's Budget	FY 2018 +/- FY 2017
BA	$5,206,169,272	$5,504,788,000	$4,474,222,000	-$1,030,566
FTE	2,991	3,047	3,047	0

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

Director's Overview

In December 2016, Congress took a bold and visionary step for cancer patients by enacting the Beau Biden Cancer Moonshot[SM]. As a central component of the 21st Century Cures Act, the Cancer Moonshot authorizes a total of $1.8 billion across seven fiscal years to support a range of promising research including: cancer vaccines, immunotherapy, new combination therapies, and other opportunities to transform the landscape of cancer prevention, diagnosis, treatment, and survivorship. Also in December, Congress enacted an appropriation of $300 million as first year funding to support the Cancer Moonshot.

The Cancer Moonshot represents an opportunity for NCI and its research partners to make sustained progress in ways that can change the course of cancer. Fortunately, NCI is benefiting from some of the best minds in the field of cancer science to implement the Cancer Moonshot. Throughout much of 2016, while Congress was developing and refining the 21st Century Cures Act, NCI gathered a Blue Ribbon Panel of experts under the leadership of the National Cancer Advisory Board to make recommendations on the overall vision, the scientific goals, and the important strategic opportunities that NCI should pursue. The panel of experts engaged more than 1,000 prominent leaders and stakeholders in the cancer research community to identify specific scientific priorities that could contribute to the ambitious goal of making a decade of cancer progress in priority areas during the next five years.

The opportunity to achieve this challenging goal galvanized researchers, clinicians, industry, advocates, and the patient community to formulate recommendations that could deliver tangible benefits for patients with all types of cancer and for those at risk of cancer. The culmination of this effort was a roster of research priorities that represents the most compelling opportunities to achieve the five-year objective. NCI is fortunate to have the insights of the Blue Ribbon Panel to guide the Moonshot Implementation Plan.

Deploying Cancer Moonshot resources to implement the Blue Ribbon Panel recommendations will spur the transformative advances that the panel envisioned. The recommendations present opportunities to deepen our understanding of cancer and thereby identify new ways to prevent and treat the disease. They build on discoveries that allow us to map cancer cells and the tumor environment in remarkable detail and to define the genomic, biochemical, and molecular basis of cancer with ever-greater precision. They rely on advances in scientific computing that allow us to assemble and analyze enormous data sets, all within an environment that will support and benefit from greater involvement of patients in collaborative research.

Taken together, the recommendations represent an opportunity to bring the most promising scientific and clinical developments to cancer patients, and to do so much sooner.

It is difficult to overstate the importance of the Cancer Moonshot as a strategic opportunity for NCI, for cancer science, and for cancer patients. Moonshot funding will permit NCI to pursue truly promising research opportunities that NCI resources otherwise could not reach.

However, it is equally important to recognize the value and benefit of the breadth of other cancer research that NCI conducts. During FY 2017, resources from the Cancer Moonshot represent about 5 percent of the NCI budget. This metric highlights the importance of NCI's core budget to advancing our broad mission.

The NCI budget supports a range of research that is essential to sustained progress to reduce the burden of cancer for all. Now, as in the past, the advances that contribute to progress in understanding, preventing, diagnosing, and treating cancer depend on many kinds of science. Based on this principle, the NCI budget supports a spectrum of biomedical research to broadly advance scientific discovery relevant to cancer. This approach yielded sustained progress over the years to reduce the burden of cancer in America, and will continue to do so in the future.

For example, 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, given that basic biological science is essential to understanding cancer and reducing the incidence, morbidity, and mortality for all types of cancer.

Research into the causes of cancer is another example of the breadth of research needed to achieve progress against cancer. Studying the interactions among genetic factors, lifestyle factors, and environmental exposures can reveal previously unknown biological processes that drive certain cancers. Improving our knowledge of these cancer risk factors offers the opportunity to develop risk prediction models, identify individuals who may be at increased risk of certain cancers, and develop interventions to reduce their cancer risk.

Another example of the range of science required for progress in cancer involves research on mutations of RAS genes that transmit signals within cells. When RAS genes mutate, cells can grow uncontrollably. Approximately 30 percent of all cancers involve mutations of these genes. Although basic research conducted more than three decades ago identified the fundamental role of RAS in certain tumors, efforts to develop treatments that target RAS have encountered many

challenges. However, recent research advances offer the promise of new approaches to address these cancers. The advances include discovering chemical approaches to developing inhibitors, understanding signaling networks regulated by RAS, developing technology to assess signaling networks, and developing research models to support drug development.

These and other examples demonstrate the spectrum of science required to make progress against cancer. For these reasons, the core of NCI's research portfolio includes:

- Basic research, including genetics, cell biology, and cancer pathogenesis
- Translational and clinical science to prevent, screen, and diagnose cancer, and to develop and test drugs, biomarkers, imaging, diagnostics, and radiotherapies
- Population studies, including epidemiological, environmental, behavioral and survivorship research
- Programs to attract, train, and retain a diverse workforce of cancer researchers with the skills required for an ever-more demanding and sophisticated research environment.

While some of these research disciplines will experience profound changes based on the new understanding of cancer that is driving precision medicine and that supports the Cancer Moonshot, progress in other disciplines will continue to depend on more traditional approaches to research.

Thanks to support from Congress over many years, funding for these traditional approaches has yielded important results that have contributed to sustained decreases in cancer mortality rates, fostered the development of new diagnostics, treatments, and prevention strategies, improved our ability to manage the symptoms of cancer and the side effects of cancer treatments, and allowed us to effectively monitor the prevalence of cancers and the factors associated with cancer risk.

The FY 2018 resources that NCI allocates to these core research disciplines will sustain broad progress and lead to a deeper understanding of the causes and mechanisms of cancer. Funding for core NCI research will not only serve as a launching pad for the success of the Cancer Moonshot, but also for other new and promising opportunities that NCI research is only beginning to reveal.

Today, despite progress that has reduced the incidence of cancer and increased cancer survivorship, too many Americans face a cancer diagnosis, and far too many are dying from the disease. Regrettably, our progress in preventing, diagnosing, and treating cancers is not universal for all forms of the disease. Although mortality rates for many cancers have decreased, mortality rates for certain cancers have actually increased. Cancer health disparities – the differences in the burden of cancer incidence, prevalence, treatment response, and mortality among different population groups – also remain a serious public health challenge.

Thus, much work remains. The National Cancer Institute and its many extramural research partners are dedicated to broadly and deliberately advancing our cancer research mission in ways that deliver timely and important results for the patients we serve.

Overall Budget Policy:
The FY 2018 President's Budget request is $4,474.222 million, a decrease of $1,030.566 million compared with the FY 2017 Annualized CR level. These deductions are distributed across all programmatic areas and basic, epidemiology or clinical research.

In FY 2018 NCI will make strategic choices that prioritize how we allocate funding to our programs. Maintaining continuity within these programs is of high value to cancer science because participating institutions collaborate on large-scale treatment trials that historically enroll up to 20,000 patients annually. Programs to train and retain a diverse workforce of researchers with the skills required to conduct demanding and sophisticated cancer research will also remain a priority in FY 2018 for NCI.

Program Descriptions and Accomplishments

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

- Understanding the Causes of Cancer
- Understanding How Cancer Develops
- Advancing Early Detection and Diagnosis
- Developing and Improving Treatments and Improving Cancer Survivorship
- 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 and activities. 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) to support the operations of the Frederick National Laboratory for Cancer Research; 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, investigator-initiated research project grants that NCI awards constitute a large portion of the research investment for all five goals. During FY 2016, NCI issued 5,578 new and non-competing grant awards across all grant mechanisms, including 2,883 traditional (R01) grants and 585 exploratory (R21) grants to support research that advances its cancer research goals. These grant numbers do not include the National Research Service Award training grants.

The FY 2016 total for new grants also includes 35 Outstanding Investigator (R35) Awards (OIA), which provide seven years of funding to investigators with outstanding records of productivity in cancer research. OIA awards are an opportunity for researchers to test high-risk hypotheses supported by a higher award level and for more years than is possible under a traditional R01 grant. In the two years since NCI began the OIA program, NCI issued 87 awards.

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

The narratives that follow highlight some of NCI's programs and identify recent progress and future plans within each scientific area. It is important to appreciate that virtually all NCI research in one scientific goal area influences the approaches used to advance scientific goals in the other scientific areas. Furthermore, although NCI research is often identified by topic and theme, basic research remains a consistent priority across virtually all areas of science at NCI.

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 each area.

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 and environmental factors. 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 on 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.

Addressing Cancer Disparities: There often are significant differences in the number of people diagnosed, living with, and dying from various types of cancer across the United States. The causes of these disparities among diverse populations are complex. Discrete biological factors among and within populations are a recognized, yet understudied, contributor to cancer differences. In FY 2016, NCI launched several programs to investigate the biology and genetics of cancer in such populations. For example, NCI is developing new cancer models derived from diverse populations and is conducting in-depth genomic analysis for several cancer types that occur at early ages in some racial and ethnic minority populations. NCI will continue to identify ways to mitigate the biological and non-biological factors contributing to cancer disparities. Cancer Disparities is a research area that NCI plans to leverage with Cancer Moonshot resources.

NCI programs such as the Surveillance, Epidemiology, and End Results (SEER) Program help researchers better understand factors that may influence cancer disparities. To cite one example, SEER data show that survival rates for women diagnosed with breast cancer have steadily improved over several decades. However, these improvements have not been shared equally, and African American women are more likely to die of their disease. To learn more about the genetic factors that may underlie the observed differences in breast cancer among African American women, NCI is funding a collaborative effort called the Breast Cancer Genetic Study in African-Ancestry Populations. This is the largest study ever to investigate how genetic and biological factors contribute to breast cancer risk among black women. Researchers from the African American Breast Cancer Consortium, the African American Breast Cancer Epidemiology and Risk

Consortium, and the NCI Cohort Consortium will share biospecimens, data, and resources from 18 previous studies to examine the genetic associations of breast cancer in African American women. In addition to research such as this, NCI supports grants and collaborations that address cancer disparities that encompass the entire cancer control continuum – from identifying and understanding the role of biology in disparities, to cancer prevention, access to treatment, and survivorship care – among population groups characterized by gender, age, race, ethnicity, education, income, social class, disability, geographic location, or sexual orientation.

Identifying BRCA1/2 Mutation Carriers: BRCA1 and BRCA2 are human genes that produce tumor suppressor proteins. When either of these genes is mutated or altered, DNA damage may not be repaired properly. As a result, cells are more likely to develop additional genetic alterations that can lead to cancer. Specific inherited mutations in BRCA1 and BRCA2 increase the risk of female breast and ovarian cancers. BRCA1 and BRCA2 germline mutations are relatively frequent among women with high-grade ovarian cancer.

Current guidelines recommend that women diagnosed with high-grade serous ovarian cancer be referred for genetic testing, yet many have not been tested. NCI has developed a framework to increase identification of families of BRCA mutation carriers by identifying and genetically testing previously diagnosed but untested women and disseminating risk information to relatives. An important component of the trace back process will involve navigating the complex ethical nature of genetic testing and communicating genetic results. This will include obtaining consent from the next-of-kin prior to testing and facilitating a family-centered approach for sharing genetic risk information. With these safeguards, this framework to test for heritable genetic conditions that increase the risk of several types of cancer can potentially improve early detection and prevention.

Cancer and Aging: Cancer has long been associated with aging, and for most cancers, their incidence increases with age. Yet, the molecular basis for aging-associated cancer formation is largely unknown. Considering the projected increase in the number of older Americans, the increase in cancer incidence with age poses a major societal problem in the United States and worldwide, including a significant burden on the healthcare system. During the past decade, there has been tremendous progress identifying pathways that are affected by and contribute to aging. These advances present an opportunity to apply the wealth of information obtained in the field of aging to understand better the molecular and cellular mechanisms that drive the increased incidence of cancer as we age. With this opportunity in mind, NCI plans to continue to support research on aging mechanisms and pathways at the cellular and molecular level. Furthermore, NCI plans to study the role of aging on cancer and anti-cancer pathways and the function of tumor suppressors and oncogenes, the microenvironment, and the immune response.

II. Understanding How Cancer Develops: Cancer is driven by alterations of a cell's genome (DNA) and its associated proteins. As a consequence, abnormal kinds and amounts of proteins emerge 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 its forms, depends on a deeper understanding of the genetic and patho-physiological changes that take place in cancer cells and the cancer microenvironment.

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.

Fusion Oncoproteins in Pediatric Cancers: Genetic recombination events that result in a combination of segments from two different genes can encode novel fusion proteins that influence neoplastic (uncontrolled) growth. Specific fusion proteins are important biomarkers for diagnosing several types of pediatric cancers and may also drive cancer development. During FY 2016, NCI issued two Funding Opportunity Announcements (FOAs) to support research into the molecular mechanisms by which fusion proteins contribute to pediatric sarcomas. This research will enhance our understanding of how these cancers develop, allow researchers to design reliable pre-clinical models to further this research, and may identify novel therapeutic targets. NCI plans to leverage the awards issued under the FOAs to create a highly dynamic and collaborative network of investigators with unique perspectives and complementary expertise. During FY 2017, NCI plans to solicit requests for administrative supplements to existing NCI grants that support new interdisciplinary collaborations for studying fusion oncoproteins in childhood cancers. Fusion Oncoproteins is an example of an area of research that NCI plans to leverage with Cancer Moonshot resources.

Technologies to Advance Cancer Research: NCI supports technology development that will drive emerging areas of cancer research, from basic through clinical. Research consistently demonstrates that the complexities of cancer often exceed the capabilities of our most advanced computational and laboratory tools. Investing in new capabilities to support research and clinical care is essential to better understand and treat cancer. NCI continuously monitors the spectrum of cancer research and stimulates new approaches to research through the Innovative Molecular Analysis Technologies and the Informatics Technology for Cancer Research programs. For example, a priority area for technology development is the convergence of tissue bioengineering, advanced materials science research, and the complex tumor microenvironment. To address this need, NCI plans to support development of highly specialized and tunable biomimetic or tissue-engineered model systems that can advance cancer discovery and deliver benefits to patients. Advancing new technologies is an example of an area that NCI plans to leverage with Cancer Moonshot resources.

Exploring the Tumor Microenvironment: The tumor microenvironment consists of cellular (immune and non-immune cells) and non-cellular stromal components that play a role in cancer initiation, metastasis, and drug resistance. To understand better the bidirectional interactions between the tumor microenvironment and cancer cells, NCI supports basic and translational research through investigator-initiated grants and programs such as the Physical Sciences-Oncology Network and the Molecular and Cellular Characterization of Screen-Detected Lesions (MCL) Consortium. Studies by the Physical Sciences-Oncology Network show that collagen architecture and mechanical properties can profoundly affect the tumor microenvironment. For example, in combination with standard chemotherapy, blocking excess collagen deposited by fibroblasts prevents breast cancer growth and metastasis. The Molecular and Cellular Characterization of Screen-Detected Lesions Consortium is characterizing tumor microenvironments to determine the molecular and cellular drivers of aggressive disease. Other scientific opportunities that are emerging from this research include the role of the tumor microenvironment in effective drug delivery and how the microenvironment supports tumor cell dormancy, immune evasion, and therapy resistance.

NCI Program Portrait: NCI Cancer Research Data Ecosystem
FY 2017 = $15.0 million
FY 2018 = $15.0 million

With funding approved by Congress in FY 2016 for the NCI Precision Oncology Initiative[SM] program, NCI is building data science platforms to integrate genetic information about tumors with data on how patients respond to therapy. This NCI initiative advances the 2011 Institute of Medicine recommendation on building a unified system to collect, integrate, and share cancer data from the broadest possible set of research studies. Fulfilling this recommendation – establishing a NCI Cancer Research Data Ecosystem – will broadly support the work of the extramural cancer research community, accelerate the pace of cancer discovery, and speed precision medicine into clinical practice. The NCI Cancer Research Data Ecosystem supports the full spectrum of research that NCI and its research partners conduct, but it has special application for the scientific goals of Improving Our Understanding of How Cancer Develops and Developing, Improving Treatments, and Improving Cancer Survivorship.

The NCI Cancer Research Data Ecosystem will incorporate genetic, biochemical, environmental, and clinical data from patients in ways that identify the molecular subtypes of tumors and support research to improve cancer care and patient outcomes. NCI is establishing the Cancer Research Data Ecosystem based on the understanding that big data emerging from research programs and precision medicine trials can be used to develop and inform models that predict how patients will response to treatment.

During prior fiscal years, NCI was constructing key building blocks that contribute to the Data Ecosystem. For example, investments in prior years allowed NCI to launch the NCI Genomic Data Commons (GDC) in June, 2016. The GDC is a unified data system that promotes sharing of genomic and clinical data among researchers. The GDC centralizes, standardizes, and makes data from large-scale NCI programs more accessible and useful to scientists and clinicians. Since June, organizations such as for-profit Foundation Medicine and the non-profit Multiple Myeloma Research Foundation have provided data sets for sharing through the GDC.

NCI's Cancer Genomics Cloud Pilot program will also contribute to the NCI Cancer Research Data Ecosystem by making data from the GDC available through cloud computing platforms. This NCI effort will also provide elastic computing resources and workspaces necessary to support cancer researchers in ways that expedite discovery of new cancer treatments.

NCI plans to expand the GDC and related components that contribute to the Cancer Research Data Ecosystem to include proteomic, clinical imaging, and other clinical datatypes. Increasing the diversity of available data in this manner will enhance the breadth and usefulness of the GDC and its ability to support scientific discovery, test hypotheses, and validate predictive models. The GDC and Cloud Pilots serve as building blocks for the broader NCI Cancer Research Data Ecosystem, which has the potential to support direct patient engagement and cancer cohorts envisioned by the Cancer Moonshot. The NCI Cancer Research Data Ecosystem can also serve as a platform for understanding fundamental cancer biology questions, including cancer initiation and cancer progression and recurrence, in ways that support new treatments and prevention strategies.

III. Advancing Early Detection and Diagnosis: Many deaths occur because cancers are diagnosed at late stages when treatment may be less effective. NCI-supported researchers are working to identify molecules – nucleic acids, proteins, metabolites, and other substances – that may improve early detection and diagnosis. This often involves uncovering the distinct molecular signatures of cancers and developing and refining molecular assays to detect cancer.

NCI has an array of programs to advance all aspects of early cancer detection and diagnosis. Examples include –

- developing new technologies and improving existing methods of noninvasive imaging to support cancer diagnosis, to identify disease subsets in patients, to determine the stage of disease, and to monitor the progress of cancer treatment

- coordinating efforts to obtain high-quality tissue specimens and associated data for the research community, and developing databases of molecularly characterized specimens

- maintaining programs such as the Genomic Data Commons, the Cancer Genome Characterization Initiative, and (in collaboration with the National Human Genome Research Institute) the Cancer Genome Atlas, that not only support the development of new treatments, but are also vital to improving cancer diagnosis.

Improving early cancer detection and diagnosis is part of – or closely linked to – the NCI Precision Oncology Initiative[SM] program, since it frequently depends on characterizing and interpreting cancer genomes. Clinicians will increasingly be using detailed, tumor-specific information to identify tumors early and to guide how tumors are categorized. Such information not only supports diagnosis, but also allows clinicians to select the best treatment for each patient.

Investigator-initiated research project grants are one mechanism that NCI relies on to support and improve early detection and diagnosis of cancer. However, other larger research programs also play important roles, as the examples highlighted above illustrate.

Integrated Proteogenomics for Precision Oncology: A major goal of precision medicine in the field of oncology is discovering how to administer the right treatment to the right patient at the right time with the right dose. Recent studies demonstrate that integrating proteomics – such as those advanced by NCI's Clinical Proteomic Tumor Analysis Consortium (CPTAC) – with genomics – such as those found in the data sets of The Cancer Genome Atlas, a joint program of NCI and National Human Genome Research Institute – could produce a more unified understanding of cancer. Proteogenomics, a field of research at the intersection of proteomics and genomics, offers a promising opportunity to generate understandings that could lead to improved patient care. To further this area of research, CPTAC continues to integrate proteogenomic and imaging from NCI's Cancer Imaging Program to support analysis of new cancer types. NCI plans to release data from this integration effort to support cancer research that others conduct. CPTAC will also apply integrated proteogenomics to clinical trials data to identify the biological mechanisms of patient response and resistance to therapies. Analyzing such data is critical to discovering how to treat each patient for the specifics of his or her disease.

Premalignant Cancer Genome Atlas: A major limitation of early detection and cancer prevention strategies is the lack of comprehensive knowledge of the pathologic changes occurring at the molecular level that drive the cancer process as lesions develop and progress. Premalignant lesions are abnormal cells and tissues that usually precede the development of invasive cancer. Premalignant lesions are often found during a diagnostic biopsy or in samples from cancer screening procedures. Some of these lesions will progress to invasive cancers, while most will remain stable or regress.

In contrast to late-stage cancer, systematic efforts to collect and genomically profile premalignant lesions are in their infancy, which makes it difficult to assess risk and develop early intervention

strategies. NCI is convening a multidisciplinary group to examine this issue and to recommend research directions and strategies to catalog and characterize premalignant lesions and the surrounding microenvironment. This work may provide a blueprint for feasibility and pilot studies to advance this field of research. The mid-term goal is to identify a small number of high-risk models (such as colorectal adenomas or breast ductal carcinoma *in situ*) for an initial pilot and for further research. The tissue collection and clinical annotation from this effort could serve as a national resource to enhance our understanding of the biology of premalignancy. This is an example of an area of research that NCI plans to leverage with Cancer Moonshot resources.

Physical Activity and Cancer Prevention & Survival: Despite epidemiologic evidence that relates physical activity to lower cancer risk and studies that suggest why this may be so, the frequency, intensity, duration, and type of physical activity required to prevent cancer and improve survival are unknown. Although many Americans exercise regularly, increasing and maintaining physical activity remains elusive for others.

Through grants and other mechanisms, NCI supports new research and behavioral intervention programs to address this challenge. For example, NCI investments led to a new data resource available to all qualified investigators. The Interactive Diet and Activity Tracking in AARP (IDATA) Study examines device-based, internet-based, and conventional self-report instruments to assess physical activity and diet for epidemiology research. IDATA resources are available through NCI's Cancer Data Access System to investigators studying nutrition and physical activity. The Comparing Relaxation Programs for Breast Cancer Patients Receiving Radiotherapy (COMPARE) Study is an example of NCI efforts to assess the effects of physical activity dynamically as breast cancer survivors undergo changes in fitness and body weight.

Liquid Biopsy Systems: A liquid biopsy examines the presence of cancer cells, nucleic acids, or proteins shed by tumor cells in blood or other body fluids. One advantage of this area of cancer diagnostics is that samples are taken from relatively non-invasive blood draws rather than from highly-invasive tissue biopsies. Liquid biopsies can be used to monitor patient response to treatment. The greater challenge involves using liquid biopsies as a tool for cancer screening.

The NCI Small Business Innovation Research (SBIR) program has been funding companies examining different facets of liquid biopsy. One SBIR-funded project analyzes circulating tumor cells and circulating cell free DNA (cfDNA) from a single blood draw. Another SBIR project profiled 12 lung cancer patients using a cfDNA-based liquid biopsy technology. Moving forward, NCI anticipates awarding additional contracts to support development of "Technologies for Differential Isolation of Exosomes and Oncosomes" (SBIR Topic NIH/NCI 359).

IV. Developing and Improving Treatments and Improving Cancer Survivorship: Research on cancer therapy has many facets that go beyond developing and testing drugs, radiotherapy, immunotherapy, and surgery, such as the 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 treatment. Increasingly, progress is linked to new knowledge about the molecular fingerprints of tumors, the structure of cancer-associated molecules and how to target them with new drugs, how cancer cells interact with the host environment and the immune system, and the altered behaviors of cancer cells.

These elements are well-recognized components of precision medicine in the field of oncology, because they are critical to designing interventions to 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 identify 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.

Longer and Better Survivorship for All Ages: Currently numbering 15.5 million, the growing population of cancer survivors represents a challenge – albeit a positive one – for clinicians, researchers and healthcare planners. Few cancer therapies are entirely benign. Many carry adverse consequences. Determining how best to follow survivors after treatment is unclear.

To address this challenge, NCI is funding several survivor cohorts (examples include the Childhood Cancer Survivor Study, the St. Jude Life Study, Women's Health Initiative and the Detroit Research on Cancer Survivors) to better identify who is at risk for adverse long-term and late-emerging treatment effects, and to identify ways to prevent or mitigate these effects. NCI is designing studies to understand better the financial consequences of cancer survivorship, such as the impact on employment. NCI is also developing surveys to identify and address barriers to enrolling older (age 65+) survivors in clinical trials that could identify ways to improve the length and quality of survival. These barriers include concerns about patient frailty, the ability to maintain complex treatment plans, and the ability to manage comorbid conditions. NCI also recognizes the special needs of childhood, adolescent, and young adult cancer survivors by continuing to support research to identify ways to reduce the effects of cancer treatment and improve quality of life for these populations.

Mounting evidence from NCI-funded survivorship studies about the needs of survivors to understand how to manage after-cancer treatment led to a national call for all cancer survivors to receive a survivorship care plan upon finishing treatment. A care plan serves as a roadmap for survivors and their healthcare providers to manage future wellbeing and to enhance patient-doctor and doctor-doctor communication.

Novel Technologies to Support Diagnosis and Clinical Decisions: NCI is using nano- and micro-technologies to develop precise and patient-specific tools for early detection and assessment of cancer therapy. These technologies offer enhanced sensitivity and a high level of multiplexing compared to existing assays. Similarly, wearable technologies are emerging as attractive tools for the continuous, passive monitoring of the health of patients undergoing cancer therapy. These efforts, conducted by NCI separately and in partnership with the U.S. Department of Defense (DOD), may enhance clinical decision making and provide a more comprehensive understanding of the disease. Another NCI-DOD partnership is developing a quantitative tracking system for cancer patients undergoing therapy. The goal of the partnership is to allow real time assessment of treatment using sensors, patient reported outcomes, and mathematical modeling, and thereby

enable physicians to assess the impact of therapy and adjust treatment as necessary. Developing novel technologies is an example area that NCI plans to leverage with Cancer Moonshot resources.

The NCI National Clinical Trials Network (NCTN): A primary goal of NCI's cancer treatment trials is identifying the molecular alterations of each tumor type and the specific treatment that works best. This approach allows NCI to focus trials on patients whose tumors are most likely to respond to treatment, which results in smaller trials, and trials that may be completed more rapidly. However, many of the targeted molecular alterations arise infrequently, and may affect a small percent of patients with the disease. Therefore, it is necessary to test the tumors of many patients to identify those with a molecular alteration that can be targeted in the trial. Hence, such trials often require a large national trial network to identify the patients necessary to be successful.

NCTN, with more than 3,000 sites across the United States, is organized to conduct trials of this design. Examples of such trials include the Lung Cancer Master Protocol (Lung-MAP), Adjuvant Lung Cancer Enrichment Marker Identification and Sequencing Trials (ALCHEMIST), NCI-MATCH, and the ongoing, national studies of non-small cell lung cancer. Many NCTN trials yield results that change the practice of oncology in important ways.

Immunotherapy: Immunotherapy is a promising cancer treatment opportunity that focuses on activating the immune system to attack cancer cells. For example, immune therapy has been used to enhance a cancer patient's immune system to attack several types of adult cancers. NCI researchers have succeeded in re-directing a patient's own T cells to recognize and kill tumor cells. This approach has been used to successfully treat some leukemias and lymphomas and is now being applied to epithelial tumors. Several immunotoxins developed by NCI have induced remission in patients with late-stage cases of mesothelioma, ovarian, triple-negative breast cancer, and other cancers. These breakthroughs are revolutionizing our understanding about the prospects for immunotherapy, which are being further enhanced through the NCI Cancer Immunology Initiative.

NCI Experimental Therapeutics (NExT) Program: The NCI NExT program, a partnership between NCI's Division of Cancer Treatment and Diagnosis and the Center for Cancer Research, shortens the timeline for new drug development and advances breakthroughs into new cancer therapies. Headquartered at the Frederick National Laboratory for Cancer Research, the NExT program includes a collaborative network of 23 specialized and comprehensive screening and chemistry centers. These centers have world-class capabilities in structural biology, bioinformatics, medicinal chemistry, crystallography, high-throughput screening, and in vivo testing of new agents in cancer models. Using robotics, data processing and control software, and sensitive detectors, high-throughput screening allows researchers to rapidly conduct thousands of tests of promising therapeutic compounds. Through the NExT program, promising molecules such as the epigenetic modifying drug thiodeoxycytidine – which activates critical tumor suppressor genes – are being tested to treat both common solid cancers and tumors of the blood forming elements. The NExT Program is also investigating new therapies to treat drug-resistant lung cancers and rare tumors of childhood.

NCI Program Portrait: NCI Precision Oncology Initiative℠ Clinical Trials
FY 2017 = $55.0 million
FY 2018 = $55.0 million

Decades of investment by Congress in NCI research have significantly improved our understanding of cancer and opened the door to many new treatment options. Thanks to these investments, we now recognize that cancers are fundamentally diseases of the genome that we can precisely target with small molecules, antibodies, and other measures. These approaches to treating cancer form the basis of precision medicine in the field of oncology.

The funding increase approved by Congress in FY 2016 for the NCI Precision Oncology Initiative℠ program allowed NCI to significantly expand NCI MATCH (Molecular Analysis for Therapy Choice), a clinical trial that selects treatment based on the genetic abnormalities identified within the individual's cancer. NCI-MATCH initially planned to enroll 3,000 patients, but the additional funding from Congress allowed NCI to more than double the number of patients. Even before the NCI MATCH treatment results become available, the trial has exceeded expectations and has already achieved important goals:

- under NCI-MATCH, invasive biopsies of tumors are being performed with minimal risk
- close to 90% of tissues obtained from these biopsies can be successfully genotyped
- for nearly 25% of patients, the study identifies a drug matched to a mutation in the patient's tumor abnormality
- the trial will finish early, with clinicians from community practices enrolling about 50% of the patients.

NCI will soon launch a similar trial – known as Pediatric MATCH – for children with advanced cancer. Although similar in concept to NCI-Match for adults, many of the molecular targets in children's tumors differ from those that occur in adult tumors.

The FY 2016 funding increase also allowed NCI to supplement 53 ongoing extramural research grants to address six broad precision medicine priorities:

- overcoming drug resistance
- developing immune biomarkers to direct immunotherapy
- creating patient-derived xenograft mouse models to mimic human cancer
- using spontaneous canine tumors to guide development of human immunotherapies
- analyzing the pancreatic tumor microenvironment to identify immunotherapy targets
- developing a GMP grade product for clinical trials of adaptive cellular therapy for solid tumors.

The supplements that NCI funded in FY 2016 were a precursor to longer term and more in-depth research to address these priorities. With the additional resources that Congress provided, NCI is also supporting whole exome DNA analysis of thousands of patient specimens in the NCI-MATCH trial and analysis of specimens from other NCI-supported early therapeutics clinical trials. NCI is also conducting whole exome DNA analysis of specimens of patients receiving standard therapies where drug resistance may often develop. These efforts should provide clues for new drug targets and explain how tumors develop resistance to drugs. Although much work remains, the clinical trials and other initiatives supported with NCI Precision Oncology Initiative℠ resources show early signs of delivering the potential for prolonged and better, healthier lives for Americans with cancer.

Specialized Programs of Research Excellence (SPORE): The NCI SPORE program supports 54 multi-project grants across 22 states that contribute to developing new treatments for cancer patients. SPORE translational research projects develop important new interventions for clinical use, such as treatments for B-cell malignancies that are less damaging to the immune system. In one of these approaches, the patient's own T cells are engineered to carry an artificial chimeric antigen receptor. The receptor targets a type of antibody light chain expressed on malignant cells, but not on all normal B-cells. For treating soft tissue sarcomas, SPORE investigators developed a new combination therapy using two drugs, olaratumab and doxorubicin. In October 2016, FDA approved this combination therapy to treat soft tissue sarcomas.

Another example of a SPORE accomplishment is early detection of lung cancer in high-risk populations through the introduction of a simple, noninvasive, quantitative CyPath assay that reliably detects cancer cells in sputum. Within the SPORE program, immunotherapy projects have significantly increased following the promising efficacy initially found in melanoma. Now nearly every SPORE organ site portfolio has immunology projects including vaccines, checkpoint inhibitors, and T cell therapies, either alone or in combination with targeted therapies or chemo-radiation therapies. Individual SPOREs are also conducting follow up studies to investigate why some patients do not respond or become resistant to the immune therapies, potentially due to genetic, proteomic, or microbiome factors.

NCI Program Portrait: NCI Patient-Derived Models Repository
FY 2017 = $6.0 million
FY 2018 = $6.0 million

NCI is establishing a national repository of Patient-Derived Models (PDMs) to advance the NCI Precision Oncology Initiative[SM] program that Congress funded in FY 2016. This unique resource will support many important research opportunities, including cancer drug discovery. NCI anticipates that the PDM repository will serve as a valuable resource for extramural researchers by facilitating efficient pre-clinical testing of oncology drugs in a wide range of tumor subgroups.

NCI's goal is to achieve a repository of more than 1,000 patient-derived models derived from tissues and blood obtained from three NCI programs: NCI-designated Cancer Centers, the NCI National Clinical Trials Network, and the NCI Experimental Therapeutics Clinical Trials Network.

Although the repository will be comprehensive, NCI is giving special focus to tumor types that are not widely available within current repositories. These include small cell lung, pancreatic, prostate, head & neck, ovarian, kidney, and bladder cancers, as well as sarcomas and melanomas. The goal is to achieve a repository of at least 50 unique patient models per cancer type to ensure that the repository adequately supports drug validation and efficacy studies.

Perhaps the most exciting feature of the PDM repository will be the extent of the clinical annotation of specimens that enter the repository. NCI will make detailed molecular information for each sample available through a database that extramural researchers can easily access. This molecular information will make the PDM repository an exceptionally powerful tool for cancer research and discovery. The PDM repository would not have been possible without support from Congress, including statutory changes that allow NIH institutes to make these substances available in the most efficient manner possible to the broad community of extramural researchers across the United States and abroad.

V. Improving Cancer Prevention and Control: Cancer prevention research focuses on actions that individuals can take to lower their risk of getting cancer. Such actions include maintaining a healthy lifestyle, avoiding exposure to known cancer-causing substances, and taking medicines or vaccines that can prevent cancer from developing. Prevention measures should ideally be tailored to an individual's underlying risk of developing cancer.

Cancer prevention draws on knowledge of the mechanisms and causes of cancer. Prevention also relies on population-based surveys to obtain epidemiological information, such as the incidence of specific types of cancers and factors that may cause a specific cancer. Through education, behavior modification, vaccination or preventive medications, and policies that limit exposures to known carcinogens, it is estimated that the overall risk of cancer can be reduced by one-third to one-half.

Cancer control science relies on basic and applied research in behavioral, social, and population sciences to enhance interventions that reduce cancer risk, incidence, morbidity and mortality, and

improve quality of life. Cancer control seeks to understand the causes and distribution of cancer throughout the population, identify and implement effective healthcare practices to reduce cancer incidence, and monitor and explain cancer trends and health disparities in the population. Cancer control research aims to generate basic knowledge about how to monitor and change individual and collective behavior, and translate that knowledge into practice.

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.

Human Papillomavirus (HPV) Vaccine One-Dose Trial: The NCI Costa Rica Vaccine Trial (CVT) showed similar high levels of vaccine efficacy over a four-year period among women who received one, two, and three doses of the HPV16/18 vaccine. Even the women who received only one dose retained stable levels of HPV antibodies in their blood serum. However, because vaccine recipients in this trial were not randomized to receive these fewer doses, a study of the minimum number of doses needed to confer durable protection could provide seminal evidence to justify changing the current vaccine recommendation from two doses to one dose for adolescents. To address this question, NCI is initiating a trial in Costa Rica to formally compare one- versus two-dose vaccination, and to estimate the public health benefit of one- and two-dose schedules. If effective, a single-dose vaccine could increase coverage in the U.S. and abroad, thereby improving HPV-related cancer prevention. While we proceed with this trial, NCI is also working to standardize and harmonize serological assays for HPV antibody testing, which will simplify the logistics and reduce the cost of trials of biosimilar HPV vaccines. This research project is an example of an area that NCI plans to leverage with Cancer Moonshot resources.

Preventive Vaccines for Cancers Not Associated with Infection: Developing preventive vaccines against infection by hepatitis B to prevent liver cancer and vaccines against HPV to prevent cervical cancer and other HPV-associated cancers are noteworthy achievements in cancer prevention. Developing vaccines for cancers not associated with microbial infection represent the next frontier in immuno-prevention.

The NCI PREVENT Cancer Preclinical Drug Development Program is expanding its support for a range of immuno-prevention opportunities. A preclinical model of Lynch syndrome – a genetic predisposition to developing colorectal and other cancers – is being used to optimize development of a vaccine to address the recurrent mutations that characterize Lynch syndrome cancers. Other targets for vaccines include tumor-associated antigens, such as mesothelin and telomerase, as well as neo-antigens, such as fusion proteins and frame-shift mutations.

NCI is also supporting development of a prostate-specific antigen-based vaccine to slow progression of prostate cancer. Known as Prostvac, this test vaccine has been shown to increase overall survival in a preliminary phase II trial in metastatic prostate cancer. A confirmatory randomized control trial in patients with advanced prostate cancer is ongoing.

Community Participation in Clinical Trials: The opportunity for individuals to join research studies in their local community permits them to stay close to family, local physicians, and support systems. The NCI Community Oncology Research Program (NCORP) supports community-based

research that integrates cancer care delivery into clinical trials. More than 800 hospitals and physician practices enroll patients into NCI clinical trials through NCORP. The result is a more comprehensive approach to improving the quality of care. As advanced technologies in genomics and molecular science influence how clinical trials are designed, the success of these trials depends on the delivery of care by health organizations, providers, and patients. However, geographical access gaps persist. To address this gap, NCORP is working to include clinical practices in rural communities and other areas of geographic need within existing NCI community-based research programs. Providing access to NCI-supported clinical studies in this way will generate a broadly applicable evidence base that may reduce cancer disparities, while improving patient outcomes.

VI. Cancer Centers: The NCI Cancer Centers program is a key component of the nation's cancer research efforts. Together with their community partners, the 69 NCI-designated Cancer Centers, located in 35 states and the District of Columbia form the backbone of NCI's extramural programs for studying and controlling cancer.

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, diagnose, 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 basic and applied research, the cancer centers deliver quality cancer care to patients and their families, which include communities with underserved and understudied populations. In addition to the 69 NCI-designated cancer centers, NCI supports research at 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.

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 supporting a well-defined career path to research independence for scientists. During FY 2016, NCI funded the first round of a new mechanism, the F99/K00, which supports the transition from graduate research to postdoctoral training. The new mechanism is designed to

position awardees to be competitive for a second NCI transition mechanism to support independence, the K99/R00, which facilitates the transition from postdoctoral training to serving as a tenure track investigator. The combination of these two mechanisms will provide awardees with the resources and a meaningful pathway to smoothly make these difficult transitions.

NCI will also merge two other career development mechanisms, the K08 and K23, to allow more physician scientists to compete for support based on their best scientific ideas. This approach will avoid creating an artificial boundary that forces applicants into specific research disciplines.

Finally, NCI will increase the level of financial support available per award through the K08 mechanism to the maximum salary allowed for principal investigators. These changes should increase the number and quality of applicants by physician-scientists pursuing cancer research.

NCI is committed to enhancing diversity within the cancer research workforce. To support this objective, the NCI Center for Cancer Training has developed training opportunities to diversify the Intramural Research Program by supporting career development, and recruiting and retaining a diverse pool of candidates for intramural research programs. In addition, the NCI Center to Reduce Cancer Health Disparities (CRCHD) coordinates diversity training at NCI. Examples of CRCHD programs include –

Partnerships to Advance Cancer Health Equity (PACHE): The PACHE program aims to increase workforce diversity and address cancer health disparities in underserved populations, a major public health concern in the United States and globally. To advance these goals, PACHE creates stable, comprehensive, long-term partnerships between institutions serving underserved populations and NCI-designated cancer centers to develop cancer programs and build capacity in cancer research, education, and outreach. In FY 2016, PACHE supported 24 partnerships, funded 58 research projects – 23 of which focused on cancer health disparities – and published 262 peer review publications. Furthermore, PACHE supported the training of 76 underrepresented early stage investigators. Next steps are to strengthen the program's growth and sustainability through increased research, training and education, and outreach while augmenting workforce diversity and reducing cancer disparities in underserved populations.

Continuing Umbrella of Research Experiences (CURE): The CURE program increases biomedical workforce diversity by training underrepresented individuals for independent cancer research careers. It uses a holistic approach beginning with middle school students, continuing through students in health professional and graduate schools to early stage investigators. CURE includes individualized program navigation, professional development workshops and mock peer review of grants, and has been successful in increasing the participation of underrepresented individuals in cancer and cancer health disparities research. In FY 2016, CURE supported 428 new students and investigators.

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

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 it can continue to perform world-class research to support the NCI national cancer mission.

Funding for this account allows NCI to operate the FNLCR laboratories and campus as modern research facilities and to repair core infrastructure that is essential to the NCI-Frederick research campus. With these funds, NCI will commence the repairs and improvements necessary to maintain or upgrade laboratories and related facilities.

NATIONAL INSTITUTES OF HEALTH
National Cancer Institute

Detail of Full-Time Equivalent Employment (FTE)

OFFICE/DIVISION	FY 2016 Final			FY 2017 Annualized CR			FY 2018 President's Budget		
	Civilian	Military	Total	Civilian	Military	Total	Civilian	Military	Total
Center for Cancer Research									
Direct:	1,344	16	1,360	1,348	14	1,362	1,348	14	1,362
Reimbursable:	1	-	1	1	-	1	1	-	1
Total:	1,345	16	1,361	1,349	14	1,363	1,349	14	1,363
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:	162	3	165	167	3	170	167	3	170
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	162	3	165	167	3	170	167	3	170
Division of Cancer Epidemiology and Genetics									
Direct:	156	3	159	165	3	168	165	3	168
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	156	3	159	165	3	168	165	3	168
Division of Cancer Prevention									
Direct:	96	1	97	100	2	102	100	2	102
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	96	1	97	100	2	102	100	2	102
Division of Cancer Treatment and Diagnosis									
Direct:	220	3	223	224	4	228	224	4	228
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	220	3	223	224	4	228	224	4	228
Division of Extramural Activities									
Direct:	103	-	103	106	-	106	106	-	106
Reimbursable:	-	-	-	-	-	-	-	-	-
Total:	103	-	103	106	-	106	106	-	106
Office of the Director									
Direct:	827	3	830	852	4	856	852	4	856
Reimbursable:	2		2	2		2	2		2
Total:	829	3	832	854	4	858	854	4	858
Total	2,962	29	2,991	3,017	30	3,047	3,017	30	3,047
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**								
2014	12.1								
2015	12.3								
2016	12.4								
2017	12.5								
2018	12.5								

NATIONAL INSTITUTES OF HEALTH
National Cancer Institute

Detail of Positions[1]

GRADE	FY 2016 Final	FY 2017 Annualized CR	FY 2018 President's Budget
Total, ES Positions	1	3	3
Total, ES Salary	185,100	565,851	576,885
GM/GS-15	280	290	290
GM/GS-14	489	518	518
GM/GS-13	456	492	492
GS-12	468	491	491
GS-11	181	182	182
GS-10	12	12	12
GS-9	128	131	131
GS-8	74	74	74
GS-7	54	60	60
GS-6	19	20	20
GS-5	8	8	8
GS-4	7	9	9
GS-3	4	2	2
GS-2	2	3	3
GS-1	2	2	2
Subtotal	2,184	2,294	2,294
Grades established by Act of July 1, 1944 (42 U.S.C. 207)	0	0	0
Assistant Surgeon General	0	0	0
Director Grade	14	15	15
Senior Grade	6	6	6
Full Grade	6	6	6
Senior Assistant Grade	3	3	3
Assistant Grade	0	0	0
Subtotal	29	30	30
Ungraded	838	928	928
Total permanent positions	2,026	2,168	2,168
Total positions, end of year	3,051	3,252	3,252
Total full-time equivalent (FTE) employment, end of year	2,991	3,047	3,047
Average ES salary	185,100	188,617	192,295
Average GM/GS grade	12.4	12.5	12.5
Average GM/GS salary	105,639	107,435	109,745

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