

# NIH Peer Review and How the Stars of U.S. Science and Health Are Born

Richard Nakamura, Ph.D.

CSR Director

Don Luckett

CSR Communications Director

# NIH . . . Turning Discovery Into Health

NIH's mission is to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.

NIH receives over 80,000 grant applications a year, but it can only fund a fraction of them. NIH peer reviews help NIH find the best, and taxpayer support allows NIH to fund many of them. These grants build the foundation for future advances in science and health.

#### **How Does NIH Find the Stars of Science?**

For 70 years, NIH has recruited groups of external scientific experts to help it evaluate grant applications from scientists across the country and abroad.





These peer review groups were designed by NIH and Congress to help ensure applications receive, fair, independent, expert and timely reviews—free from inappropriate influences—so NIH can invest in research that will one day lead to new ways to treat and prevent illnesses that ravage lives here and abroad. This is CSR's mission.

# The NIH Center for Scientific Review Evaluates the Majority of NIH Grant Applications

#### The Center for Scientific Review:

- Receives all NIH grant applications
- Reviews 75% of them while the other NIH Institutes and Centers review the rest
- Recruits 17,000 reviewers a year
- Holds 1,500 review meetings a year

Cost of review is less than 1% of awards because reviewers donate 20-60 hours to write their critiques and only receive a \$200 honorarium to discuss them at their meetings.

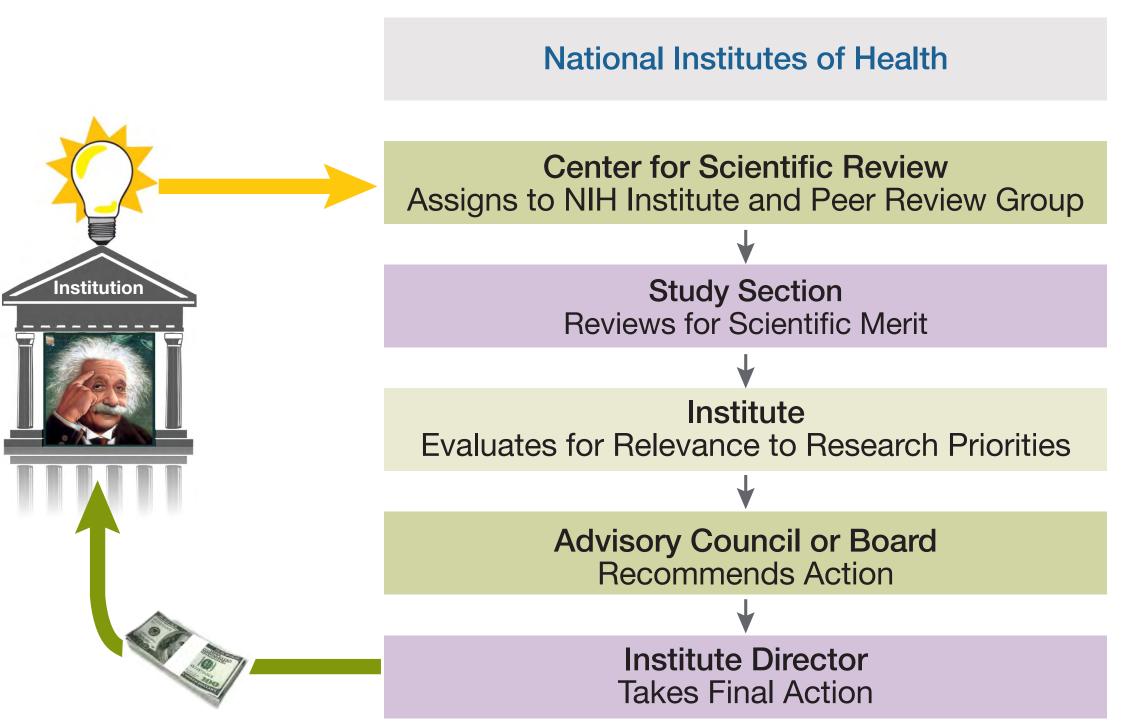
## **How NIH Peer Review Works**

NIH has a two-stage review process powered by the input of multiple external experts and other stakeholders.

Stage One: Evaluation for Scientific Merit by external scientific experts from academia and industry.

Stage Two: Evaluation for Relevance to Research Priorities by the relevant NIH Institute or Center, which consults more senior scientific experts, patients and patient advocates on its Advisory Council.

# Peer Review and Funding of NIH Grant Applications



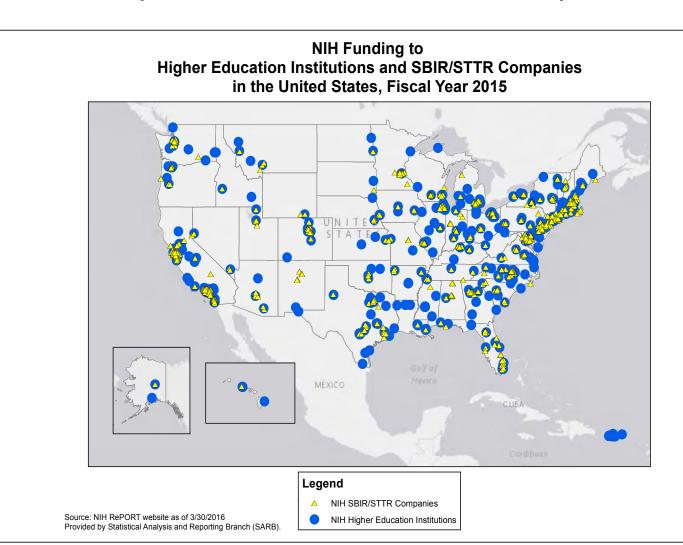
#### **Who Sets NIH Priorities?**

NIH Institutes set their priorities based on input from the scientific community and Congress, as well as industry, public and patient representatives.

#### **How NIH Peer-Reviewed Research Pays Off**

#### **Economic Benefits**

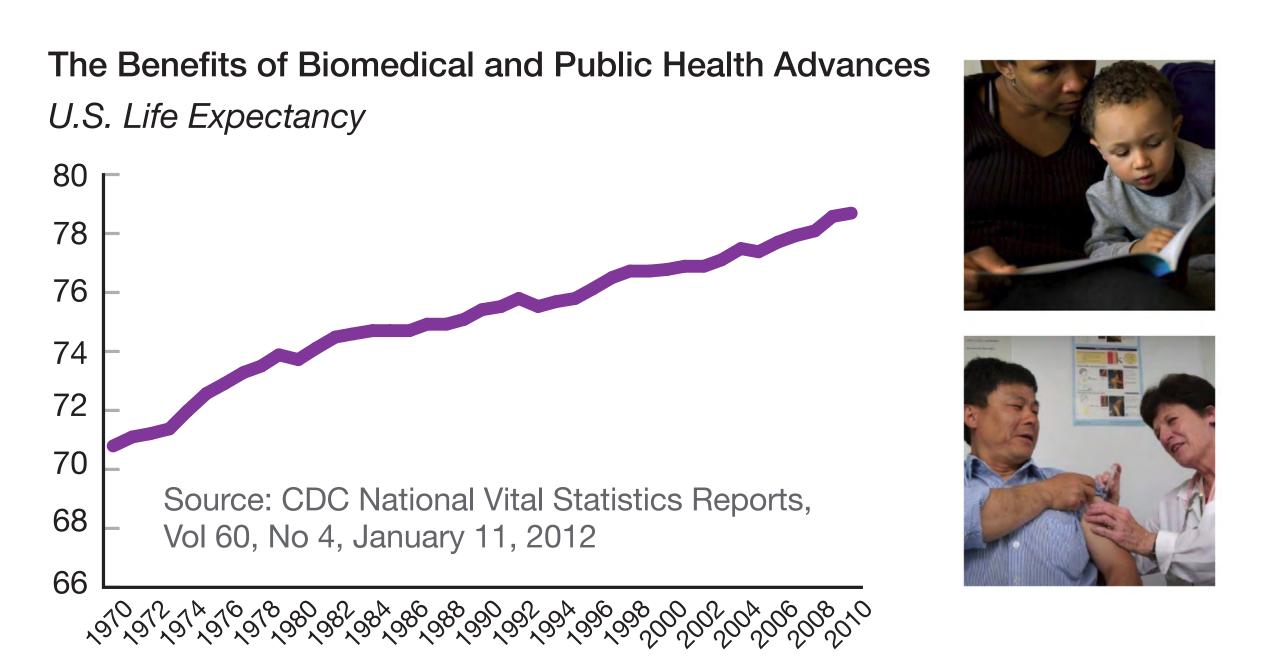
NIH Supports 443 Higher Education Institutions across the U.S. and many of them help foster the development of local biotech companies. NIH funds over 1,000 of these companies.



United for Medical Research reported that NIH extramural funding **generated \$57.8 billion in economic output** nationwide in 2012<sup>1</sup> — A \$1.00 increase in public basic research stimulates an additional \$8.38 of industry R&D investment after 8 years, and a \$1.00 increase in public clinical research stimulates an additional \$2.35 of industry R&D investment after 3 years.<sup>2</sup>

Research-related gains in average life expectancy from 1970 to 2000 have an economic value estimated at \$95 trillion post-1970, or about \$3.2 trillion per year.

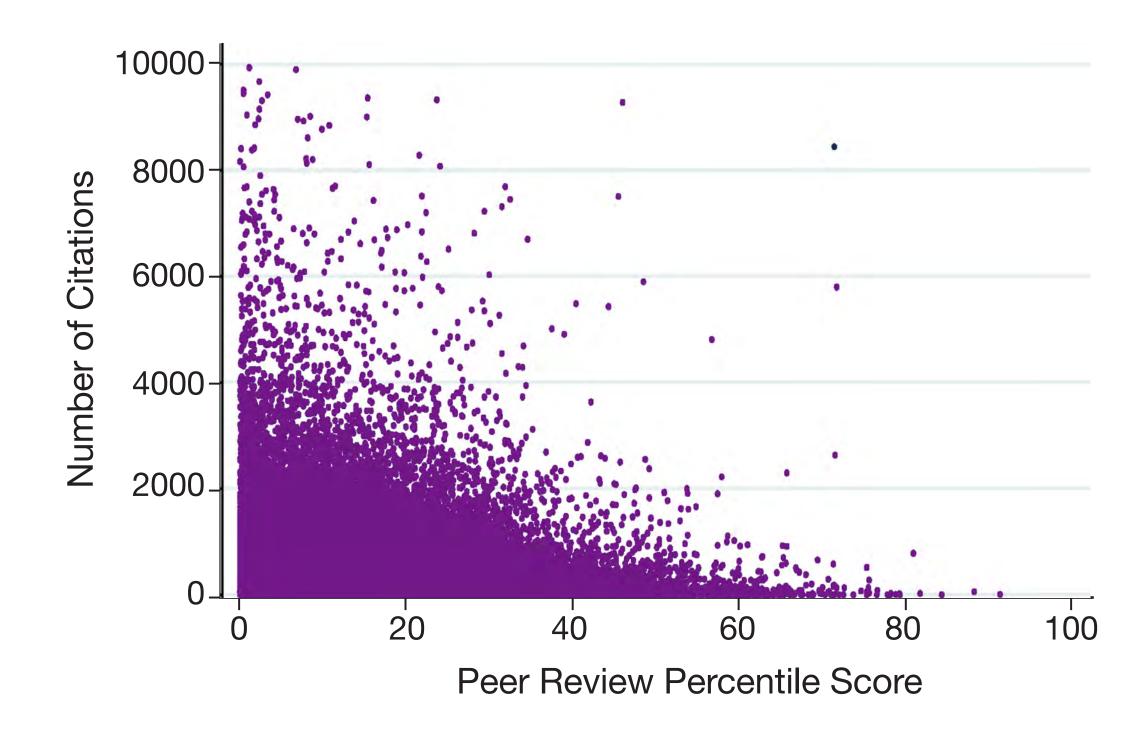
#### **Scientific and Health Advances**



NIH peer-reviewed research has advanced fundamental, cutting-edge advances in science and health that has allowed millions to leave their doctor's office with new drugs, cures and preventions for diseases that afflicted their parents or grandparents.

- 1.35 million deaths are prevented each year due to NIH research advances in treating or preventing cardiovascular disease, stroke, cancer and diabetes<sup>4</sup>
- Nearly 80% of the Nobel Prizes in Physiology/Medicine were awarded to or shared by NIH scientists since 1964<sup>5</sup>

# NIH Peer Review Scores Correlated with Better Research Outcomes



Researchers from Harvard and Boston Universities recently reported in Science magazine<sup>6</sup> that better peer review scores were consistently associated with better research outcomes, after examining over 130,000 NIH grants awarded between 1980 and 2008.

Reviewers appear to be able to make fairly fine distinctions that cannot otherwise be explained by the investigator's publication history, grant history, institutional affiliations, career stage, and degree types.

A one-standard deviation better score was associated with 15% more citations, 7% more publications, 19% more high-impact publications, and 14% more follow-on patents.

#### Taking Risks and Discovering Great Possibilities

Scientific and health breakthroughs are heralded in the press almost every day. And you often can trace them back—directly or indirectly—to one or thousands of NIH peer review groups that found great promise in an application.

Importance of Taking Risks: As with small businesses and even large corporations, researchers and NIH need to take risks to advance science and health. Allowing ideas to compete and sometime fail can be messy at times, BUT it is essential to a robust and dynamic research enterprise.

#### Placing a Bet on the Lowly Flatworm Transforms Regeneration Research



The only individuals studying flatworms in 1997 were kids who watched them regenerate themselves from tissue bits in biology class. This was the year a new investigator, Dr. Sánchez Alvarado, at Stowers Institute in Kansas City, Missouri, sent NIH a bold application to develop the molecular and genetic tools to study regeneration in flatworms. Reviewers saw the promise and NIH funded his research, which has reinvigorated the field of regeneration research.

#### Microscopy Breakthrough Found in Diapers



NIH Pioneer Award Winner Dr. Ed Boyden at MIT was frustrated by the limits of light microscopes. They cannot bring key molecular structures into focus without losing track of the larger cellular context. He turned to a polymer gel used to retain water in diapers. He tagged proteins he wanted to study with fluorescent antibodies that bind to the proteins and the polymer gel. When it expanded in water, Dr. Boyden was able to see the detail he couldn't see before. Expansion microscopy

holds the promise of helping him and other researchers learn more about the abnormal biochemistry of disease and come up with new targets for drug design.

## **Geneticist Advances Autism and Schizophrenia Research**



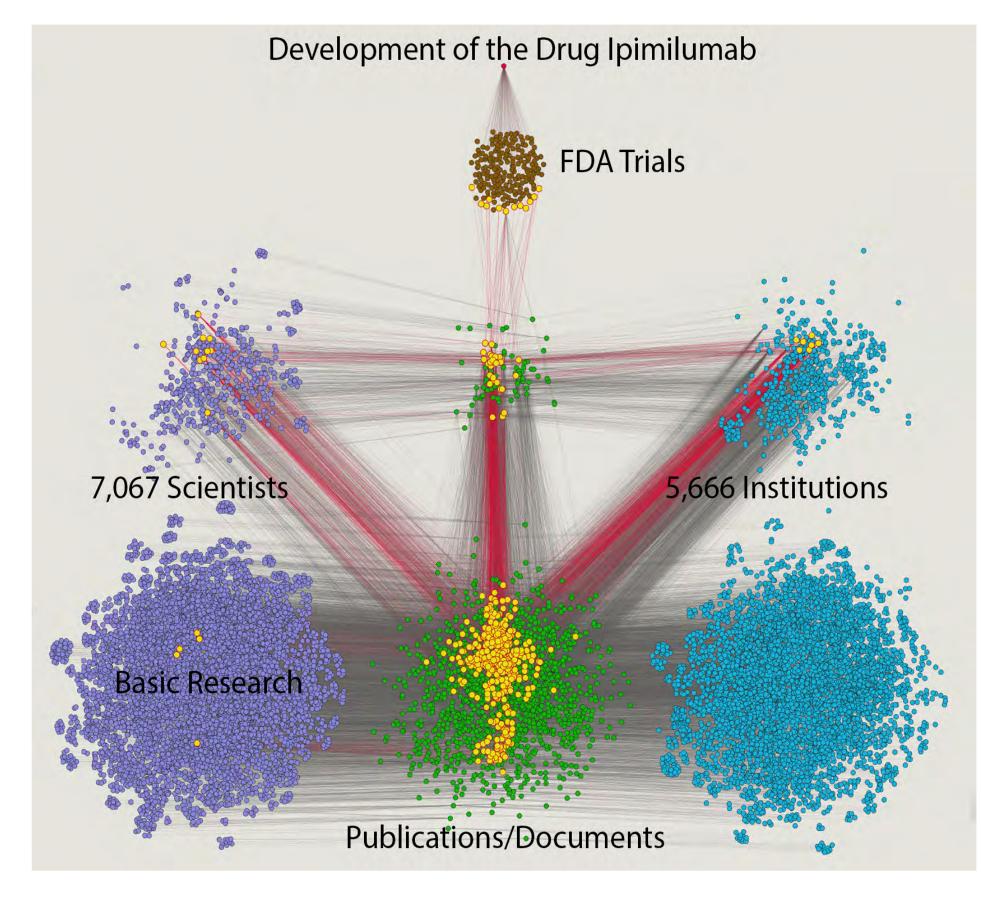
View the Full Power

of Peer Review

**Stories and More** 

Dr. Mary-Claire King is famous for identifying a gene associated with breast cancer, but she raised eyebrows when she proposed to venture into a field new to her with an unconventional idea. She proposed that some cases of autism and schizophrenia could be caused by severe genetic mutations that arise in every generation. Reviewers and NIH were impressed with her research plan and team, and she received a grant. She has since proved her hypothesis and opened up a promising line of research.

# **Big Advances Are Built on Lots of Unheralded NIH Reviews and Grants**



Blockbuster drugs were shown to be built on the efforts of large numbers of scientists by researchers using new analytic tools at the Gladstone Institutes in San Francisco.<sup>7</sup>

70% of major drugs
were developed or
made possible by
NIH-funded research:
2000 congressional report:
The Benefits of Medical
Research and the Role
of the NIH.8

Image caption: R.S. Williams et al. at the Gladstone Institutes show the development of the drug Ipimilumab — the first immuno-therapy that induces sustained clinical remissions in patients with previously intractable cancers.

#### The Bottom Lines

#### **NIH Does What Industry Cannot**

NIH plays a dominant role in supporting basic biomedical and behavioral research in the U.S. that lays the ground work for transformative research — like precision medicine — which will lead to new cures and preventions. Industry does not fund most basic research because they are unwilling to wait 20-30 years for it to pay off. So public investments are crucial for the U.S. to maintain its lead in science and health research.



See How Real Reviewers Work! www.csr.nih.gov/video/video.asp



## NIH Peer Review Works for the U.S.

NIH peer review may not be perfect, and NIH continues to look for ways to improve it. But peer review remains a very viable way to help the U.S. make the public investments it needs to empower researchers across the country to advance U.S. science, health and economic growth.

#### **Learn More**

## www.csr.nih.gov

#### References

<sup>1</sup>The Impact of a Sequester on the National Institutes of Health and Implications for Jobs and the U.S. Economy, Everett Ehrlich, United for Medical Research, 2013. http://www.unitedformedicalresearch.com/wpcontent/uploads/2013/02/UMR\_Impact\_of\_Sequestration\_2013.pdf.

<sup>2</sup>Does Public Scientific Research Complement Private Investment in Research and Development in the Pharmaceutical Industry? Andrew A. Toole. (2007) Journal of Law and Economics, vol. 50.

http://www.ucema.edu.ar/u/je49/capital\_humano/Murphy\_Topel\_JPE.pdf.

<sup>3</sup>The Value of Health and Longevity, Kevin M Murphy and Robert H Topel, U. Chicago and NBER, 2006:

<sup>4</sup>NIH funding trajectories and their correlations with US health dynamics from 1950 to 2004, Kenneth G. Manton, et al., PNAS 2009 106 (27) 10981-10986, published ahead of print June 22, 2009.

<sup>5</sup>The NIH Almanac, 2014, Nobel Laureates Web page: http://www.nih.gov/about/almanac/nobel/

<sup>6</sup>Big names or big ideas: Do peer-review panels select the best science proposals? Danielle Li and Leila Agha, Science 24 April 2015: 348 (6233), 434-438.

<sup>7</sup>From Scientific Discovery to Cures: Bright Stars within a Galaxy, R.S. Williams, S. Lotia, A.K. Holloway, A.R. Pico, Cell, Volume 163, Issue 1, Pages 21-23.

<sup>8</sup>The Benefits of Medical Research and the Role of the NIH, Report from the Joint Economic Committee, Senator Connie Mack, Chair, May 2000, p. i: http://www.faseb.org/portals/2/pdfs/opa/2008/nih\_research\_benefits.pdf.