By Stuart Anderson

Immigrant Scientists Invaluable to the United States

EVERY YEAR when the Nobel Prizes are announced, out of curiosity, I check to see if any immigrants to the United States won a prize in science. The 2014 Nobel Prize awards followed a now predictable pattern: University of California-Santa Barbara Professor Shuji Nakamura, who was born in Japan, shared the prize in physics for the invention of efficient blue light-emitting diodes, which help improve energy efficiency.

Many immigrant scientists come to the United States as international students or university professors and influence their fields in profound ways. The stories and numbers behind immigrant scientists can be documented historically across a range of fields and up to the present day. But these contributions would have been impossible without important changes to U.S. immigration law.

Immigration Policy

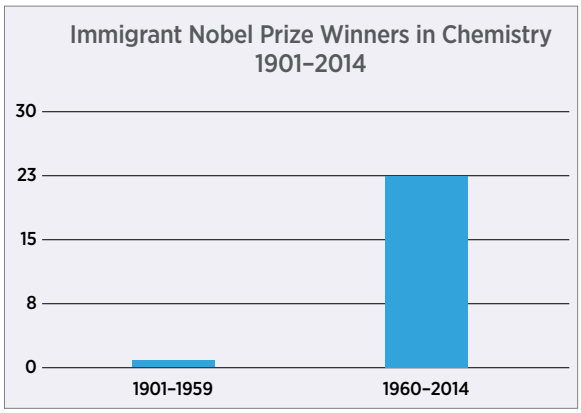
From the founding of the nation until 1921, no numerical restrictions existed to limit immigration to the United States. In 1921, Congress passed "national origins" legislation that, through the use of restrictive country quotas, aimed to stop the immigration of Jews, Italians, and other European immigrants not of Anglo-Saxon or Nordic descent. In 1924 those restrictions increased and became permanent. This followed the Immigration Act of 1917, which established, among other things, an "Asiatic Barred Zone" to prevent the immigration of Asians to the United States, expanding the scope of The Chinese Exclusion Act of 1882.

Although in 1943 Congress repealed the Chinese Exclusion Act and in 1952 changed the Asiatic Barred Zone, it was not until the passage of the Immigration and Nationality Act of 1965 that immigration was open potentially to anyone in the world without regard to national origin. In addition, the increase in quotas in 1965 and in 1990, which raised family and employment-based green card quotas, opened the door wide to Asian immigrants, particularly those who came to the United States as international students. These changes in the law were key factors in enhancing the ability of the United States to assimilate talented individuals from around the world into our culture and economy.

Nobel Prizes

The Nobel Prize, the most prestigious award in science, began in 1901 and has been given annually by the Royal Swedish Academy of Sciences. Research I conducted on Nobel Prize winners illustrates how the impact of immigrant scientists has increased dramatically over the past half century, corresponding with the changes in U.S. immigration law.[1] A good example is in the field of chemistry. Between 1901 and 1959, only one immigrant to the United States (William Francis Giauque) won the Nobel Prize in Chemistry. But over approximately the same number of years between 1960 and 2014, 23 immigrants won the Nobel Prize in Chemistry.[2] (See Figure 1.)

Figure 1



Source: Royal Swedish Academy of Sciences, National Foundation for American Policy, George Mason University Institute for Immigration Research.

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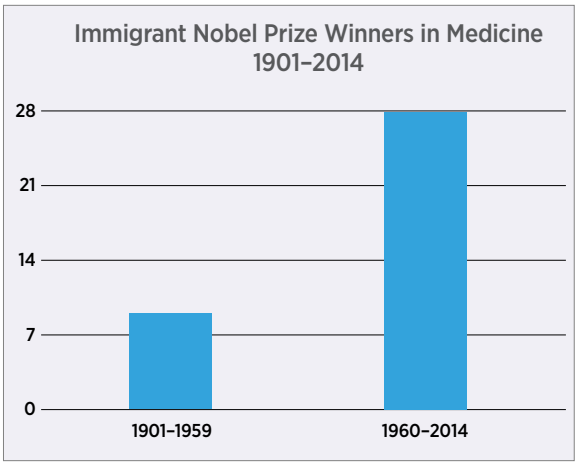
In 2013 all three winners of the Nobel Prize in Chemistry were immigrants to the United States. Michael Levitt, a professor at the Stanford University School of Medicine, was born in South Africa. Martin Karplus, who was born in Austria, is a professor at Harvard University. And Israeli-born Arieh Warshel teaches at the University of Southern California, in Los Angeles.

The Royal Swedish Academy of Sciences awarded the Nobel Prize to the three men for laying "the foundation for the powerful [computer] programs that are used to understand and predict chemical processes. Computer models mirroring real life have become crucial for most advances made in chemistry today."[3]

The Nobel Prize in Medicine has also seen a trend of increasing immigrant contributions. From 1901 to 1959, nine immigrants to the United States won the Nobel Prize in Medicine. But from 1960 to 2014, 28 immigrants were awarded the Nobel Prize in Medicine.[4]

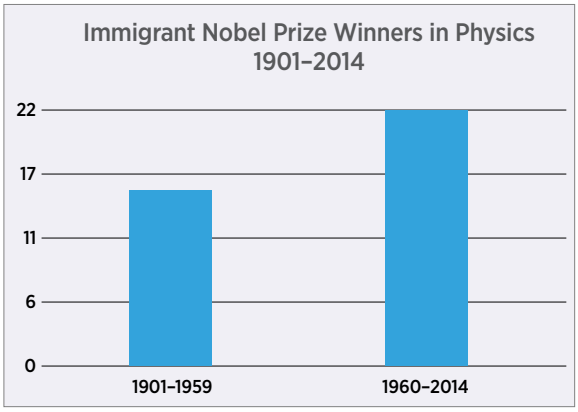
Figure 2



Source: Royal Swedish Academy of Sciences, National Foundation for American Policy, George Mason University Institute for Immigration Research.

In physics, 15 immigrants won the Nobel Prize from 1901 to 1959, while 22 immigrants won the Nobel Prize in Physics between 1960 and 2014. The prevalence of so many immigrant winners of the Nobel Prize in Physics prior to 1959 owes not to generous U.S. immigration policies, which were restrictive during that time period, but to the rise of fascism in Europe. Government policies that institutionalized anti-Semitism and persecution, such as laws banning Jews from holding certain jobs, restricting admission to university and confiscating property drove many outstanding Jewish scientists out of Germany and other countries. One of the few ways around restrictive U.S. immigration rules prior to World War II was to receive a job offer from a U.S. university. That "loophole" is how the United States gained the contributions of notable scientists such as Enrico Fermi and ultimately led to the success of the Manhattan Project, the race to build the first atomic bomb.

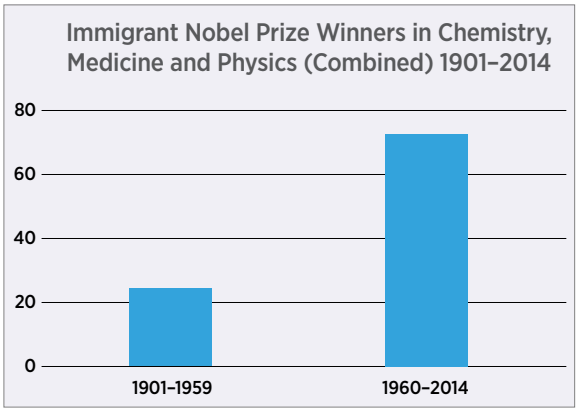
Figure 3



Source: Royal Swedish Academy of Sciences, National Foundation for American Policy, George Mason University Institute for Immigration Research.

If one combines the Nobel Prizes awarded in the three science categories, then it is possible to see the division on immigrant contributions before and after 1960. Over approximately the same length of time, immigrants have won three times as many Nobel Prizes in Chemistry, Medicine, and Physics since 1960 as they won prior to 1960. (Immigrants won 73 Chemistry, Medicine, and Physics awards between 1960 and 2014, compared with 25 between 1901 and 1959.)

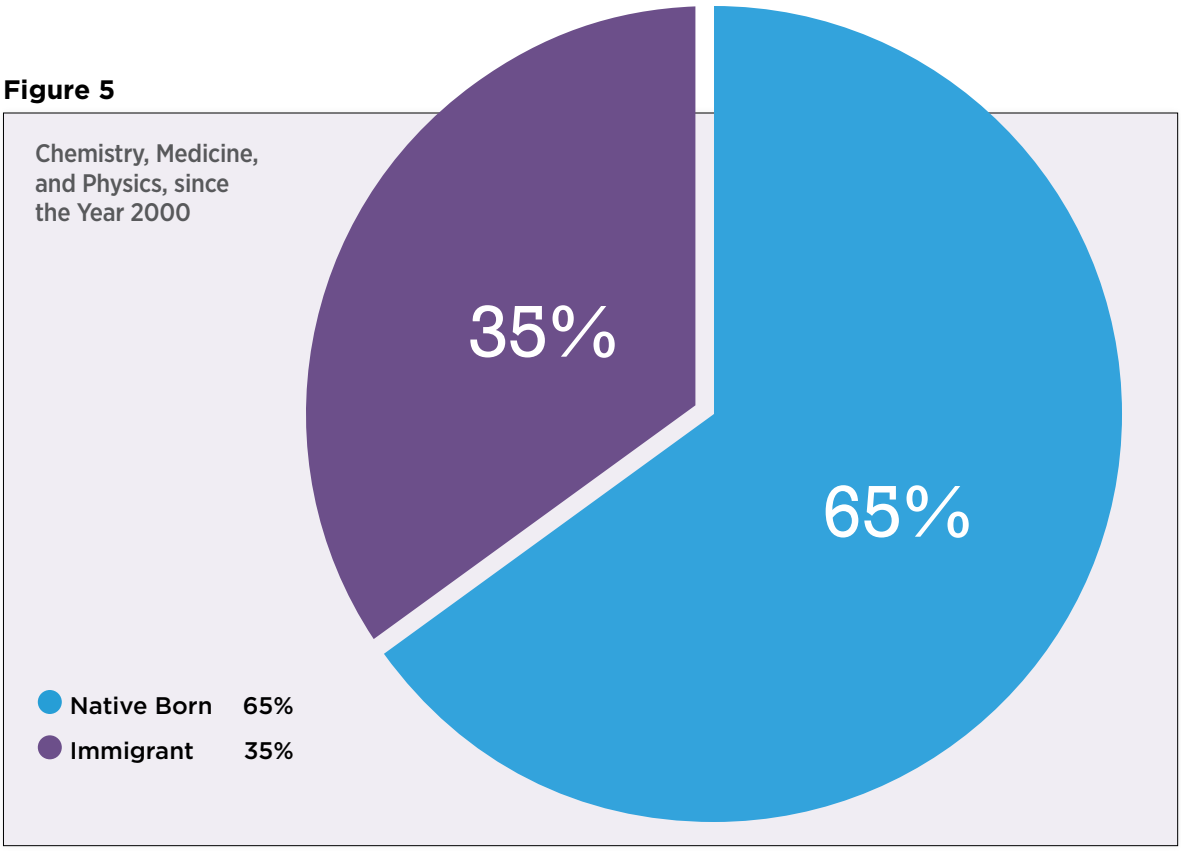
Figure 4



Source: Royal Swedish Academy of Sciences, National Foundation for American Policy, George Mason University Institute for Immigration Research.

Another way to look at the data is to examine the percentage of immigrants among U.S. Nobel Prize recipients in science fields since the year 2000. Out of the 72 Nobel Prizes won by U.S. citizens in Chemistry, Medicine, and Physics since 2000, 25 (35 percent) have been awarded to immigrants. (See Figure 5.)

Figure 5



Source: Royal Swedish Academy of Sciences, National Foundation for American Policy, George Mason University Institute for Immigration Research.

Cancer Researchers

If there is one group of immigrants most Americans would likely welcome above all others it is cancer researchers. To focus in-depth on a specific area of scientific contribution by immigrants, I examined the biographies of approximately 1,500 cancer researchers at the top seven cancer research centers in the United States (measured by grants from the National Cancer Institute). The research showed that 42 percent of the researchers at the top seven cancer research centers are foreign-born, a remarkable figure considering only 13 percent of the U.S. population is foreign-born.[5]

The influence of foreign-born researchers is quite large at some of the leading cancer institutions in the United States. At the University of Texas MD Anderson Cancer Center, 62 percent of the cancer researchers are immigrants. At Memorial Sloan-Kettering Cancer Center in New York, 56 percent of the researchers are foreign-born.[6]

Many of the researchers come from countries that would have been effectively barred from immigration to the United States prior to the repeal of the national origins quotas and elimination of the Asiatic Barred Zone. Twenty-one percent of the cancer researchers at the top seven cancer research institutes were born in China, while

TABLE 1

Immigrant Researchers at America's Top Cancer Centers

Cancer Research Center	Percentage of Cancer Researchers Who Are Foreign-Born
University of Texas MD Anderson Cancer Center	62 percent
Memorial Sloan-Kettering Cancer Center	56 percent
Fox Chase Cancer Center	44 percent
Johns Hopkins Sidney Kimmel Comprehensive Cancer Center	35 percent
Dana-Farber Cancer Institute	33 percent
UCSF Helen Diller Family Comprehensive Cancer Center	32 percent
Fred Hutchinson Cancer Research Center	30 percent

Source: National Foundation for American Policy, cancer center websites, direct contact with individual researchers and cancer center staff. Analysis of approximately 1,500 biographies of cancer researchers on staff at the 7 comprehensive cancer centers that received the highest amount of P30 grants from the National Cancer Institute in 2010.

another 10 percent were born in India. Cancer researchers in the United States today come from more than 50 countries, including Taiwan and South Korea.[7]

Four immigrant cancer researchers have won the Nobel Prize: Elizabeth Blackburn (2009), born in Australia, Baruj Benacerraf (1980), born in Italy, and Carl and Gerty Cori (1947), husband and wife researchers born in Austria-Hungary.

Elizabeth Blackburn shared the 2009 Nobel Prize in Medicine with Jack Szostak (Harvard Medical School), a British-born immigrant to the United States, and U.S.-born Carol Greider (Johns Hopkins University School of Medicine). Greider was Elizabeth Blackburn's student in 1985 when they "published a paper announcing the discovery of the enzyme telomerase."[8] Since the enzyme serves an important function in the health of cells, the discovery has helped launch research into cancer, cardiovascular disease, and other age-related illnesses.[9]

Rainer Storb, MD, head of the Transplantation Biology Program and one of the founders of the Fred Hutchinson Cancer Research Center, was born in Germany and came to Seattle in the 1960s on a Fulbright Fellowship. He became a U.S. citizen and helped create Seattle's marrow transplantation program.[10] According to ScienceWatch, Storb has been the 10th most cited physician-scientist and the 43rd most cited scientist overall worldwide, including the second most-quoted researcher in the field of oncology.[11]

Contemporary contributions by immigrant cancer researchers are part of a story that has lasted for more than a century. (See Table 2.) George H.A. Clowes, born in the United Kingdom, introduced the first chemotherapy treatment, while Leo Loeb, born in Germany, helped establish that mammary cancer was hereditary. In 1907 immigrants Loeb and Clowes were two of the 11 founding members of the American Association for Cancer Research.[12]

When Baruj Benacerraf came to the United States after his family left France in

TABLE 2

Notable Immigrant Cancer Researchers: Past and Present

Immigrant	Place of Birth	Contribution to Cancer Research and Medicine
Baruj Benacerraf	Venezuela	Earned Nobel Prize (1980) for "discoveries concerning genetically determined structures on the cell surface that regulate immunological reactions" and led Sidney Farber Institute
Elizabeth Blackburn	Australia	Earned Nobel Prize in Physiology or Medicine (2009) "for the discovery of how chromosomes are protected by telomeres and the enzyme telomerase"
George H.A. Clowes	United Kingdom	Introduced first chemotherapy, an original founder of American Association for Cancer Research
Carl Cori	Austria-Hungary	Earned Nobel Prize (1947) with wife Gerty Cori for "their discovery of the course of the catalytic conversion of glycogen"
Gerty Cori	Austria-Hungary	First woman to earn Nobel Prize (1947), shared with husband Carl
Tom Curran	United Kingdom	Past President of American Association for Cancer Research; he "pioneered laboratory studies of a novel molecule called HhAntag to treat brain cancer without the need for traditional chemotherapy or radiation"
Emmanuel Farber	Canada	Past President American Association for Cancer Research; pioneer in liver cancer research, toxicology and chemical carcinogenesis
Peter Jones	South Africa	Former Director of USC Norris Comprehensive Cancer Center, noted researcher in field of epigenetics
Waun Ki Hong	South Korea	Considered one of the founders of cancer chemoprevention; key researcher at MD Anderson; past-president American Association for Cancer Research
Leo Loeb	Germany	In 1907 helped establish mammary cancer was hereditary; pioneer in examining link between cancer and reproductive hormones; an original founder (and past-president) of American Association for Cancer Research
Frank McCormick	United Kingdom	A leader in the development of "targeted cancer therapies"; president of American Association for Cancer Research
Enrico Mihich	Italy	Made notable advances in chemotherapy and in the understanding of host-defense mechanisms; past-president of American Association for Cancer Research
Andrew Schally	Poland	Earned Nobel Prize (1977) for "discoveries concerning the peptide hormone production of the brain"
Carl Voegtlin	Switzerland	First head of the National Cancer Institute (19381943); past-president, American Association for Cancer Research

Source: American Association for Cancer Research; National Foundation for American Policy.

1939, he was rejected by 10 medical schools because at the time such schools maintained quotas against Jewish and foreign applicants (and he was both). Benacerraf, born in Venezuela, eventually was admitted to the University of Virginia. He became a U.S. citizen and served as a doctor in the U.S. Army after World War II. He conducted research, publishing more than 600 papers in his career, and became leader of the Sidney Farber Institute, later called the Dana-Farber Cancer Institute, in 1980. That same year he was awarded the Nobel Prize in Physiology or Medicine for "his work on how the human body distinguishes its own cells from foreign bodies."[13]

Leading in Science and Technology

Positive changes to immigration policy can yield profound changes. The repeal of the "national origins" quotas in the 1965 Immigration and Nationality Act and the end of the Asiatic Barred Zone, combined with increases to immigration in the 1990 Act, opened the door to many outstanding individuals who otherwise could not have immigrated to the United States. While the rise in immigrant Nobel Prize winners also reflects an increase in the reputation and capability of U.S. academic institutions post-1960, a greater openness to immigration helped make the United States the world's leading destination for research in vital science and technology fields. **IE**

STUART ANDERSON, former staff director of the Senate Immigration Subcommittee, is executive director of the National Foundation for American Policy, an Arlington, Virginia-based policy research organization. He is the author of the book *Immigration* (Greenwood, 2010).

References

1 Parts of this article were adapted from Stuart Anderson, *The Increasing Importance of Immigrants to Science and Engineering in America*, NFAP Policy Brief, National Foundation for American Policy, June 2014. Funding from the Ewing Marion Kauffman Foundation supported the research.

2 Royal Swedish Academy of Sciences, National Foundation for American Policy, George Mason University Institute for Immigration Research.

3 Press Release, The Royal Swedish Academy of Sciences, October 9, 2013.

4 Royal Swedish Academy of Sciences, National Foundation for American Policy, George Mason University Institute for Immigration Research.

5 Parts of this article were adapted from Stuart Anderson, *The Contributions of Immigrants to Cancer Research in America*, NFAP Policy Brief, National Foundation for American Policy, February 2013. Funding from the Ewing Marion Kauffman Foundation supported the research. At each center there were some individuals for whom no biographical information at all was available and they were excluded. For individuals with incomplete data that left it unclear whether the person was foreign-born, despite attempts at verification, such individuals were either excluded from the count or by default treated as native-born in an attempt to arrive at conservative estimates of the percentage of foreign-born at the facilities.

6 Ibid.

7 Ibid.

8 Goutam Naik, "U.S. Cell-Aging Researchers Awarded Nobel," *The Wall Street Journal*, October 6, 2009, A5.

9 Ibid. See also Stuart Anderson, *Immigration* (Greenwood, 2010).

10 Rainer Storb, M.D., profile, Medical Advisory Board, Gabrielle's Angel Foundation for Cancer Research.

11 Information received from Fred Hutchinson Cancer Research Center.

12 Appreciation to Kathleen Case, archivist, American Association for Cancer Research for invaluable assistance with the history of cancer research.

13 Neena Satija and Mark Feeney, "Baruj Benacerraf, 90; shared 1980 Nobel Prize," *The Boston Globe*, August 3, 2011. He shared the Nobel Prize in 1980 with George Snell and Jean Dausset