Born of a 19th century magnate's vision of heroic science, the Nobels remain the prizes everybody wants to win—and nobody wants to tamper with

At 100, Alfred Nobel's Legacy Retains Its Luster

NOBEL CENTURY

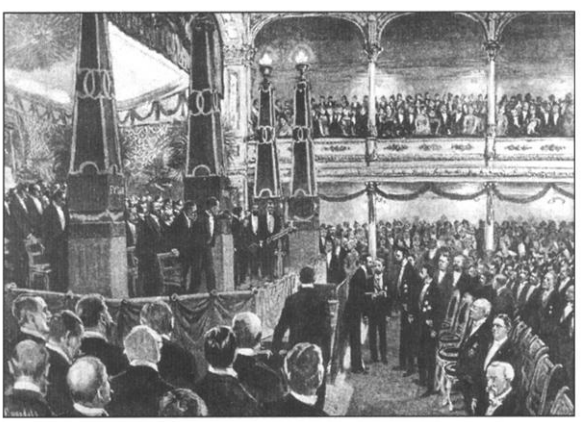
This year the Nobel Prizes turn 100. This special Focus section explores how the science awards achieved iconic status, why they have overlooked some major discoveries, and how they change the lives of those who win them.

CAMBRIDGE, U.K.— This week, several scientists saw their names equated with dazzling achievement, a standing they will never lose. The general public is now discovering how these newfound celebrities reached their pinnacles: what obstacles they overcame, whose shoulders they stood upon to see so far. Reporters are hanging on their every utterance, soliciting their views on topics ranging from world peace to whether porridge or a raw egg is the breakfast of champions. Colleagues, too, are scrutinizing this latest crop of Nobel Prize–winners in a new light. Will the new demigods honor or diminish the Nobel pantheon?

Most scientists would love to run that gantlet, but few ever will. Not counting this year's winners, just 280 prizes in three science categories—physics, chemistry, and physiology or medicine—have been handed out since the Nobels made their debut 100 years ago. Hard work and dedication alone won't earn a membership in this exclusive club. "It's never for lifetime achievement," says Svante Lindqvist, director of the Nobel Museum in Stockholm. "That's the wonderful thing about the prize." Instead, it's the sublime spark of creativity that counts. For some éminences grises, that's the prize's tragic flaw. "The only real problem with the prize as I see it is its focus on a single major discovery," says Bruce Alberts, president of the U.S. National Academy of Sciences. "Giant contributors" have been bypassed, he says, "to my regret—and the Nobel's loss."

Is the heroic drama losing currency in this era of big science? Do lab chiefs deserve all the fame when prizewinning experiments often are carried out by underlings? Should some Nobel science prizes go to institutions, as the Peace Prize does on occasion? Is it fair to limit a prize to three living individuals? The mandarins at the Royal Swedish Academy of Sciences (RSAS) who anoint the winners take such questions seriously. "The academy feels the temperature outside," says physicist Anders Bárány, secretary of the academy's Nobel Committee for Physics. "If necessary, it adjusts."

Science sought to take the temperature as well by polling several dozen prominent scientists. They delivered a resounding defense of the status quo. As epochal as a Nobel can be for the winners, most said, the real beneficiary is science itself. "It puts science on the map, at least once a year," says laureate Peter Doherty of the St. Jude Children's Research Hospital in Memphis, Tennessee. And quaint, quirky, and sometimes anachronistic as the prize might seem, nothing else approaches its status or does its job in remotely the same way.



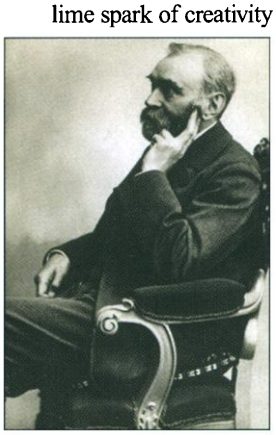
Grand debut. The first Nobel Prize ceremony in 1901 was an instant hit, although the King of Sweden gave it a miss.

CREDIT: THE NOBEL FOUNDATION

An explosive legacy

The prizes are named after Alfred Nobel, inventor of dynamite and one of the world's richest men when he died in 1896. Fluent in five languages, Nobel was a tireless and effective promoter of an explosives empire spanning 20 countries. But his surviving letters also reveal a lonely, often sickly man plagued by low self-esteem.

Nobel may have been prompted to establish the prizes by a French obituary appearing after his brother Ludvig died in 1888. Thinking it was Alfred who had passed away, the newspapers tolled the end of the "merchant of death" who had built a fortune on devising ways to mutilate and kill people. Mortified, Alfred "became so obsessed with his posthumous reputation that he rewrote his last will, bequeathing most of his estate to a cause upon which no future obituary writer would be able to cast aspersions," Kenne Fant wrote in



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SOME NOBEL MILESTONES

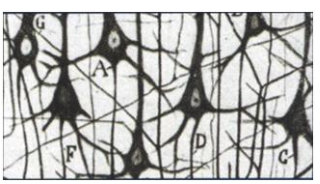
1896 ◀
Alfred Nobel dies, leaving his fortune to a nonexistent prize foundation.

1901 ▼
First prizes given in chemistry, physics, peace, and physiology or medicine. Cash award per prize is 150,782 Swedish crowns.

THE NOBEL FOUNDATION

1903
Marie and Pierre Curie, with Antoine Henri Becquerel, share physics prize for radioactivity research.

Svante Arrhenius receives chemistry prize for studies of electrolytic dissociation.



NATIONAL LIBRARY OF MEDICINE

1906 ▲
Camillo Golgi and Santiago Ramón y Cajal share physiology or medicine prize for work on nervous system structure.

Alfred Nobel (Arcade Publishing).

When Nobel succumbed to a stroke in 1896, he left behind a handwritten will as famed for its imprecision as its jaw-dropping philanthropic gesture. Most of his estate, valued at $9 million at the time, was left to endow a fund to award prizes annually to people who had "rendered the greatest services to mankind." The fund's interest every year would be divided into five equal parts for the three science prizes and for prizes for peace and literature.

It took executors of Nobel's will 3 years to liquidate his far-flung assets, set up the Nobel Foundation to administer the fund, forge agreements with the awarding institutions, and settle with Nobel's relatives, some of whom challenged the will. Shrewdly anticipating that the prize's impact would be diluted if the money were spread too thinly, the Nobel family insisted that each prize be limited to three living individuals. They thought that rationing the awards "would glorify the name," says Bárány.

The Nobel Prize was a true novelty and an instant hit. "It really was the first prize that had an international quality," says 1989 laureate Harold Varmus, president of the Memorial Sloan-Kettering Cancer Center in New York City. Part of the allure was the fantastic sums involved: In 1901, each prize was 150,000 Swedish crowns, roughly 30 times a professor's annual salary—and twice the French Academy of Sciences' entire budget that year. The worldwide press coverage of the first Nobel awards ceremony in 1901 was so glowing that King Oskar II of Sweden, who had declined to present the prizes, realized his mistake and bestowed the honors the next year, a tradition every Swedish monarch has upheld.

The human dramas behind the awards quickly came to the fore. For instance, when Marie and Pierre Curie shared the 1903 physics prize with Antoine Henri Becquerel, the public devoured the couple's rags-to-riches story. Marie, mother and pioneer in the strange new phenomenon of radioactivity, was "instantly transformed into a worldwide celebrity," Burton Feldman writes in *The Nobel Prize* (Arcade Publishing). "Because of her, newspapers around the globe changed their way of reporting the Nobel Prize, generating endless publicity, and thereby finally changing the meaning of the awards."

The Nobels soon showed a darker side as well. One of the most controversial Nobelists was Fritz Haber, awarded the 1918 chemistry prize for his discovery of how to fix nitrogen from air as ammonia for fertilizer. Haber had also spearheaded Germany's development of poison gas during World War I. Critics excoriated the RSAS for honoring a person linked with so much human suffering.

Prize politics took on a new dimension in the 1930s, when Adolf Hitler, furious that Jewish scientists in Germany had won Nobels, laid plans for an Aryan alternative: the Hitler Prize, which never came to pass. In the early years of the Cold War, Soviet dictator Joseph Stalin also toyed with the idea of establishing Nobel alternatives, including a Mendeleev Prize for science. "Stalin considered the Nobels a diabolical conspiracy against Soviet Russia," says Michael Sohlman, executive director of the Nobel Foundation. "He thought it was ridiculous that a small and unimportant country like Sweden would control a huge prize." Stalin's prizes, too, came to nothing.

Picking favorites

Meanwhile in Stockholm, behind a façade of incontestable probity, the men and women who choose Nobel laureates engaged in their annual battle of wills. As designated in Nobel's will, the RSAS selects the winners of the physics and chemistry prizes, while Sweden's Karolinska Institute chooses the winners in physiology or medicine. The prize bodies appoint five-member juries, which in turn gather hundreds of nominations each year, whittling these to a few dozen that merit serious consideration.

During a months-long vetting process, the prize committees ask outside experts to prepare dossiers on leading candidate discoveries, which this year in physics, for example, amounted to fewer than 20. Experts vet the experts' reports. "Even Toyota would be impressed with our quality assurance," remarks Karolinska president Hans Wigzell, who serves on the physiology or medicine committee (*Science*, 28 September, p. 2374). By early autumn, the physics and chemistry juries report to the RSAS's general assembly, which can reject a selection and name its own winner—a prerogative it has rarely exercised. Few outsiders were privy to these deliberations until 1974, when the Nobel Foundation decreed that only the past 50 years of its archives would remain secret.

Every year since then, new information

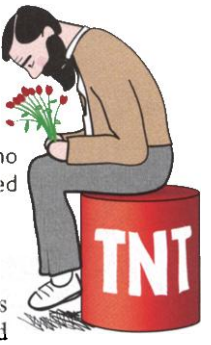


ILLUSTRATION: C. SLAYDEN

NOBEL NUGGETS

Why no math prize? Folklore says it's because a mathematician stole Nobel's girlfriend. "It's a constant apocryphal story," says Michael Sohlman, executive director of the Nobel Foundation. "We have found no evidence to support this, no evidence that Alfred Nobel was even interested in mathematics."

2001 AWARDS

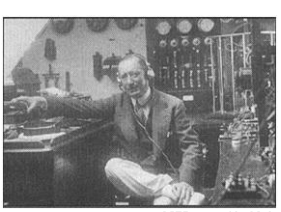
Two of this year's Nobel Prizes had been awarded as this issue of *Science* went to press.

The prize for physiology or medicine, awarded on 8 October, went to Leland H. Hartwell, Timothy Hunt, and Paul M. Nurse, for discoveries of key regulators of the cell cycle.

The prize for physics, awarded on 9 October, went to Eric A. Cornell, Wolfgang Ketterle, and Carl E. Weiman, for the discovery of the new form of matter known as a Bose-Einstein condensate.

All of the new science laureates and their work will be profiled in next week's issue.

1908
Ernest Rutherford honored with chemistry prize for pioneering research in transmutation chemistry.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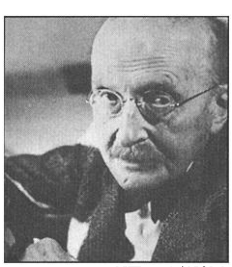
1909 ▲
Guglielmo Marconi and Carl Ferdinand Braun honored for invention of the radio.

1911 ▶
Marie Curie wins chemistry prize. She is the first woman honored independently and the first person to win two prizes.


THE NOBEL FOUNDATION

1915–1919
Prizes disrupted during World War I. Some prizes not given in certain years.

1918 ▶
Max Planck wins physics prize for research in quantum mechanics.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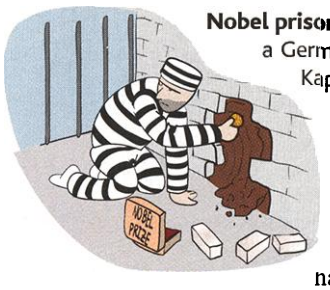
NOBEL NUGGETS



Nobel prisoners. Lev Landau (physics, 1962) was imprisoned by Stalin in 1938 as a German spy but freed after a year thanks to pleas by his colleague Pyotr Kapitsa (physics, 1978). In the 1940s, Kapitsa himself was put under house arrest for 8 years. During World War II, German scientists Otto Hahn (chemistry, 1944), Max von Laue (physics, 1914), and Werner Heisenberg (physics, 1932) served time in a secret British prison camp, Farm Hall. Hahn was awarded the Nobel while there.

nas emerged to help demystify the process. For example, the archives lay bare the machinations that prevented Albert Einstein from winning a prize for his most influential work. In the first 2 decades of the 20th century, dozens of scientists nominated him for the physics prize for relativity. "One man stopped Albert Einstein year after year," says Bárány: Allvar Gullstrand, a 1911 physiology or medicine laureate on the physics jury who doubted that relativity would stand the test of time. According to the archives, a young academy member, C. W. Oseen, resolved the impasse in 1921 by nominating Einstein for the physics prize for his lesser (but surely Nobel-worthy) theory of the photoelectric effect. Gullstrand accepted the compromise, and Einstein won the 1921 award.

Historical records fail to explain some astounding errors of judgment. Witness the 1949 prize in physiology or medicine, shared by neuroscientist António Egas Moniz for his development in 1935 of the prefrontal lobotomy. The jury failed to appreciate how widely discredited the procedure had become by the time it tapped Moniz. "It was a terrible mistake that caused permanent damage to thousands of patients," says 1981 physiology or medicine laureate Torsten Wiesel of Rockefeller University in New York City.

In some cases, controversial awards have triggered seismic shifts in the Nobel science committees' policies. In the early days, for example, the RSAS and its juries took nominations for key inventions seriously. They adhered to the wording in Nobel's will, which declared that the physics prize should go to the most important discovery or *invention*, and the chemistry prize to the most important discovery or *improvement*. In back-to-back years, the 1908 physics prize honored color photography, the 1909 prize wireless radio.

That penchant for the practical started to change after the 1912 physics prize, which drew howls of derision. That year, Nobel archives show, the physics jury chose Dutch scientist Heike Kamerlingh Onnes for his groundbreaking work in low-temperature superconductivity. But under pressure from a prominent industrialist in the RSAS, the academy dinged Onnes in favor of a Swede, Gustaf Dalén, who had developed a prosaic, if clever, technique for engineering lighthouse lamps to switch on and off automatically.

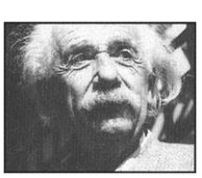
The ensuing uproar provoked unprecedented soul-searching within the RSAS, says Bárány. When the prize juries took a hiatus during World War I, he says, representatives of the awarding institutions met and "reflected whether they were going in the right direction." They decided that any invention so evi-

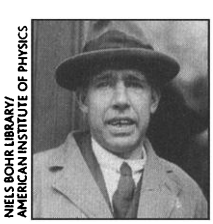
UN-NOBELS: A FEW OF THE MANY OTHER PRIZES FOR SCIENTIFIC ACHIEVEMENT

Name	Awarded by	For	Cash reward	Notes
Abel Prize	Norwegian government	Mathematics	To be determined	To start 2002 as "Nobel equivalent" for mathematics.
Crafoord Prize	Royal Swedish Academy of Sciences	Mathematics, astronomy, biosciences, geosciences, polyarthritis	$500,000	
Fields Medal	International Mathematical Union	Mathematics	$15,000	Annually since 1936 to mathematicians under 40
Heineken Prizes	Royal Netherlands Academy of Arts and Sciences	Biochemistry and biophysics; environmental sciences	$150,000	Annually since 1964; field varies from year to year
Japan Prize	Science and Technology Foundation of Japan	Prize area changes from year to year; computer science in 2002	$455,000	Every 4 years since 1985
Kyoto Prize	Inamori Foundation	Separate prizes in technology and science; prize areas rotate from year to year	$415,000	Annually since 1985
Lemelson Prize	Massachusetts Institute of Technology	Invention	$500,000	Annually since 1995; field varies by year
Royal Society Medals	British Royal Society	17 medals in various fields	Various	Annual; first awarded in 1731
Wolf Prize	Wolf Foundation	Agriculture, chemistry, math, medicine, and physics	$100,000	Annually since 1978
Albert Lasker Medical Research Awards	Lasker Foundation	Biomedical science	$50,000	Annually since 1946; winners often go on to win Nobels
Balzan Prize	International Balzan Foundation	Various fields	$600,000	Annually since 1961

ILLUSTRATION: C. SLAYDEN

1921 ▼
Albert Einstein honored with physics prize for theory of the photoelectric effect.





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1922 ▲
Niels Bohr wins physics prize for quantum theory.

1932
Werner Heisenberg receives physics prize for work in quantum mechanics.

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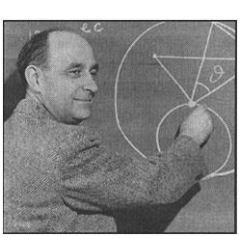
1933 ▶
Erwin Schrödinger and Paul Dirac share the prize for physics.

1938 ▶
Enrico Fermi wins physics prize for study of nuclear reactions.



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1940–1942
No prizes given during part of World War II.

dently practical that it could launch a company would be ineligible for a prize. "Dalén was the stimulus for this," says Bárány. In today's biotech era, the most-practical Nobels tend to be given in the physiology or medicine category, although Sweden's current emphasis on "strategic" research should ensure that physics and chemistry prizes rooted in applied science are not necessarily a thing of the past. "I would be extremely surprised if members of the prize committees were not influenced by this climate," Bárány says.

One Nobel tradition unlikely to change any time soon is secrecy. Juries endeavor to keep winners in the dark until a congratulatory phone call on the day a prize is announced. "We've had wives say, 'I absolutely won't wake my husband,' " Bárány says. One call to a chemistry laureate was made to a carpet cleaner with the same name. He took it in good humor, responding that "there's a lot of chemistry in carpet cleaning," says Bárány, whose grandfather, Robert Bárány, won a 1914 Nobel for insights into the inner ear. On rare occasions—particularly with the Peace Prize—the names of controversial selections have leaked out early, but in general the science juries are known for deafening silence.

A timeless anachronism?

When Carlo Rubbia won the 1984 physics prize for the discovery of the W and Z particles a year earlier, the award was as much in honor of the hundreds of scientists at CERN, the European laboratory for particle physics near Geneva where the particles were found, as it was for Rubbia and co-laureate Simon van der Meer. So if Rubbia, CERN's director, was cited, why not also cite CERN itself? RSAS statutes do not prohibit an institution from receiving a physics or chemistry prize. (Karolinska rules expressly bar an institute from a physiology or medicine Nobel.) Although Bárány is not allowed to comment on the 1984 prize deliberations, he says the physics jury would consider awarding a future prize to an institution.

However, many are loath to see an entity win a science Nobel. "Institutions don't make discoveries; individuals do," says 1980 chemistry laureate Walter Gilbert of Harvard University. Honoring institutions, adds Will Stewart, chief scientist at the telecom giant Marconi in London, would "drastically reduce the 'PR for science' role that may be the greatest value of the Nobels. Who ever heard of any of Einstein's institutes besides the Swiss patent office?" And many scientists cringe at the thought of a Nobel Prize going to the public consortium or the private company involved in what could be this year's biggest science story, the sequencing of the human genome. Still, there may be ways to honor sequencing. "There are wise people in the field who have identified the goal of sequencing a whole organism," notes Wellcome Trust director Mike Dexter.

A related issue strikes a deeper chord: Does a lab chief deserve to bask in the glory alone? If genius is 1% inspiration and 99% perspiration, as non-Nobelist Thomas Alva Edison famously remarked in 1932, in most labs 99% of that sweat is shed by grad students, postdocs, and other rank-and-file researchers. "The senior scientists should not get all the credit unless they are the only ones who deserve it," argues chemist Joan Valentine of the University of California, Los Angeles, who believes that James R. Heath, a graduate student, should have shared in the 1996 prize for the discovery of buckyballs. Then there are baneful errors of omission, such as Albert Schatz, who science historians believe discovered streptomycin while working in Selman Waksman's lab at Rutgers University. Although both were listed as discoverers on the streptomycin patent, the 1952 prize for the finding went solely to Waksman, who neglected to mention Schatz in his Nobel lecture.

Most abundant are cases in which senior scientists had their Nobel dreams shattered by the three-person limit. Two recent causes célèbres are nitric oxide researcher Salvador Moncada for missing out in 1998 and Oleh Hornykiewicz last year (*Science*, 26 January, p. 567). Of his own 1995 prize, says Paul Crutzen of the Max Planck Institute for Chemistry in Mainz, Germany, "I would have felt equally well, maybe better, if the prize had gone to five or six people."

But expanding the winners' circle beyond three would mean rewriting statutes laid down for all the prize-awarding bodies. That would be a hard sell. "There are no plans to change the rule," says Nobel Foundation board chair Bengt Samuelsson. And although perceived injustices may abound, few scientists seem prepared to take up this cause. Restricting prizes to three winners at most, notes physical chemist Philippe Poulin of the Centre de Recherche Paul Pascal in Pessac, France, allows the public to "identify the 'Einstein' of the year."

Nobel conservatism appears to spring from a desire not to tamper with a winning formula. "The fact that the prizes have such luster is one of life's deep mysteries," says 1996 chemistry laureate Richard Smalley of Rice University in Houston. The Nobel Foundation's top priority, he says, "is to keep the prize lustrous. ... I suspect that anything they do will risk the magic they've had going for them thus far."

The most magical day for the winners comes on 10 December—the anniversary of Alfred Nobel's death—when they are feted at a banquet in Stockholm City Hall. There they will collect vouchers for checks for their share of the prize, this year set at 10 million Swedish crowns ($939,000). If a far richer science prize were ever to come along and up the ante, that might "put the Nobel selection process into a real soul-searching era," says Smalley. "Until then you might as well relax. It ain't gonna change." **–RICHARD STONE**

NOBEL NUGGETS

Saved. Hours before Nazi troops descended on the Niels Bohr Institute in Copenhagen, George de Hevesy (chemistry, 1943) dissolved in acid the gold medals belonging to James Franck (physics, 1925) and Max von Laue (physics, 1914). After the war, the gold was reconstituted and the reminted medals returned to their owners.

ILLUSTRATION: C. SLAYDEN

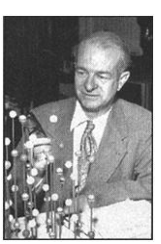
1945 ▶
Alexander Fleming, Ernst Chain, and Howard Florey share prize in physiology or medicine for discovery of penicillin.

Wolfgang Pauli gets physics prize for discovery of exclusion principle.

P. BARBER/CMSP

1953
Hans Krebs and Fritz Lipmann share prize in physiology or medicine for studies of citric acid cycle biology.

1954 ▼
Linus Pauling gets the chemistry prize for his quantum chemical bonding theory.



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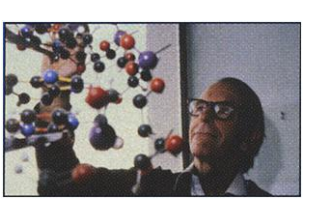
1958 ▶
Frederick Sanger honored for the first analysis of a protein, insulin.

George Beadle, Edward Tatum, and Joshua Lederberg honored with physiology or medicine prize for the one-gene–one-enzyme postulate.



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1961
Melvin Calvin gets the chemistry prize for his study of photosynthesis.