A young boy walks on a bronze sculpture of Albert Einstein, outside the National Academy of Sciences building in Washington, D.C.
Bottom right: A special postage stamp, issued in Berlin, Germany, on June 15, 2005, commemorates "100 years of relativity, atoms, quants."

ORIGINS OF GENIUS

Albert Einstein's transformation from an obscure patent clerk to the world's most famous scientist began during one 'miracle year'

BY JIM SCHNABEL

LIGHT IS BOTH PARTICLE AND WAVE. Time flows differently for objects in motion. Gravity is not a force but a warping of space. A little mass holds a fantastic amount of energy.

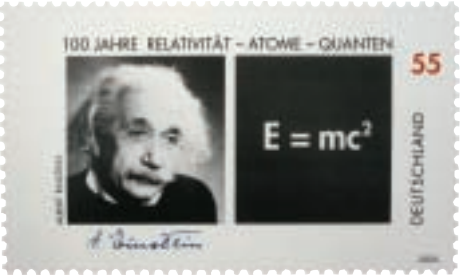
Albert Einstein's theories still boggle the mind, more than a century after he used them to ignite a scientific revolution. But who was this shaggy-haired icon of genius? Did he inherit his creativity or just have lucky breaks in life—or both?

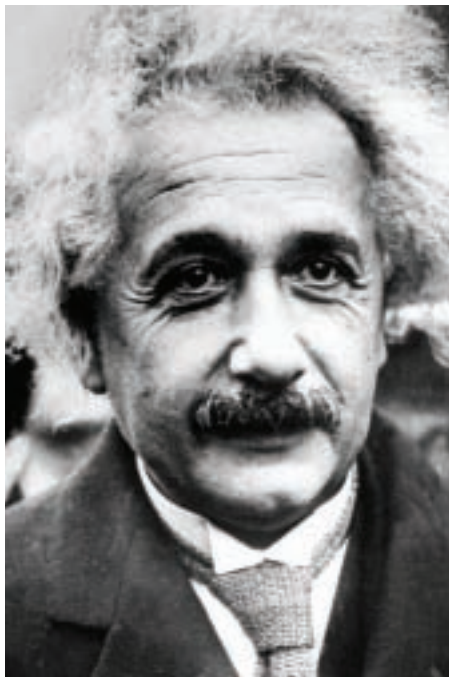
He was born on March 14, 1879, in the city of Ulm, in the Germanic kingdom of Württemberg. His family moved to Munich soon after, where his father, Hermann, and Uncle Jakob started a cutting-edge tech business, selling generators and other electrical supplies. Thus, young Albert, almost uniquely among the children of his day, had a thorough exposure to emerging concepts of electromagnetism.

Hermann, a non-practicing Jew and an opponent of the drive to unify greater Germany, also set a clear example of stubborn, non-conformity for his son—which Albert's strong-minded mother, Pauline, reinforced.

Although he did well in math and physics at Munich's Luitpold Gymnasium (essentially a high school), Einstein chafed at its traditional, rote memorization methods, and was seen as a loner and a rebel. "Your mere presence in this class destroys the other students' respect for me," complained a Greek teacher—a fellow who also blustered that Einstein would amount to nothing in life. The school later revised its view of him enough to rename itself the Albert Einstein Gymnasium. But Einstein never forgot how its methods had nearly crushed his spirit. The natural curiosity that is essential for science, he wrote decades later, is like "a delicate little plant" that "stands mainly in need of freedom."

Einstein might well have inherited a creative bent, but if so, it was not entirely a gift. He often showed a chilly detachment from people. Presented with his newborn younger sister, he asked, "Where are its wheels?" and until the age of 7 he had the strange habit of softly repeating, to himself, sentences he had just spoken. He shunned sports and crowds, preferring to read or to play the violin. Some modern psychologists think he had Asperger's syndrome, a mild autism-spectrum disorder. Einstein himself would later





admit to a "pronounced lack of need for direct contact with other human beings and human communities."

Before turning 16, when he would have been called up for military service, he renounced his citizenship and moved to Switzerland. (His parents by then had moved to northern Italy after the failure of the business in Munich.) Einstein tried to get into Zurich Polytechnic two years early, but failed the entrance exams, and instead spent two years finishing high school in the nearby town of Arau.

He was in luck, though. The school used progressive educational methods, and put unusually strong emphasis on visual conceptualization. One day there, Einstein asked himself: What would it be like to move alongside a beam of light? He later described this thought-experiment as his first step toward the theory of relativity.

He entered Zurich Polytechnic in 1896, and once again was a bit of a rebel. "I played hooky a lot, and studied the masters of physics alone," he remembered later. Einstein would graduate in 1900 near the bottom of his class. But he made friends at the school, and these included a rare female physics student, a Serbian young woman named Mileva Maric. "We understand each other's dark souls so well," he told her. Soon they were living together: two nerdy bohemians whose domestic talk was infused with advanced physics. "When I read [the physicist] Helmholtz for the first time," he once wrote to her, "I could not … believe that I was doing so without you beside me."

When Maric became pregnant in 1901, Einstein sent her to stay with her parents in Serbia, to avoid scandal. He seems to have rather coldly insisted that their first child, Lieserl, born out of wedlock, be put up for adoption. But the couple married in 1903, and had two more children. Although they separated in 1914 and eventually divorced (Einstein later married his first cousin, Elsa), Maric gave Einstein emotional and even intellectual support in those early years. She also kept house for him—which, throughout his life, he was never able to do for himself.

Einstein's poor showing at Zurich Polytechnic meant that he could not get a decent academic job. He scraped by with family money and occasional freelance teaching assignments, but his underemployment was a source of frustration.

It may have been yet another stroke of luck, though, for his isolation from academia in those years freed him to move along his own creative paths. Physics at the turn of the century—especially the classical mechanics of Isaac Newton—was rattling itself loose. Experimenters were gathering new data on phenomena such as the speed of light, and these data didn't always fit the existing theories. Einstein knew that there was a vast opportunity for a theorist who could find a way to make physics whole again.

In 1902, he finally got a steady job, at the Swiss patent office in Bern, as a junior examiner of patent applications for electrical devices. Again, he was in luck. He found that he could do his patent work in a few hours daily, leaving him plenty of time for his theorizing. His office and apartment also were not far from the train station and Bern's famous clock tower, a reference for all train-timekeeping in the vicinity. Clocks and trains were to be for Einstein what the falling apple had been for Newton.

"What would it be like to move alongside a beam of light?"

Einstein would later describe his teenage thought-experiment as his first step toward the theory of relativity.

Left to right: Einstein, pictured here at age 14, showed a chilly detachment from people throughout most of his life; the scientist enjoyed playing the violin, a pastime he began as a child; Einstein in Paris in 1929, four years before his move to the United States; an avid sailor, he loved to take his boat out on a lake, where he could relax and think; newly transplanted in America, Einstein sets the first line of type for the first enlarged edition of the *Jewish Daily Bulletin* in 1934.

Miracle Year

Einstein's transformation from an obscure patent clerk to the world's most famous scientist began in 1905. In that year he managed, despite having no academic affiliation, to get three truly revolutionary papers published in *Annalen der Physik*, one of the top physics journals of its day.

In the first, he solved a conundrum about the way in which light knocks electrons out of metal—the "photoelectric effect" by which modern solar cells work. He proposed that light interacts with electrons as it does because it is made of discrete, albeit wavelike particles (later called photons) and each of these carries a discrete level of energy, corresponding to its wave frequency.

The second big paper outlined his initial theory of relativity—later called the "special theory of relativity." Its essence was remarkably simple: New experiments showed that the speed of light (in a vacuum) was always the same in all directions and for any observer whether moving or stationary. But if the speed of light is fixed and absolute in this way, Einstein reasoned, then other properties such as time must be changeable and relative, even if the changes they undergo are usually very subtle. From a train speeding past a stationary clock tower, for example, the clock will seem to run slow. The light that carries the clock's image will take a tiny bit longer to reach the receding train, with every tick of its hands. (By the same logic, a clock on a receding train also will seem, from the platform, to run slow.)

In his final paper that year, Einstein showed that, in part due to relativity, the light-speed constant c links mass to energy: E=mc2. One implication was that nothing can travel faster than c. Another was that a little mass is equivalent to a lot of energy—a key insight that would lead to the development of nuclear power and nuclear weapons.

Celebrity

Within a few years, Einstein began to be offered academic jobs, and his career took off. Meanwhile, he developed the "general theory of relativity." Its most revolutionary concept was that gravity reflects a warping of space—and time—in the vicinity of a large mass. When astronomers confirmed during a 1919 solar eclipse that the sun's mass bent starlight to the degree that Einstein's theory predicted, he became a global celebrity virtually overnight. *The New York Times* quoted the eminent British physicist J.J. Thomson: "It is not the discovery of an outlying island, but of a whole continent of new scientific ideas of the greatest importance…"

Einstein moved his work to the U.S. in 1933, after the Nazis came to power in Germany. By the time he died in 1955—while based at a special institute at Princeton University—he had written or co-authored more than 300 papers. Even today his ideas continue to underlie large areas of physics and the technologies derived from it.

Yet the aspects of his personality that had helped him to persevere in his pre-celebrity days may have been a net liability to him in his later years. Despite being instrumental in persuading President Franklin D. Roosevelt to set up the Manhattan Project—to build an atomic bomb before Nazi Germany did—Einstein embraced an uncompromising pacifism after the war, and even publicly wished that the U.S. had never built nuclear weapons. He also somewhat obstinately resisted the emergence of quantum physics and its assertion of fundamental uncertainties, complaining that God "does not play dice"—and wasting years trying to prove that.

After Einstein died of an aortic aneurysm at the age of 76, fellow Princeton physicist Robert Oppenheimer gave a eulogy that captured, in one sentence, much of the genius' character: "There was always with him a wonderful purity at once childlike and profoundly stubborn."