History of Science

Stories and anecdotes about famous – and not-so-famous – milestones and personalities in science and technology

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ACADEMIC & INSTITUTIONAL RESEARCH

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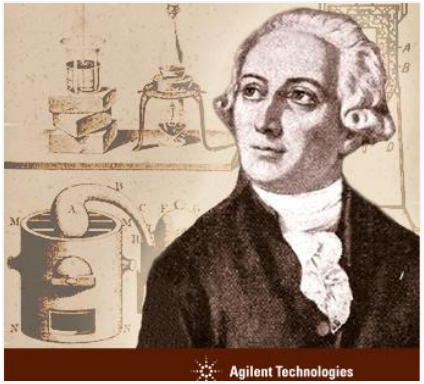
The Father of Modern Chemistry



For more information go to:

- The Chemical Revolution of Antoine-Laurent Lavoisier (American Chemical Society)
- Antoine-Laurent Lavoisier (Chemical Heritage Foundation)
- Agilent Solutions
- R&D 100 Awards

Antoine-Laurent de Lavoisier was born on August 26, 1743. He studied law to please his wealthy family, but his passion was chemistry. As a student during the Enlightenment, he declared, “I am young and eager for glory.”

At the time, chemistry was more of a superstition than a science. People still believed in **Aristotle’s classical elements** of earth, water, air and fire. Evaporation could convert water into earth. And combustion and rust were caused by a fire-like element called **phlogiston** (Greek for “burning flame”).

Lavoisier applied very precise measurements to his experiments. He discovered that the sediment from evaporation actually came from the inside of the container. He discovered that combustion is caused by **oxygen** (which he named after the Greek for “acid former”). He established the law of **conservation of mass**. His 13-year-old wife learned English just so she could translate research for him, and art just so she could illustrate his works.

Lavoisier invented the **chemical nomenclature** still used today, identifying 55 substances as true “elements” (substances that could not be broken down further), including hydrogen, carbon and phosphorus. He wrote, “I have tried to suppress the use of reasoning, which is often an unreliable instrument, in order to follow the torch of observation and of experiment.” Overall, he changed chemistry from a *qualitative* science to a *quantitative* one, elevating it to the level of physics and mathematics.

Lavoisier also had his faults. He tried to take credit for the work of other scientists, including Joseph Priestly. His list of elements included *light* and *caloric*. And he believed that the existence of atoms was philosophically impossible.

But Lavoisier’s greatest fault was his status as a nobleman and a tax collector. He was executed by guillotine in 1794 at the height of the French Revolution, despite appeals in the name of science. Joseph Lagrange declared, “It took them only an instant to cut off that head, and a hundred years may not produce another like it.”

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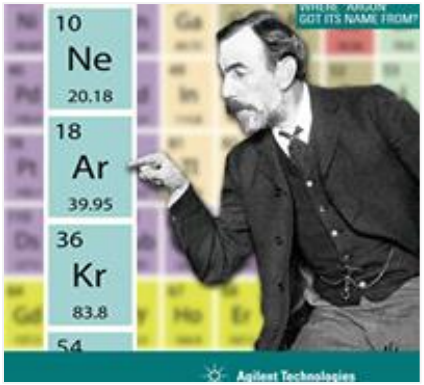
He Discovered an Entire Area of the Periodic Table



For more information go to:

- Sir William Ramsay (Nobel Prize Organization)
- William Ramsay (Chemical Heritage Foundation)
- Permanent Gas Analysis – Separation of Argon and Oxygen on a MolSieve 5A Column using the Aiglent 490 Micro GC (application note, PDF)
- Analysis of oxygen and argon content in high purity nitrogen (application note, PDF)

Sir William Ramsay, the British chemist, was born on October 2, 1852.

In 1892, Ramsay became fascinated by a discovery from a fellow chemist, Lord Rayleigh (John William Strutt). Rayleigh had observed that nitrogen extracted from the air always had a higher density than nitrogen extracted by other means. Ramsay theorized that there must be another gas present, some element in the atmosphere that had not yet been discovered.

Though Ramsay and Rayleigh worked on the problem separately, they shared their progress. Two years later, they jointly announced the discovery of a new, heavier gas. Ramsay named it **argon** after the Greek *argos* for “lazy,” as the new gas was thought to be fairly inactive with other chemicals.

Over the next several years, Ramsay discovered **neon**, **krypton** and **xenon**. He also discovered the first presence of **helium** anywhere outside of the sun. Ramsay had identified an entirely new group of elements in the periodic table. They were originally called “inert gases” due to their lack of chemical reactivity. They are now more accurately known as “noble gases.”

In 1904, Sir Ramsay and Lord Rayleigh were jointly awarded **Nobel Prizes**: Ramsay for chemistry and Rayleigh for physics.

As a side note, Sir Ramsay also played a role in the technological history of **India**. As a British advisor in 1900, he recommended **Bangalore** as the site for establishing the **Indian Institute of Science**, a public university for scientific research and higher education.

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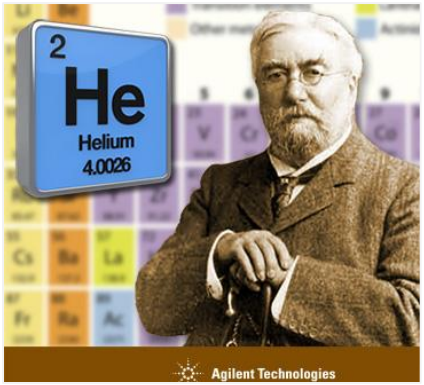
Helium and More Helium



May 17 was the 178th birthday of British astronomer **Sir Joseph Norman Lockyer**, one of the two people credited with discovering the element **helium**.

Using **electromagnetic spectroscopy**, in 1868 Lockyer observed a yellow spectrum line near the edge of the Sun that could not be explained by any known material. He decided it must be caused by an unknown solar element, which he named after the Greek “Helios” for “sun.” (A similar observation was made the same year by French scientist **Pierre Janssen**, so both men are credited with the discovery.) Despite being the second-most abundant element in the universe, terrestrial helium was not identified until 10 years later.

Today, helium is commonly used as a carrier gas in **gas chromatography**.

For more information go to:

- Sir Joseph Norman Lockyer (Planet Facts)
- Helium (Chemicool)
- Agilent 7000C Triple Quadrupole GC/MS System

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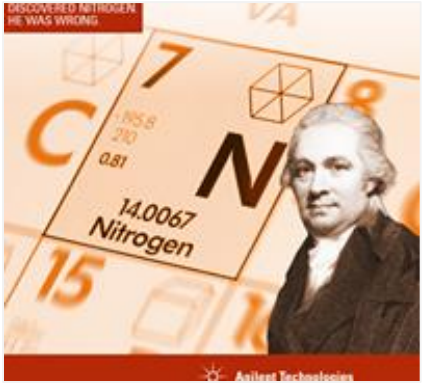
How Nitrogen Was Discovered



For more information got to:

- Daniel Rutherford – discoverer of nitrogen gas
- What is phlogiston?
- Agilent Technologies' Revolutionary Atomic Spectroscopy Instrument Runs Entirely on Air
- Agilent: Elemental analysis that runs on air

The Scottish scientist, **Daniel Rutherford**, who was born November 3rd 1749, is credited (somewhat erroneously) for discovering the element nitrogen.

Nitrogen is the most abundant element in our atmosphere, comprising about 78 percent of the air we breathe. It is found in all proteins and nucleic acids and is a primary ingredient in ammonia, used in everything from fertilizers to explosives. It is even used to protect historic documents such as the U.S. Declaration of Independence.

How did science discover an invisible, colorless, odorless and tasteless gas – 200 years before we had Agilent instruments?

At the time, scientists believed in the theory of **phlogiston**. Supposedly, all flammable substances contained phlogiston, which would be released during combustion. Conveniently, phlogiston had no color, smell, taste or mass, making it undetectable.

Back to Rutherford. As a student, he was asked to investigate why a candle will not burn in carbon dioxide. He put a mouse in a closed jar until it died. Then he burned a candle in the jar until it stopped burning. Then he burned phosphorus in the jar until it too stopped burning. He took the remaining "air" and passed it through a solution that absorbs carbon dioxide.

Through this process, Rutherford had removed all oxygen and carbon dioxide from the air. He identified the remaining gas as "phlogisticated" or "noxious" air, since nothing could live or combust in it. Rutherford had correctly isolated nitrogen, though he was incorrect about what it was.

The word "nitrogen" was later coined from the French words nitre ("saltpeter") and gène ("producing"), as the gas was an essential component of nitric acid.

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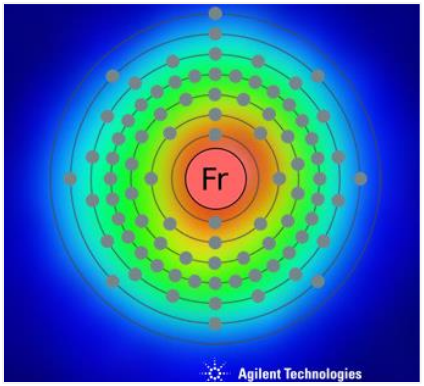
The Sad and Tragic Story of Francium



Francium is one of the rarest naturally occurring elements on Earth. All isotopes of francium are radioactive; the most stable has a half-life of only 22 minutes. ("Half-life" is the time it takes for half of a sample to break down.) Experts believe that no more than 15 grams of francium (less than an ounce) exist throughout the world.

Francium was also one of the last naturally occurring elements to be discovered. By the 1930s, only three boxes in the **periodic table** remained empty – atomic numbers 43, 85 and 87.
No. 87 was finally discovered in 1939 by 29-year-old Marguerite Perey at the Curie Radium Institute in Paris, who named it after France.

"It is my great hope that francium will be useful for the establishment of an early diagnosis of cancer," Perey wrote. At the time, radiation was viewed as a new scientific marvel. For instance, radium was being used in face creams, tonics and candy. Doctors sewed capsules of it into the surgical wounds of cancer patients. Women painted it onto their teeth to make them glow.

But troubling effects had begun to occur. Madame Marie Curie, Perey's mentor who first coined the word "radioactivity," had died from long-term radiation exposure five years before Perey's discovery. Women who worked with radium paint developed widespread bone cancer. Contrary to being a cure-all for cancer, francium and other radioactive elements were actually highly toxic carcinogens.

In 1962, Perey became the first woman elected to the French Académie des Sciences (even Marie Curie was not given that honor). But she spent the last 15 years of her life battling pervasive and crippling bone cancer before finally succumbing to it in 1975.

For more information go to:

- Francium (Chemistry Explained)
- Francium (Royal Australian Chemical Institute)
- Marguerite C. Perey (Catholic University of America)
- My Great-Great-Aunt Discovered Francium. And It Killed Her. (NY Times)
- Dako, an Agilent Technologies Company
- Addressing the Need for Better Cancer Diagnostics

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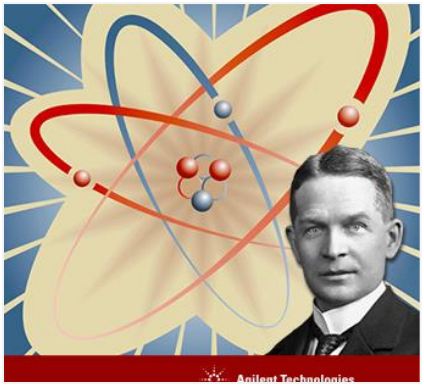
The Importance of Isotopes



For more information go to:

- Frederick Soddy—Pioneer in Radioactivity
- Uranium Enrichment
- Using Lead Isotope Ratios to Distinguish between Samples of the Traditional Chinese Medicine Dan-shen (PDF)
- Application of the Agilent 4500 Series FTIR to the Stable Isotope Technique for Assessing Intake of Human Milk in Breastfed Infants (PDF)
- Agilent ICP-MS Systems
- Agilent FTIR Systems

Frederick Soddy, an English pioneer in nuclear chemistry and atomic science, was born September 2, 1877. Working with Ernest Rutherford, he studied radioactive decay and coined the term “half-life.”

Soddy also theorized in 1912 that some elements could be chemically identical but have different atomic structures. He called this concept an “**isotope**” (after *isos topos*, Greek for “same place”). His theory remained controversial until it was confirmed by the discovery of the neutron in 1932.

(**Uranium** is an example. U-235 and U-238 both contain 92 protons, but U-238 has three extra neutrons and is more stable. Nuclear power reactors work by “enriching” or increasing the percentage of U-235, which is more easily fissioned or split.)

After receiving the 1921 **Nobel Prize** in Chemistry, Soddy grew frustrated with science and became a social advocate. He criticized scientists for ignoring the moral and ethical consequences of their work, including his own work on radioactivity. He argued that science could produce enough food and health care for the entire world, but that economic systems promoted inequality. He saw the tragic consequences of the first atomic bombs in World War II. Sadly, Soddy and his wife were never able to have children; his work with radioactivity had rendered him sterile.

Today, isotopes are a fundamental part of science. Isotopes are used in **carbon-14 dating**, a method for calculating geological age.

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The Woman Behind the Atomic Bomb

For more information go to:

- Lise Meitner (Jewish Women's Archive)
- Lise Meitner, "Our Madame Curie" (Wired)
- Agilent Technologies Announces Support for Women in Science, Engineering and Technology in Korea

When we think of the scientists who enabled the **atomic bomb**, we tend to think of men: Niels Bohr, Albert Einstein, Enrico Fermi, J. Robert Oppenheimer and Edward Teller. Less known is **Lise Meitner**, whose name has been buried in history by a combination of politics, jealously, and racial and gender discrimination.

Meitner was born on November 1, 1878 in Austria, when women were not allowed to attend public institutions of higher learning. She studied privately and later became only the second woman to earn a physics doctorate at the University of Vienna. The famous physicist **Max Planck**, who normally rejected women from even attending his lectures, made Meitner his assistant.

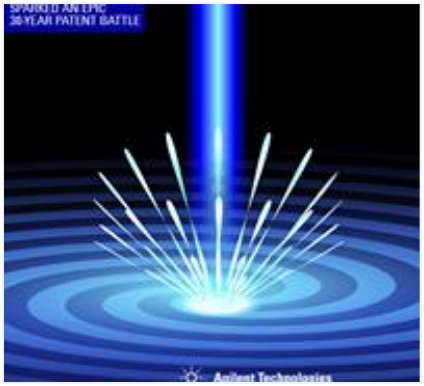
In Germany, she collaborated with chemist **Otto Hahn**, where they jointly discovered the element protactinium. But after Germany annexed Austria in the 1938 *Anschluss*, the Jewish Meitner was forced to flee to Sweden. She continued to collaborate with Hahn in secret, which led to the discovery of **nuclear fission**. While Hahn performed the experiments, it was Meitner who came up with the scientific explanation. Nevertheless, when Hahn published his findings, he excluded Meitner's name, given the anti-Jewish climate in Nazi Germany.

Their discovery spurred Einstein to write to U.S. President Roosevelt, resulting in the creation of the **Manhattan Project**. Meitner was invited to join the effort, but declared, "I will have nothing to do with a bomb." Nevertheless, she became known after the war as "the mother of the atomic bomb."

In 1944, Otto Hahn was awarded the **Nobel Prize in Chemistry** for nuclear fission. Lise Meitner's contributions were ignored. Numerous scientists protested her exclusion; Hahn (after repeatedly downplaying her contributions) later recommended her to the Nobel committee 10 times without success. The slight became known for years as the "Nobel mistake."

After the war, Meitner was invited back to Germany to resume her scientific work. But after she learned of the Holocaust and its effects, she decided never to return to that country. In 1966, two years before her death, Meitner, Hahn and Fritz Strassmann jointly won the Enrico Fermi Award for nuclear fission. Element 109, meitnerium, is named after her. Her tombstone reads, "Lise Meitner: a physicist who never lost her humanity."

Who Invented the Laser?



For more information go to:

- U.S. Patent 3392261A: Portable beam generator
- A Brief History of Lasers
- Bright Idea: The First Lasers
- Agilent SureScan Microarray Scanner

On July 9, 1968, inventor **Fred Schollhammer** earned a U.S. patent for a “portable beam generator.” This small, gun-shaped device would utilize “an energized beam” for “melting or partial vaporization.” Though Schollhammer never actually constructed such an apparatus, its design has been replicated in countless science fiction movies.

In the real world, American physicist **Gordon Gould** waged an epic battle against the U.S. government for recognition as the inventor of the **laser**.

Albert Einstein first theorized in 1917 that energized atoms could amplify radiation. In 1953, scientists successfully amplified microwaves to create the first “**maser**” (“microwave amplification by stimulated emission of radiation”). The race was on to accomplish the same amplification with visible light. Gould was the first to coin the term “laser” (“light amplification by stimulated emission of radiation”) as a graduate student in 1959. But he mistakenly believed that he had to build a working model before he could apply for a patent. As a result, others filed first.

Gould promptly sued the Patent Office, claiming his detailed notebooks proved he was “first to invent.” What followed was one of the most historic patent battles in U.S. history, lasting 30 years.

Companies including Bell Labs, Hughes Research Labs and Westinghouse did not want to pay royalties on what rapidly became a $400 million laser industry. They claimed Gould’s notes were incomplete, and filed numerous countersuits. It was not until 1985 that a Federal Court ordered the Patent Office to grant Gould a patent for an important laser component. Gould would ultimately earn 48 patents related to lasers.

Ironically, if Gould had been granted his original patent, the industry may never have taken off as freely as it did. But because of the 30-year delay, Gould instead earned millions of dollars in retroactive royalties.

Today, lasers are widely used throughout science and industry, including manufacturing, communications, electronics, chemistry and biology. Agilent’s predecessor, **Hewlett-Packard**, marketed the first commercial desktop laser printer. Agilent’s electronic measurement spin-off, **Keysight**, has a business devoted to optical laser source products.

But who actually invented the laser? The answer remains controversial to this day.

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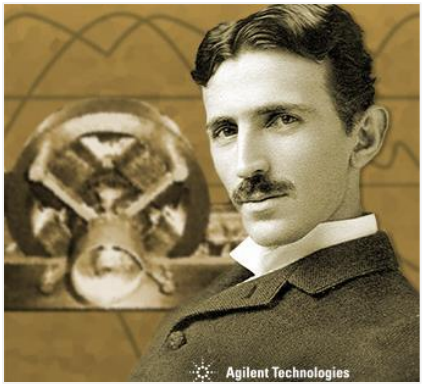
Remembering Nikola Tesla



For more information go to:

- Tesla Memorial Society of New York
- Nikola Tesla Museum
- Tesla Science Center at WardenClyffe
- The Tesla Conspiracy

Today **Thomas Edison** is recognized around the world as a prolific inventor and the father of the electrical industry. Less recognized is **Nikola Tesla**, a Serbian American born on July 10, 1856, who played an equally important role in the evolution of electronics.

Over his lifetime, Tesla obtained almost 300 patents for his inventions. He pioneered early **X-ray imaging**. In 1893 he theorized the possibility of **wireless communications**. In 1898 he demonstrated the world's first **remote-controlled device**, a radio-controlled boat. (Witnesses attributed the boat's operation to magic, telepathy or a hidden trained monkey.)

Tesla's pioneering work with **alternating electrical current systems** was one of his biggest contributions. He licensed his AC patents to **George Westinghouse**, helping to fuel the infamous "**war of currents**" in the 1890s. While Edison advocated *direct current* systems, Westinghouse argued that *alternating current* was safer, more reliable and more efficient.
Westinghouse won the war, and alternating current ultimately became the worldwide electrical standard. But Tesla was a victim of bad business practices, losing lucrative royalties and rights as the electrical industry took off. He died alone, impoverished and in relative obscurity in 1943.

In his later years, Tesla's obsession with developing a "**death ray**" (a "superweapon that would put an end to all war") earned him a reputation as a mad scientist. While he claimed that the device had been built and demonstrated, he never put his plans in writing and the device was never found. After Tesla's death, all of his papers and belongings were seized by the U.S. government, fueling conspiracy theories that continue to this day.

In 1960, the General Conference on Weights and Measures designated the term "**tesla**" for the measure of magnetic field strength.

That Time When Chemistry Saved All of Mankind

For more information go to:

- Fritz Haber (Nobelprize.org)
- Carl Bosch (Nobelprize.org)
- The Haber Process (chemguide)
- World's Greatest Invention?
- Engineered the Production of the Single Most Important Product Affecting the World's Population – Synthetic Fertilizer (Science Heroes)
- Agilent Energy & Chemicals
- Agilent Food Testing & Agriculture

At the beginning of the 20th century, scientists believed that Earth's growing population was about to exceed its available food supply. Agriculturalists raced to develop breakthrough **fertilizers** that could make farmlands more productive.

China scattered human waste on its rice fields. England ground skeletons into fertilizer. Paris used horse dung. America used bison bones. Peru built an entire economy by exporting more than 12 tons of guano (bird and bat droppings) around the world until it ran out.

Chemists knew that **nitrogen** was an ideal fertilizer. But while the element was plentiful in the atmosphere, it was almost impossible to find in solid compounds. (Bolivia, Chile and Peru actually went to war over the saltpeter reserves in the Atacama Desert.)

In 1909, German chemist Fritz Haber (whose birthday we celebrate on December 9) demonstrated a process that could extract **ammonia** (a nitrogen compound) from atmospheric nitrogen and hydrogen, drop by drop. The German chemical company BASF bought Haber's process, and employee Carl Bosch was able to scale the process to industrial levels.

The **Haber-Bosch process** enabled the mass production of nitrogen-based fertilizers. It was hailed as a miracle that could literally create "bread from air," and earned its two inventors the 1918 **Nobel Prize**.

(Ironically, the process also enabled the mass production of nitrogen-based explosives during World War I. Haber is known as the father of chemical weapons.)

Author Vaclav Smil declared that "the industrial synthesis of ammonia from nitrogen and hydrogen has been of greater fundamental importance to the modern world than the invention of the airplane, nuclear energy, space flight, or television."

Today, half the world's population still uses the Haber-Bosch process to fertilize its crops. In fact, you can thank Haber and Bosch for 40 percent of the life-giving nitrogen that's in your body right now. So when your son or daughter asks for a chemistry set, please get them one!

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The Man Who Discovered Vitamin C

The Hungarian physiologist **Albert Szent-Györgyi** is credited with discovering **vitamin C** (L-ascorbic acid), for which he won the Nobel Prize in 1937. But his life story is just as remarkable as his scientific discovery.

Szent-Györgyi can thank famed musician Gustav Mahler for his very existence. His mother aspired to become an opera singer, but Mahler told her she wasn't good enough and recommended she get married instead.

Albert himself studied anatomy until he was drafted into World War I as a medic. Disgusted with the war, he shot himself in the arm so he could be sent home to complete his medical education. But he remained politically active. During the Second World War, he offered his Nobel Prize money to Finland to help that country fight the Soviet invasion.

Szent-Györgyi became active in the Hungarian resistance, using his wealth to help his Jewish friends escape the country. The Hungarian prime minister sent him on a covert mission – under the guise of a scientific lecture in Cairo – to secretly negotiate with the Allies. When Adolf Hitler found out, he personally issued a warrant for Szent-Györgyi's arrest. The physiologist spent the rest of the war hiding from the Nazi Gestapo.

After the war, many supported Szent-Györgyi for Hungary's presidency, but he disliked the Communist regime. He emigrated to American in 1947, where he established the **National Foundation for Cancer Research**. Still politically active, at the age of 74 he refused to pay his taxes to protest the U.S. war in Vietnam.

Today, **vitamin C** is recognized as an essential nutrient for human growth and development. It heals wounds, repairs tissues, acts as an antioxidant, and helps prevent scurvy. (Whether vitamin C helps prevent or cure the common cold remains open to debate.)

For more information go to:

- Vitamin C
- Albert Szent-Györgyi's Discovery of Vitamin C
- Quantitative Analysis of Vitamin C by Ion Suppression Chromatography
- Analysis of Water Soluble Vitamins in Multivitamin Tablets Using Poroshell 120 EC-C18
- Determination of water soluble vitamins with the Agilent 1120 Compact LC after method development with the Agilent 1200 Series Rapid Resolution LC system and back transfer
- Evolution of alternative biosynthetic pathways for vitamin C following plastid acquisition in photosynthetic eukaryotes
- Vitamin C promotes wound healing through novel pleiotropic mechanisms

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The Discovery of Insulin

On July 27, 1921, Canadian scientist **Frederick Banting** became the first person to isolate the hormone **insulin** for the control of **diabetes**. He was only 32 years old when he won the **Nobel Prize in Medicine** two years later, making him the youngest laureate in that field.

Insulin regulates sugar in the bloodstream. The hormone was first identified in 1869, in little islands of cell clusters produced by the pancreas. ("Insulin" comes from the Latin for "little islands.") A link was soon established between the pancreas and diabetes – if the pancreas was removed, the subject would develop diabetes – but no one could figure out exactly why. Scientists believed the pancreas was secreting something that regulates sugar glucose. But every time they tried to remove the little islands, the cell clusters would die.

Banting realized that the pancreas was also producing digestive juices that were killing the little islands. By tying off various parts of the organ, he was able to isolate and preserve the part of the pancreas that contained what he called "isletin" (later renamed "insulin").

There is an interesting side story. Banting's two lab assistants, Charles Best and Clark Noble, flipped a coin to see who would take the first shift. Best won the toss and ended up assisting throughout the summer. As a result, Banting shared credit for his insulin discovery with the young assistant… as well as half of his Nobel Prize money. This had to be one of the luckiest coin tosses in history.

Today, almost 400 million people worldwide – more than 8 percent of the adult population – suffer from diabetes and depend on insulin.

For more information go to:

- International Diabetes Federation
- The Discovery of Insulin
- Frederick G. Banting biography
- Agilent: Quality control of insulin (application note)
- Agilent: Insulin (application note)

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The Story of Streptomycin

Selman Waksman, an American biochemist who was born on July 2, 1888, first coined the term “antibiotic” in its modern usage. His lab at Rutgers University was credited with discovering more than 20 antibiotics, including streptomycin and neomycin.

Antibiotics are substances that kill or inhibit the growth of bacteria. **Streptomycin** was the first antibiotic to be effective against **tuberculosis**, and is on the World Health Organization’s “List of Essential Medicines.”

Two stories about streptomycin are worth sharing. The first is a controversy about its discovery. **Albert Schatz**, one of Waksman’s graduate students, actually isolated streptomycin and discovered its properties. At Waksman’s urging, Schatz waived all royalty rights to the antibiotic to ensure its widespread adoption. He later learned that Waksman retained his own royalty agreement.

Even worse, Waksman increasingly downplayed Schatz’ role in the discovery. When the Nobel Prize committee announced Waksman as its 1952 winner in Physiology or Medicine, numerous academics recommended Schatz as a co-recipient. Nobel ruled that Schatz was “a mere lab assistant working under an eminent scientist.” Nevertheless, they revised Waksman’s award from “discovery of streptomycin” to “ingenious, systematic and successful studies… that led to the discovery of streptomycin.”

The truth about Schatz’ role was not confirmed until 60 years later in 2012, when a researcher found the original lab notebooks in a forgotten cardboard box. Unfortunately, Schatz had died five years earlier in academic obscurity.

For more information go to:

- Selman A. Waksman (nobelprize.org)
- Waksman Institute of Microbiology (Rutgers University)
- WHO Model Lists of Essential Medicines (World Health Organization)
- Notebooks Shed Light on an Antibiotic’s Contested Discovery (New York Times)

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The Story of Streptomycin

For more information go to:

- Antibiotics Redux: Medicines That Change the Course of History (Library of Congress)
- Confirmatory Method for the Determination of Streptomycin and Dihydrostreptomycin in Honey by LC-MS/MS
- High Resolution HPLC Analysis of Streptomycin Sulfate by ELSD (PDF application note)
- Agilent Small Molecule Pharmaceuticals Solutions

The second story about streptomycin has a happier ending. During World War II, Schatz was trying to manufacture enough streptomycin to use in human tests. By the end of the war, he had produced enough for exactly one test subject. The subject was a 23-year-old lieutenant badly wounded by machine gun fire. He had developed a life-threatening lung infection and was not responding to massive doses of penicillin.

Streptomycin saved the young soldier's life, giving him a miraculous recovery and confirming the antibiotic's effectiveness. Years later, this lieutenant would go on to become Senate Majority Leader and a candidate for President of the United States. His name was **Robert Dole**.

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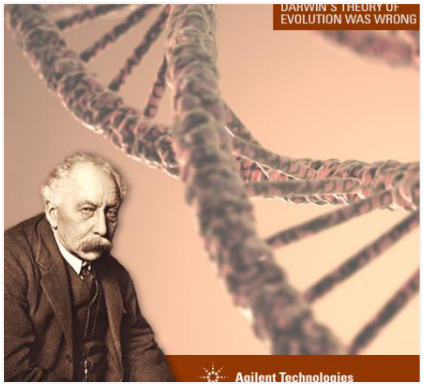
The Man Who Invented “Genetics”



This story remembers British naturalist **William Bateson**, who was born on August 8, 1861. Bateson knew since childhood that he wanted to be a naturalist. **Charles Darwin** had just developed a unifying theory for the life sciences, called “**evolution**.”

But Bateson disagreed with Darwin. While Darwin argued that species evolve through a slow and continuous process, Bateson observed that distinct features in plants and animals often appeared and disappeared randomly between generations. He became fascinated by **discontinuous variation**.

Bateson discovered the work of **Gregor Mendel**, an Austrian monk who was researching pea plants. Mendel studied how traits are inherited, coining the terms “dominant” and “recessive.”

Bateson applied Mendel’s theory of inheritance to Darwin’s theory of evolution, and called the new discipline “**genetics**” (from the Greek for “to give birth”). Bateson also coined the terms “zygote” (for a fertilized cell) and “allelomorph” (for a gene variant, usually shortened to “allele”).

Interestingly, Bateson was adamantly opposed to the theory of **chromosomes**. He finally accepted the idea near the end of his life after visiting Thomas Hunt Morgan’s “fly laboratory”.

While genetics studies specific genes and their role in inheritance, the more complex field of **genomics** studies an organism’s entire genetic makeup, including its interaction with non-genetic factors.

For more information go to:

- William Bateson (Encyclopaedia Britannica)
- William Bateson (1861-1926) (The Embryo Project Encyclopedia)
- Coining the Term “Genetics” (1900 – 1902) (HistoryofInformation.com)
- Agilent Genomics

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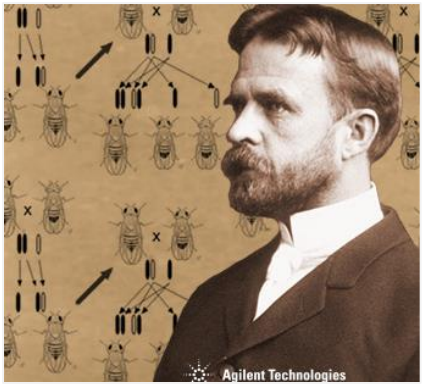
He Spent 17 Years in a Room Filled with Flies



For more information go to:

- Thomas H. Morgan Biography
- Thomas Hunt Morgan and Sex Linkage
- Thomas Hunt Morgan at Columbia University
- Agilent Technologies Introduces Tools for Next-Generation Genome Engineeringl
- Agilent Genomics Solutions

American biologist **Thomas Hunt Morgan** was born on September 25, 1866. As a child, he was fascinated by fossils and bird eggs. As an adult, he became fascinated by experimental zoology, seeking physical and chemical explanations for the way organisms developed. He rejected Darwin's mechanism of **natural selection** in favor of the possibility of **biological evolution**, and spent years looking for a mutation that could be inherited.

In 1910, Morgan was surprised to find a single white-eyed male among a swarm of red-eyed fruit flies. When he bred the white-eyed male with a red-eyed female, all of the offspring were red-eyed. However, a *second* generation produced some additional white-eyed males! Morgan realized that hereditary traits were carried on specific **chromosomes**, and that some traits were sex-linked. He proposed that chromosomes contain collections of smaller units called **genes**. ("Gene" is derived from the Greek *genesis* for "birth" and *genos* for "origin.")

Morgan and his students spent 17 years in Columbia University's "Fly Room" – a 16 x 23-foot room described as "cramped, dusty, smelly and cockroach ridden" – where they studied thousands of fruit flies and their successive generations. One of his students developed the first genetic map in 1913, and their discoveries formed the basis for modern **genetics**.

Morgan was awarded the 1933 **Nobel Prize in Physiology or Medicine** for his work. The Division of Biology that he established at the California Institute of Technology has produced seven Nobel Prize winners. Today, the "Morgan*"* is the unit for measuring distances along chromosomes.

While **genetics** studies specific genes and their role in inheritance, the more complex field of **genomics** studies an organism's entire genetic makeup, including its interaction with non-genetic factors.

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The Man Who Unlocked the Secret of DNA

For more information go to:

- Discovering DNA: Friedrich Miescher and the early years of nucleic acid research
- Alfred Day Hershey
- Independent functions of viral protein and nucleic acid in growth of bacteriophage
- The Hershey-Chase Blender Experiment (PDF)
- Agilent Genomics Solutions

You probably know that **DNA** (deoxyribonucleic acid) holds the genetic instructions for all living organisms. You may not know that it took scientists almost a hundred years to figure this out. We can thank **Alfred Hershey**, who was born on December 4, 1908.

DNA was first discovered in 1869 by the Swiss physician Friedrich Miescher. Nevertheless, for the next century scientists believed that genetic information was carried by **proteins**, not DNA. The structure of DNA appeared too simple to be genetic material.

Hershey, an American bacteriologist, studied **bacteriophages**, which are viruses that can infect bacteria. (The difference between a **virus** and a **bacterium** is that a virus is not a living organism. It does not have a mechanism for reproducing. Instead, it infects and takes over other cells, using those cells' own processes to create more viruses.)

Hershey and his partners observed that when two different bacteriophages infect the same bacteria, they often exchange genetic information with each other. This led Hershey and his assistant Martha Chase to conduct the 1952 **Hershey-Chase experiment**, one of the most famous experiments in molecular biology. They showed that when a bacteriophage infects a bacterium, its DNA enters the host cell but its proteins do not.

The Hershey-Chase experiment led to further studies that ultimately proved the hereditary properties of DNA. Hershey shared the 1969 **Nobel Prize** in Physiology or Medicine for his discoveries.

Barbara McClintock and Her Jumping Genes

Barbara McClintock was born June 16, 1902. Dr. McClintock is currently the only female ever to receive an unshared **Nobel Prize** in Physiology or Medicine. And she had to endure decades of skepticism and ridicule before her work was ever acknowledged.

As a botanist, McClintock studied **maize**, a type of corn characterized by different-colored kernels. Because each maize kernel is an embryo produced by individual fertilization, it is ideal for genetic analysis.

In the 1930s, scientists believed that **chromosomes** were fixed and unchanging, like beads on a string. McClintock demonstrated instead that chromosomes can move, break, cross over and recombine, creating new genetic traits. She further showed that such chromosomal changes can be passed from parents to offspring. Her work was considered so revolutionary at the time that she was ridiculed by the scientific community and largely ignored.

It was not until *four decades later*, after scientists unlocked the genetic code, that McClintock was finally proven correct. **Transposons**, or "jumping genes," actually constitute more than 65 percent of the human genome. McClintock won the Nobel Prize in 1983 for her pioneering work in **cytogenetics** (cellular genetics).

Today, **epigenetics** (the concept of heritable changes not caused by changes to the DNA sequence) is a fundamental concept in genetics. McClintock's pioneering work has been especially valuable in current disease research. Scientists believe that jumping genes are involved in the transformation of normal cells into cancerous cells.

For more information go to:

- Barbara McClintock and the Discovery of Jumping Genes (Transposons)
- Agilent: Epigenetics Research Using SureSelect Human Methyl-Seq (video)
- Agilent's Portfolio for Gene Regulation
- Agilent Epigenetic Analysis Solutions (PDF)

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Have You Washed Your Hands Today?

For more information go to:

- Dr. Semmelweis' biography (semmelweis.org)
- The Doctor Who Championed Hand-Washing And Briefly Saved Lives (National Public Radio)
- The Semmelweis Reflex explains why people reject the new
- Introducing the new Agilent FTIR imaging microscope
- Introducing the Agilent 5100 ICP-OES
- Introducing the next generation of MP-AES technology

Chances are that you have never heard of **Ignaz Semmelweis**, a Hungarian physician who was born July 1, 1818. Yet if not for him, many of us might not be alive today… or might never have been born.

In the mid-1800s, there were two maternity clinics in Vienna, Austria. While one had a maternal mortality rate of less than 4 percent, the other's was more than 10 percent. In other words, one in 10 women who gave birth in that clinic died after childbirth. Shockingly, even women who delivered *in the street* had a higher survival rate than those admitted to the clinic.

Semmelweis, an assistant at the clinic, wracked his brains trying to determine the cause of this **puerperal fever** (also known as "childbed fever"). Both clinics had the same climates, procedures, religious practices, and populations. The only difference was that this clinic's doctors also performed autopsies, while the safer clinic employed only midwives.

Semmelweis argued that cadaverous particles left on the hands of the doctors were fatally infecting the women. He advocated that physicians *wash their hands* between examinations. Indeed, after he implemented this practice, the mortality rate dropped 90 percent.

But Semmelweis' peers were furious. The concept of **germs** had not yet been discovered. At the time, disease was attributed to miasma and bad humours. The medical community refused to believe that the solution to high mortality rates could be so simple. Physicians throughout Europe were insulted and offended that they should have to wash their hands, which they didn't normally do. Semmelweis himself could offer no scientific explanation for his recommendation.

Semmelweis lost his position and was ostracized by the medical community. (After he departed the clinic, hand-washing was abandoned and mortality rates jumped six-fold.) Semmelweis became increasingly obsessed with a hygiene crusade that fell on deaf ears, and he was ultimately committed to an asylum. Ironically, he suffered an infection after being beaten by guards and he died 14 days after being admitted, at the age of 47.

More than 20 years later, **Louis Pasteur** developed the **germ theory of disease**. Hygiene and cleanliness are now critical in medical care around the world. Today, Semmelweis is recognized as "the father of infection control" and a pioneer of antiseptic procedures. And the term "**Semmelweis Reflex**" refers to the human tendency to reject new knowledge that contradicts established beliefs.

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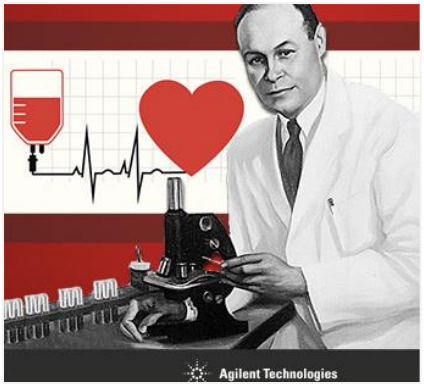
The Man Who Enabled Blood Transfusions



For more information go to:

- Charles Drew
- The Truth About the Death of Charles Drew
- Serum Vs. Plasma
- 10 facts on blood transfusion (World Health Organization)
- Metabolite Identification in Blood Plasma Using GC/MS and the Agilent Fiehn GC/MS Metabolomics RTL Library (PDF)
- The influence of sample collection methodology and sample preprocessing on the blood metabolic profile

Dr. Charles Drew was born June 3, 1904. Drew is credited with discovering methods for preserving blood and enabling blood transfusions.

At the time, transfusions were all but impossible because there was no way to store blood. Within days after leaving the body, blood begins to clot, the white blood cells deteriorate and the electrolytes change.

As a medical student, Drew discovered that he could preserve blood by separating the **plasma** (the liquid part) from the rest and refrigerating the two parts separately. He further discovered that – unlike differing blood types – all people have the same plasma type and can be universal donors.

During World War II, Drew helped establish the **first large-scale national blood bank** for the U.S. military. He pioneered numerous best practices, including absolute sterility, centralized donation centers, mobile bloodmobiles, testing for contamination and handling only by skilled personnel.

However, the military excluded African-Americans from donating blood. As an African American, Drew was not allowed to participate in his own program. The military later changed its policy, but still demanded the segregation of African-American blood for no scientific reason. Drew vigorously objected and resigned his post.

Drew died in 1950 when he fell asleep while driving and crashed his automobile. He was only 45 years old. Contrary to popular myth, he was not refused a blood transfusion because of his race. In fact, a transfusion may even have hastened his death, as massive chest injuries had completely blocked blood flow to his heart.

Today, more than 108 million units of donated blood are collected every year by 10,000 blood banks in 168 countries around the world.

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He Saved More Lives Than Any Other Human

In the late 1700s, **Edward Jenner**, an English physician, dedicated himself to the eradication of **smallpox**, one of the leading causes of death at the time. It was believed that milkmaids were immune to the disease, but no one knew why. Dr. Jenner observed that milkmaids were often exposed to cowpox, and theorized that the resulting blisters somehow protected these women from the deadlier smallpox.

On May 14, 1796, Dr. Jenner took the pus from cowpox blisters and used it to inoculate an eight-year old boy. After several exposures to smallpox, the boy showed no signs of infection.

Dr. Jenner published his findings in 1798, but it was not until 1840 that the British government finally passed the first Act promoting vaccinations. (The word "**vaccine**" is Latin for "from the cow.")

After worldwide vaccination campaigns throughout the 19th and 20th centuries, smallpox was declared to be eradicated in 1979. Today, Edward Jenner is considered "the father of immunology."

His contribution is believed to have saved more lives than the work of any other human in history.

For more information go to:

- About Edward Jenner (The Jenner Institute)
- Dr. Jenner's House (Jenner Museum)
- Agilent Human Disease Research

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These stories and anecdotes about famous – and not-so-famous – milestones and personalities in science and technology are meant to bring science to life.

You are welcome to use these stories for teaching purpose to educate students about the importance of analytical chemistry.

Visit Agilent Technologies Blog http://blog.agilent.com/ for more stories.