Milestones of Science

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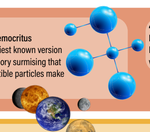
Science
AAAS

B.C.

599-500 B.C.
Greek philosophers begin constructing natural and rational explanations for phenomena.

582-500 B.C.
Pythagoras
Recognizes connection between mathematics and nature.

499-300 B.C.
Leucippus and Democritus
Articulate the earliest known version of atomism—a theory surmising that minute, indestructible particles make up everything.

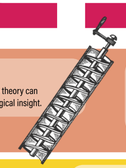


427-347 B.C.
Plato
Emphasizes the value of theory.

384-322 B.C.
Aristotle
Promotes logic and common sense in the observation and classification of natural phenomena. His writings become a cornerstone of Western thinking for nearly 2,000 years.

299-200 B.C.
Euclid
Writes *The Elements*, one of the earliest logically built texts using axioms and logical deduction for geometric proofs.

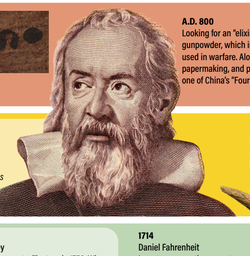
287-212 B.C.
Archimedes
Recognizes how theory can lead to technological insight.



A.D. 140
Ptolemy
Summarizes his theory of geocentric astronomy—hypothesizing that everything revolves around the Earth—and this theory reigns until Copernicus (1543).

A.D. 131-200
Galen
Writes important text on human anatomy that is preeminent until Vesalius (1543).

~ A.D. 500
Zero
Symbol for "zero" is created in India.



A.D. 800
Looking for an "elixir of life," Taoists develop gunpowder, which ironically ends up being used in warfare. Along with the compass, papermaking, and printing, it is considered one of China's "Four Great Inventions."

1000

~1000
Mayan and Hindu skywatchers make astronomical observations for agricultural and religious purposes.

1166
Oxford University is founded and becomes a model for other European universities.

1285-1349
William of Ockham
Touts simplicity in explanation as a virtue.

1454
Johannes Gutenberg
Demonstrates movable-type printing press in Germany.

1543
Andreas Vesalius
Publishes *De Humani Corporis Fabrica*, displacing Galen as the authority on anatomy.

1543
Nicolaus Copernicus
Publishes *De Revolutionibus Orbium Coelestium*, displacing the geocentric (Ptolemaic) system with the heliocentric system, in which the planets in our solar system revolve around the sun.

1570
Tycho Brahe
Increases accuracy of astronomical observation by developing more accurate instrumentation.

1590
Zacharias Janssen
Builds first microscope.

In 1590, Zacharias Janssen put two lenses at the ends of a tube and made a crude microscope. Now, combinations of chemical dyes and advanced optics can reveal color-coded proteins moving inside living cells.

1600

1600
William Gilbert
Publishes *De Magnete*, in which he postulates that the Earth behaves as a huge magnet.

1608
Hans Lippershey
Manufactures the first telescopes.

1609
Johannes Kepler
Publishes *Astronomia Nova*, in which he defines first two laws of planetary motion

1610
Galileo Galilei
Using one of the first telescopes, he makes extensive astronomical observations and publishes *Sidereus Nuncius*.

1620
Francis Bacon
Publishes *Novum Organum*, in which he espouses careful observation and inductive reasoning as the basis of scientific study.

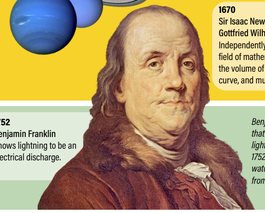
1629
William Harvey
Publishes *Exercitatio anatomica de motu cordis et sanguinis in animalibus*, by which he establishes the geometry of the circulatory system.

1637
Rene Descartes
His *Discours de la Méthode* combines skepticism, algebra, and geometry in a powerful mathematical method of analysis.

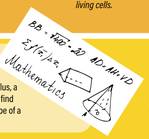
1654
Pierre de Fermat and Blaise Pascal
Develop the basis for the theory of probability, or the odds of one outcome over another.

1660
The Royal Society in England is legally chartered.

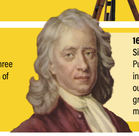
1661
Robert Boyle
Publishes *The Sceptical Chymist*, helping to establish a more modern basis for chemistry.



1670
Sir Isaac Newton and Gottfried Wilhelm Leibniz
Independently discover calculus, a field of mathematics that can find the volume of shapes, the slope of a curve, and much more.



1676
Anton van Leeuwenhoek
Uses a simple microscope to magnify the world up to 200 times. In pond water, he sees tiny living organisms, which opens a pathway to microbiology.



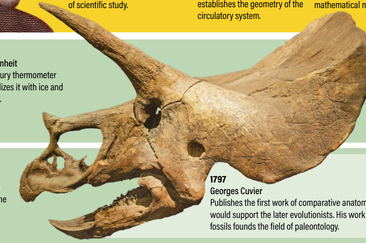
1686
John Ray
Starts publishing a three volume classification of 18,600 plant species.

1687
Sir Isaac Newton
Publishes his *Principia Mathematica*, in which he mathematically lays out the laws of motion, universal gravitation, and the scientific method in general.

1700

1705
Edmund Halley
Predicts that a comet will return in 1758. When it does, it serves as a powerful demonstration of science's ability to understand the world.

1714
Daniel Fahrenheit
Invents mercury thermometer and standardizes it with ice and boiling water.



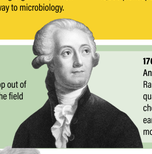
1720
Lady Mary Wortley Montagu
Introduces early technique of immunization against diseases.

1735
Carolus Linnaeus (Carl von Linné)
Publishes *Systema Naturae*, thereby greatly pushing forward systematic study of rules and classification of the living kingdoms.

1752
Benjamin Franklin
Shows lightning to be an electrical discharge.

Benjamin Franklin long suspected that an electrical current created lightning. He proved that in June 1752 by flying a kite into a storm and watching lightning send a spark from a suspended key.

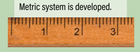
1759
Kaspar Wolff
Shows that specialized organs develop out of unspecialized tissue, which spawns the field of developmental biology.



1769
Antoine Lavoisier
Raises the practice of making quantitative measurement in chemical studies to a level that earns him credit as "the father of modern chemistry."

1780
Luigi Galvani
Observes the connection between electricity and muscle action.

1790
Metric system is developed.



1791-1802
Benjamin Banneker
Publishes astronomical and mathematical almanacs and earns the title "first African-American man of science."

1795
James Hutton
Publishes *Theory of the Earth*, arguing for a picture of gradual, steady terrestrial changes that became known as uniformitarianism.

1796
Edward Jenner
Develops a technique he calls "vaccination," and the science of immunology begins.

1797
Georges Cuvier
Publishes the first work of comparative anatomy that would support the later evolutionists. His work with fossils founds the field of paleontology.

1800

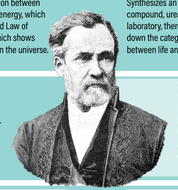
1806
Alessandro Volta
Invents the electric battery, thereby opening the way to several new sciences—including electrochemistry—and technologies.

1808
John Dalton
Publishes *A New System of Chemical Philosophy*, refining the idea of atoms and how they combine.

1809
Jean-Baptiste de Lamarck
Publishes *Zoological Philosophy*, in which he proposes that evolution occurs by the inheritance of traits acquired during one's lifetime.

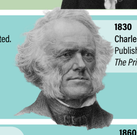
1820
Hans Christian Oersted
Discovers the connection between electricity and magnetism—the basic principle of electromagnetism.

1824
Sadi Carnot
Writes about the relation between heat and mechanical energy, which anticipated the Second Law of Thermodynamics—which shows that order decreases in the universe.



1828
Friedrich Wohler
Synthesizes an organic compound, urea, in the laboratory, thereby breaking down the categorical distinction between life and nonlife.

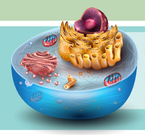
1828-1839
First electric cars created.



1830
Charles Lyell
Publishes first volume of *The Principles of Geology*.

Mid-1830s
Charles Babbage
Developed the precursor to the modern computer, the Analytical Engine. Mathematician **Ada Lovelace** publishes the first computer program in 1843.

1837
Louis Agassiz
Argues for the existence of an ice age in the past.

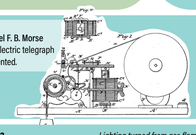


1838-1839
Matthias Schleiden and Theodor Schwann
Develop cell theory—showing that living things are made of cells.

1840
James Joule
Develops the concept of conservation of energy.

1840
Justus von Liebig
Father of the fertilizer industry, Von Liebig publishes *Die organische Chemie in ihrer Anwendung auf Agricultur und Physiologie*, in which he argues that crops need nitrogen-based fertilizer for optimal growth.

1837
Samuel F. B. Morse
First electric telegraph is invented.



1845
Alexander von Humboldt
Publishes the first of five volumes in his treatise, *Kosmos*, which describes the life's work of this renowned explorer.

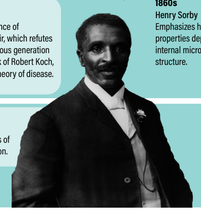
1859
Charles Darwin
Publishes the *Origin of Species*, outlining his theory of evolution partly based on studies of finches. Through natural selection their beaks evolved to best suit their function.

When Charles Darwin published On the Origin of Species *in 1859, the modern era of evolution started, especially in conjunction with Gregor Mendel's work with peas, which revealed how species might evolve. More details about the behavior of genes—such as Barbara McClintock's discovery that they can jump along the chromosomes—keep improving our understanding of heredity.*

1859
Louis Pasteur
Demonstrates the presence of microorganisms in the air, which refutes the concept of spontaneous generation and, along with the work of Robert Koch, consolidates the germ theory of disease.

1860s
Henry Sorby
Emphasizes how material properties depend on their internal microscopic structure.

1865
Gregor Mendel
Publishes work containing his famous laws of heredity, which he worked out by breeding pea plants.



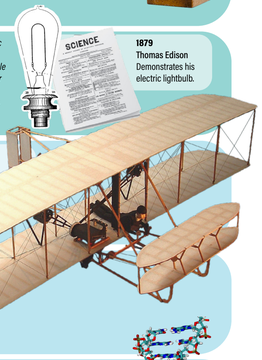
1866
Alfred Nobel
Patents dynamite, which turns out to be a relatively safe and useful explosive. He later uses his fortune to set up the Nobel Prizes that honor scientists and scholars in six areas.

1869
Dmitri Mendeleev
Publishes his *Periodic Table of the Chemical Elements*.

1869
Friedrich Miescher
Isolates DNA for the first time—from the nuclei of white blood cells—and calls it "nuclein."

1873
James Clerk Maxwell
Publishes the mathematical equations that describe the interplay between electricity and magnetism.

Lighting turned from gas flames to electric glows, at least potentially, when Thomas Edison created the first commercially viable lightbulb in 1879. He also developed power plants and switches to create an entire system for electric lighting. One year later, Edison also founded Science*, the AAAS journal, in 1880.*



1879
Thomas Edison
Demonstrates his electric lightbulb.

1887
Nikola Tesla
Tesla, one of the world's greatest inventors, develops the first induction motor that runs on alternating current.

1889
Camillo Golgi
Reveals the cellular anatomy of the brain.

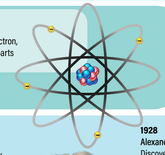
1893
Daniel Hale Williams
Performs the first open-heart surgery.

1895
Wilhelm Röntgen
Discovers X-rays, which can reveal bones right through the skin.

1896
George Washington Carver
Advances agriculture over four decades of research, including work on crop rotation.

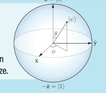
1897
Marie Curie
She and her husband, Pierre, clarify the concept of radioactivity as an atomic property.

1897
J. J. Thomson
Discovers the electron, one of the basic parts of an atom.



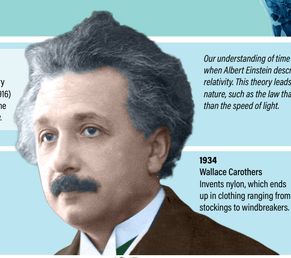
1900

1900
Max Planck
Quantum science is born and reveals that energy comes in packets of a fixed size.



1903
Orville and Wilbur Wright
Accomplish first manned airplane flight at Kitty Hawk, NC. During 12 seconds of flight, Orville flew the plane about 120 feet.

1905
Albert Einstein
Develops his special theory of relativity, and later (in 1916) expands this concept as the general theory of relativity.



Our understanding of time changed forever in 1905, when Albert Einstein described his theory of special relativity. This theory leads to some constraints on nature, such as the law that nothing can travel faster than the speed of light.

1908
Paul Ehrlich
Wins Nobel Prize for contributions to immunity. He uses chemicals to treat syphilis, coining the term "chemotherapy."

1909
Fritz Haber creates a chemical process for making ammonia using nitrogen fixation, leading to mass production of fertilizers—and explosives.

1912
Alfred Wegener
Proposes that sections of the Earth's crust move slowly across the globe, and calls this the "continental drift theory."

1920s
Quantum mechanics—the study of the physics of atomic and subatomic particles—emerges.

1927
Georges Lemaître
Introduces the Big Bang theory that describes the beginning of the universe.

1927
Werner Karl Heisenberg
Publishes his famous uncertainty principle, critical to the foundation of quantum mechanics.

1928
Alexander Fleming
Discovers that a strain of mold gives off a substance—later identified as penicillin—that kills some bacteria.

1929
Edwin Hubble
Successfully argues that the universe is expanding.

1930
Linus Pauling
Updates chemistry with ideas from quantum mechanics.

1934
Wallace Carothers
Invents nylon, which ends up in clothing ranging from stockings to windbreakers.

1934
Kurt Gödel
Reveals that some mathematical ideas cannot be proved true or false.

1938
Hans Spemann
Proposes the concept of cloning, or making an exact copy of an organism.

1939-1945
Birth of nuclear technology and the development of atomic bombs.

Early 1940s
Charles Richard Drew
Leads the way to producing and storing plasma for blood transfusions.

1940
Konrad Zuse
Builds the first programmable computer, the Turing-complete Z3.

1942
Conrad Hal Waddington
Coins the term "epigenetics" to describe heritable modifications to a cell's genetic material that do not change the DNA sequence.

1946
Completion of the electronic numerical integrator and computer, or ENIAC.

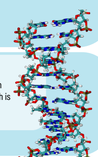
1947
William Shockley, Walter Brattain and John Bardeen
Invent the transistor, which is the fundamental device in all modern electronics.

1951
Barbara McClintock
Describes transposable genetic elements, often called "jumping genes."

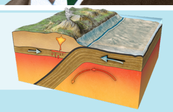
1951-1953
Rosalind Franklin
Performs X-ray crystallography on DNA, which helps unveil its structure.

1952
Jonas Salk
Develops polio vaccine.

1953
James Watson and Francis Crick
Publish the structure of DNA, often called the "blueprint for life," which is basically a twisted ladder.

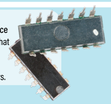


1953
Harry Hess, Dan McKenzie, Jason Morgan, and J. Tuzo Wilson
Develop the theory of tectonic plates, which are the parts that make continents drift.



1957
Soviets launch the Sputnik satellite starting the space race that led to the U.S. putting the first man on the moon in 1969.

1958
Jack Kilby and Robert Noyce
Invent integrated circuits that are the electronic "brains" of everything from digital watches to supercomputers.

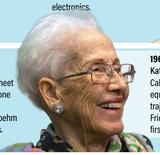


1959
Mary and Louis Leakey
Unearth the first of many fossils of human ancestors in the Olduvai Gorge in Tanzania.

1961
Murray Gell-Mann
Postulates the existence of the quark—basically a unit that constitutes atomic particles.

1962
Rachel Carson
Publishes *Silent Spring*, linking pesticide use to ecological ills.

1962
Discovery of graphene—a sheet of carbon just one atom thick—by Hanns-Peter Boehm and colleagues.



1962
Katherine Johnson
Calculated the mathematical equations that determined the orbital trajectory for John Glenn's successful Friendship 7 mission, making him the first American to orbit the earth.

1964
Arno Penzias and Robert Wilson
Detect radiation remaining from the Big Bang.

1965
Stephanie Kwolek
develops the light, bullet-resistant material Kevlar while working at DuPont.

1968
Discovery of electro-optics effects in liquid crystals, setting the stage for the invention of liquid crystal and LED displays, including TVs and smartphones.

July 20, 1969
Apollo 11's Lunar Module lands on the moon, and astronaut Neil Armstrong becomes the first person to set foot on the moon.

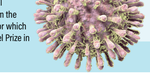
1969
Willard S. Boyle and George E. Smith invent the charge-coupled device (CCD) sensor, which goes on to transform photography.

1969
The U.S. Department of Defense's Advanced Research Projects Agency creates ARPAnet, the precursor to the internet and the World Wide Web.

1970
Hamilton Smith and Daniel Nathans
Develop first recombinant DNA techniques that can mix genes from different organisms.

1970s
The Standard Model of particle physics emerges and explains how fundamental particles—such as quarks and leptons—interact.

1972
Tu Youyou
discovers the antimalarial artemisinin—isolated from the plant *Artemisia annua*—for which she shared the 2015 Nobel Prize in Physiology or Medicine.



1983
Françoise Barré-Sinoussi and Luc Montagnier
Discover the human immunodeficiency virus.

1983
Kary Mullis
Develops the polymerase chain reaction (PCR) that fundamentally changes how biological research is done.

1985
Ozone hole discovered over Antarctica makes a dramatic statement about the effect of human activities on the environment.

1987
The first publication by **Yoshizumi Ishino** of what later became known as CRISPR—repeats in the DNA of certain organisms that scientists subsequently harnessed to create a revolutionary gene-editing tool.

1990
Human Genome Project begins with a goal of sequencing all of the human chromosomes.

1990
Seiji Ogawa
Describes blood-oxygen-level-dependent contrast, or BOLD, an fMRI method that records activity in the brain.

1991
Two hikers discover Ötzi, the Iceman of the Alps, who turns out to be 5,300 years old—the oldest frozen mummy ever found.

1992
World Wide Web is demonstrated at CERN.WWW.net.

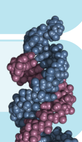
1993
Andrew Wiles
Announces proof of Fermat's Last Theorem, which had eluded mathematicians for more than 350 years.

1993
V. Ambros and B. Wightman
Discover microRNA—short RNAs that regulate genes through RNA interference (see 1995).

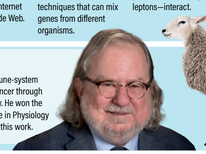
1994
IBM Simon released. Retrospectively called the first "smartphone," even though the term was not coined until a year later.

1995
The Bose-Einstein condensate—a new form of matter—is created in a laboratory.

1995
Su Guo and Kenneth Kemphues
Describe RNA interference, which can be used to shut off specific genes.



1996
James Allison
Engineers immune-system cells to fight cancer through immunotherapy. He won the 2018 Nobel Prize in Physiology or Medicine for this work.



1997
Ian Wilmut and Keith Campbell
Clone a mammal from adult cells for the first time—a sheep named Dolly.

1998
John Gearhart and James Thomson
Independently grow embryonic stem cells that might be used to make any other kinds of cells, from bone and blood to muscles and neurons.

2000

2001
Draft sequence of human genome published.
In 2001, the Human Genome Project and Celera (led by Craig Venter)—the latter group's study was published in Science—unveiled the order of pieces, or sequence, of the roughly 30,000 genes in human chromosomes. This work opened the way to a future of therapies designed just for you, or personalized medicine.

2001
Chinese farmers find feather-covered, ducklike dinosaur fossil.

2001
Toumaï fossil
Skull of oldest-known human relative is discovered.

2003
Jie Han and Pieter Jonker
Invent theory of fault-tolerant nanocircuits that lets these microscopic networks work even when they contain defects.

2003
Wilkinson Microwave Anisotropy Probe captures an image of the oldest light in the universe, revealing that the universe is 13.7 billion years old.

2004
NASA's Opportunity Rover finds sediments once deposited by liquid water on Mars. It served for 14 years, well beyond its planned 90-day mission.

2004
Discovery that transplantation of gut bacteria from one mouse to another can cause increased obesity, a milestone in microbiome research.

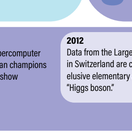
2004
The first Defense Advanced Research Projects Agency (DARPA) Grand Challenge—a competition for driveless cars—takes place. No teams finish the 150-mile course.

2006
Shinya Yamanaka
Turns adult human cells into so-called induced pluripotent stem cells.

2008
Daniel Nocera
Creates a cheap catalyst to split water, which could drive renewable energy.

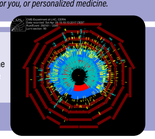
2008
Hideo Hosono
and his team discover superconductivity in an iron-based material.

2010
Scientists at the J. Craig Venter Institute create *Mycoplasma laboratorium*—the first completely synthetic DNA that can replicate itself.

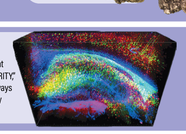


2011
IBM's Watson supercomputer defeats two human champions on the television show *Jeopardy!*

2012
Data from the Large Hadron Collider in Switzerland are consistent with the elusive elementary article called the "Higgs boson."



2013
Karl Deisseroth
Makes the brain transparent with a process called "CLARITY," which creates many new ways to study basic neurobiology and mental-health issues.



2014
The European Space Agency's *Philae* probe becomes the first object to land softly on a comet, named 67P.

2016
The first direct evidence of gravitational waves, predicted by Einstein's general theory of relativity.

2016
Researchers show that killing of senescent (nondividing) cells in model animals can extend their life and reduce disease.

2019
The first photo of a supermassive black hole at the center of the distant M87 galaxy, captured by the Event Horizon Telescope.

2019
Google, together with NASA and Oak Ridge National Laboratory, claim "quantum supremacy," a milestone in quantum computing innovation.

2020
Vaccine makers Pfizer/BioNTech and Moderna produce novel mRNA-based vaccines against the SARS-CoV-2 coronavirus responsible for the COVID-19 pandemic—design, testing, and production was carried out in record time, setting a new standard for vaccine development.

2021
Google's DeepMind AI predicts the molecular structure of hundreds of thousands of proteins, including almost all proteins in the human body.

2022
First genetically modified animal organ—a pig heart—is transplanted into a human.

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