SCIENCE AND TECHNOLOGY

Science and Technology News 2008

The following were some of the more newsworthy developments in science and technology in the past year. (See also Astronomy, Computers and Telecommunications, and the Chronology of the Year's Events.)

Phoenix Lander Finds Water Ice on Mars

NASA's Phoenix lander arrived on Mars on May 25, 2008. The lander was designed to analyze the soil and ice to better understand the Martian environment, and to determine whether the soil could support life. Positive results could possibly pave the way for future manned missions and colonization.

NASA also hoped the mission would help educate a wider public about the space program and its science. Media relations manager Veronica McGregor created an enthusiastic persona for the Phoenix lander on the Twitter microblogging site. On June 19, its tens of thousands of followers received this breaking news: "Are you ready to celebrate? Well, get ready: We have ICE!!!!! Yes, ICE, *WATER ICE* on Mars! w00t!!! Best day ever!!"

Later experimentation revealed that the soil contained salt, had a pH of 8, and contained the nutrients magnesium, sodium, potassium and chloride. According to mission scientist Samuel P. Kounaves, "You could probably grow asparagus, but not strawberries."

The primary mission had been planned to last 90 Martian days; as of Oct. 2008, it had far exceeded this, and had analyzed double the planned amount of soil samples. It was expected to shut down at the end of Nov. 2008. If the lander weathers the cold, dark Martian winter, it will report back in the spring.

LHC Switches On, Then Off

On Sept. 10, 2008, the European Organization for Nuclear Research (better known as CERN) began operating the Large Hadron Collider (LHC) in Geneva, Switzerland. The largest and highest-energy particle accelerator ever built successfully sent beams of protons all the way around the 27 km (17 mi) track. Nine days after this promising beginning, a faulty electrical connection between 2 superconducting magnets caused them to stop functioning properly. Several magnets were damaged in the resulting chain of events, requiring the LHC to be shut down for repairs. It was scheduled to start up again in early spring 2009.

Once it is fully functioning, the LHC will generate approximately 15 petabytes of data every year, enough to fill more than 1.7 mil dual-layer DVDs. To analyze this mountain of information, scientific organizations in 33 countries have formed the LHC Computing Grid. Data will first be distributed to 11 major centers in Europe, North America, and Asia using dedicated fiber-optic cables; those centers will in turn send data to more than 140 second-tier centers. The complete grid will require some 100,000 computer processors and is expected to be able to handle up to half a million jobs in one day. In addition to using the LHC's data to either prove or disprove the existence of the Higgs boson and other particles, scientists expect to apply lessons learned from the grid itself to process other projects.

Helium Shortage Ahead

Helium isn't just for balloons. The stable, non-reactive gas is an excellent conductor of heat; its unique properties make it indispensable in fields including microchip production, fiber optics, welding, and the space program. But according to Washington Univ. professor of chemistry and physics Lee Sobotka, the world is facing a shortage of helium. The world's largest reserve, located in Amarillo, Texas, will be depleted within eight years. Most helium on Earth is a byproduct of billions of years of radioactive decay, and there is no easy way of generating more of it. Sobotka is calling for laboratories and industry to conserve, recapture, and reuse helium, and on refiners of oil and natural gas to capture helium, which is a byproduct of refining processes.

Secrets of 2,100-Year-Old Computer Revealed

Previous research on the Antikythera Mechanism, a compact gear-driven device dating back at least 2,100 years, showed that it was used to calculate astronomical cycles, including eclipses and phases of the moon and planets. An international team led by experts from Cardiff Univ. announced July 30, 2008, that they had deciphered additional inscriptions using high-resolution imaging and three-dimensional X-rays to gain a better understanding of the device. The Corinthian names of 12 calendar months indicate that the computer was from northwestern Greece, and suggest a possible link with the school of Archimedes. The researchers also found that the lengths of the months were regulated in a 19-year cycle, a possibility which historians had previously dismissed as being too complex for that society. Another dial may have been used to determine the starting date of the Olympic games, which were held every four years, beginning with the first new moon after the summer solstice.

New Progress on the "Luke Arm"

When the U.S. Dept. of Defense wanted a new prosthetic arm for disabled veterans, they came to New Hampshire inventor Dean Kamen, best known as the creator of the Segway personal transporter. The best artificial arms currently available have only three degrees of freedom: they can move at the wrist and elbow, and open and close a hook of some sort. By contrast, the human arm has 22 degrees of freedom.

In 2008, after spending two years and $18.1 million on the project, Kamen demonstrated prototypes of the new "Luke arm." Named for Luke Skywalker's prosthetic arm in the *Star Wars* films, it has 18 degrees of freedom. It is sensitive enough to pick up a grape, precise enough to scratch its user's nose, and strong enough to lift a 40-pound weight.

The Luke arm is modular, with separate electronics in the hand, forearm, and upper arm, so it can be used by people with different degrees of amputation. A small vibrating attachment provides tactile feedback. It can use a variety of control inputs, ranging from completely noninvasive foot pedals to direct connection with the user's nerve endings. In tests, users have learned to use the arm to perform basic functions in as little as one day. As of late 2008, Kamen was hoping to start clinical trials of the Luke arm, a necessary step for FDA approval.

One Step Closer to Real-Life "Invisibility Cloak"

Harry Potter's invisibility cloak and *Star Trek*-style cloaking devices don't exist in the real world, but developing them may not be impossible. Scientists working on "metamaterials"—new materials with unusual properties that do not occur in nature—have taken several important steps toward rendering objects invisible from view.

When light strikes normal materials, it bounces off them; the wavelengths reflected back to the observer determine what the object looks like. Competing teams of researchers have been developing metamaterials that can bend light around objects, effectively making them invisible. So far, all these approaches are limited to very, very small objects, and must be keyed to one specific wavelength for a given material, rather than the entire visible spectrum.

In 2006, scientists at Duke Univ. demonstrated a "cloaking device" for microwave wavelengths, which are longer than visible light. At the end of 2007, researchers at the Univ. of Stuttgart demonstrated that the same could be done for wavelengths in the visible spectrum, using a lattice of incredibly small wires. Additional techniques were developed in 2008 by teams at Carnegie Mellon Univ. and the Univ. of Grenada. Meanwhile, scientists in Shanghai and Hong Kong made progress on an "anti-cloak" that would render a cloaked object partly visible.

Science Glossary

This glossary covers some concepts that come up frequently in the news, in biology, chemistry, geology, and physics. See also Astronomy, Computers and Telecommunications, Environment, Health, Meteorology, Weights and Measures.

Biology

Note: For classification terms such as *kingdom*, *phylum*, etc., see Environment chapter.

Amino acid: one of about 20 similar small molecules that are the building blocks of proteins.

Antibiotic: a substance produced by or derived from a bacterium, fungus, or other organism that battles bacterial infections and diseases, killing bacteria or halting their growth.

Autoimmunity: a condition in which an individual's immune system reacts against his or her own tissues; leads to diseases such as lupus, diabetes, inflammatory bowel disease, rheumatoid arthritis.

Bacteriophage: a virus that infects or lyses bacteria. Also called "phage."

Bacterium (plural, bacteria): one of a large, varied class of microscopic and simple, single-celled organisms; bacteria live almost everywhere—some forms cause disease, while others are useful in digestion and other natural processes.

Biodiversity: richness of variety of life forms—both plant and animal—in a given environment.

Cell: the smallest unit of life capable of living independently, or with other cells; usually bounded by a membrane; may include a nucleus and other specialized parts.

Cholesterol: a fatty substance in animal tissues; it is produced by the liver in humans, is found in foods such as butter, eggs, and meat, and is an essential body constituent.

Chromosome: one of the rod-like structures in cell nuclei that carry genetic material (DNA).

Cloning: the process of copying a particular piece of DNA to allow it to be sequenced, studied, or used in some other way; can also refer to producing a genetic copy of an organism.

DNA (deoxyribonucleic acid): the chemical substance that carries genetic information, which determines the form and functioning of all living things.

Ecosystem: an interdependent community of living organisms and their climatic and geographical habitat.

Enzyme: a protein that promotes a particular chemical reaction in the body.

Estrogen: one of a group of hormones that promote development of female secondary sex characteristics and the growth and health of the female reproductive system; males also produce small amounts of estrogen.

Eukaryote: single- or multi-celled organisms whose cells have distinct nuclei.

Evolution: the process of gradual change that may occur as a species adapts to its environment; natural selection is the process by which evolution occurs.

Gene: a portion of a DNA molecule that provides the blueprint for the assembly of a protein.

Gene pool: the collection and total diversity of genes in an interbreeding population.

Gene therapy: a treatment in which scientists try to implant functioning genes into a person's cells so the genes can produce proteins that the person lacks or that help the person fight disease.

Genetic sequencing: the process of determining the order of subunits within a gene or even the order of all genes for an organism.

Genome: the complete set of an organism's genetic material.

Hormone: a substance secreted in one part of an organism that regulates the functioning of other tissues or organs.

Meiosis: the process of cell division that results in gametes (sperm or egg cells), all of which contain half the number of chromosomes as their precursor.

Metabolism: the sum total of the body's chemical processes providing energy for vital functions, and enabling new material to be synthesized.

Mitosis: the process by which a cell divides its nucleus and other cell materials into two duplicate daughter cells with the same DNA.

Neuron: a nerve cell, of the type found in the brain or spinal cord, that sends electrical and chemical messages to other cells.

Nucleus (plural: nuclei): the center of an atom; or the portion of a cell that contains genetic material and regulates growth and metabolism.

Organism: a living entity, capable of growth, metabolism, and usually reproduction.

Phenotype: the observable properties and characteristics of an organism arising at least in part from its genetic makeup.

Pheromone: a chemical secreted by an animal to influence the behavior of other members of its own species.

Placebo effect: a phenomenon in which patients show improvements even though they have taken a medically inactive substance, called a placebo.

Prokaryote: a single-celled organism that does not have a distinct nucleus, such as bacteria, cyanobacteria, and blue-green algae.

Protein: a complex molecule made up of one or more chains of amino acids; essential to the structure and function of all cells.

RNA (ribonucleic acid): a complex molecule similar to the genetic material DNA, but usually single-stranded; several forms of RNA translate the genetic code of DNA and use that code to assemble proteins for structural and biological functions in the body.

Species: a population of organisms that breed with each other in nature and produce fertile offspring; other definitions of species exist to accommodate the diversity of life on Earth.

Stem cell: a cell that can give rise to other types of cells; for instance, bone marrow stem cells divide and produce different types of blood cells.

Steroid: type of hormone that freely enters cells (other hormones bind to cell surfaces); different varieties can suppress immune response or influence stress reaction, blood pressure, or sexual development; includes testosterone- and estrogen-related compounds.

Testosterone: a hormone that stimulates the development and maintenance of male sexual characteristics and the production of sperm; women also produce small amounts of testosterone.

Virus: a microscopic, often disease-causing, organism made of genetic material surrounded by a protein shell; can only reproduce inside a living cell.

Chemistry

Acid: a class of compound that contrasts with bases. Acids taste sour, turn litmus red/pink, and often produce hydrogen gas in contact with some metals. Acids donate protons (hydrogen atoms minus the electron) in chemical reactions.

Base: a substance that yields hydroxyl ions (OH-) when dissolved in water; any of a class of compounds whose aqueous solutions taste bitter, feel slippery, turn litmus blue, and react with acids to form salts; also known as **alkaline**.

Carbon fiber: an extremely strong, thin fiber made by pyrolyzing (decomposing by heat) synthetic fibers, such as rayon, until charred; used to make high-strength composites

Chlorofluorocarbon (CFC): one of a group of industrial chemicals that contain chlorine, fluorine, and carbon and have been found to damage Earth's ozone layer.

Element: a substance that cannot be chemically decomposed into simpler substances; the atoms of an element all have the same number of protons and electrons.

Isotope: an atom of a chemical element with the same number of protons in its nucleus as other atoms of that element, but with a different number of neutrons.

Molecule: the basic unit of a chemical compound, composed of two or more atoms bound together.

Noble gases: a group of gasses including helium, neon, argon, krypton, xenon, and radon that are not reactive except in rare and limited instances. Also called "inert gases."

Osmosis: the transfer of a fluid from an area of higher concentration to an area of lower concentration, usually through a membrane.

Phase: any of the possible states of matter—solid, liquid, gas, or plasma—that change according to temperature and pressure.

Polymer: a huge molecule containing hundreds or thousands of smaller molecules arranged in repeating units.

Salt: a neutral compound produced by the reaction of an acid and a base.

Breaking the Sound Barrier; Speed of Sound

The prefix **Mach** is used to describe supersonic speed. It was named for Ernst Mach (1838-1916), a Czech-born Austrian physicist. When a plane moves at the speed of sound, it is Mach 1. When the plane is moving at twice the speed of sound, it is Mach 2. Mach may be defined as the ratio of the velocity of a rocket or a jet to the velocity of sound in the medium being considered.

When a plane passes the sound barrier—flying faster than sound travels—listeners in the area hear thunderclaps, but the pilot of the plane does not hear them.

Sound is produced by vibrations of an object and is transmitted by alternate increase and decrease in pressures that radiate outward through a material media of molecules—somewhat like waves spreading out on a pond after a rock has been tossed into it.

The **frequency of sound** is determined by the number of times the vibrating waves undulate per second and is measured in cycles per second. The slower the cycle of waves, the lower the frequency. As frequencies increase, the sound is higher in pitch. The human ear is usually not sensitive to frequencies of fewer than 20 vibrations per second or greater than about 20,000 vibrations per second—although this range varies among individuals.

Intensity, or loudness, is the strength of the pressure of these radiating waves and is measured in decibels. (See Weights and Measures.)

The **speed of sound** is generally defined as 1,088 feet per second at sea level at 32° F. It varies in other temperatures and in different media. Sound travels faster in water than in air, and even faster in iron and steel.

Light; Colors of the Spectrum

Light, a form of electromagnetic radiation similar to radiant heat, radio waves, and X rays, is emitted from a source in straight lines and spreads out over larger areas as it travels; light per unit area diminishes as the square of the distance.

The English mathematician and physicist Sir Isaac Newton (1642-1727) described light as an **emission of particles**; the Dutch astronomer, mathematician, and physicist Christiaan Huygens (1629-95) developed the theory that light travels by a **wave motion**. It is now believed that these 2 theories are essentially complementary, and the development of quantum theory has led to results where light acts like a series of particles in some experiments and like a wave in others.

The **speed of light** was first measured in a laboratory experiment by the French physicist Armand Hippolyte Louis Fizeau (1819-96). Today the speed of light is known very precisely as 299,792.458 km per sec (or 186,282.396 mi per sec) in a vacuum; in water the speed of light is about 25% less, and in glass, 33% less.

Color sensations are produced through the excitation of the retina of the eye by light vibrating at different frequencies. The different colors of the spectrum may be produced by viewing a light beam that is refracted by passage through a prism, which breaks the light into its wavelengths.

Customarily, the **primary colors** are taken to be the 6 monochromatic colors that occupy relatively large areas of the spectrum: red, orange, yellow, green, blue, and violet. Scientists have differed, however, in how many and which primary colors they recognized. The color sensation of **black** is due to complete lack of stimulation of the retina, that of **white** to complete stimulation.

The **infrared and ultraviolet rays**, below the red (long) end of the spectrum and above the violet (short) end of the spectrum, respectively, are invisible to the naked eye. Heat is the principal effect of the infrared rays, and chemical action that of the ultraviolet rays.

Discoveries and Innovations: Chemistry, Physics, Biology, Medicine

	Date	Discoverer	Nationality
Acetylene gas	**1862**	Berthelot	French
ACTH	**1927**	Evans, Long	U.S.
Adrenaline	**1901**	Takamine	Japan
Aluminum, electrolytic process	**1886**	Hall	U.S.
Aluminum, isolated	**1825**	Oersted	Danish
Anesthesia, ether	**1842**	Long	U.S.
Anesthesia, local	**1885**	Koller	Austrian
Anesthesia, spinal	**1898**	Bier	German
Aniline dye	**1856**	Perkin	English
Anti-rabies	**1885**	Pasteur	French
Antiseptic surgery	**1867**	Lister	English
Antitoxin, diphtheria	**1891**	Von Behring	German
Argyrol	**1897**	Bayer	German
Arsphenamine	**1910**	Ehrlich	German
Aspirin	**1853**	Gerhardt	French
Atabrine	**1932**	Mietzsch, et al.	German
Atomic numbers	**1913**	Moseley	English
Atomic theory	**1803**	Dalton	English
Atomic time clock	**1948**	Lyons	U.S.
Atomic time clock, cesium beam	**1948**	Essen	English
Atom-smashing theory	**1919**	Rutherford	English
Bacitracin	**1943**	Johnson, Meleneyl	U.S.
Bacteria, description	**1676**	Leeuwenhoek	Dutch
Bleaching powder	**1798**	Tennant	English
Blood, circulation	**1628**	Harvey	English
Blood plasma storage (blood banks)	**1940**	Drew	U.S.
Bordeaux mixture	**1885**	Millardet	French
Bromine from the sea	**1826**	Balard.	French
Calcium carbide	**1888**	Wilson	U.S.
Calculus	**1670**	Newton	English
Camphor synthetic	**1896**	Haller	French
Canning (food)	**1804**	Appert	French
Carbon oxides	**1925**	Fisher	German
Chemotherapy	**1909**	Ehrlich	German
Chloamphenicol	**1947**	Burkholder	U.S.
Chlorine	**1774**	Scheele	Swedish
Chloroform	**1831**	Guthrie, S.	U.S.
Chlortetracycline	**1948**	Duggen	U.S.
Classification of plants and animals	**1735**	Linnaeus	Swedish
Cloning, DNA	**1973**	Boyer, Cohen	U.S.
Cloning, mammal	**1996**	Wilmut, et al.	Scottish
Cocaine	**1860**	Niermann	German
Combustion explained	**1777**	Lavoisier	French
Conditioned reflex	**1914**	Pavlov	Russian
Cortisone	**1936**	Kendall	U.S.
Cortisone, synthesis	**1946**	Sarett	U.S.
Cosmic rays	**1910**	Gockel	Swiss
Cyanamide	**1905**	Frank, Caro	German
Cyclotron	**1930**	Lawrence	U.S.
DDT (not applied as insecticide until 1939)	**1874**	Zeidler	German
Deuterium	**1932**	Urey, Brickwedde, Murphy	U.S.
DNA (structure)	**1953**	Crick	English
		Watson	U.S.
		Wilkins	English
Electric resistance, law of	**1827**	Ohm	German
Electric waves	**1888**	Hertz	German
Electrolysis	**1852**	Faraday	English
Electromagnetism	**1819**	Oersted	Danish
Electron	**1897**	Thomson, J.	English
Electron diffraction	**1936**	Thomson	English
		Davisson, G.	U.S.
Electroshock treatment	**1938**	Cerletti, Bini	Italian
Erythromycin	**1952**	McGuire	U.S.
Evolution, natural selection	**1858**	Darwin	English
Falling bodies, law of	**1590**	Galileo	Italian
Gases, law of combining volumes	**1808**	Gay-Lussac	French
Geometry, analytic	**1619**	Descartes	French
Gold, cyanide process for extraction	**1887**	MacArthur, Forest	British
Gravitation, law	**1687**	Newton	English
HIV (human immuno-deficiency virus)	**1984**	Montagnier	French
		Gallo	U.S.
Holograph	**1948**	Gabor	British
Human heart transplant	**1967**	Barnard	S. African

Classification

Source: *Funk & Wagnalls New Encyclopedia*

In biology, classification is the identification, naming, and grouping of organisms into a formal system. The 2 fields that are most directly concerned with classification are taxonomy and systematics. Although the 2 disciplines overlap considerably, taxonomy is more concerned with nomenclature (naming) and with constructing hierarchical systems, and systematics with uncovering evolutionary relationships. Two kingdoms of living forms, Plantae and Animalia, have been recognized since Aristotle established the first taxonomy in the 4th century BC. In addition, there are the following 3 kingdoms: Protista (one-celled organisms), Monera (bacteria and blue-green algae; also known as the kingdom Procaryotae), and Fungi. The 7 basic categories of classification (from most general to most specific) are: kingdom, phylum (or division), class, order, family, genus, and species. Below are 2 examples:

ZOOLOGICAL HIERARCHY

Kingdom	Phylum	Class	Order	Family	Genus	Species name	Common name
Animalia	Chordata	Mammalia	Primates	Hominidae	Homo	Homo sapiens	Human

BOTANICAL HIERARCHY

Kingdom	Division*	Class	Order	Family	Genus	Species name	Common name
Plantae	Magnoliophyta	Magnoliopsida	Magnoliales	Magnoliaceae	Magnolia	M. virginiana	Sweet Bay

* In botany, the division is generally used in place of the phylum.

Gestation, Longevity, and Incubation of Selected Animals

Information reviewed by Ronald M. Nowak, author *Walker's Mammals of the World* (6th ed., Johns Hopkins University Press, 1999). Average longevity figures supplied by Ronald T. Reuther. These apply to animals in captivity; the potential life span of animals is rarely attained in nature. Figures on gestation and incubation are averages based on estimates.

Animal	Gestation (days)	Average longevity (years)	Maximum longevity (yr-mo)
Ass	365	12	47
Baboon	187	20	45
Bear (black)	219	18	36-10
Bear (grizzly)	225	25	50
Bear (polar)	240	20	45
Beaver	105	5	50
Bison	285	15	40
Camel	406	12	50
Cat (domestic)	63	12	37
Chimpanzee	230	20	60
Chipmunk	31	6	10
Cow	284	15	30
Deer (white-tailed)	201	8	20
Dog (domestic)	61	12	20
Elephant (African)	660	35	70
Elephant (Asian)	645	40	77
Elk	250	15	26-8
Fox (red)	52	7	14
Giraffe	457	10	36-2
Goat (domestic)	151	8	18
Gorilla	258	20	54
Guinea pig	68	4	8
Hippopotamus	238	41	61
Horse	330	20	50
Kangaroo (gray)	36	7	24
Leopard	98	12	23
Lion	100	15	30
Monkey (rhesus)	166	15	37
Moose	240	12	27
Mouse (meadow)	21	3	4
Mouse (dom. white)	19	3	6
Opossum (American)	13	1	5
Pig (domestic)	112	10	27
Puma	90	12	20
Rabbit (domestic)	31	5	13
Rhinoceros (black)	450	15	45-10
Rhinoceros (white)	480	20	50
Sea lion (California)	350	12	34
Sheep (domestic)	154	12	20
Squirrel (gray)	44	10	23-6
Tiger	105	16	26-3
Wolf (maned)	63	5	15-8
Zebra (Grant's)	365	15	50

	Incubation time (days)
Chicken	21
Duck	30
Goose	30
Pigeon	18
Turkey	26

Major Venomous Animals

Snakes

Asian pit viper — from 2 ft to 5 ft long; throughout Asia; reactions and mortality vary, but most bites cause tissue damage, and mortality is generally low.

Australian brown snake — 4 ft to 7 ft long; very slow onset of cardiac or respiratory distress; moderate mortality, but because death can be sudden and unexpected, it is the most dangerous of the Australian snakes; antivenom.

Barba Amarilla or fer-de-lance — up to 7 ft long; from tropical Mexico to Brazil; severe tissue damage common; moderate mortality; antivenom.

Black mamba — up to 14 ft long, fast-moving; S and C Africa; rapid onset of dizziness, difficulty breathing, erratic heart-beat; mortality high, nears 100% without antivenom.

Boomslang — less than 6 ft long; in African savannahs; rapid onset of nausea and dizziness, often followed by slight recovery and then sudden death from internal hemorrhaging; bites rare, mortality high; antivenom.

Bushmaster — up to 12 ft long; wet tropical forests of C and S America; few bites occur, but mortality rate is high.

Common or Asian cobra — 4 ft to 8 ft long; throughout southern Asia; considerable tissue damage, sometimes paralysis; mortality probably not more than 10%; antivenom.

Copperhead — less than 4 ft long; from New England to Texas; pain and swelling; very seldom fatal; antivenom seldom needed.

Coral snake — 2 ft to 5 ft long; in Americas south of Canada; bite may be painless; slow onset of paralysis, impaired breathing; mortalities rare, but high without antivenom and mechanical respiration.

Cottonmouth water moccasin — up to 5 ft long; wetlands of southern U.S. from Virginia to Texas. Rapid onset of severe pain, swelling; mortality low, but tissue destruction can be extensive; antivenom.

Death adder — less than 3 ft long; Australia; rapid onset of faintness, cardiac and respiratory distress; at least 50% mortality without antivenom.

Desert horned viper — in dry areas of Africa and western Asia; swelling and tissue damage; low mortality; antivenom.

European viper — 1 ft to 3 ft long; bleeding and tissue damage; mortality low; antivenom.

Gaboon viper — more than 6 ft long; fat; 2-in. fangs; south of the Sahara; massive tissue damage, internal bleeding; few recorded bites.