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Absolute magnitude is a measure of a star's actual brightness, as opposed to its apparent *Magnitude*.

Adams, John Couch (1819-1892) was an English astronomer who calculated the existence of the planet Neptune from the effects that its gravity had on the observed motion of Uranus. Neptune was discovered in 1846 by J.G. *Galle* close to the position Adams had calculated.

Aldebaran is a *Red Giant* star 68 light-years away in the constellation *Taurus*. It is about 40 times the diameter of the Sun.

Aldrin, Edwin (b.1930) was the lunar module pilot on the Apollo 11 mission which made the first manned Moon landing in July 1969. Aldrin followed *Neil Armstrong* onto the Moon, where the two collected samples and set up scientific experiments.

Algol is a star 82 light-years away in the constellation *Perseus*, which periodically changes in brightness. The variability is caused by a second star which eclipses it every 2.87 days.

Alpha Centauri is the nearest bright star to the Sun, 4.3 light-years away; it lies in the southern hemisphere constellation *Centaurus*. Actually, it is a group of three stars, one of which, *Proxima Centauri*, is slightly closer than the others.

Altair is a bright white star about 16 lightyears away in the constellation Aquila, the eagle.

Altazimuth mounting is a simple form of mounting for a telescope or binoculars. The mounting allows the instrument to swivel freely up and down (in altitude) and from side to side (in azimuth).

Andromeda is a major constellation of the northern hemisphere of the sky, representing a princess of Greek mythology. It is best seen during autumn evenings.

Andromeda galaxy is a spiral-shaped galaxy of about 300,000 million stars visible to the naked eye as a fuzzy patch in the constellation *Andromeda*. It lies about 2.2 million light-years away.

Anglo-Australian Observatory is an astronomical observatory at Siding Spring, New South Wales, Australia, jointly operated by the UK and Australian governments. Its main telescope is the 13-foot Anglo Australian reflector, opened in 1974.

Antares is a red giant star about 400 lightyears away in the constellation *Scorpius*. It is about 300 times the diameter of the Sun.

Aphelion is the farthest point from the Sun that a body such as a planet reaches in its orbit.

Apogee is the farthest point from the Earth that a body such as an artificial satellite reaches in

its orbit.

Apollo project was the American man-on-the-Moon program. A total of 12 American astronauts landed on the Moon in the Apollo project between July 1969 and December 1972. The astronauts were launched into space in the three-man Apollo command module; two of them later transferred into the spidery lunar module to make the Moon landing. Apollo capsules were also used to ferry astronauts to the *Skylab* space station, and for the link-up in July 1975 with a Soviet *soyuz*.

Aquarius, the water carrier, is a constellation of the zodiac, lying in the equatorial region of the sky. The Sun passes in front of Aquarius in late February and early March.

Arcturus is a red giant star 36 light-years away in the constellation Bootes, the herdsman. It is 27 times the diameter of the Sun.

Arecibo Radio Observatory, in Puerto Rico, is the location of the world's largest radio astronomy dish, 1,000 feet in diameter. The Arecibo radio telescope is slung from towers in a natural hollow in the hills.

Ariel satellites are a series of UK scientific satellites, launched by the United States. Most famous of the series was the X-ray satellite Ariel 5, launched in 1974.

Aries, the ram, is a faint constellation of the zodiac lying in the northern hemisphere of the sky. The Sun passes in front of Aries from late April to mid-May.

Aristarchus (3rd century BC) was a Greek astronomer who measured the relative sizes and distances of the Sun and Moon. He found that the Moon is roughly one-third the size of Earth, which is nearly correct; however, he badly underestimated the size and distance of the Sun. Nonetheless, he found that the Sun was considerably bigger than the Earth, and therefore made the first known suggestion that the Earth orbits the Sun, rather than the other way about.

Aristotle (384-322 BC) was a Greek scientist who maintained that the Sun orbited the Earth, along with all other celestial objects. Aristotle held that only circles, or combinations of circular motions, were allowable to explain the orbital paths of the planets. This view was eventually overthrown by *Johannes Kepler*.

Armstrong, Neil (b.1930) was the first man to step onto the Moon. He commanded the Apollo 11 mission, which made the first manned Moon landing in July 1969. His first words on the Moon were: "That's one small step for a man; one giant leap for mankind."

Asteroids are lumps of rock and metal orbiting the Sun. They are also known as minor planets. Asteroids range in size from about 620 miles down. As many as 100,000 asteroids may be visible in the largest telescopes. The first asteroid to be discovered was Ceres.

Astronomer Royal is an honorary title given to a leading British astronomer. Until 1972, the title was automatically awarded to the director of the *Royal Greenwich Observatory*, but now the two posts have been separated. The current Astronomer Royal is the Cambridge radio astronomer, Sir Martin Ryle.

Astronomical unit is the average distance between the Earth and Sun; it is often abbreviated a.u. One a.u. is 92,955,803 miles.

Atlas rocket is used for launching American satellites and space probes, either with an Agena or a Centaur upper stage. Atlas rockets were used to launch American astronauts into orbit in the *Mercury Project*.

Aurora is a display of colored light in the sky near the Earth's north or south pole. Charged particles from the Sun are attracted to the poles. When the particles enter the upper atmosphere, they make the gas there glow. In the northern hemisphere, this effect is called the *aurora borealis*, or northern lights. In the southern hemisphere, it is known as the *aurora australis*, or southern lights.

Baade, Walter (1893-1960) was a German astronomer who discovered that there are two main populations of stars, identifiable by slightly different chemical compositions. The older generation stars are found at the centers of galaxies, while stars of the younger generation, which include the Sun, are found in the spiral arms of galaxies.

Background radiation is a slight warmth in the Universe, detectable at short radio wavelengths, which is believed to be energy left over from the *Big Bang*. According to measurements of the background radiation, space is not completely cold but has a temperature of 2.7 degrees above absolute zero.

Barnard, Edward Emerson (1857 1923) was an American astronomer who discovered numerous comets and the fifth moon of Jupiter. He made a famous series of photographs of the Milky Way. In 1916 he discovered *Barnard's Star*.

Barnard's star is a red dwarf, and the second closest star to the Sun. It lies 6 lightyears away in the constellation Ophiuchus, the serpent bearer, but is too faint to be seen without a telescope. Barnard's star is believed to have planets.

Barred spiral galaxy is a galaxy in which the stars and gas near the center are arranged into a long, straight bar. Spiral arms curve from the ends of the bar.

Bessel, Friedrich Wilhelm (1784 1846) was a German astronomer who in 1838 made the first measurement of the distance of a star, 61 Cygni. He measured the star's distance from its *Parallax*. Bessel also deduced the existence of the white dwarf companions of the stars *Procyon* and *Sirius*.

Betelgeuse is a red giant star, about 650 light-years away in the constellation *Orion*. Betelgeuse varies in size between about 300 and 500 times the diameter of the Sun.

Big Bang is the giant explosion which is believed to have marked the origin of the Universe as we know it. The Big Bang is estimated to have occurred about 18,000 million years ago, and the Universe has been expanding ever since.

Binary star is a pair of stars orbiting around a common center of gravity. Some binaries can

be seen as double in a telescope, but others are so close together that they can only be identified as binaries by analysis of their light; these are known as spectroscopic binaries. In some binaries, such as *Algol*, the stars eclipse each other; these are known as eclipsing binaries.

Black hole is an area of space in which the pull of gravity is so strong that nothing can escape, not even light. Black holes are believed to form when giant stars collapse at the ends of their lives. Giant black holes may exist at the centers of galaxies, where they provide the power source for objects such as *Quasars*.

Brahe, Tycho (1546-1601) was a Danish astronomer who made the most accurate observations of the planets in the days before the telescope was invented. He believed that the Sun orbited the Earth, but that the other planets orbited the Sun. *Johannes Kepler* used Tycho's observations to work out the true motions of the planets.

Von Braun, Wernher (1912- 1977) was a German-American rocket engineer who, in wartime Germany, designed the V2 rocket and later, in the United States, designed the SATURN family of rockets that took men to the Moon.

Callisto is Jupiter's second largest satellite, 2,995 miles in diameter. It orbits Jupiter every 16.69 days at an average distance of 1 mile.

Cancer, the crab, is a faint constellation of the northern sky. The Sun passes through it from late July to mid-August.

Canopus is the second brightest star in the sky. It lies about 110 light-years away in the southern hemisphere constellation of Carina, the keel, and is approximately 25 times the diameter of the Sun.

Cape Canaveral, in Florida, is the main site used by the United States for space launchings. It was temporarily renamed Cape Kennedy from 1963 to 1973.

Capella is a bright yellow star, 45 light years away in the constellation Auriga, the charioteer.

Capricornus, the sea goat, is a constellation of the southern hemisphere of the sky. The Sun passes in front of it in late January to mid-February.

Cassegrain telescope is a popular design of reflecting telescope, named after the French physicist N. Cassegrain who invented it in 1672. Light collected by the main mirror is reflected on to a secondary, which reflects it back to an eyepiece mounted in a hole in the middle of the main mirror.

Cassini, Jean Dominique (1625-1712) was a French astronomer, born in Italy, who discovered four satellites of Saturn, and drew attention to the gap in Saturn's rings now known as Cassini's division.

Cassiopeia is a famous constellation of the northern sky, representing a queen of Greek mythology. Cassiopeia has a distinctive W shape.

Castor is a bright white star 45 light-years away in the constellation *Gemini*. Castor is

actually a system of six stars linked by gravity.

Centaurus, the Centaur, is a constellation in the southern hemisphere of the sky, containing the closest star to the Sun, *Proxima Centauri*.

Cepheid variable is a type of star that expands and contracts in size, changing in brightness as it does so. The period of variability of a Cepheid is directly related to its average brightness, the brightest Cepheids taking the longest to vary. Since it is so easy to measure the brightness of a Cepheid by observing its variation period, astronomers use Cepheids as important distance indicators.

Ceres is the largest asteroid, 62 miles in diameter, and the first to be discovered, by *Giuseppe Piazzi* in 1801. Ceres orbits the Sun every 4.6 years between the orbits of Mars and Jupiter.

Chromosphere is a layer of hot gas about 9,940 miles deep surrounding the visible surface of the Sun (the *Photosphere*). The chromosphere is only visible in special instruments or at total solar eclipses when the Moon blocks out the dazzling light from the photosphere. The chromosphere is then visible as a red strip of light, from which it takes its name meaning "color sphere."

Comet is a body consisting of rocky blocks and dust particles cemented into a "dirty snowball" by frozen gas. Comets orbit the Sun on elongated paths. When closest to the Sun, the gases of the comet melt to form the flowing tail. Dust released from comets burns up in the atmosphere to produce *Meteors*.

Conjunction is an alignment of celestial bodies, when a planet lies in the same direction as the Sun. In the case of Mercury and Venus, which can come between the Sun and Earth, astronomers distinguish between *Inferior Conjunction*, when they are on the near side of the Sun, and *Superior Conjunction*, on the far side of the Sun.

Constellation is a pattern of stars in the sky. A total of 88 constellations covers the entire sky, many of them representing figures from ancient mythology.

Copernicus, Nicolaus (1473-1543) was a Polish astronomer who proposed that the Earth orbited the Sun like a normal planet, rather than being the center of the universe as had been previously assumed. This view was confirmed by the observations of *Galileo* and the calculations of *Johannes Kepler*.

Corona is the thin gaseous atmosphere of the Sun, visible as a pearly glow around the Sun at a total eclipse. It consists of gas boiled off from the Sun's surface.

Crab nebula, 6,000 light-years away in *Taurus*, is the remains of a star which was seen by oriental astronomers to flare up as a *Supernova* in AD 1054.

Crater is a roughly circular depression on the surface of a planetary body, usually caused by the impact of a smaller solid projectile.

Cruz, the southern cross, is the smallest constellation in the sky.

Cygnus, the swan, is a constellation of the northern sky often called the northern cross because of its shape. Its brightest star is *Deneb*.

Declination is a coordinate for locating objects in the sky, the celestial equivalent of latitude.

Deimos is the smaller and more distant moon of Mars, roughly 8 miles in diameter, orbiting Mars every 1.26 days at an average distance of 12,427 miles from the planet's center.

Deneb is a white star 1,500 light-years away in the constellation *Cygnus*.

Doppler effect is the change in wavelength of light from an object, caused by the object's motion. If the object is receding, then its light is lengthened (reddened) in wavelength. The *Red Shift* of light from galaxies shows that the universe is expanding.

Eclipse occurs when the Earth and Moon enter each other's shadow. When the Moon passes in front of the Sun, a solar eclipse is seen in those areas on which the Moon's shadow falls. When the Moon enters the Earth's shadow, a lunar eclipse ensues. On average, one or two solar and lunar eclipses are visible from a given place each year.

Ecliptic is the path followed by the Sun around the sky each year. It gets its name because only when the Sun and Moon are both on or near this line can eclipses occur.

Effelsberg Radio Observatory, near Bonn, Germany, is the site of the world's largest fully steerable radio dish, 328 feet in diameter.

Electron is an atomic particle with a negative electric charge. In an atom, the rapidly moving electrons orbit in "shells" around the nucleus.

Elements, chemical. The most abundant element in the Universe is hydrogen, comprising about 90 percent of all matter. Helium accounts for another 10 percent. All other elements, which astronomers term the heavy elements, make up only about 1 percent of the Universe. Originally, the Universe is believed to have contained only hydrogen and helium, formed in the *Big Bang*. The heavier elements have been built up by nuclear reactions inside stars, and distributed through space by *Supernovae*.

Elliptical galaxy is a galaxy made of old stars, with no spiral arms. Elliptical galaxies range in size from almost globular to a cross-sectional shape like that of a football.

Eneke's comet is the comet of shortest known orbital period, 3.3 years. The comet was discovered in 1818 by the French astronomer Jean Louis Pons, and had its orbit calculated by the German astronomer Johann Franz Encke (1791-1865).

Equatorial mounting is a form of mounting for telescopes. One axis of the mount is aligned parallel with the axis of the Earth; by turning this axis, the rotation of the Earth can be counteracted, so that the image stays still in the telescope's field of view.

Equinox is the instant when the Sun crosses the celestial equator. At the equinoxes, which occur in late March and September, the Sun is overhead on the equator at noon, and everywhere on Earth has equal day and night; the name *equinox* means "equal night."

Europa is the smallest of the four main moons of Jupiter, 1,942 miles in diameter. It orbits Jupiter every 3.55 days at an average distance of about 416,900 miles.

European Space Agency is an organization of European countries involved in space research. ESA is involved in satellite projects both on its own and in conjunction with NASA.

Explorer satellites are a continuing series of American scientific satellites. The first American satellite was Explorer 1, launched on January 31, 1958.

Flare is a brilliant outburst on the surface of the Sun caused by a local eruption of energy, usually near a *Sunspot*. Flares eject atomic particles into space which cause radio interference on Earth.

Gagarin, Yuri (1934-1968), a Soviet cosmonaut, was the first man to fly in space. On April 12, 1961, he orbited the Earth once in his spaceship Vostok 1.

Galaxy is a collection of stars bound together by gravity. The smallest galaxies contain about a million stars, whereas the largest contain a million times more. Most galaxies are spiral in shape, like our own *Milky Way*, but about one in five is an *Elliptical Galaxy*.

Galileo Galilei (1564-1642) was an Italian scientist who made the first serious astronomical observations with a telescope. He found that Venus shows phases, so that it must orbit the Sun, and he also discovered the four brightest moons of Jupiter. With his telescope, Galileo saw that there were countless stars invisible to the naked eye. His observations helped establish the theory of *Copernicus* that the Earth orbits the Sun.

Galle, Johann Gottfried (1812-1910) was a German astronomer who on September 23, 1846, discovered the planet *Neptune* close to the position calculated by J.C. *Adams* and U.J.J. *Leverrier*.

Ganymede is the largest moon of Jupiter, 3,275 miles in diameter. Ganymede orbits Jupiter every 7.15 days at an average distance of just over 621,000 miles.

Gemini, the twins, is a famous constellation of the northern hemisphere of the sky. Its two brightest stars are *Pollux* and *Castor*. The Sun passes in front of Gemini in late June and July.

Gemini project was a series of American space flights in the two-man Gemini capsule. During the Gemini program, in 1965 and 1966, astronauts learned the techniques of rendezvous and docking of spacecraft and space walks that were vital to the *Apollo Project*.

Geosynchronous orbit is an orbit used by artificial satellites, particularly communications satellites, 22,307 miles above the equator. At this height the satellite moves at the same rate as the Earth spins, and thus appears to hang stationary over a point of the equator.

Glenn, John (b. 1921) was the first American to orbit the Earth. He performed three orbits in his Mercury capsule on February 20, 1962.

Globular cluster is a ball-shaped group of stars found around the center of a galaxy. There

are about 125 globular clusters arranged in a halo around our own galaxy, each containing between about 100,000 and a million stars.

Goddard, Robert H. (1882-1945) was an American rocket pioneer who on March 19, 1926, launched the world's first liquid fueled rocket.

Gravity is the general force of attraction between bodies in the universe. It does not operate within atoms, whose particles are controlled by nuclear forces.

Hale, George Ellery (1868-1938) was an American astronomer who discovered that sunspots are cooler areas on the Sun associated with magnetic fields. Hale was the founder of three major observatories: *Yerkes* observatory, and the observatories on Mount Wilson and Mount Palomar (now called *Hale Observatories*).

Hale Observatories is the name given since 1970 to the astronomical observatories on Mount Wilson and Mount Palomar in California, both founded by George Hale. Mount Wilson contains the famous 8-foot reflector opened in 1917. On Mount Palomar is the 16-foot Hale reflector, which was the world's largest until surpassed by a larger telescope at the Zelenchukskaya Observatory, Russia.

Halley, Edmond (1656-1742) was a British astronomer who in 1705 calculated the orbit of the comet that bears his name. In 1720 he became second Astronomer Royal, and spent the rest of his life at Greenwich observing the complex motions of the Moon.

Halley's comet is a famous comet that orbits the Sun every 76 years. Its next return is due in 1986, although it will not be easy to see.

Hercules is a major constellation of the northern hemisphere of the sky. named after a hero from Greek mythology.

Herschel, Sir John (1792-1871) was an English astronomer, son of Sir William, who made a major survey of the southern skies from the Cape of Good Hope, thereby completing the survey of the heavens begun in the northern hemisphere by his father.

Herschel, Sir William (1738-1822) was an English astronomer, born in Germany, who discovered the planet *Uranus*. He made a major survey of the northern sky, cataloguing all objects of interest. His son, John, extended the work to the southern hemisphere. Between them, this father-and-son combination were among the greatest observers in the history of astronomy.

Hertzsprung Russell diagram is a graph in which the temperature of stars is plotted against their brightness. A star's position on the H-R diagram shows whether it is a normal star (on the *Main Sequence*), a red giant (large but cool) or a white dwarf (small but hot).

Hipparchus (2nd century BC) was a Greek astronomer who is regarded as the greatest astronomer of antiquity. He made many accurate measurements of the motion of the Earth in space, including the length of the year, and made an important catalogue of 850 stars in which he introduced the *Magnitude* system.

Hoyle, Sir Fred (b. 1915) is an English astronomer best known for his support of the *Steady State Theory* of the Universe. Hoyle also proposed that the chemical elements were built up from hydrogen by nuclear reactions inside stars, an idea now accepted.

Hubble, Edwin (1889-1953) was an American astronomer who in the 1920s discovered that galaxies are far outside our own galaxy, and also found that the Universe is expanding. He made his first discovery by identifying individual stars in the *Andromeda Galaxy*, and his second discovery by studying the *Red Shift* in light from galaxies.

Hubble constant is a figure that shows how fast the Universe is expanding, and thus how long ago the *Big Bang* took place. According to latest measurements, galaxies move at about 10 miles a second for every million light-years they are apart.

Huygens, Christian (1629-1695) was a Dutch scientist who in 1655 discovered Saturn's largest moon, *Titan*, and explained that Saturn's rings are made of a swarm of tiny moonlets.

Hyades is a cluster of about 200 stars. 148 light-years away in the constellation *Taurus*.

Hydrogen in space. Hydrogen is the simplest and most abundant of all the elements in space. Stars are made mostly of hydrogen, as are the glowing clouds of gas such as the *Orion Nebula*. Hydrogen emits radio waves at 21-centimeters.

Inclination is the angle of a planet's orbit to the Earth's orbit, or of a satellite to the Earth's equator.

inferior conjunction is the instant when Mercury or Venus are in line between the Earth and Sun.

Infra-red astronomy is the study of the Universe at wavelengths longer than those of red light. These studies reveal objects such as gas clouds and forming stars which are too cool to emit visible light, and brilliant objects such as the centers of galaxies that are otherwise obscured by dust.

Intelsat is the name of the communications satellites that provide a global telephone, radio, and TV network. Early Bird, the first, was launched in 1965. The current Intelsat IV A series can each carry 6,000 telephone calls.

Interstellar molecules are molecules in space, usually detected by the radio waves they emit. Over 30 interstellar molecules of varying complexity are known, including water, ammonia and formaldehyde. Their presence indicates the existence of dense gas clouds, such as those from which stars form.

Io is the nearest of the four main satellites of Jupiter, orbiting every 1.77 days at an average distance of 262,218 miles. Io is 2,257 miles in diameter.

Jansky, Karl (1905-1950) was an American radio engineer who in 1932 discovered radio waves coming from the Galaxy, thereby founding the study of radio astronomy.

Jodrell bank is the location near Macclesfield, Cheshire, of the radio observatory of the University of Manchester. Its main instrument is the famous 249-foot diameter dish.

Juno was the third known asteroid, discovered in 1807. It is about 143 miles in diameter and orbits the Sun every 4.36 years between the orbits of Mars and Jupiter.

Jupiter is the largest planet of the solar system. It is a large ball of gas, similar in composition to the Sun, but may have a central rocky core. The visible surface is not solid, but consists of swirling, multi-colored clouds, the only permanent feature of which is the red spot, apparently the top of a storm cloud.

Kepler, Johannes (1571-1630) was a German mathematician and astronomer who worked out the laws of planetary motion (*Kepler's Laws*) from the observations of Tycho Brahe. Kepler's work finally established that the Earth is a planet orbiting the Sun, as *Copernicus* had proposed.

Kepler's laws are the three laws of planetary motion calculated by *Johannes Kepler*. The first, and most important law, is that planets orbit the Sun in elliptical paths (not circular paths as had been assumed previously). Secondly, the planet moves fastest when it is nearest to the Sun. These two laws were published in 1609. The third law, published in 1619 notes that there is a direct connection between a planet's orbital period and its distance from the Sun.

Kitt Peak Observatory is an astronomical observatory near Tucson, Arizona, containing the largest collection of telescopes in the world. Its main telescope is a 13-foot reflector.

Landsat is the name of two American satellites for surveying the Earth. Their photographs are used to make maps of remote countries, identify locations of new mineral resources, detect areas of crop disease and monitor pollution.

Leavitt, Henrietta (1868-1921) was an American astronomer who discovered the relationship between the period of variability of a *Cepheid Variable* and the star's average brightness, a discovery which was used in measuring the size of the galaxy by *Harlow Shapley*.

Lemaitre, Georges (1894-1966) was a Belgian astronomer who originated the *Big Bang* theory of cosmology.

Leo, the lion, is a constellation of the equatorial region of the sky. The Sun passes in front of Leo from mid-August to mid-September. The brightest star in Leo is *Regulus*.

Leonov, Alexei (b. 1934), a Soviet cosmonaut, was the first man to walk in space. He spent 10 minutes outside the Voskhod 2 spacecraft on March 18, 1965.

Leverrier, Urbain (1811-1877) was a French astronomer who, like the Englishman J.C. Adams, calculated the existence of the planet Neptune. He sent his results to the Berlin observatory, where the planet was discovered by *J.G. Galle*.

Libra, the scales, is a faint constellation of the southern hemisphere of the sky. The Sun passes in front of Libra during November.

Lick Observatory is the astronomical observatory of the University of California, on Mount Hamilton. Its main telescopes are a 10-foot reflector and a 36-inch refractor.

Light-year is the distance traveled by a beam of light in one year. It is equivalent to 6 trillion miles.

Local Group is the cluster of about 20 known galaxies of which our own galaxy is the second largest member. The largest member of the local group is the *Andromeda Galaxy*.

Lowell Observatory is an astronomical observatory at Flagstaff, Arizona, founded in 1894 by Percival Lowell. Its main telescope is a 6-foot reflector.

Lowell, Percival (1855-1916) was an American astronomer who believed in the existence of canals on Mars dug by intelligent beings. He also predicted the existence of another planet beyond Neptune, and initiated a search at his own observatory which culminated in the discovery of Pluto by *Clyde Tombaugh*.

Luna probes are a series of Soviet Moon probes, members of which have photographed the Moon and landed on its surface. Two automatic Moon rovers have been delivered by Lunar probes, and others have automatically brought lunar samples back to Earth.

Lunik spacecraft launched from the former USSR in 1959 were the first probes to strike the Moon and photograph the side which is turned away from Earth.

Lyra, the Lyre, is a small but prominent constellation of the northern sky. Its brightest star is *Vega*.

Magellanic clouds are two satellite galaxies of our own Milky Way. They are each about 160,000 light-years away, and are about 1/30 and 1/200 the size of the Milky Way.

Magnitude is the scale that measures a star's apparent brightness as seen from Earth. The faintest stars visible to the naked eye are called magnitude 6; they are 100 times fainter than the first magnitude stars. Objects even brighter are given negative (minus) magnitudes. Objects fainter than magnitude 6 are given progressively larger positive magnitudes.

Main sequence is the classification given to stars in the healthy prime of their lives, when they are burning hydrogen at their centers to create energy, as is the Sun. Main-sequence stars form a band running across the *Hertzsprung-Russel Diagram*.

Mare (plural maria) is the name given to the large, dark plains which extend over much of the Earth-turned hemisphere of the Moon.

Mariner spacecraft are a series of American planetary probes. Mariner 9 made a complete photographic map of Mars in 1971 and 1972, and Mariner 10 took the first closeup photographs of Mercury and Venus in 1974.

Mars is the fourth planet in line from the Sun. It is known as the red planet, because of the distinctive color of its surface rocks, caused by extensive amounts of iron oxide. There is little air or water on Mars, and temperatures are frigid. Despite searches by the *Viking Probes*,

there is no sign of life on Mars.

McDonald Observatory is an astronomical observatory near Fort Davis, Texas with 6.5-foot and 8.8-foot reflectors.

Mercury is the nearest planet to the Sun, not much larger than our own Moon. Its surface is lunar-like, covered with craters presumably formed by meteorite impacts. Mercury has no real atmosphere.

Mercury project was the first American attempt to fly men in space, in the one-man Mercury capsule. The program lasted from May 1961 to May 1963, during which time a total of 6 astronauts were launched into space, the longest flight lasting 34 hours.

Messier, Charles (1730-1817) was a French astronomer who made a list of over 100 nebulae and clusters of stars, many of which are still known by their Messier or M numbers.

Meteor is a dust particle from space, seen as it burns up in the atmosphere. Meteors are believed to be dust from comets. When the Earth crosses the orbit of a comet, as happens several times a year, a meteor shower is seen. Most meteors are about the size of a grain of sand, and burn up long before reaching the Earth's surface.

Meteorite is a lump of rock or metal from space that penetrates the atmosphere to reach the Earth's surface. If a meteorite is large enough it will blast a crater, like the one nearly a mile wide in Arizona. Otherwise it will fall harmlessly to the ground like the world's largest known meteorite, weighing 60 tons, near Grootfontein in Namibia (southwest Africa).

Milky Way is the faint band of starlight seen crossing the sky on clear, dark evenings. The Milky Way is actually the lane of our galaxy seen from inside, therefore our galaxy is also known as the Milky Way. There are about 100,000 million stars in the Milky Way galaxy, which is 100,000 light-years in diameter.

Moon is the Earth's nearest natural neighbor in space. It is a rocky body pitted with countless craters believed to have been formed by meteorite impacts. In some places, volcanic eruptions have produced the dark lava plains known as *maria* ("seas"). The Moon turns on its axis in the same time as it takes to orbit the Earth, so that it keeps one face permanently turned towards us. The Moon is airless, waterless and lifeless.

Mullard Radio Observatory, at Cambridge, England, is the site of two large aperture synthesis radio telescopes, the One Mile and the Five Kilometers instruments (the names signify their length). *Pulsars* were discovered at the observatory, which is operated by the University of Cambridge.

NASA, the National Aeronautics and Space Administration, is the American government agency for civilian space flight, founded in 1958.

Nebula (plural **nebulae**) is a mass of gas and dust in space. Some are believed to be the sites of star formation, such as the *Orion Nebula*. Some nebulae are made to glow by the light of stars inside them, others shine by reflection, but others are dark and invisible. Neptune is the

eighth planet in average distance from the Sun, discovered in 1846 by J.G. *Galle*. Neptune has a deep gaseous atmosphere, underneath which is believed to be a core of rock and ice. The planet appears as nothing more than a greenish disk in even a large telescope.

Neutron star is a small, highly compressed star about 6 to 12 miles in diameter left behind after the death of a star more massive than the Sun. In a neutron star, gravity has compressed the electrons and protons of the star's atoms to form the atomic particles called neutrons.

Newton, Isaac (1642-1727) was an English scientist whose laws of motion and gravity explained why planets orbit the Sun as deduced by *Johannes Kepler*. Newton's work on light led to his design of a reflecting telescope.

NGC is an abbreviation for the New General Catalogue of star clusters and nebulae, compiled in 1888 by the Danish astronomer J.L.E. Dreyer and widely referred to by astronomers.

Nova is a stellar outburst caused by the transfer and ignition of gas between two stars in a binary system. The star that causes the outburst is a *White Dwarf*, on to the surface of which gas flows from a normal companion, and then erupts in a nuclear explosion.

Nutation is a slight nodding of the Earth's axis caused by the uneven gravitational pulls of the Sun and Moon. Nutation slightly alters the Earth's tilt in space every 18.6 years.

Object glass is the main lens at the front of a refracting telescope.

Occultation is the covering of a celestial body by the Moon. The occultation of stars by the Moon is used to track the Moon's orbit around the Earth.

Opposition is the instant when a planet is opposite in the sky to the Sun. At opposition, a planet is seen due south at midnight.

Orbit is the path in space of one body around another. Orbits are usually elliptical in shape, although the orbits of the planets scarcely depart from circles.

Orbiter spacecraft, 5 of which were launched from the USA in 1966 and 1967, orbited the Moon at heights of a few hundred miles and took detailed photographs of practically the whole surface. showing details down to 31 feet across.

Orion is a major constellation in the equatorial region of the sky, representing a figure from Greek mythology. Its two brightest stars are *Rigel* and *Betelgeuse*, and it also contains the *Orion Nebula*.

Orion nebula is a glowing mass of gas about 1,500 light-years away in the constellation *Orion*. New stars are forming inside the nebula, and it is their light which makes it glow. A whole cluster of stars will probably be formed from the Orion nebula.

Oscillating universe is the theory which says that the current expansion of the Universe will eventually slow, stop, and be reversed, so that the Universe collapses again to another *Big Bang*. According to this theory, the Universe continues in endless cycles of expansion and contraction. However, astronomers do not presently believe that the expansion of the

Universe will be halted.

Ozone Triatomic oxygen (O₃).

Pallas is the second largest asteroid, 378 miles in diameter, and the second to be discovered, by Wilhelm Olbers in 1802. Pallas orbits the Sun every 4.6 years between the orbits of Mars and Jupiter.

Parallax is the slight shift in position of a nearby star when viewed from opposite sides of the Earth's orbit. The amount of parallax shift reveals the star's distance. Stars beyond about 100 light-years distance have parallaxes too small to be accurately measured.

Parsec is a unit of distance in astronomy, equivalent to 3.26 *Light-Years*. It is the distance at which a star would show a *Parallax* of 1 second of arc, although no star is actually quite this close.

Pegasus is a large constellation of the northern hemisphere of the sky, representing the winged horse of Greek mythology. Its main feature is a great square marked out by four stars.

Perigee is the nearest point to the Earth that a body such as an artificial satellite reaches in its orbit.

Perihelion is the nearest point to the Sun that a body such as a planet reaches in its orbit.

Perseus is a constellation of the northern sky, representing a figure from Greek mythology. Its most famous star is *Algol*.

Phobos is the larger and nearer of the two moons of Mars, roughly 14 miles in diameter, orbiting every 7.65 hours 3,700 miles from the planet's center.

Photon A "packet" or quantum of light radiation.

Photosphere is the visible surface of the Sun, a layer of gas at a temperature of about 10,830 F.

Piazzi, Giuseppe (1746- 1826) was an Italian astronomer who on January 1, 1801, discovered the first asteroid, *Ceres*.

Pioneer probes are a series of American craft to investigate the Solar System. Pioneers 10 and 11 took remarkable close-up photographs of Jupiter in 1973 and 1974.

Pisces, the fishes, is a constellation of the equatorial region of the sky. The Sun passes in front of Pisces from mid-March to mid-April.

Planet is a large non-luminous body in orbit around a star, which can be made of rock or gas. Planets are not large enough to generate energy at their centers by nuclear reactions, as do stars.

Planetary nebula is a shell of gas ejected from a red giant at the end of its life, leaving the star's hot core as a central *White Dwarf*. Planetary nebulae are so named because they

superficially resemble a planet's disk when seen through a small telescope.

Pleiades are a group of 200 stars about 400 light-years away in the constellation *Taurus*.

Pluto is the planet with the greatest average distance from the Sun (over 3,666 million miles), discovered in 1930 by *Clyde Tombaugh*. Actually, its orbit is so eccentric that from 1979 to 1999 it comes closer to the Sun than Neptune. Many astronomers think that Pluto is an escaped satellite of Neptune. Latest measurements suggest that it is the smallest planet of the Solar System.

Polaris, the pole star, lies approximately 400 light-years away in the constellation *Ursa Minor*.

Pollux is an orange giant star, 36 light-years away in the constellation *Gemini*, of which it is the brightest star.

Precession is a wobbling of the Earth on its axis every 26,000 years like a spinning top, caused by the gravitational pulls of the Sun and Moon.

Procyon is the brightest star in the constellation Canis Minor, 11.4 light-years away. It has a *White Dwarf* companion.

Prominences are eruptions of gas from the surface of the Sun, often associated with sunspots.

Proper motion is a change in a star's position over time caused by its movement around the Galaxy. The proper motions of stars are not noticeable to the naked eye, but over thousands of years they slowly change the shapes of the constellations.

Proxima Centauri is a red dwarf star 4.3 light-years away, the closest member of the *Alpha Centauri* triple system.

Ptolemy (c. 100-c. AD 178) was a Greek scientist who in his book the *Almagest* put forward the Earth-centered view of the Universe that was accepted until the time of *Copernicus*.

Pulsar is a rapidly rotating *Neutron Star* that gives out a radio pulse every time it spins. Pulsars were discovered by Cambridge radio astronomers in 1967. The fastest pulsar, at the center of the *Crab Nebula*, flashes 30 times a second; the slowest ones flash every 3 seconds or so.

Quasar is a small but brilliant object far off in space. Quasars can give out the energy of hundreds of galaxies from a space not much larger than our own solar system.

Radio astronomy is the study of the Universe in radio waves, emitted naturally by many objects in space. Radio astronomy has led to the discovery of objects such as *Quasars and Pulsars* and has also helped astronomers map the structure of our own Galaxy through the *Twenty-one Centimeter Radiation* of hydrogen.

Radio galaxy is a galaxy that emits considerable radio energy, both from a central point and from lobes either side of the galaxy that seem to have been ejected in explosions. Radio galaxies are closely related to *Quasars*.

Radio telescope is a device for collecting radio waves from space. Most radio telescopes are like reflecting telescopes in design, but because radio waves are so much longer than light waves, radio telescopes have to be correspondingly larger to see the sky in as much detail.

Red dwarf is a faint star that is smaller and cooler than the Sun. Because they burn so slowly, red dwarf stars live very long.

Red giant is a large star with a cool surface, which has swelled up towards the end of its life. In about 5,000 million years, our Sun will become a red giant like *Arcturus*.

Red shift is the lengthening in the wavelength of light from a receding object, such as a galaxy. The amount of red shift, which is caused by the *Doppler Effect*, reveals how fast the object is receding.

Reflecting telescope is a telescope that uses a mirror to collect and focus light. The first reflector was built in 1668 by *Isaac Newton*, but the idea had previously been proposed in 1663 by the Scottish scientist James Gregory.

Refracting telescope is a telescope that uses lenses to collect and focus light. The invention of the refractor is attributed to the Dutch optician Hans Lippershey in 1608, although he was almost certainly not the first to make one.

Regulus is a blue-white star about 84 lightyears away in the constellation *Leo*, of which it is the brightest star.

Rigel is a blue giant star 850 light-years away, the brightest star in *Orion*. Rigel is 78 times the Sun's diameter.

Right ascension is a coordinate for locating objects in the sky, the celestial equivalent of longitude.

Rosse, Lord (1800-1867) was an Irish astronomer who in 1845 completed a 6-foot reflector, then the largest in the world, with which he studied nebulae and star clusters.

Royal Greenwich Observatory was set up in 1675. In 1958 it moved from Greenwich to Herstmonceux, Sussex. Its largest telescope is an 8.2-foot reflector.

Sagittarius, the archer, is a constellation of the southern hemisphere of the sky. The Sun passes in front of Sagittarius from midDecember to mid-January.

Salyut is a Soviet space station, smaller than the *American Skylab*. The first of the Salyut series was launched in 1971.

Satellites are any bodies that move in an orbit around another, more massive body. The planets, for example, are satellites of the Sun. And the Moon is a satellite of the Earth. Many other artificial, or man-made satellites orbit the Earth, too. They are used for such purposes as radio and television communications, and for gathering information on the Earth and the weather.

Saturn is the sixth planet from the Sun. Like Jupiter, it is a ball of gas. Saturn's most interesting feature is its rings, about 170,000 miles in diameter, made of tiny ice-covered blocks of rock.

Saturn rockets are two related rockets designed for manned launchings. The smaller Saturn I B was used for launching Apollo capsules into Earth orbit: the larger Saturn V was used to launch the Apollo Moon missions.

Schmidt, Maarten (b.1929) is an American astronomer who in 1963 measured the *Red Shift* of the first quasar. 3C 273.

Schmidt telescope is a wide-angle photographic telescope using both lenses and mirrors, designed in 1930 by the Estonian optician Bernhard Schmidt.

Scorpius, the scorpion, is a constellation of the southern sky whose brightest star is *Antares*. The Sun passes across part of Scorpius at the end of November.

Seyfert galaxy is a galaxy with a brilliant core, rather like a scaled-down *Quasar*. Astronomers think that Seyfert galaxies are closely related to quasars.

Shapley, Harlow (1885-1972) was an American astronomer who first measured the size of our Milky Way galaxy, and showed that the Sun lies about two-thirds of the way to the edge.

Shepard, Alan (b. 1923) was the first American astronaut to fly in the *Mercury Project*. He did not go into orbit, but completed a brief suborbital flight. In 1971 he commanded the Apollo 14 Moon landing mission.

Sidereal period is the time taken for an object such as a planet or satellite to complete one orbit relative to the stars.

Sirius is the brightest star in the sky, 8.7 light-years away in the constellation Canis Major. It has a White Dwarf companion.

Skylab was an American space station made from a converted Saturn V upper stage. Astronauts spent up to 84 days in Skylab in 1973-1974.

Solar day is the time taken for an object to complete one orbit relative to the Sun.

Solar system is the collection of planets and other objects orbiting the Sun.

Solar transit is the passage of a celestial body, such as the planet Mercury, across the face of the Sun.

Solar wind is a steady stream of electrically charged subatomic particles, given out by the Sun. In Earth's atmosphere, it gives rise to the glowing displays called *Auroras*.

Solstices are the two periods of the astronomical year when the Sun is farthest north or south of the equator: roughly June and December 21st. They correspond to the longest and shortest

day, respectively, in the northern hemisphere and the opposite in the southern hemisphere.

Soyuz is a Soviet spacecraft capable of holding two or three men. Soyuz capsules can fly on their own, or are used to ferry cosmonauts to *Salyut* space stations.

Space Age is the name often given to the age of scientific discovery that began with the first *Sputnik* in 1957.

Space shuttle is the latest major development of the Space Age, a giant vehicle that is rocketed into orbit, then glides back to Earth to be fitted up for the next space journey. The USA launched its first space shuttles in 1981. They are designed to carry large loads, including satellites, and to cut launch costs by over 50 percent.

Spacelab is a scientific space station designed in Europe to be carried in orbit by the space shuttle. It made its first successful flight in November/December 1983. On later flights scientists will be able to work in Spacelab for up to a month.

Spectrum is the band of colors obtained when the light from a body is split into its various wavelengths. This is usually done by a spectrograph, which photographs the spectrum. A spectrum gives information about the temperature of a body and the materials composing it.

Spica is a blue-white star 260 light-years away in the constellation Virgo.

Spiral galaxy is the most common type of galaxy in space. Old stars are arranged in a central bulge, while newer stars form spiral arms around it. Our *Milky Way* galaxy is a spiral, as is the *Andromeda Galaxy*.

Sputnik was a series of early Soviet satellites. Sputnik 1, launched on October 4, 1957, was the first artificial satellite.

Star is a glowing ball of gas in space. Any quantity of matter above a certain mass will become a star, as it is heated up by thermonuclear reaction. In our own *Solar System*, this critical mass can be measured by Jupiter, the Sun's largest planet, which is just too lightweight to have become a star.

Steady state theory, put forward by Fred Hoyle and Thomas Gold, supposes the Universe to have no sudden beginning or end in time, and matter to be continuously created to fill the spaces created by its expansion. It is a cosmology (philosophy of the Universe as a whole) at present out of favor.

Stellar spectroscopy is the analysis of light from stars. It reveals the star's composition, its temperature, and whether it is a dwarf or a giant.

Stonehenge is a monument on Salisbury Plain, England, which some astronomers believe embodies advanced astronomical knowledge. The oldest parts of it date back 4,500 years. Sun is our nearest star, almost a million miles in diameter. It is believed to have been born, along with the rest of the solar system, 4,600 million years ago. It keeps hot by nuclear reactions at its center which turn the hydrogen of which it is mostly made into helium.

Sunspot is an area on the Sun's surface about 2,700 F cooler than its surroundings, so that it appears darker by contrast. Sunspots are believed to be caused by strong magnetic fields which block the outward flow of heat from the Sun's interior.

Supergiant stars are those 300 or more times as wide as the Sun. Examples are *Antares* and *Betelgeuse*.

Superior conjunction is the instant when Mercury and Venus are on the far side of the Sun from Earth.

Supernova is a tremendous flare-up following the collapse of an aged, giant star. The end product of a supernova is either a tiny *Neutron Star* or a *Black Hole*. The Crab nebula may have been caused by a supernova.

Surveyor space probes were launched from the USA from 1966 to 1968 to map and land on the Moon, in preparation for the first manned landings in the Apollo spacecraft.

Synodic period is the time taken for an object to come back to the same position as seen from Earth.

Taurus, the bull, is a major constellation of the equatorial region of the sky. Its brightest star is *Aldebaran*, and it also contains the *Crab Nebula*, the *Hyades*, and the *Pleiades*. The Sun passes in front of Taurus from mid-May to late June.

Telescope is a device for collecting and focusing light, thereby revealing faint objects and fine detail otherwise invisible to the naked eye. The most important statistic about a telescope is its aperture, rather than its magnification.

Tereshkova, Valentina (b. 1937) was the first woman to fly in space. She orbited the Earth for nearly three days in the Soviet Vostok 6 spacecraft during June 1963.

Titan is the largest satellite of Saturn, 3,623 miles in diameter. It orbits Saturn every 15.95 days at a distance of 0.75 million miles. It is the only satellite known to have a substantial atmosphere

Titan rocket is an American space launcher used in various designs to orbit *Gemini* astronauts, Earth satellites, and planetary probes.

Tombaugh, Clyde (b. 1906) is an American astronomer who discovered the planet *Pluto* in 1930 at the *Lowell Observatory*.

Tracking station is an array of telescopes, radio telescopes or cameras that moves to keep track of an artificial satellite, such as a weather satellite.

Transit is the passage of a solar system body across the face of the Sun, or of a celestial object across an observer's north-south meridian.

Triton is the largest moon of *Neptune*, and may also be the largest moon in the Solar System; its estimated diameter is 3,728 miles. Triton orbits Neptune every 5.88 days at a distance of

220,586 miles.

Tsiolkovsky, Konstantin (1857-1935) was a Soviet prophet of astronautics who at the turn of the century worked out the theory behind rocket propulsion, invented the idea of step rockets, and predicted the establishment of space stations in orbit.

Twenty-one centimeter radiation is emitted naturally by hydrogen gas in space. It is detected by radio astronomers who have used it to trace the spiral shape of our Milky Way galaxy.

Tyuratam is the main Soviet launch site, their equivalent of Cape Canaveral, northeast of the Aral Sea.

UFO is short for Unidentified Flying Object, sightings of which are often connected with "visitors from space."

Ultraviolet astronomy is the study of the Universe at wavelengths shorter than those of visible light. Ultraviolet radiation is emitted strongly by very hot stars and gas and thus provides information on energetic processes in the Universe.

Ultraviolet waves are electromagnetic waves shorter and more penetrating than those of visible light but longer than X-rays or gamma rays. Special telescopes can detect UV waves reaching Earth from space from very hot stars and other bodies.

Universe is space plus all its galaxies and other contents, taken as a whole. According to the Theory of Relativity, because space-time curves in the presence of matter, the Universe is "finite but unbounded." That is, it has no end, but a ray of light would travel around it until the light returned to its source.

Uranus is the third largest of the Sun's family of nine planets, and is seventh most distant from its parent star. It is a gas giant, visible through telescopes as a greenish disk. Its axis has the greatest tilt towards the Sun of any planet. It has five known moons and, as recently discovered, a thin orbiting rocky ring.

Ursa Major, the great bear, is a famous constellation in the northern sky. Seven of its stars make up the familiar saucepan shape, also known as the Big Dipper or the Plow.

Ursa Minor, the lesser bear, is a constellation at the north pole of the sky. Its brightest star is *Polaris*.

Variable stars change in brightness because of variations in the size of the star itself, as in a *Cepheid Variable*, because one star in a binary eclipses the other, as with *Algol*, or even because of gas passing between two close stars, as in a *Nova*. Over 25,000 variable stars of all types are known.

Vega is a white star, 26 light-years away, in the constellation *Lyra*.

Venus is the second planet from the Sun, and the brightest object as seen from Earth after the Sun and Moon. The brightness of Venus is partly caused by its unbroken layer of white

clouds. Below the clouds, its dense atmosphere of carbon dioxide is too hot for life, producing temperatures up to 896 F. For reasons unknown; Venus rotates back to front (east to west) very slowly.

Vernal equinox is the moment when the Sun moves into the northern hemisphere of the sky, on or around March 21 each year.

Vesta is the third largest asteroid, 334 miles in diameter, and the fourth to be discovered, by Wilhelm Olbers in 1807. Vesta orbits the Sun every 3.6 years between the orbits of Mars and Jupiter.

Viking probes were two American spacecraft sent to look for life on Mars in 1976. Though both landed successfully, no sure signs of Martian life were detected.

Virgo, the virgin, is a constellation of the equatorial region of the sky, whose brightest star is SPICA. The Sun passes in front of Virgo from mid-September to early November.

Voskhod Russian spacecraft were developed from the earlier VOSTOK spacecraft to hold a crew of two or three astronauts.

Vostok was a Soviet one-man capsule, a sphere 7.5 feet in diameter, in which Yuri Gagarin made the first manned space flight. A total of six cosmonauts made flights in Vostoks, the longest lasting five days.

Voyager probes are the two latest from the USA to be sent on journeys through and beyond the Solar System. Launched in 1977, Voyager 1 and 2 have already sent back fascinating details of Jupiter and Saturn, and are now on their way to the outermost planets.

Weightlessness is a condition of matter when outside a gravitational field. Astronauts have to live in the condition of weightlessness when they are in orbit or in more distant spaceflight.

White dwarf is an extremely compact, dense star, only about the size of Earth but with the mass of the Sun. A white dwarf is a late stage in the life history of an average star such as the Sun, at a point where the star is using up the last of its fuel.

Biology

Algae: The simplest of plants. They have a plant body but no root, stem or leaves. Algae may be single-celled or many-celled plants and range in size from the microscopic to seaweeds.

Amino acids: The molecules that link up to make proteins. See *protein molecules*.

Ammonite: Member of a very large group of prehistoric sea creatures. They were related to the cephalopods (the octopus and nautilus). The ammonites became extinct some 65 million years ago.

Amylase: An enzyme which breaks up starch. The names of enzymes often end in "ase."

Androecium: All the *stamens* in a flower.

Angiosperm: A flowering plant, such as a daisy or buttercup. There are two groups of angiosperms - *monocotyledons* and *dicotyledons*. The word angiosperm means vessel seed - the seeds are protected inside an *ovary* as they grow. Angiosperms and *gymnosperms* are together known as the seed plants.

Annual rings: Rings seen on the cut surface of logs and stems. They indicate the age of the tree. Stems grow from the center outward. Every year, the new *xylem* produced by *secondary thickening* produces one annual ring. Toward the center of each ring the cells are large and are made in spring when growth is most active. At the outside of the ring, the cells are smaller and are made later in the year. These cells form a darker band, so that each year's growth can easily be counted.

Antibiotic: A substance produced by one living organism which is poisonous to another. The most famous antibiotic is penicillin which has been used for more than 40 years to kill disease-causing bacteria. Penicillin is produced by several species of the mold *penicilium*. Antibiotics are widespread in the world of microbes, but only about 50 different antibiotics have been found suitable for medical use.

Antibodies: *Protein molecules* produced by the body to defend itself against invading microbes. Antibodies are also produced against toxins and surgical grafts from another person. This capacity of the body to reject foreign tissues is the main problem in transplant surgery.

Arachnids: *Arthropods* that have eight legs in contrast to the insects which have six legs. Spiders and mites are the most common arachnids.

Arthropods: Animals with outside skeletons and limbs that have many joints. Insects form by far the largest group of arthropods. Crabs, prawns and spiders are also examples of common arthropods.

Auxin: A chemical hormone that affects the rate or direction of plant growth.

Bacillus: A rod-shaped bacterium. A bacillus is responsible for tuberculosis.

Bacteriophage: *Viruses* which infect bacteria. Bacteriophages are now used in genetic engineering to insert selected DNA in bacteria.

Biosphere: The surface of the earth and the lower atmosphere where all living things are to be found. The biosphere includes all seas and oceans.

Biotechnology: The use of biological knowledge for practical purposes.

Bulb: A short underground stem wrapped in swollen leaf bases, for example, onion, daffodil. New plants can grow from its buds by *vegetative reproduction*.

Calyx: A ring of *sepals* on the outside of a flower.

Cambium: A *meristem* inside a plant stem or root. Cambium cells divide and grow to make the stem or root thicker, producing *secondary thickening*. There are two sorts of cambium. Vascular cambium makes new *xylem* and *phloem*. Cork cambium makes cork and secondary *cortex*, giving the stem a thick waterproof coat to replace the *epidermis*.

Cambrian: The period in earth history which lasted from 570 to 500 million years ago. A widespread abundance of sea life is recorded by the fossils of the Cambrian age. All the major groups of animals were present at this time except the vertebrates.

Camouflage: A disguise that hides a plant or animal from animals that eat it. Camouflage generally involves a pattern or color that makes the plant or animal difficult to see against its surroundings. For example, white feathers are camouflage for the ptarmigan, a bird that lives in snowy lands.

Carbon: The "backbone" element of life. Each carbon atom has the capacity to join with four atoms. It can thus form chemical structures essential to all life.

Carbohydrates: Organic molecules made of carbon, hydrogen and oxygen. Sugars and starch are the best known carbohydrates.

Carnivore: An animal that feeds mainly on other animals. Carnivores, such as lions, are often called predators and the animals that they feed on are called their prey.

Carpel: A structure in a flower where seeds are made. A flower may have one or more carpels. A carpel generally has a sticky tip (*stigma*) connected to a swollen base (*ovary*) by a stalk (*style*). The carpels are together known as the *gynoecium*.

Cartilage: A tough whitish substance, flexible and strong, made of connective tissues. Gristle in meat is cartilage.

Cellulose: Chains of carbohydrate molecules. Cellulose forms the walls of plant cells. It is a fibrous material and therefore not easily digested. Animals that live on plants, like cows and

sheep, have specially evolved digestive systems to obtain maximum nourishment from cellulose.

Chlorophyll: The green chemical pigment in plants. Chlorophyll traps energy from sunlight during *photosynthesis* and uses it to split water molecules into hydrogen and oxygen.

Chloroplast: A microscopic sac in green plant cells where *photosynthesis* takes place. Inside a Chloroplast are layers or disks called *grana* surrounded by a liquid called *stroma*. In the grana, chlorophyll captures energy from sunlight and splits water molecules into hydrogen and oxygen. In the stroma, hydrogen and carbon dioxide are combined to make carbohydrates.

Chromosome: Rod-shaped structures visible in the nuclei of cells when they are about to divide lengthwise. It has been known for a long time that the chromosome carry the chemical code of instructions that controls life.

Coelenterates: The group of animals containing sea-anemones, jellyfish and corals. All live in water and most in the sea. Of the many-celled animals the coelenterates are the simplest in structure. They are the simplest form of life to have nerve cells. The coelenterates have been a very successful life form. Their ancestors (similar to day's animals) can be found in the fossil record of more than 500 million years ago.

Collagen: A fibrous protein. It is one of the main materials which bind cells and animal tissues together. Leather is the "fixed" collagen of the skin.

Cone: A reproductive structure of a typical *gymnosperm*. The woody scales of a cone are basically modified leaves. Each scale can produce reproductive cells. Cones are either male or female. Male cones produce *pollen*. They are small and do not live long. Female cones are larger and take up to three years to produce seeds. In animals, cones are light sensitive cells in the eye.

Corm: A swollen underground stem such as in a crocus. It contains stored food, and new plants can grow from its buds by *vegetative reproduction*.

Corolla: A ring of petals in a flower, above the calyx. The word corolla means crown, and the petals are often the showiest part of a flower.

Cortex: The area of packing cells between the *vascular bundles* and the *epidermis* in a plant stem or root. In animals, the cortex is the outer layer of the brain or kidney.

Cotyledon: A leaf in a seed. A cotyledon becomes the first leaf of the *embryo* plant, and may be quite different from all the other leaves. Cotyledons store food for the embryo plant. Only *angiosperms* and *gymnosperms* have cotyledons.

Crustaceans: A large group of the arthropods. Most crustaceans live in water. Shrimps, crabs and water-fleas are common examples.

Cuticle: The waterproof outer skin of a plant leaf or stem, on top of the *epidermis*. The cuticle is transparent and is not made of cells.

Cytoplasm: Everything enclosed by the cell membrane except the nucleus. Cytoplasm was a convenient description of the contents of cells at a time when it was not possible to know what cells actually contained. But cytoplasm is far more than fluid within the cell. It contains numbers of working molecules (*enzymes*), coded plans and instructions (carried by RNA), assembly units for proteins (*ribosomes*), energy generators (*mitochondria*) and other components of considerable complexity.

Deciduous: A plant that regularly sheds all its leaves. Deciduous plants usually lose their leaves at the end of the growing season, before the winter. Many *angiosperms* such as oak, beech and ash trees are deciduous. Larch is one of the few *gymnosperms* that is deciduous.

Decomposer: An animal or fungus that feeds on the dead remains or waste material of other living things. Decomposers break down their food into simple raw materials that can be reused by plants.

DNA: (short for deoxyribonucleic acid) This chemical carries the *genetic* code for all organisms, except some *viruses*. The code determines the form, development and behavior pattern of an organism. DNA is part of the *chromosomes* which exist within the nuclei of cells.

Diatom: A single-celled green alga with a silica case made of two halves that fit together, one inside the other, like a box. Diatoms are the main organisms of *plankton*.

Dicotyledon: A flowering plant with two *cotyledons* in its seed. Dicotyledons have broad leaves with veins in a net-like pattern. Their stems can grow thicker as well as longer, and the *vascular bundles* are arranged in a ring. The flowers have petals and other parts in fours or fives. Dicotyledons include all broad-leaved trees and most shrubs and herbaceous plants.

Dinosaur: A member of the major group of reptiles in earth history. Their extinction some 65 million years ago is a biological mystery.

Drupe: A fruit with one hard stone surrounded by soft flesh and skin. The seed is inside the stone. Cherries, plums and peaches are examples of drupes. A blackberry is several small drupes joined together.

E.coli: A type of bacteria widely used in research.

Echinoderms: A group of animals that includes starfish, which is distinct from other animal groups. Echinoderms are different from other life forms in their five-fold symmetry. Evidence from living animals and fossils indicates that their closest relatives were the distant ancestors of the *vertebrates*.

Electron microscope: A microscope which enables us to see specimens by beams of electrons instead of light. The magnification obtained is far greater than is possible with the best optical microscopes.

Embryo: The youngest stage of a new individual, which develops from fertilized egg cells. The embryo is undeveloped.

Endosperm: A food supply inside a seed. Grain seeds and oil seeds, such as linseed, have a large endosperm. Some seeds have no endosperm and store food in *cotyledons* instead. Endosperm contains chemical substances that control the growth of the developing seed.

Enzymes: These are proteins made by the "machinery" of the cell. Enzymes greatly increase the rates of chemical reactions within the cell. The chemistry of life would not be possible without enzymes.

Epidermis: A single layer of cells just below the surface of plant stems or leaves. With the *cuticle*, it provides a tough skin. In animals, the epidermis is the outer layer of skin.

Epiphyte: A plant that grows on the surface of another plant, but is not a *parasite*. For example, mosses growing on tree trunks are epiphytes. The word epiphyte means "on top of a plant."

Ethane: An odorless gas at normal temperatures. Ethane (C₂H₆) is an organic molecule and a hydrocarbon because it is composed of both hydrogen and carbon.

Evergreen: A plant that keeps its leaves all the year round. Most *gymnosperm* trees such as pine and spruce are evergreen.

Food chain: A sequence of events when a *herbivore* eats a plant, and then a *carnivore* eats the herbivore. This is a 3-link food chain. In a 4-link food chain a second carnivore eats the first carnivore. Food chains are nearly always part of a *food web*.

Food web: Interconnecting *food chains*. Links between food chains occur when animals feed on different foods. There are usually many connections between food chains so that each link of a food chain is always part of a *food web*.

Fossil: A permanent record of a prehistoric organism. A fossil usually consists of mineral material which has replaced the original tissues of the organism. Often only fragments of fossilized part of an animal or plant are found.

FronD: The leaf of a fern.

Fruit: The ripe *ovary* of a flower containing the seed. A fruit such as a lupine, that dries out and splits open to shoot the seeds out is called *dehiscent*. A fruit such as a poppy that releases the seeds some other way is called *indehiscent*.

Fruiting body: A plant structure that makes *spores*.

Gametes: The male and female sex cells. These may be sperm and ova in animals, or *pollen* and egg-cells in seed plants.

Gene: A unit which determines an inherited characteristic of an organism. The characteristic may or may not be expressed (show itself in a particular organism). Genes are made of *DNA* and are part of the *chromosomes* which exist in the nucleus of the cell.

Genetic: Concerned with *genes* and heredity.

Genetic engineering: The manipulation (engineering) of the *genes* for practical purposes. Genes that instruct the machinery of the cell to make a wanted protein are put into another organism, such as a bacterium, to produce that product in quantity.

Genus: The classification which includes the most closely related species. A genus may contain one or many different species. We belong to the genus *Homo* and the species *sapiens*.

Germination: The process in which a seed starts to grow. There are two different sorts of germination in flowering plants. In plants with *hypogeal germination*, such as broad beans, the *cotyledons* stay under the soil. In plants with *epigeal germination*, such as sunflowers, the *cotyledons* grow out of the seed and above the ground.

Glands: An organ or collection of cells which produce one or more special chemicals. These are released through vessels to either the inside or to the outside of the organism. Glands are associated with such processes as the digestion of food and the release of sweat. Some glands in animals secrete hormones into the blood stream.

Grooming: An activity of an animal to keep its skin or coat, or another individual's skin or coat, in good condition. Grooming removes dirt and pests.

Gymnosperm: One of the cone-bearing plants or their close relatives. Gymnosperms make seeds but do not have flowers. The main group of gymnosperms are conifers, for example, larch, spruce and pine. The word gymnosperm means naked seed - the seeds develop from unprotected *ovules*. Gymnosperms and *angiosperms* are together known as the seed plants.

Gynoecium: All the *carpels* in a flower.

Hemoglobin: The molecule which carries oxygen in the red blood cells of *vertebrate* animals. Some *invertebrate* animals also have hemoglobin in their blood.

Hemophilia: A *genetic* disorder which prevents blood from clotting. Hemophilia affects only males.

Herbivore: An animal that feeds mainly on plants, for example, a grazing animal such as a cow or a sheep.

Hormones: Chemicals that organisms produce in minute amounts but which can have dramatic effects on their life processes. Hormones play an important part in the lives of both plants and animals. Animal hormones usually go straight into the blood stream. A common hormonal effect is that produced by adrenaline which increases heart rate and raises blood pressure, producing a state of alertness and readiness for vigorous physical activity.

Inflorescence: A group of flowers on one stalk.

Interferon: A natural substance produced by cells to counter infections by *viruses*. Interferon inhibits the reproduction of viruses within infected cells.

Invertebrate: All animals which do not possess a backbone, although we do not usually think of single-celled animals, like the amoeba, as invertebrates.

Liverwort: A simple green plant related to a moss. Liverworts are mostly small and flat, with shoots simpler than those of a moss. They live in moist, shady places.

Lymph: The same as blood *plasma* (colorless blood fluid without the red cells). Lymph drains from the tissues and enters the lymphatic system of vessels. These eventually lead to the *vena cava*, the main vein in all four-legged *vertebrates*, as well as humans.

Mammal: An animal with a backbone which feeds its young on milk from mammary glands. Almost all mammals have hair or fur. Whales and dolphins have lost their fur during their evolution in the sea. All mammals maintain a constant body temperature (warm-blooded). The only other group of animals to maintain constant body temperature are birds. Man is the most advanced mammal, though whales and dolphins with their large brains must also be considered very advanced mammals.

Marsupials: A form of *mammal* found mainly in Australasia which bears its young in a very immature state. Young kangaroos, for example, are only 4 cm (1.5 inches) long at birth and must find their way into the mother's pouch where they fasten securely to a nipple. Not all marsupials have pouches.

Meiosis: Cell division associated with the production of sex cells (sperm and ova). This process reduces the number of *chromosomes* in the nucleus by half. Thus, when male and female reproductive cells unite, the number of chromosomes possessed by the species is restored.

Meristem: A plant growing point. The cells in a meristem can divide so that the plant grows bigger. The main meristems are at the tip of each root and shoot. A meristem inside a plant is called *cambium*.

Methane: A gas at normal temperatures, colorless, odorless and inflammable. Methane is an organic molecule and a hydrocarbon because it is composed of hydrogen and carbon (CH₄). Mixed with air, oxygen or water, methane is highly explosive.

Micropyle: A microscopic hole in the *ovule* of a flowering plant where the pollen tube enters after *pollination*. The Micropyle can sometimes be seen as a small hole in a seed coat.

Migration: A seasonal movement made by many birds, fish and mammals, often between breeding and feeding grounds. Animals migrate to make the best use of food and warmth.

Mitochondria: Small rod-shaped bodies within cells. The mitochondria produce the energy needed by the cell to drive its life processes.

Mitosis: Normal cell division in which exact copies of the *chromosomes* are made, one set of chromosomes going to each new cell before the old one finally divides.

Mollusks: A large group of animals including snails, mussels, oysters and whelks. Mollusks

have soft bodies and most have shells. The largest and most advanced of mollusks are the cephalopods: the octopuses and squid.

Monocotyledon: A flowering plant with only one *cotyledon* in its seed. They have long, narrow leaves with veins growing side by side. Their stems can grow longer but not thicker, and the *vascular bundles* are scattered. The flowers have petals and other parts in threes. Monocotyledons include all grasses, palms and lilies.

Monotremes: Egg-laying *mammals* which survive only in Australasia. They are the duckbilled platypus and the spiny anteater. The platypus spends its life in water, much like a duck. The anteater is like a hedgehog and feeds on insects. In prehistory there must have been many kinds of monotremes in between these two extreme examples.

Mutation: A change in the *genes* (DNA) which produces an inherited change in the organism. Most mutations are changes in single genes.

Mycorrhiza: Root-like threads of fungi that grow in close association with tree roots. Both the fungus and the tree seems to benefit from the relationship.

Natural selection: The survival of members of a species best suited to live and reproduce in a given environment.

Nectar: A sweet liquid produced by many petals. Nectar is collected for food by insects and other animals that visit the flower.

Nucleic acids: The DNA and RNA molecules. The unique structure of these molecules enables them to carry coded information. This information specifies and controls the form and development of all organisms. DNA holds the information within the cell nucleus. RNA carries copies of this information into the cell, where it is acted upon.

Omnivore: An animal that feeds on both plant and animal material. Human beings are omnivores.

Organic: Refers to matter of which living things are made. As this is highly organized matter, scientists called it organic. At one time all organic substances came from living things. But in modern times many organic substances are made in the laboratory and factory.

Organic molecules: In biology this refers to molecules formed by living organisms. However, a great range of organic molecules are now man-made for many different purposes. All organic molecules contain the element *carbon*.

Ovary: The part of the female reproductive system in flowering plants and animals that makes egg cells. A ripe ovary in a flowering plant is a *fruit*.

Ovule: An area containing an egg cell in seed plants. The ovule has one or more protective coats called integuments. In *angiosperms* an ovule is inside an *ovary*.

Palisade layer: The layer of cells in a typical plant leaf that contains most of the *chloroplasts*. The palisade layer is just below the upper *epidermis* and gets more sunlight than the rest of the

leaf.

Parasite: A living thing that gets its food from another living thing without necessarily killing it.

Pesticide: A chemical that is used to kill pests. Most pesticides are used to kill insects and are called insecticides. The use of pesticides must be carefully controlled so that *food webs* are not destroyed.

Phloem: The food pipeline in plants. It is made up of rows of living cells called sieve tubes joined end to end, together with their support cells. Phloem is usually part of a *vascular bundle*.

Photosynthesis: The process in which green plants use energy from sunlight to convert carbon dioxide and water to make their own food. Photosynthesis takes place in *chloroplasts*.

Pith: An area of spongy packing cells in the center of a plant stem. Sometimes the pith is hollow.

Placenta: The organ in the uterus of pregnant *mammals* to which the growing embryo is attached. The embryo receives food and oxygen through the blood system of the placenta while waste products travel in the blood in the opposite direction. All mammals that reproduce in this way are called placental mammals.

Plankton: Microscopic plants and animals that live in great numbers in water. Plankton is the main source of food for many animals. Plankton that is mainly plants is called phytoplankton, and plankton that is mainly animals is called zooplankton.

Plasma: (Blood plasma) The liquid part of blood. It contains all the important substances of blood but no blood cells.

Plasmid: A section of *DNA*. Bacteria exchange plasmids as part of their natural behavior. Scientists use this capacity of bacteria to insert new *DNA* into organisms in research and *genetic engineering*.

Platelets: Minute fragments in the blood which play an important part in the clotting and sealing of wounds.

Pleistocene: The period in earth history from 1.5 million years ago until 10 thousand years ago. During this time there were four ice ages and modern man (*Homo sapiens*) evolved.

Plumule: The miniature shoot in a seed, part of the *embryo* plant.

Pollen: Yellow dust produced by *gymnosperms* and *angiosperms*. Each particle of pollen-- a pollen grain-- contains one male sex cell. Pollen grains must travel to a female sex cell in the *ovule* and fertilize it for seeds to grow. The journey to the ovule is called *pollination*.

Pollination: The transfer of *pollen* from male cones or anthers of seed plants to an *ovule*. Pollen travels by air, water or animals, particularly insects. In *gymnosperms*, pollen lands

directly on the naked ovule. In *angiosperms* the pollen lands on a special area called the *stigma*, above the *ovary*, and grows a tube down into the ovary.

Preen: An activity of a bird to trim and clean its feathers, usually with its beak.

Protein molecules: Living tissues are made of proteins. Proteins exist in an almost limitless number of different forms. The units of proteins are smaller molecules known as *amino acids*. There are some 20 different amino acid molecules in living proteins. The amino acids are formed into long chains which fold up into very complicated structures. The form of these structures is always exactly the same for any given protein. The structure of the human *hemoglobin* molecule, for example, is always the same, unless faulty. The structure of a protein molecule matches its task in the body.

Prothallus: A small, flat disk that grows from the *spore* of a fern. The Prothallus produces male and female sex cells that can grow into the main fern plant.

Protista: A name given to all single-celled organisms whether animals, plants, fungi or bacteria.

Protozoa: A name given to all single-celled animals.

Radicle: The miniature root in a seed, part of the *embryo* plant.

Respiration: This takes place within living cells where food is "burned" in the presence of oxygen to release energy.

Rhizome: A swollen underground plant stem, such as in an iris. It contains stored food and can produce new plants from its buds by *vegetative reproduction*.

Savanna: A dry grassy plain with few or no trees, in tropical regions.

Secondary thickening: Cells produced from the *cambium* of many seed plants that make stems and roots grow thicker. Wood is mostly *xylem* cells produced by secondary thickening.

Segmented worms: Worms, such as the earthworm, are made of a series of units (segments). Each segment is a similar structure both inside and outside. The structures of blood vessels and nerves, for example, are repeated in each segment.

Sepal: A leaf-like structure that protects the bud of a flower. The sepals are together known as the *calyx*.

Sorus: A small patch, generally brown, on the underside of a fern *frond* where *spores* are made. Each Sorus contains several *sporangia*.

Species: A group of organisms which resemble each other and interbreed. One species can seldom breed with another species, but there are a few exceptions to this rule. The species of plants, animals and other organisms therefore remain distinct.

Sponges: The simplest of all many-celled animals. Sponges are composed of many

cooperating cells but they have no system of nerves. They live attached to rocks or the seabed. Except for one family of sponges all live in the sea. Most sponges are supported by a skeleton. A bath sponge is the skeleton of a certain type of sponge.

Sporangium: (plural *sporangia*) A structure that makes *spores* in fungi, algae, mosses and ferns. In mosses, the sporangium is a special case with a lid and is called a capsule.

Spore: A reproductive cell of a fungus, alga, moss or fern, capable of growing into a new plant. Some spores have tough protective coats that can survive periods of drought or cold. Some single-celled animals make spores to help them survive adverse conditions.

Stamen: A structure that makes *pollen* in a flowering plant. Each stamen has a stalk (filament) and an anther, where the pollen is made. The stamens together are known as the *Androecium*.

Stoma: (plural *stomata*) A small hole in the epidermis of a plant leaf that can open and close to control the flow of air and water vapor in and out of a leaf. Each stoma is controlled by two sausage-shaped cells in the epidermis, called guard cells.

Symbiosis: The close association of two different kinds of organisms to their mutual benefit. Good examples are lichens which are formed of green algae and fungi. The algae use sunlight to make food while the fungi provide water and some protein.

Synapse: The gaps between nerve cells across which nerve impulses pass. An impulse is changed from an electrical signal into a chemical and back into an electrical signal for the purpose of crossing a synapse. Such a substance is called a chemical transmitter.

Taxonomy: The science of classifying living organisms.

Termite: An insect that looks like an ant (but is in fact related to cockroaches), and that lives in large colonies. Some termites live in huge towers that they build out of mud. Most live in the tropics. Some grow special fungus gardens in their nests and use the fungus to add to their diet of vegetable matter.

Territory: A patch of land defended by an animal against other members of the same species. Some animals hold territories all year round, others only at breeding time.

Transpiration: Evaporation of water from the leaves of plants. Transpiration causes water to travel from the roots, up the stem and out through the leaves. Transpiration supplies all parts of the plant with water, which it uses to make food, and it helps the leaves and stems keep their shape.

Tropism: A change in direction or rate of growth of a plant root or shoot in response to the environment. Tropisms are controlled by chemicals called *auxins*.

Tuber: A rounded swelling at the end of an underground shoot or root. For example, a potato is a tuber. A tuber contains stored food and new plants can grow from its buds by *vegetative reproduction*.

Vaccination: The introduction of dead or inactive bacteria or *viruses* into the blood stream. The presence of these are enough to cause the cells of our immune system to make *antibodies*. These antibodies will then protect us against future infections by the disease.

Vacuole: A small drop of fluid within an animal cell. In plants vacuoles are larger, occupying most of the volume of the cell.

Vascular bundle: A group of vessels, sieve tubes and supporting cells (*xylem* and *phloem*) that carry food and water around a plant.

Vegetative reproduction: A process in which some plants can produce new plants from a small part of themselves without the need for flowers or seeds. *Rhizomes, tubers, bulbs* and *corms* are organs of vegetative reproduction.

Vertebrate: An animal with a backbone. The backbone is sometimes called the vertebral column.

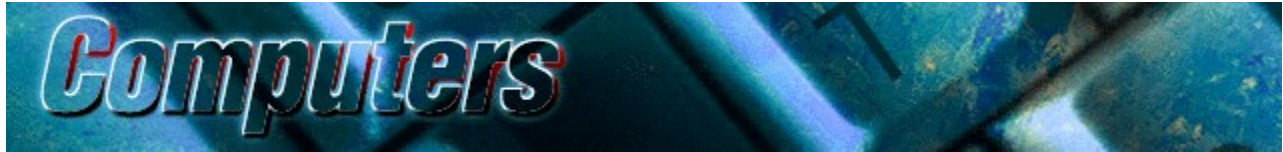
Virus: A simply constructed system which only becomes alive when it enters a living cell. It then uses the "machinery" of the cell to make more viruses. Although viruses are a common cause of disease, they do not all cause disease. Viruses are so small that they can only be seen and studied with an *electron microscope*.

Vitamins: Substances needed in minute amounts for the health of animals. Vitamins are different and unrelated substances.

Xylem: The water pipeline in plants. In flowering plants xylem is made of rows of dead cells called vessels joined end to end. Xylem is usually part of a *vascular bundle*.

Yeasts: Single-celled fungi of great practical value to man in the production of wine and beer and in baking.

Zygote: A fertilized egg before it begins to divide and develop into a new organism. The cell resulting from a male and female cell coming together.



AC: See alternating current.

Accelerator, particle: An apparatus for bombarding atomic nuclei with atomic particles such as protons.

Access time: The time taken to retrieve information from a storage device such as a disk or tape and place it in a computer's main memory.

Accumulator: A part of the computer's central processing unit in which results accumulate as numbers and are held temporarily. The numbers are added to, subtracted from or compared with each other.

Address: A number that identifies the location in a computer's memory at which a particular piece of data and an instruction code are held.

Alpha particle: A particle sent out by many radioactive atoms. It is made up of two protons and two neutrons. It carries two units of positive charge.

Alternating current: Electric current that rapidly decreases from maximum in one direction, through zero, and then increases to maximum in the other direction. The usual household electricity supply is alternating at 60 cycles per second.

Amplifier: An electronic device that increases the strength of a signal such as radio waves or audio waves.

Amplitude: The maximum value of an alternating current during a cycle. The higher the amplitude, the louder a sound wave, or the brighter a light.

Amplitude modulation (AM): Sound signals can be broadcast by using them to modulate (vary) the amplitude (strength) of radio waves. In AM broadcasts, the amplitude of the carrier waves varies to match changes in the electric waves coming from the radio studio. Electrical interference produces this modulation too. This means that this kind of modulation suffers from background hiss and clicks.

Anode: The positive electrode to which electrons travel inside a vacuum tube.

ASCII: American Standard Code for Information Exchange. The standard code which allows 128 characters-- upper (capital) and lower case letters, numbers 0 to 9, and a range of special characters such as punctuation marks-- to be expressed in a computer 8-bit byte. For example, A=65 and a=97.

Assembly language: A low-level computer language which represents each instruction performed by the central processor as a short code of letters and numbers. (Compare with *high-level language*.) Assembly language takes instructions from the programmer and turns

them into a machine code that the machine can understand.

Atom: The smallest part of an element that cannot be divided by chemical means. An atom of any substance consists of a nucleus made up of protons and neutrons surrounded by orbiting electrons. The atoms of the various elements differ in the number of protons, neutrons and electrons which make them up.

Atom smasher: The name given to machines such as the cyclotron that accelerate atomic particles to speed at which they can split atoms.

Atomic number: The number of protons in the nucleus of an atom. This is usually the same as the number of electrons orbiting the nucleus.

Audio frequency: The frequency of a sound or electrical signal which is in the range of frequencies that the human ear can hear-- about 20 to 20,000 cycles per second.

Automaton: A mechanical object that can move under its own power. The word is usually used to mean the earlier automatic toys that acted like human beings or animals.

Bar code: A pattern of black and white stripes that can be read by a laser scanner. Bar codes are often printed on products such as food packages and cans to identify the products for computer check-out and stocktaking.

BASIC: A high-level computer language. It is used more than any other language with microcomputers.

Battery: A device that converts chemical energy into electrical energy. Most batteries consist of a series of electric cells. They give out direct current (DC).

Beta-particle: A fast-moving electron sent out by a radioactive atom.

Binary: A numbering system based on the number 2, as opposed to the normal decimal system which uses 10. Only two symbols, 0 and 1, are needed to express any number. All instructions and data to a computer have to be turned into binary for the computer to understand them. Inside the computer the binary numbers exist as sequences of on-off or high-low pulses of electric current. This is called machine code.

Bit: Short for Binary Digit. It is represented by either a 1 or a 0. (See byte.)

Branch: Instruction in a computer program which tells the central processor to leave the normal sequence of instructions and go to another part of the program.

Bubble chamber: A chamber used for detecting atomic particles. The chamber is filled with liquid hydrogen or some similar fluid. The particles heat the fluid along their paths and form bubbles that can be photographed.

Bubble memory: A memory chip in which data is stored as tiny regions of magnetism called bubbles.

Buffer: A short term computer memory that holds instructions or data until another part of the computer is ready to receive them.

Bug: An error in a computer program that may cause the program to work badly or not work at all. "Debugging" means to correct a program

Byte: A group of 8 bits. There are 256 different bytes made by rearranging the 0 and 1 bits.

Camera: The front end of a television or video system. It converts an image into a black and white or color picture and then transmits it as an electronic signal which can be seen on a TV screen and /or recorded on magnetic tape.

Capacitor: (condenser) A device for storing an electric charge. It is usually formed by two metal plates separated by an insulating layer. It will not allow a direct current to pass, although it will allow an alternating current through, especially if the current alternates very rapidly.

Cathode: The negative electrode in a vacuum tube (valve). Electrons flow from the cathode to the anode.

Cathode-rays: Electrons flowing from the cathode to the anode in a vacuum tube (valve).

Cathode-ray tube (CRT): A video display terminal, like a TV set, used with computers as an input/output device.

Cell: An electrical device used to make electric current by means of chemical change. A simple cell may consist of two different metals immersed in a dilute solution of acid. Cells joined together are called a battery.

Central processing unit (CPU): The part of the computer that joins all the other units together and controls its overall operation. Adding, subtracting and comparing are done in the central processing unit.

Character: A term used for any of the letters, numerals, signs and symbols used in computers.

Chip: An electronic device in which all the parts such as transistors making up its circuits are contained within one small piece of semiconductor, usually silicon.

Circuit: A complete path through which an electric current flows away from and back to the source of the current, which may be an electric generator or an electric cell.

Clock: An electronic device in every computer that produces electric signals at a very fast and regular rate. These signals regulate the running of the computer.

Cloud chamber: A chamber containing water vapor, used for detecting radiation. The radiation passing through the vapor produces charged atoms that condense the water vapor and leave a trace that can be photographed.

Coaxial cable: Cable for transmitting very high frequency currents. It consists of a copper

wire running through and insulated from a copper tube which serves as a second wire.

Cobol: A computer language, short for Common Business Oriented Language. It is used a great deal with larger computers.

Coherent light: Light in which all the waves are synchronized or in step. Their peaks and troughs coincide and add to each other.

Compiler: A program that converts a high-level language such as BASIC into the machine code that actually drives the computer. The compiler translates the whole program into machine code before the program can start.

Conductor, electrical: A substance through which an electric current passes easily. Most metals are good conductors.

Cosmic rays: Radiation bombarding the Earth's surface from outer space. The rays consist mainly of positively charged protons, with a much smaller number of negatively charged electrons.

CPU: Central processing unit of a computer.

CRT: Cathode-ray tube.

Data: The information that is worked on by a computer. It can be words, numbers or both.

Database: A large file of data, for instance set of statistics, that is stored in a computer system. The information is indexed so that it can be used, updated and extended as required in different ways.

Digital: A digital system works by producing or using a series of numbers. A digital watch displays the time as numbers for hours, minutes and seconds. Nearly all computers are digital machines because they need data in the form of binary numbers.

Diode: A radio valve with two electrodes-- a cathode (with heating filament) and an anode. Electrons travel from the hot cathode to the anode only when the cathode is more negative than the anode. A diode therefore allows current to pass in one direction only, so turning alternating current into direct current.

Direct current (DC): A one-way electric current, for example, that produced by a battery.

Disk: A storage device that allows the computer system to store and retrieve data at high speed. Plastic disks are coated with a magnetic surface on which programs and data are recorded as magnetic patterns.

Electromagnet: A bar of soft iron, around which is coiled a wire. Current in the wire turns the bar into a magnet, but the bar loses its magnetism as soon as the current is switched off.

Electromagnetic radiation: Energy in the form of waves that consist of an electric field at right angles to a magnetic field. Electromagnetic waves include a whole range of different

wavelengths that make up the electromagnetic spectrum.

Electron: The outermost parts of every atom are made up of negatively charged particles called electrons. A flow of electrons is an electric current.

Electron microscope: The ordinary microscope cannot be used to magnify objects that are smaller than the wavelength of light rays. But these tiny objects can be seen by using beams of electrons instead, since electrons act as though they have a wavelength very much shorter than that of light.

Element: A substance that cannot be split up into simpler substances by chemical change.

Firmware: A computer program that is held in a permanent form, such as on a ROM chip, so that it can be constantly used. Operating systems in most microcomputers are stored in firmware.

Floppy disk: A soft disk coated with electronic recording material. These disks are used as additional memory systems in computers.

Flowchart: A chart used to develop computer programs. The chart plots information and the order in which it should be used.

Frequency: The frequency of any electromagnetic radiation is the number of waves that pass a given point in one second. A frequency of one hertz (Hz) is equal to one cycle per second. One kilohertz (kHz) is equal to 1000 hertz. The frequency of a sound wave governs its pitch. The frequency of a light wave governs its color.

Frequency modulation (FM): Sound signals can be broadcast by using them to modulate (vary) the frequency (rate) of radio waves. In the radio receiver, the frequency variations of the radio waves are turned back into sounds. The receiver does not detect amplitude modulation caused by electrical interference, so the background noise is very low. This one reason why FM receivers are used in high quality sound systems.

Gamma-rays: Rays given out by some radioactive substances. They belong to the same electro-magnetic family as light waves and X-rays, but they have a much shorter wavelength.

Graphics: The production of pictures and diagrams by a computer. The pictures and diagrams are made up of formations of small graphics characters of various shapes and colors.

Grid: An electrode in a valve or cathode-ray tube used to control the flow of current through it.

Hardware: The machines that make up a computer system, as opposed to the programs needed to operate it. Anything you can actually touch is hardware.

Hertz (HZ): A unit for measuring frequency.

High-level language: A computer programming language that uses a single instruction to represent a whole group of instructions that the central processor actually carries out. The high-level language may be in English words or groups of symbols.

Holography: A method of reproducing 3-D pictures by using a laser beam instead of a camera.

Infra-red rays: Radiation given off by warm bodies such as fires or human beings. The rays are not visible to the human eye but can be photographed on special film. The wavelength of infra-red rays is just longer than those of visible light.

Input: programs or data that are fed into a computer. Input units include keyboards.

Instruction: A command given in a computer program which produces action by the computer. Instructions are written by the programmer. These are taken by the compiler in the computer and translated into machine code instructions which the machine can understand.

Integrated circuit: A silicon chip on which all the necessary components such as transistors, resistors and capacitors have been etched in miniature.

Ion: An atom or group of atoms that have an electrical charge. The electric charge is caused by the loss or gain of electrons. An atom with fewer electrons than protons is positively charged; one with more electrons than protons has a negative charge.

K: Commonly used measurement of memory size in computers. Although it comes from the metric "kilo" meaning a thousand, 1k is one kilobyte, or 1024 bytes.

Laser: A device that produces an intense beam of light. The beam is very narrow, coherent (all its waves are in step) and of a single color.

Light: A section of the electromagnetic family of waves to which the human eye is sensitive. Visible light covers a range of wavelengths, the longest of which produces the color red and the shortest of which produces the color violet. Light travels at a speed of 186,000 miles (300,000 kilometers) per second in empty space.

Location: A part of a computer memory unit containing a particular instruction code or some data. Each location has an address to identify it in order to retrieve its contents.

Loop: a Set of computer instructions that is repeated until some given condition is satisfied.

Loudspeaker: A device that turns electrical currents into sound waves that can be heard.

Machine language: The binary coded instructions which the central processing unit of a computer can recognize.

Magnetic tape: An inexpensive way of storing data. It is slower than disk storage.

Mainframe: A large computer that needs its own air-conditioned room.

Medium wave: A radio wave with a wavelength between 200 and 1000 meters.

Mega:- A prefix meaning "million." A megabit is a million bits, a megabyte is a million bytes, a megawatt is a million watts.

Meter: The main unit of length in the metric system. It was originally intended to equal one ten-millionth of the distance from the North Pole to the Equator. A meter is 39.37 inches.

Microcomputer: A small computer containing a microprocessor to which larger peripheral units may be connected. In a home microcomputer, these often include a television set and a cassette player.

Microphone: A device which converts sound waves into electrical currents. It is used in telephone transmitters, radio, tape recorders, etc.

Microprocessor: A complete central processing unit contained in one silicon chip.

Microprocessor: Very short radio waves with wavelengths of about 0.1 to 30 centimeters.

Modem: A device that enables computers to be connected by telephone wires. It converts the computer's electronic digital signals into analogue signals such as audio signals that can travel along a telephone line. Another modem at the other end of the line will turn the analogue signals back into digital signals for the receiving computer.

Modulation: Putting signals (speech or music) on a radio wave. The wave on which they are imposed is called the carrier wave.

Nanosecond: One thousand millionth of a second.

Neutron: An uncharged atomic particle found in the center of all atoms except hydrogen. It has a fairly large mass-- nearly 1840 times as heavy as an electron.

Nucleus, atomic: The positively charged center of an atom. It is made up of one or more protons and, except for hydrogen one or more neutrons. Practically all the weight of an atom is in its nucleus.

Oscilloscope: An electronic instrument in which an electric signal or anything that can be reduced to an electric signal is displayed as a "trace" by a spot of light moving on a cathode-ray-tube screen.

Output: The processed data or other information that the computer presents through output units. Output units include video screens and printers.

Peripherals: Input, memory or output units that may be temporarily connected to the central processing unit. Peripherals include printers and disk drives.

Photoelectric cell: A device in which electrons are given out, or in which the electrical resistance changes, when light falls on it. The current passing through such a cell varies according to the brightness of the light. The current can therefore be used to measure the amount of light falling on the cell.

Photon: A tiny "packet" of electromagnetic radiation. It can be thought of as a short train of waves of a particular wavelength.

Potential difference: Another name for voltage difference. The potential difference between two ends of a conductor results in a flow of electrical current.

Program: A complete set of instructions that enable the computer to solve a particular problem or undertake a particular task when given the data required. A computer also contains several permanent programs that operate its various units.

Proton: A positively charged atomic particle found in the nuclei of all atoms. The positive charge on a proton is equal to the negative charge on an electron. Protons have a mass slightly less than that of neutrons.

Radar: Short for Radio Direction and Ranging, a system in which radio pulses are sent out and reflected back by any objects in their path. The returning pulses are recorded on a screen and their distance found by measuring the time taken for the radio pulses to get to the object and back.

Radioactivity: A substance whose atoms break up by themselves, not as the result of an outside force, is said to be radioactive. The radioactive substance usually gives out alpha-and beta-particles, or gamma rays.

RAM: Random Access Memory. A computer memory in which programs and data are held temporarily, and in which any instruction or data may be instantly retrieved or changed.

Real-time: A computer system that can give the user immediate answers via a terminal.

Rectifier: Any device which turns alternating current into direct current by presenting a greater resistance to a current flowing in one direction than to one flowing in the other.

Register: A small memory unit within the central processing unit of a computer. It is used for the temporary holding of data, instructions and results.

Resistance: The property of an electrical circuit that opposes the flow of current passing through it. Resistance is measured in ohms and is calculated by dividing the voltage (in volts) by the current (in amps).

ROM: Read-Only Memory in a computer. A memory that has its program permanently fixed into it and which cannot be changed by the user. The computer can never write any information into this memory.

Semiconductor: A substance such as silicon or germanium which is neither a good conductor of electricity nor a good insulator. Transistors are made from semiconductors.

Software: The programs that make computers operate. Software is contrasted to the hardware of the actual computer machinery.

Sonar: A system of underwater location and direction-finding. Objects are located when they reflect back an "echo" of ultrasonic waves. (Compare with *radar*.)

Spectroscope: An instrument for splitting up light into its different colors and studying the spectrum so produced.

Spectrum: The series of color bands obtained when light is split up into its rainbow colors. The spectrum of white light is a range of colors and each part of the spectrum is a different wavelength.

Static electricity: A stationary electric charge-- for example, that produced by rubbing a glass rod with a silk cloth.

Terminal: An input/output device linked directly to the computer. The most common terminal is a keyboard and screen.

Time-sharing: The sharing of one computer system between several users. Each user has access to the central processor to run their own programs.

Transformer: A device for converting alternating current at one voltage to alternating current at another voltage. It consists of a primary coil and a secondary coil, wound separately on a soft iron core. Currents in one coil produce currents in the other coil, and the ratio of the voltages in each is equal to the ratio of the number of turns in each coil.

Transistor: A semiconductor electronic device that can amplify or rectify current. Transistors are the main parts in integrated circuits.

Triode: An electronic valve with three electrodes inside it-- an anode, a cathode and a control grid. It can be used to amplify varying electric currents.

Ultraviolet radiation: Light waves which are of smaller wavelength than the light at the violet end of the visible spectrum.

VHF: Very high frequency radio waves.

Videotex: A system which allows a television owner to communicate with a computer system, and have chosen pages of information sent down a telephone line and projected on the TV screen.

Visual display unit (VDU): A computer output unit consisting of a cathode ray tube video screen.

Voice recognition: A system that allows people to give the computer instructions and data by speaking.

Voice synthesis: The production of artificial voice sounds which enable the computer to speak.

Volt: The unit of voltage (electromotive force and potential difference). It is defined as the potential difference between two points in a conductor if 1 joule of work is done when 1 coulomb of charge passes between them.

Voltaic cell: A simple electric cell which produces an electric current by means of two plates

of different metals in acid or other chemicals.

Watt: Unit of electrical power. It is defined as the rate of work done in joules per second, and is equal to the current in amperes times the voltage.

Wavelength: The distance from the crest of one wave to the crest of the next. Radio wavelengths are measured in meters. The wavelength is equal to the speed of the wave divided by its frequency.

Word: The central processor of a computer handles bits in groups of a set length called a word. The longer the word, the greater the computer's power. Word lengths can be of 4,8,16, or 32 bits. Most microcomputers work in 8-bit or 16-bit words.

Word processor: A special computer system designed to handle text and considerably speed up the typing process.

X-rays: Electromagnetic waves which have a very short wavelength. X-ray photography is widely used in hospitals for detecting broken bones, ulcers, appendicitis and so on.



Aborigine: An original inhabitant of a particular land.

Apartheid: A policy of racial segregation in South Africa. In South Africa, Europeans control the government and business life and attempt to enforce a policy that separates the people of South Africa by race. For example, marriages between people of different races is forbidden.

Archipelago: A group of many islands. Indonesia is an archipelago.

Aurorae: Disturbances in the ionosphere that are caused by streams of particles from the Sun. These disturbances take the form of glowing lights.

Block mountains: Mountains formed when blocks of land are forced up by pressure between parallel cracks in the Earth's crust.

Caucasoid: One of the three main subgroups used by anthropologists to divide humankind. Caucasoids are the largest subgroup and have more facial or body hair than people of the other two groups.

Chestnut-brown soil: Soil that is unleached and brown because it contains a great deal of humus.

Climate: The kind of weather a region gets over many years.

Collective: In Communist countries, a large farm run by the government that employs many workers who receive wages.

Continental shelf: The sloping edges of a continent that are submerged in the ocean.

Crust: The thin outer layer of the Earth's surface.

Deciduous: A term used to describe trees that shed their leaves in autumn. Deciduous trees have broad leaves and grow in lands with temperate climates. Deciduous trees include oaks, birches, elms, and beeches.

Delta: The mouth of a river into which the tide flows from the ocean.

Desalination: The process by which salt is removed from sea water. Desalination is expensive, but is used in desert areas lacking fresh water.

Dormant: A term used by scientists to describe a volcano that may lie quiet for hundreds of years, but have the potential to erupt again.

Dry gallery: A room in an underground cave system that contains no running water or mineral deposit formations.

Dyke: A strong wall that is used to hold back the sea. Dykes are used in the Netherlands, where nearly half of the country is below sea level during high tide.

Erg: A desert made up of sand.

Erosion: The process by which rocks and land are weathered away by the wind.

Estuary: The mouth of a river into which the tide flows from the ocean.

Exosphere: The outermost layer of the atmosphere. The exosphere is made up of the lightest gases, helium and hydrogen, and hundreds of miles out, the exosphere thins to nothing.

Extinct : A term used by scientists to describe a volcano that has stopped erupting.

Fault: Great pressure inside the Earth may open up parallel cracks, or faults, in the land. A block of land between two such faults may be forced up by pressure from each side.

Fault scarp: The steep slope bordering a Horst.

Fjord: A sea inlet created by glaciers and ice sheets.

Floodplain: Broad, level land near the mouth of a river.

Fold mountains: Mountains formed when land masses collided millions of years ago and some rocks were folded over onto others. The Himalayas and the Rockies are fold mountains.

Fringed curtains: Stone features that are formed when water drips from wavy cracks in the ceiling of a limestone cave.

Gauchos: Cowboys in Uruguay and Argentina who look after livestock.

Giant: A term used to describe low-density planets that are made up of gases. Jupiter, Saturn, Uranus, and Neptune are giant planets.

Glacier: A river of ice.

Hammada: A bare, rocky desert without sand.

Have-nots: A term sometimes used for the group of the world's developing nations. Developing nations often do not have enough food and are in a short supply of schools, doctors, and hospitals.

Haves: A term sometimes used for the group of the world's developed nations.

Homelands: Black African states set up within the country of South Africa.

Homo sapiens: The term scientists use to describe modern humans. Homo sapiens means thinking men.

Horst: A block of land that are pushed up to form a mountain.

Humus: The decayed remains of dead plants, animals, and animal excretions. Soils with plenty of humus are usually dark in color.

Ionize: To knock electrons off of a gas atom. In the ionosphere, the Sun's fierce radiation ionizes the gas atoms and makes the atoms electrically charged.

Ionosphere: The fourth layer above the Earth's surface. The gases that make up the ionosphere are sparse and are electrically charged.

Klima: The Greek word for slope. The word *climate* comes from this word because the ancient Greeks thought that the Earth sloped southward to the hot Equator and northward to the icy poles.

Kubbutzim: Farming settlements in Israel, where the chief crops are cereals, fruits, sugar, and vegetables.

Latitude: A measurement of how far north or south of the Equator a particular area of the Earth lies. Latitude affects climate because the Sun's rays are stronger at the Equator than at the poles, so lands nearer the Equator are usually hotter.

Leached: A term used to describe soil in which heavy rainfall has dissolved many of the chemicals. These soils are rich in bauxite but poor for farming. The plants that grow in tropical climates are those of the dense, tall, evergreen rain forest.

Levees: Low embankments that are formed when deposits of eroded material slowly build up along river banks.

Light-year: The distance traveled by light in one year. One light-year is equal to nearly 6 trillion miles. Light travels at a speed of 186,282 miles a second.

Llanos: Grasslands in northern South America.

Marsupial: An animal that carries its young in a pouch until fully grown. A kangaroo is a marsupial.

Meander: A bend in a river.

Melanesia: A group of islands in the Pacific Ocean near Australia. This group includes Nauru and Wake, and the Caroline, Kiribati, Mariana, and Marshall islands. Melanesia means little islands.

Mesosphere: The third layer above the Earth's surface. The mesosphere, which is above the stratosphere, is the coldest layer of all.

Mestizo: A person of mixed Indian and European origin.

Meteorologists: Weather experts who study and attempt to predict the Earth's air

conditions. They make regular measurements of the air conditions that make up our weather. These include the air temperature, measured by thermometers, the movement of air (winds), measured by anemometers; and the changing air pressure, measured by barometers.

Mongoloids: One of the three main subgroups used by anthropologists to divide humankind. Mongoloids are the second largest subgroup and have yellowish skin, straight black hair, and slanted eyes.

Moraine: A mass of rocks or sand left by a glacier.

Munataks: Peaks of ice that rise through the thick blanket of ice that covers Antarctica.

Nappe: A mountain that is formed by a fold in the Earth's crust.

Negroid: One of the three main subgroups used by anthropologists to divide humankind. Negroids have dark skin and curly or tightly coiled hair.

Oceanic islands: Islands that rise steeply from the ocean floor.

Open-cast: A method of mining where minerals are extracted from the Earth's surface instead of through underground mines.

Oxbow lake: A lake formed when a river cuts a straight channel through the neck of a bend, leaving a separate loop.

Polders: Rich areas of farmland in the Netherlands. Polders are enclosed by Dykes to keep the sea from flooding the farms.

Polynesia: A group of islands in the Pacific Ocean. Polynesia means many islands and is spread over a wide area bounded by New Zealand, Easter Island, and Hawaii.

Potholer: A cave explorer.

Recumbent fold: A tilted mountain fold in the Earth's crust.

Reg: A stony desert, covered by loose gravel or pebbles.

Salt pans: Hollows of land along a saltwater coastline. Sea water is flooded into a salt pan and, after the Sun has evaporated the water, salt is collected.

Ship of the desert: Another name for the camel. A camel can go for days without water. Camels store water in a hump on their back. Some camels have two humps.

Sink: A narrow column of rock in which a stream flows down from the Earth's surface into an underground limestone cave.

Stalactite: A hanging mineral deposit that is formed when drops of water seep through the ceiling cracks of a limestone cave. The deposit grows downward in a long column.

Stalagmite: A mineral deposit that is formed when water droplets fall to the floor of a limestone cave. The deposit grows upward in a long column.

Stratosphere: The cold upper layer above the Troposphere. The stratosphere rises to about 40 miles over the Earth's surface and contains a layer of sun-shielding oxygen, called the ozone.

Stupa: A bell-shaped building that crowns a round terrace. The stupa contains a relic of the Buddha or a Buddhist saint. Stupas can be found in Indonesia.

Terrestrial: A term used to describe dense, rocky planets. Mercury, Venus, Mars, Pluto, and Earth are terrestrial planets.

Tide: The rise and fall of the ocean that are caused mainly by the gravitational pull of the Moon. Tides occur every 24 hours and 50 minutes—one complete orbit of the Moon around the Earth.

Troposphere: The lowest layer of the atmosphere. This layer is between 5 and 10 miles thick and is the only layer that holds enough air for people and other living things to breathe.

Tsunami: A huge wave caused by a powerful volcanic explosion.

Volcano: A hole or crack in the Earth's crust through which molten rock is pushed up to the Earth's surface. The volcanic eruptions release gases and steam from the rocks.

Warm front: The edge of a warm air mass enclosed between areas of cold air. In the area beyond the warm front, the air rises over the cold air, forming clouds.



Abacus: A counting device invented by the Chinese. An abacus is made up of a frame with parallel wires that holds sliding counters, such as beads.

Archaeologist: One who studies about how people lived long ago.

Archaeology: The study of the past.

Aztecs: The Aztecs were warriors who made human sacrifices at religious events. They learned architecture and art from the Maya Indians and built cities. They lived in Mexico at the time of the Spanish invasion under Cortes in 1519.

Basilica: A large hall near the forum of a Roman town.

Bourgeoisie: The middle classes in 16th century France, such as merchants and lawyers. The church and the nobles were ranked above the bourgeoisie.

Chinampa: A reed platform resting on the bottom of a marshy lake. Chinampas were used by the Aztec peasants in the city of Tenochtitlan to grow crops.

Chiton: A loose tunic worn by men and women in ancient Greece.

Condottieri: Italian soldiers of fortune during the Renaissance period.

Conquistadores: Spanish conquerors that came to the New World to claim a part.

Cuneiform: Wedge-shaped letters in the writing of the Sumerian people living 6,000 years ago in Mesopotamia. Cuneiform was written on baked clay tablets using hard reeds.

D-Day: on June 6, 1944 U.S. and British forces landed on the beaches of Normandy, France and fought their way across the continent into the heart of Nazi Germany. There they were joined by the Russians from the east. On May 8, 1945 the Germans surrendered.

Democracy: A government in which citizens have the right to make decisions. The idea of a democracy was developed by the Greeks.

Dinosaur: The first animals that could lay eggs on land were reptiles. The greatest of these were the dinosaurs. The word dinosaur means "terrible lizard." Most of them were peaceful plant-eaters. They ranged in size from a few feet to almost 100 feet long. The fiercest dinosaur was the meat-eating Tyrannosaurus.

Feudal System: Under this system peasant farmers swore to work for and obey powerful nobles. In return, the nobles promised to protect them. In this way the peasants became the obedient *vassals* of their *lord*.

Forum: The center of an early Roman town. All the town's main streets led from the town gates to the forum. The forum was a spacious, open-air meeting place surrounded by covered markets, temples, council chambers and a large hall.

Frigidarium: An unheated pool in a Roman bath. After swimming in the baths' heated pools or sitting in the steam rooms, the Romans would jump into the frigidarium to be refreshed.

Fuhrer: Title assumed by Adolf Hitler as head of Nazi Germany.

Genghis Khan: The early life of Genghis Khan is shrouded in a mist of legend. Temujin (later Genghis Khan) was probably born in 1167, the son of a tribal chief. By 1206 he had succeeded in uniting all the Mongol tribes and impressed his authority on them.

Hodometer: A device invented by the Chinese to record distance traveled. The odometer was attached to a wheeled vehicle and certain distances were marked using a system of cogs.

Homo sapiens: The name scientists have given for a group of people living 100,000 years ago. These homo sapiens, also called Neanderthals, wore clothes and could make tools and weapons. Homo sapiens means thinking men.

Hoplites: Greek spearmen who marched into battle shoulder to shoulder with their spears ready for attack. A line of hoplites formed a phalanx.

Islam: The idea of submission, or obedience, to the god Allah. Islam was founded by an Arab named Muhammad in AD 600. Followers of Islam are called Muslims.

Jousting: To train for battle, knights fought in mock battles, or jousts. These fights were friendly but dangerous, even though blunt swords and lances were used.

Ju-jitsu: A Japanese and Chinese fighting sport in which opponents fight unarmed.

Kendo: A Japanese and Chinese fighting sport in which opponents fight with wooden swords.

Knight: The knight was the tank of the medieval period but he was expected to be more than just a good fighter. The knight was supposed to be brave and noble, armed with lance, sword, and shield, he rode forth to defend the Church, help the weak, and fight the king's foes.

Kung-fu: A Japanese and Chinese fighting sport in which opponents fight unarmed.

Li: A Chinese measurement equal to 550 yards or 500 meters.

Luftwaffe: The German air force during World War II.

Mail: Small, round links of iron that made up the armor of the early knights.

Mammoth: The huge extinct elephant with hairy skin and long tusks curving upward was a mammal. It lived in the Ice Age after the dinosaurs were extinct. Some remains have been found in North America, Europe, and Asia.

Mita: The duty of an Inca peasant to work in the Inca army or mines in place of paying taxes to the emperor.

Pearl Harbor: On December 7, 1941 the Japanese launched a surprise attack and bombed Pearl Harbor, Hawaii. More than 2,400 military personnel and civilians were killed in that raid, and over 1,000 were wounded.

Pharaoh: The title of the rulers of ancient Egypt. The Pharaohs were not only kings, but also war leaders and gods. They owned all the land and farmers had to give them part of all they produced. For part of the year the farmers worked on royal projects such as building pyramids or new irrigation ditches.

Protestant: A word used to describe a church that found its beginnings during the protests against the Catholic Church in Germany in the 1510s. There are many different kinds of Protestant churches still present today.

Pyramids: A huge structure with a square base and four triangular sides meeting at a point, built by the ancient Egyptians as a royal tomb. They were built by slaves from Nubia and by ordinary people. A foundation of stones was laid first. Then earth ramps were built to get the stones to the next level.

Quipu: A piece of string used by the Incas to keep records. Other pieces of differently colored string were tied to the Quipu and knots were made in them. The colors represented different objects and the knots indicated numbers.

Runes: Letters in the writing of the Vikings. Runes were carved on wood or stone.

Saga: A Viking story that was learned by heart and passed down from generation to generation.

Samurai: Powerful Japanese warriors that lived during the 11th century. These well-armed fighting men rode horses and were pledged to fight for truth and honor.

Seismograph: A machine invented by the Chinese for recording earthquake tremors. The seismograph was attached to the ground. During an earthquake, a vertical pole tilted to trigger a mechanism that indicated the direction of the tremor.

Sepoy: An Indian soldier who enforced British rule in India during the 19th century.

Shaduf: A bucket on a pole used by the Egyptians to lift water out of the Nile River. The water would then be poured into ditches to irrigate fields.

Strigil: An instrument used to scrape olive oil off the body at a Roman bath.

Sumerian: The Sumerian civilization was one of the first civilizations. It flourished 6,000 years ago in Mesopotamia, between the Tigris and Euphrates rivers.

Thing: A Viking court that determined the compensation for a person who turned in a law-breaker.

Third World: The third world is the name given to the developing countries of Africa, South America and Asia. Many of these countries were still colonies at the end of World War II but they have since gained their independence.

Thrall: A slave that worked for a Viking family. Thralls would work alongside family members on the farm, but would also perform other additional tasks.

Toga: In ancient Rome, the principle outer garment worn in public by citizens. It was a loose, flowing, one piece garment made of wool or silk, usually undyed.

Tortilla: A flat maize pancake that was the staple food of the Aztecs. They are still a basic part of Mexican food.

U.N.: On October 24, 1945 the United Nations was established to promote world peace and to guarantee human dignity. An organization made up of representatives from nearly every country, the UN was instrumental in either avoiding or bringing to an end a number of conflicts.

Underground railroad: A network of northerners who, during the American Civil War, helped slaves slip across the southern borders in free states.

Vikings: Scandinavian sea pirates who ravaged the coasts of Europe during the eighth, ninth, and tenth centuries. The Vikings Believed that the spirits of important people had to sail to a land of the dead. Kings and chiefs were therefore buried in their ships with all their belongings. Vikings are known to have reached Greenland and America.

Water-clock: A device invented by the Chinese to measure time.



Nature

Aestivation: A kind of hibernation where animals sleep during the summer in order to survive the hot, dry weather. Many animals that aestivate during the summer by burrowing into muddy river beds and other cool places.

Algae: Simple water plants that have been in the oceans for over 3,000 million years. Algae use sunlight to help them make food. Scientists divide algae into two main groups, blue-green algae and all other algae.

Angiosperm: Any of the flowering plants that protects its seeds in a seed coat, or ovary.

Arthropod: An animal that has jointed legs, such as an ant, spider, or a crab.

Bacteria: Tiny, one-celled organisms that feed off substances that are, or were, alive.

Berry: A fleshy fruit where each segment of the fruit has grown from a different part of the flower.

Bryophytes: Early land plants that have simple stems and leaves, but no true roots. Liverworts and mosses are bryophytes.

Campos: Warm grasslands of South America.

Carrion: Dead flesh that is eaten by scavenging animals

Cartilage: A tough, bendy material that makes up part of the skeleton. The tip of your nose is made of cartilage.

Cell: The microscopic building block of all living things. All plants and animals are made up of one or more cells.

Chlorophyll: The substance that makes plants look green and helps them to make food using the energy from sunlight.

Chordate: A metazoan animal that has some kind of backbone.

Coelenterate: An invertebrate animal that has hollow guts, such as sea anemones and jellyfish.

Compound leaf: A leaf that is made up of leaflets or groups of leaflets.

Conifer: A plant group that produces pollen and seeds in cones and have small needle-like leaves. Conifers are the main group of gymnosperms and include cedars, pines, spruces, and redwoods.

Cotyledon: A seed leaf that stores food for a growing plant. After the plant's leaves have

developed, the cotyledon are not needed and shrivel up.

Crustacean: An animal that has a hard crusty shell and several pairs of jointed legs. Crustaceans are usually sea creatures, such as crabs, lobsters, and barnacles. As crustaceans grow, they shed their hard shells for new ones underneath.

Cycads: The oldest living gymnosperms. Cycads are tropical with huge fern like leaves and produce one or more cones at the top of the stem.

Deciduous: Describes a tree that has broad leaves and sheds them during the winter.

Dehiscent: Means *splitting open*. A dehiscent fruit, such as a pea, will split open when it is ripe.

Dicot: Any of the flowering plants that have two seed leaves. The leaves of a dicot are broad with complicated, branching veins. During the growing season, a dicots stem becomes thicker. Dicots include hardwood trees and most shrubs.

Drupe: A fruit with a fleshy outer layer and hard inner layer (called the stone). The seed is located inside the hard inner layer. Peaches, plums, and cherries are drupes.

Echinoderm: An invertebrate animal that has spiny skin, such as a sea urchin or starfish.

Endosperm: Special tissue in a young plant that stores the starch, sugar, and fat needed by the plant to grow.

Fungi: Plants that have no roots, stems, or leaves. Fungi usually grow as a mass of thin threads, call spawn. Fungi do not need light to grow and begin life as a single cell, or spore.

Germinate: To sprout, either from a seed or a spore.

Gymnosperms: One group of cone-bearing plants. Gymnosperm means naked seed. Most gymnosperms produce pollen and seeds in cones instead of in flowers.

Hibernation: The long, death-like sleep. Many animals hibernate to save energy during the winter, when food is scarce. A hibernating animals temperature drops very low and its breathing and heart beat slow down. Hibernation can last anywhere from several hours to several months.

Indehiscent: Fruits that do not split open when ripe. Indehiscent fruits grow only when the seed coat wall rots and frees the baby plant.

Insect: An animal that has six legs, a pair of antennae, and a body made up of three parts.

Instinct: The tendency for an animal to behave a certain way that is characteristic of their species, without ever being taught the behavior. The urge to run away from attack and danger is an instinct.

Invertebrate: An animal that has no backbone. Jellyfish, segmented worms, snails, and spiders

are examples of invertebrates.

Larva: A young insect that changes shape as it matures into an adult. For example, a caterpillar is the larva of a moth or butterfly.

Lichen: A plant that is part alga and part fungus. Most lichens grow very slowly and provide food for slugs and certain insects.

Mammal: A vertebrate animal that feeds its young with milk from the mother. Mammals are also warm-blooded and have hair. Man is a mammal.

Marsupial: A mammal that spends its infancy protected in a pouch on the mother's body. Kangaroos and koala bears are marsupials.

Metamorphosis: The transformation of a baby insect into an adult. During metamorphosis, the insect undergoes a two dramatic changes in shape.

Metazoan: An animal with many cells.

Migrants: Birds that travel between a winter and summer home. Migrants always travel in flocks to better survive the long journey.

Monocotyledon: Any of the flowering plants that have only one seed leaf and long, narrow leaves with veins growing side by side. During the growing season, a monocotyledon's stem becomes longer. Monocots include palm trees, lilies, and grasses.

Mycelium: The mass of threads that make up a fungus. These threads are also called spawn. If a bit of mycelium breaks off from a fungus, a new fungus may form.

Nymphs: Insects that develop into adults without changing their shape.

Ornithologist: A scientist who studies birds.

Ovary: A special coat that protects a plant's seeds. A ripe ovary is a fruit.

Pampas: Middle and cool grasslands of South America.

Parasite: A type of fungi that feeds on living plants or animals.

Plankton: Tiny organisms that float on the surface layer of the ocean. Plant plankton is food for the many microscopic animal plankton that drift with the ocean currents.

Pome: A fruit that has seeds, but no hard inner layer, such as an apple or pear.

Prairie: A grassy plain in North America.

Preening: An activity done by birds to keep their feathers clean. Preening involves running the beak through the feathers to remove dirt and keep them tidy.

Protozoan: A creature made up of only one cell. There are over 30,000 kinds of protozoans

and most are too small to be seen without a microscope.

Pteridophytes: The first land plants with well-developed stems and leaves, true roots and tubes to carry food and water. Pteridophytes include ferns, club mosses, and plants with feathery leaves.

Rizoid: A hairy root that anchors bryophytes to the ground.

Saprophyte: A type of fungi that feeds on dead plants or animals or on animal droppings.

Savanna: A vast grassland that stretches across the continent of Africa. The grasses of a savanna are tall and there are few trees.

Scavengers: Animals that feed upon the remains of dead plants and animals.

Spawn: The mass of threads that make up a fungus. Scientists also call these threads mycelium. If a bit of spawn breaks off from a fungus, a new fungus may form.

Spinnerets: Special parts of a spider's body that produces silky threads for making webs and wrapping prey.

Spore: A single cell of a fungus. New fungi usually begin life as a spore.

Stone: The hard inner layer of a drupe. A tomato is a berry.

Vertebrate: An animal with a backbone and skull. There are five groups of vertebrates: fishes, amphibians, reptiles, birds, and mammals.



Acheulian industry: A human toolmaking industry characterized by fine hand axes. These tools have been found in Africa and Europe, often with the fossil remains of *Homo erectus* and early *Homo sapiens*, such as Swanscombe man.

Algae: Simple plants without stems, leaves or roots. Some are single-celled; others are many celled, e.g. seaweeds.

Amino acid: Complicated chemical compound of carbon, hydrogen, oxygen and nitrogen. Amino acids are the "building blocks" of *Proteins*.

Arthropod: An *Invertebrate* with a hard outer skeleton and jointed legs. Arthropods include insects, spiders, scorpions, trilobites, crabs and lobsters.

Aurignacian culture: The first of the late *Paleolithic* human cultures. Dating from about 30,000 years ago, it spread from Africa into the Middle East and Europe. Stone tools include long, thin flakes used as blades and scrapers. The Aurignacians also made ornaments and jewelry from bone, ivory and stone and were the first cave artists.

Bacteria: Microscopic living organisms whose *Nucleic Acids* are not contained within a nucleus.

Binocular vision: Type of vision achieved when both eyes are focused on an object at the same time. Because each eye sees the object from a slightly different angle, the brain receives a stereoscopic (three-dimensional) picture with an impression of depth and distance. All primates and some other *Vertebrates* have binocular vision.

Biology: The study of living organisms.

Bipedalism: Walking on two legs as opposed to four legs (quad-ripedalism). Bipedal animals include man, birds and many dinosaurs.

Bivalve: A *mollusc*, such as a mussel, that has its shell in two parts linked by a hinge. Bone The hard material that makes up the skeletons of most *Vertebrates*.

Bovids: A group of artiodactyls (even-toed hooved mammals) that include antelope, bison, cattle, sheep and goats.

Brachiopod: An *Invertebrate* with a shell in two parts linked by a hinge. Brachiopods differ from *Bivalves* in that they have symmetrical shells and one part is larger than the other. Their internal structure is also different.

Canine teeth: Pointed "dog" teeth, or "eye" teeth, found in mammals and some mammal like reptiles. There are two canine teeth in each jaw, just behind the *Incisor Teeth*.

Carnivore: 1. A meat-eating animal. 2. A member of the mammal *Order Carnivora*, which includes the cats, bears, dogs, weasels and seals.

Cartilage: The material softer than *Bone*, that makes up the skeletons of sharks and rays. It is also found in various parts of the skeletons of other *Vertebrates*.

Cephalopod: A *Mollusc* with tentacles projecting from its head. Cephalopods include nautiloids, ammonites, belemnites, squid and octopuses.

Chlorophyll: The green pigment found in plants. It absorbs light energy from the Sun and this energy is used in *Photosynthesis*.

Clactonian industry: A human toolmaking industry that existed in Clacton-on-Sea in Britain about 300,000 years ago. Stone tools include choppers and flake blades.

Clay: A sediment of very fine particles.

Echinoderms: A group of "spiny skinned" *Invertebrates* that includes starfish, sea urchins, sea lilies and sea cucumbers.

Edentates: A group of mammals that includes anteaters, sloths and armadillos. The name literally means "without teeth". Members of this group have few teeth or none at all.

Evolution: The gradual process of change that produces new groups of animals and plants.

Flint: A pebble or nodule of hard rock composed of the chemical silicon dioxide. Flints are usually found in Cretaceous and Tertiary chalk deposits.

Fossil: The remains or evidence of an ancient living organism preserved in rock or some other material.

Gastropods: A *Mollusc* group that includes snails and slugs.

Genus: (*plural: genera*) A term used in the classification of animals and plants. A genus may include several *Species*. And several genera may make up an *Order*.

Geology: The study of the Earth, its history and its rocks.

Gondwanaland: The name given to the large southern continent that formed during the Silurian period. It consisted of Africa, India, South America, Antarctica and Australia. Gondwanaland began to break up into these continents during the Jurassic period.

Gravettian industry: A human toolmaking industry, dating from about 25,000 years ago and named after La Gravette in France. Stone tools included long knife blades with blunt backs and sharp points.

Herbivore: A plant-eating animal.

Hominid: A member of the family Hominidae. This group includes all members of the *Genus*

Homo and the australopithecines.

Incisor teeth: The cutting teeth found at the front of the jaws of mammals and some mammal like reptiles.

Index fossil: A fossil used to identify and date a rock layer, or stratum.

Insectivore: **1.** An animal that feeds on insects. **2.** A member of the mammal *Order* Insectivora, which includes shrews, moles and hedgehogs.

Invertebrate: An animal without a backbone.

Ironstone: A rock containing large amounts of iron-bearing minerals. Ironstone is often found in the form of rounded lumps, or nodules.

Laurasia: The name given to the northern part of *Pangaea* that broke away from *Gondwanaland* during the Triassic period. Laurasia began to split up into North America and Eurasia (Europe and Asia) during the late Cretaceous and early Tertiary periods.

Levalloisian industry: A human toolmaking industry, dating from about 70,000 years ago and named after the Levallois suburb of Paris. Stone tools include oval flake knives.

Magdalenian culture: Human toolmaking and artistic culture, dating from about 15,000 years ago and named after La Madeleine in France. Tools and weapons from this period include barbed harpoons and spear points, carved spear throwers and eyed needles. Many tools were carved from bone or antler. The Magdalenians were the finest cave painters.

Mesolithic: Middle Stone Age. The general name given to the human cultures that date from about 10,000 years ago. Mesolithic peoples were hunters and fishermen.

Molar teeth: The crushing back teeth of a mammal.

Molluscs: A large group of *Invertebrates* that includes such animals as snails, mussels and squid. They are all soft-bodied animals, but their bodies are often protected by a shell.

Mousterian industry: A human toolmaking industry, dating from about 70,000 years ago and associated with Neanderthal man. Stone tools include scrapers, knives and points.

Mudstone: A rock formed from hardened and compressed *Clay*.

Neolithic: New Stone Age. The name given to Stone Age farming cultures. These date from about 9,000 years ago until the start of the metal age about 5,000 years ago.

Nucleic acids: Long chain molecules known as DNA and RNA. These are found in the nucleus of a cell and provide instructions for making proteins and other cell activities. DNA is the material that passes on characteristics from one generation to the next.

Oldowan industry: A human toolmaking industry, dating from about two million years ago and named after Olduvai in Tanzania. The stone tools are known as pebble tools.

Palaeolithic: Old Stone Age. The name used to describe all the human toolmaking industries and cultures up to about 10,000 years ago.

Palaeontology: The study of fossils.

Pangaea: The name given to the supercontinent that formed from *Gondwanaland* and the northern continents during the Permian period. During the Triassic period it began to split up into *Gondwanaland* and *Laurasia*.

Photosynthesis: The process in which a plant converts carbon dioxide and water into oxygen and sugar, using sunlight as a source of energy. The plant uses the sugar to make new plant material.

Premolar teeth: The crushing teeth of mammals found just in front of the *Molar Teeth*.

Protein: A complicated chemical compound made up of many different *Amino Acids*. Proteins form an essential part of every living cell.

Protozoan: A single-celled animal, such as an amoeba.

Sandstone: A rock formed from sand (medium-sized particles mostly consisting of quartz).

Sedimentary rock: A rock formed from particles that have been compressed. The particles are either eroded rock particles deposited in water or the remains of once-living animals. A sedimentary rock is sometimes known as a deposit, particularly if the sediment is young and not completely compressed into rock.

Shale: Thin layers of rock formed from *Clay*.

Solutrean industry: A human toolmaking industry, dating from about 20,000 years ago and named after Solutre in France. Stone tools include beautifully-worked, long, laurel-leaf spear points.

Species: The smallest group used in the classification of animals and plants. Several species may belong to a *Genus*. Members of the same species can breed successfully with each other, but they cannot breed with members of another species.

Vertebrate: A backboned animal.

