



ubiquinone (coenzyme Q) Any of a group of related quinone-derived compounds that serve as electron carriers in the *electron transport chain reactions of cellular respiration. Ubiquinone molecules have side chains of different lengths in different types of organisms but function in similar ways.

ubiquitous computing (ambient computing; pervasive computing) A model for the development of computing in the early 21st century. It envisages a movement away from computers as distinct specialized devices; rather, many objects used in everyday life will contain embedded computing devices that can recognize and interact in useful ways with each other and with their environment. Commonly cited examples are the refrigerator that is aware of its contents via embedded tags and is thus able to suggest shopping lists, plan menus, warn of approaching expiry dates, etc.; a home environment (heating, lighting, etc.) that continuously adjusts itself according to data from biometric monitors incorporated into clothing; and automatic recognition of a returning home owner so that security alarms are switched off and appropriate in-house systems activated. Such a model becomes possible as the size of computing devices decreases and their power increases, with wireless networking making the ad-hoc self-configuring networks necessary for ubiquitous computing viable (*see* BLUETOOTH). A key issue is how humans interact with such a system. The ideal is that such interaction should be unobtrusive and natural for the user, emphasizing speech recognition and *artificial intelligence. Another issue is privacy: a truly useful ubiquitous computing system will inevitably acquire a large amount of personal data about its users. Ubiquitous computing is currently a subject of both academic and commercial research.

UHV Ultrahigh vacuum. *See* VACUUM.

ulna The larger of the two bones in the forearm of vertebrates (*compare* RADIUS). It articulates with the outer carpals at the wrist and with the humerus at the elbow.

ultracentrifuge A high-speed centrifuge used to measure the rate of sedimentation of colloidal particles or to separate macromolecules, such as proteins or nucleic acids, from solutions. Ultracentrifuges are electrically driven and capable of speeds up to 60 000 rpm.

ultradian rhythm *See* BIORHYTHM.

ultrafiltration The process in which hydrostatic pressure causes water and small dissolved molecules and ions to move across a membrane against a *concentration gradient. Ultrafiltration is responsible for the formation of *tissue fluid and *glomerular filtrate from blood. In both these processes the ultrafiltered fluid has the same composition as the plasma except that it does not contain blood cells or large protein molecules.

ultrahigh frequency (UHF) A radio frequency in the range 3×10^9 – 0.3×10^9 Hz; i.e. having a wavelength in the range 10 cm to 1 m.

ultramicroscope A form of microscope that uses the *Tyndall effect to reveal the presence of particles that cannot be seen with a normal optical microscope. Colloidal particles, smoke particles, etc., are suspended in a liquid or gas in a cell with a black background and illuminated by an intense cone of light that enters the cell from the side and has its apex in the field of view. The particles then produce diffraction-ring systems, appearing as bright specks on the dark background.

ultramicrotome *See* MICROTOME.

ultrasonics The study and use of pressure waves that have a frequency in excess of 20 000 Hz and are therefore inaudible to the human ear. **Ultrasonic generators** make use of the *piezoelectric effect, *ferroelectric materials, or *magnetostriction to act as transducers in converting electrical energy into mechanical energy. Ultrasonics are used in medicine for diagnosis, particularly in conditions such as pregnancy, in which X-rays could have a harmful effect, and for treat-

ment, the vibratory effect being used to break up kidney stones, etc. Ultrasonic techniques are also used industrially to test for flaws in metals, to clean surfaces, to test the thickness of parts, and to form colloids.

ultrastructure The submicroscopic, almost molecular, structure of living cells, which is revealed by the use of an electron microscope.

ultraviolet microscope A *microscope that has quartz lenses and slides and uses *ultraviolet radiation as the illumination. The use of shorter wavelengths than the visible range enables the instrument to resolve smaller objects and to provide greater magnification than the normal optical microscope. The final image is either photographed or made visible by means of an *image converter.

ultraviolet radiation (UV) Electromagnetic radiation having wavelengths between that of violet light and long X-rays, i.e. between 400 nanometres and 4 nm. In the range 400–300 nm the radiation is known as the **near ultraviolet**. In the range 300–200 nm it is known as the **far ultraviolet**. Below 200 nm it is known as the **extreme ultraviolet** or the **vacuum ultraviolet**, as absorption by the oxygen in the air makes the use of evacuated apparatus essential. The sun is a strong emitter of UV radiation but only the near UV reaches the surface of the earth as the *ozone layer of the atmosphere absorbs all wavelengths below 290 nm. Ultraviolet radiation is classified in three ranges according to its effect on the skin. The ranges are:

UV-A (320–400 nm);

UV-B (290–320 nm);

UV-C (230–290 nm).

The longest-wavelength range, UV-A, is not harmful in normal doses and is used clinically in the treatment of certain skin complaints, such as psoriasis. It is also used to induce *vitamin D formation in patients that are allergic to vitamin D preparations. UV-B causes reddening of the skin followed by pigmentation (tanning). Excessive exposure can cause severe blistering. UV-C, with the shortest wavelengths, is particularly damaging. It is thought that short-wavelength ultraviolet radiation causes skin cancer and that the risk of contracting this has been increased by the depletion of the ozone layer.

Most UV radiation for practical use is produced by various types of *mercury-vapour lamps. Ordinary glass absorbs UV radiation

and therefore lenses and prisms for use in the UV are made from quartz.

ultraviolet-visible spectroscopy (UV-visible spectroscopy) A technique for chemical analysis and the determination of structure. It is based on the principle that electronic transitions in molecules occur in the visible and ultraviolet regions of the electromagnetic spectrum, and that a given transition occurs at a characteristic wavelength. The spectrometer has two sources, one of ultraviolet and the other of white visible light, which together cover the whole wavelength range of the instrument. If the whole wavelength range is used, the source is changed over at the appropriate point. The radiation from the source is split into two beams of equal intensity. One beam is passed through a dilute solution of the sample while the other is passed through the pure solvent and is used as a reference against which the first is compared after transmittance. The cells used for the sample and reference solutions are usually made of silica and are matched.

umbel A type of *racemose inflorescence in which stalked flowers arise from the same point on the flower axis, resembling the spokes of an umbrella. An involucre (cluster) of bracts may occur at the point where the stalks emerge. This arrangement is characteristic of the family Umbelliferae (Apiaceae; e.g. carrot, hogweed, parsley, parsnip), in which the inflorescence is usually a compound umbel.

umbilical cord The cord that connects the embryo to the *placenta in mammals. It contains a vein and two arteries that carry blood between the embryo and placenta. It is severed after birth to free the newly born animal from the placenta, and shrivels to leave a scar, the navel, on the animal.

umbra See SHADOW.

uncertainty principle (Heisenberg uncertainty principle; principle of indeterminism) The principle that it is not possible to know with unlimited accuracy both the position and momentum of a particle. This principle, discovered in 1927 by Werner Heisenberg, is usually stated in the form: $\Delta x \Delta p_x \geq h/4\pi$, where Δx is the uncertainty in the x -coordinate of the particle, Δp_x is the uncertainty in the x -component of the particle's momentum, and h is the *Planck constant. An explanation of the uncertainty is that in order to locate a particle exactly, an

observer must be able to bounce off it a photon of radiation; this act of location itself alters the position of the particle in an unpredictable way. To locate the position accurately, photons of short wavelength would have to be used. These would have associated large momenta and cause a large effect on the position. On the other hand, using long-wavelength photons would have less effect on the particle's position, but would be less accurate because of the longer wavelength. The principle has had a profound effect on scientific thought as it appears to upset the classical relationship between cause and effect at the atomic level.

underdamped See DAMPING.

undernourishment See MALNUTRITION.

undulopodium (*pl.* undulopodia) A slender flexible outgrowth of a eukaryote cell used for locomotion or propelling fluids over the surface of the cell. The term 'undulopodium' is used to designate a eukaryotic 'flagellum' or a 'cilium' (which have the same structure), to emphasize the distinction between these structures and the *flagellum of a bacterium. Many protists and sperm cells swim by means of undulopodia, and various organisms use them to establish feeding currents, or to clear debris from epithelial surfaces. All undulopodia have a shaft, about 0.25 μm in diameter, consisting of a longitudinal array of *microtubules, the **axoneme**, which is surrounded by an extension of the cell's plasma membrane. The axoneme has two single microtubules running down the middle surrounded by nine pairs of microtubules. At its base the axoneme connects with a **basal body** (or **kinetosome**), which organizes assembly of the axoneme microtubules. Cilia are shorter than flagella and move by a whiplike power stroke followed by a recovery stroke in the opposite direction. Flagella generate successive waves that pass from the base to the tip. In both cases, flexing of the shaft is produced by a sliding motion of the microtubule pairs relative to each other. This involves the successive formation and breakage of molecular bridges between adjacent pairs. The bridges are composed of a protein, dynein, and their formation requires energy in the form of ATP.

UNFO Urea nitrate–fuel oil. An explosive based on the fertilizer urea nitrate mixed with fuel oil, similar in its action to ammonium nitrate–fuel oil (ANFO). It has been

used in a number of terrorist attacks, most notably a car bombing in the basement of the World Trade Centre, New York, on 26 February 1993.

ungulate A herbivorous mammal with hooved feet (see UNGULIGRADE). Ungulates are grouped into two orders: *Artiodactyla and *Perissodactyla.

unguligrade Describing the gait of ungulates (e.g. horses and cows), in which only the tips of the digits (i.e. the hooves) are on the ground and the rest of the foot is off the ground. Compare DIGITIGRADE; PLANTIGRADE.

uniaxial crystal A double-refracting crystal (see DOUBLE REFRACTION) having only one *optic axis.

unicellular Describing tissues, organs, or organisms consisting of a single cell. For example, the reproductive organs of some algae and fungi are unicellular. Unicellular organisms include bacteria, protozoans, and certain fungi and algae. Compare ACELLULAR; MULTICELLULAR.

Unicode A standard for storing, manipulating, and displaying textual data. The Unicode character set currently (2008) allows for 1 114 112 **codepoints**, of which over 90 000 have been assigned characters. A codepoint is an unsigned integer denoting a position in a character encoding system. Unicode codepoints are generally represented as U+ followed by a four-byte hexadecimal number: for example, U+0041 (decimal 65, the letter capital A). Unicode also specifies various normative classifications for each character (upper-case letter, lower-case letter, decimal number, etc.), rules (e.g. how to decompose a composite character, such as an accented letter, into its component characters), and algorithms (e.g. for collation) as well as reference charts showing the visual form of each character. For backward compatibility the characters assigned to codepoints 0 to 127 are the same as *ASCII character set; and those assigned to 0 to 255 Unicode are the same as ISO-8859-1, a superset of Latin alphabet no. 1.



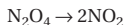
- The Unicode Consortium home page

unified-field theory A comprehensive theory that would relate the electromagnetic, gravitational, strong, and weak interactions (see FUNDAMENTAL INTERACTIONS) in one set of equations. In its original context

the expression referred only to the unification of general *relativity and classical electromagnetism theory. No such theory has yet been found but some progress has been made in the unification of the electromagnetic and weak interactions (see ELECTROWEAK THEORY).

Einstein attempted to derive *quantum mechanics from unified-field theory, but it is now thought that any unified-field theory has to start with quantum mechanics. Attempts to construct unified-field theories, such as *supergravity and *Kaluza-Klein theory, have run into great difficulties. At the present time it is not clear whether the framework of relativistic *quantum field theory is adequate to give a unified theory for all the known fundamental interactions and elementary particles, or whether one has to go to extended objects, such as superstrings or supermembranes. Unified-field theories and other fundamental theories, such as *superstring theory and *supermembrane theory, are of great importance in understanding cosmology, particularly the *early universe. In turn cosmology puts constraints on unified-field theories. See also GRAND UNIFIED THEORY.

unimolecular reaction A chemical reaction or step involving only one molecule. An example is the decomposition of dinitrogen tetroxide:



Molecules colliding with other molecules acquire sufficient activation energy to react, and the activated complex only involves the atoms of a single molecule.

union See SETS.

unisexual Describing animals or plants with either male or female reproductive organs but not both. Most of the more advanced animals are unisexual but plants are often *hermaphrodite. Flowers that contain either stamens or carpels but not both are also described as unisexual. See also MOONOECIOUS; DIOECIOUS.

unit A specified measure of a physical quantity, such as length, mass, time, etc., specified multiples of which are used to express magnitudes of that physical quantity. For many scientific purposes previous systems of units have now been replaced by *SI units.

unit cell The group of particles (atoms, ions, or molecules) in a crystal that is re-

peated in three dimensions in the *crystal lattice. See also CRYSTAL SYSTEM.

unit magnetic pole See MAGNETIC POLES.

unit vector A vector that has the magnitude 1. If **a** is any non-zero vector the unit vector in the direction of **a** is given by $\mathbf{a}/|\mathbf{a}|$ and is denoted $\hat{\mathbf{a}}$.

univalent (monovalent) Having a valency of one.

universal constants See FUNDAMENTAL CONSTANTS.

universal indicator A mixture of acid-base *indicators that changes colour (e.g. red-yellow-orange-green-blue) over a range of pH.

universality See PHASE TRANSITION.

universal motor See ELECTRIC MOTOR.

universe All the matter, energy, and space that exists. See COSMOLOGY; EARLY UNIVERSE; HEAT DEATH OF THE UNIVERSE.

UNIX A general-purpose *computer operating system that allows several users, at different terminals, to use the machine at the same time. It was developed in 1969 and became generally available in 1971.

 SEE WEB LINKS

- The Open Group's UNIX page

unnil- See TRANSACTINIDE ELEMENTS.

Unruh effect The phenomenon, predicted in 1976 by the Canadian physicist William Unruh, that an accelerating body would seem to be surrounded by particles at a non-zero temperature, which is proportional to the acceleration. The vacuum state of a non-accelerating observer is different to that of an accelerating observer because of distortion of the zero-point fluctuations. The effect itself is very small and has not been verified experimentally. There is **Unruh radiation** associated with this effect. The effect itself is very small and has not been verified experimentally.

unsaturated 1. (of a compound) Having double or triple bonds in its molecules. Unsaturated compounds can undergo addition reactions as well as substitution. Compare SATURATED. **2.** (of a solution) See SATURATED.

unstable equilibrium See EQUILIBRIUM.

upper atmosphere The upper part of the *earth's atmosphere above about 30 km.

This is the part of the atmosphere that cannot be reached by balloons.

upthrust See ARCHIMEDES' PRINCIPLE.

UPVC Unplasticized PVC: a tough hard-wearing form of PVC used for window frames and similar applications.

upwelling In the oceans and some inland seas, the process by which colder water, often rich in nutrients, is brought up from a lower depth to the surface layers. Coastal upwelling occurs where persistent surface winds blow parallel to the coastline, with the coast to the left of the wind in the northern hemisphere and to the right in the southern hemisphere. The warmer surface water is deflected away from the coast and colder water rises to replace it. Regions of coastal upwelling often support important fisheries and birdlife, e.g. off the coasts of California, Peru, and Ghana. Equatorial upwelling occurs in the Atlantic and Pacific Oceans along the equator as a result of the effects of the trade winds.

uracil A *pyrimidine derivative and one of the major component bases of *nucleotides and the nucleic acid *RNA.

uraninite A mineral form of uranium(IV) oxide, containing minute amounts of radium, thorium, polonium, lead, and helium. When uraninite occurs in a massive form with a pitchy lustre it is known as **pitchblende**, the chief ore of uranium. Uraninite occurs in Saxony (east central Germany), Romania, Norway, the UK (Cornwall), E Africa (Congo), USA, and Canada (Great Bear Lake).

uranium Symbol U. A white radioactive metallic element belonging to the *actinoids; a.n. 92; r.a.m. 238.03; r.d. 19.05 (20°C); m.p. 1132±1°C; b.p. 3818°C. It occurs as *uraninite, from which the metal is extracted by an ion-exchange process. Three isotopes are found in nature: uranium-238 (99.28%), uranium-235 (0.71%), and uranium-234 (0.006%). As uranium-235 undergoes *nuclear fission with slow neutrons it is the fuel used in *nuclear reactors and *nuclear weapons; uranium has therefore assumed enormous technical and political importance since their invention. It was discovered by Martin Klaproth (1743–1817) in 1789.

 **SEE WEB LINKS**

- Information from the WebElements site

uranium(VI) fluoride (uranium hexafluoride) A volatile white solid, UF₆; r.d.

4.68; m.p. 64.5°C. It is used in the separation of uranium isotopes by gas diffusion.

uranium hexafluoride See URANIUM(VI) FLUORIDE.

uranium-lead dating A group of *dating techniques for certain rocks that depends on the decay of the radioisotopes uranium-238 to lead-206 (half-life 4.5×10^9 years) or the decay of uranium-235 to lead-207 (half-life 7.1×10^8 years). One form of uranium-lead dating depends on measuring the ratio of the amount of helium trapped in the rock to the amount of uranium present (since the decay $^{238}\text{U} \rightarrow ^{206}\text{Pb}$ releases eight alpha particles). Another method of calculating the age of the rocks is to measure the ratio of radiogenic lead (^{206}Pb , ^{207}Pb , and ^{208}Pb) present to non-radiogenic lead (^{204}Pb). These methods give reliable results for ages of the order 10^7 – 10^9 years.

uranium(IV) oxide A black solid, UO₂; r.d. 10.96; m.p. 2500°C. It occurs naturally as *uraninite and is used in nuclear reactors.

uranium series See RADIOACTIVE SERIES.

Uranus The third largest *planet in the *solar system and the seventh in order from the *sun. Its mean distance from the sun is 2876.679×10^6 km, its mass is 8.6810×10^{25} kg (14.5 times that of earth), and its mean equatorial diameter is 51 119 km; it has a *sidereal period of 84.32 years. Its average period of axial rotation is 17h 14.4m. The equator of Uranus is tilted at 98° with respect to its orbit, so that each pole is facing the sun continuously during half of each orbit, giving each pole 42 years of sunshine followed by 42 years of darkness. The equatorial region experiences a rapid alternation of day and night. The temperature of Uranus is very low, about 50 K, and its atmosphere contains molecular hydrogen and helium, with 2.3% methane. Methane forms an icy cloud layer in the upper atmosphere, and its absorption of red and infrared light gives the planet its aquamarine or cyan colour. The planet itself is believed to have an ice mantle some 8000 km thick surrounding a rocky core. The planet has 27 known satellites; the largest, Triton, is thought to be a captured *Kuiper belt object. Uranus also has a system of about 20 rings, nine of which were discovered in 1977 with the rest being photographed in 1986 by the US Voyager II probe.

 **SEE WEB LINKS**

- NASA's introduction to Uranus and its satellites

urea (carbamide) A white crystalline solid, $\text{CO}(\text{NH}_2)_2$; r.d. 1.3; m.p. 135°C. It is soluble in water but insoluble in certain organic solvents. Urea is the major end product of nitrogen excretion in mammals, being synthesized by the *urea cycle. Urea is synthesized industrially from ammonia and carbon dioxide for use in *urea-formaldehyde resins and pharmaceuticals, as a source of nonprotein nitrogen for ruminant livestock, and as a nitrogen fertilizer.

urea cycle (ornithine cycle) The series of biochemical reactions that converts ammonia, which is highly toxic, and carbon dioxide to the much less toxic *urea during the excretion of metabolic nitrogen. These reactions take place in the liver in mammals and, to a lesser extent, in some other animals. The urea is ultimately excreted in solution in *urine.

urea-formaldehyde resins Synthetic resins made by copolymerizing urea with formaldehyde (methanal). They are used as adhesives or thermosetting plastics.

urea nitrate See UNFO.

ureter The duct in vertebrates that conveys urine from the *kidney to the *bladder.

urethane resins (polyurethanes) Synthetic resins containing the repeating group $-\text{NH}-\text{CO}-\text{O}-$. There are numerous types made by copolymerizing isocyanate esters with polyhydric alcohols. They have a variety of uses in plastics, paints, and solid foams.

urethra The duct in mammals that conveys urine from the *bladder to be discharged to the outside of the body. In males the urethra passes through the penis and is joined by the *vas deferens; it therefore also serves as a channel for sperm.

Urey, Harold Clayton (1894–1981) US physical chemist, who became a professor at the University of California in 1958. His best-known work was the discovery of *deuterium (heavy hydrogen) in 1932, for which he was awarded the 1939 Nobel Prize for physics.

URI Uniform resource indicator: an identifier that uses the syntax defined in RFC 3986. URIs are divided into two parts by a colon. The first part is a label indicating the **scheme** of the URI, and the second part identifies the resource using the syntax appropriate to that scheme. For example, the URI 'tel:+44-020-7...' uses the 'tel' scheme, which identifies telephone numbers; there-

fore, the second part uses the standard syntax for telephone numbers (in this case specifying a number in London, England). Internet URLs (see WORLD WIDE WEB) are a subset of URIs, with the schemes http, ftp, smtp, etc.



SEE WEB LINKS

- The URI specification

uric acid The end product of purine breakdown in most mammals, birds, terrestrial reptiles, and insects and also (except in mammals; see UREA) the major form in which metabolic nitrogen is excreted. Being fairly insoluble, uric acid can be expelled in solid form, which conserves valuable water in arid environments. The accumulation of uric acid in the synovial fluid of joints causes gout.

uridine A nucleoside consisting of one uracil molecule linked to a D-ribose sugar molecule. The derived nucleotide uridine diphosphate (UDP) is important in carbohydrate metabolism.

urinary system The collection of organs and tissues that perform *osmoregulation and *excretion. The mammalian urinary system consists of two *kidneys each linked to the bladder by a ureter.

urine The aqueous fluid formed by the excretory organs of animals for the removal of metabolic waste products. In higher animals, urine is produced by the *kidneys, stored in the *bladder, and excreted through the *urethra or *cloaca. Apart from water, the major constituents of urine are one or more of the end products of nitrogen metabolism – ammonia, urea, uric acid, and creatinine. It may also contain various inorganic ions, the pigments urochrome and urobilin, amino acids, and purines. Precise composition depends on many factors, especially the habitat of a particular species: aquatic animals produce copious volumes; terrestrial animals need to conserve water and produce much less (about 1.0–1.5 litres per day in humans).

uriniferous tubule See NEPHRON.

URL See WORLD WIDE WEB.

USB drive In general, any storage device that can be attached to a computer through a special type of connection (universal serial bus connection). The term is particularly used for small portable storage devices typically sealed in plastic. Their physical size is reflected in the various names for this type of

device – **thumb drive**, **pen drive**, **keyring drive**. They have capacities as high as 1 gigabyte and on most modern personal computers they can be recognized as an additional drive without the need for a special driver. Storage devices of this type are increasingly used for backup, data transfer, storage of photographs or MP3 files, etc.

uterus (womb) The organ of female mammals in which the embryo develops. Paired in most mammals but single in humans, it is situated between the bladder and rectum and is connected to the *fallopian tubes and to the *vagina. The lining (*see* ENDOMETRIUM) shows cyclical changes (*see* MENSTRUAL CYCLE; OESTROUS CYCLE) associated with egg production and provides a thick spongy layer in which the fertilized egg becomes embedded. The outer wall of the uterus is thick and muscular; by contracting, it forces the fully grown fetus through the vagina to the outside.

UTF-8 8-bit Unicode Transformation Format. A method of encoding Unicode codepoints using one-byte unsigned integers; from one to four such integers are used depending on the codepoint. UTF-8 is the most widely used Unicode encoding scheme and is the default encoding for *XML documents.

 **SEE WEB LINKS**

- Details of UTF-8 encoding from the Unicode (version 5) standard

utriculus (utricle) A chamber of the *inner ear from which the *semicircular canals arise. It bears patches of sensory epithelium concerned with detecting changes in the direction and speed of movement (*see* MACULA).

UV *See* ULTRAVIOLET RADIATION.

UV-visible spectroscopy *See* ULTRAVIOLET-VISIBLE SPECTROSCOPY.