

to transfer their captured energy from the sun to help in photosynthesis. Carotenoids color fruits and vegetables and give them their characteristic red, orange, and yellow colors and serve as antioxidants in human nutrition. Over 600 carotenoids are known.

carpal bones Hand bones. The carpal bones include the navicular, lunate, pisiform, capitate, trapezium, trapezoid, hamate, and the triquetrum. They are arranged in two rows, the proximal (near the body) and the distal (near the fingers).

See also SKELETON.

carpal tunnel A small passage located below the wrist at the heel of the hand where the median nerve, the major nerve to the hand, as well as tendons that bend the fingers pass through.

carpel The female reproductive part of the flower, including the ovary, style, and stigma.

Carrel, Alexis (1873–1944) French *Surgeon* Alexis Carrel was born in Lyons, France, on June 28, 1873, to a businessman, also named Alexis Carrel, who died when his son was very young. Carrel was educated at home by his mother Anne Ricard and at St. Joseph School, in Lyons. He received a bachelor of letters degree in 1889 from the University of Lyons, a bachelor of science the following year, and, in 1900, his Ph.D. at the same university. He worked as prosector at the Lyons Hospital and taught anatomy and operative surgery at the university. By 1906, he was at the Rockefeller Institute for Medical Research, where he carried out most of his landmark experiments.

Influenced by the assassination by knife of the president of France in 1894, he dedicated himself to develop a way to suture blood vessels, which ironically he developed after he studied with a French embroidress who showed him how to do embroidery. His first attempt was made in France in 1902. He subsequently developed the triangulation technique of vascular suture. He won the Nobel Prize in physiology or medicine in 1912 for his work on vascular suture and the transplantation of blood vessels and organs.

During World War I, Carrel served as a major in the French army medical corps and helped devise a widely used method of treating war wounds, called the Carrel-Dakin method, a method of wound irrigation in which the wound is intermittently irrigated with Dakin's solution, a germicidal fluid (no longer used).

Carrel's researches were mainly concerned with experimental surgery and the transplantation of tissues and whole organs. As early as 1902, he published a technique for the end-to-end anastomosis (union) of blood vessels, and during the next few years he did every conceivable form of anastomosis, although many were not accepted until the 1950s. In 1908, he devised methods for the transplantation of whole organs and had tested kidney and heart transplantations as early as 1905. In 1910 he demonstrated that blood vessels could be kept for long periods in cold storage before they were used as transplants in surgery, and he also conducted aortocoronary bypass surgery, before the advent of anticoagulants.

In 1935, in collaboration with Charles Lindbergh, Carrel devised a machine for supplying a sterile respiratory system to organs removed from the body. Carrel was able to perform surgeries that showed that circulation, even in such vital organs as the kidneys, could be interrupted for as long as two hours without causing permanent damage. The cover of the June 13, 1938, *Time* magazine showed Charles Lindbergh and Alexis Carrel with the new perfusion pump.

His books, such as *The Culture of Organs* and *Man, the Unknown, Treatment of Infected Wounds* (with Georges Debelly), were important works. He died in Paris on November 5, 1944.

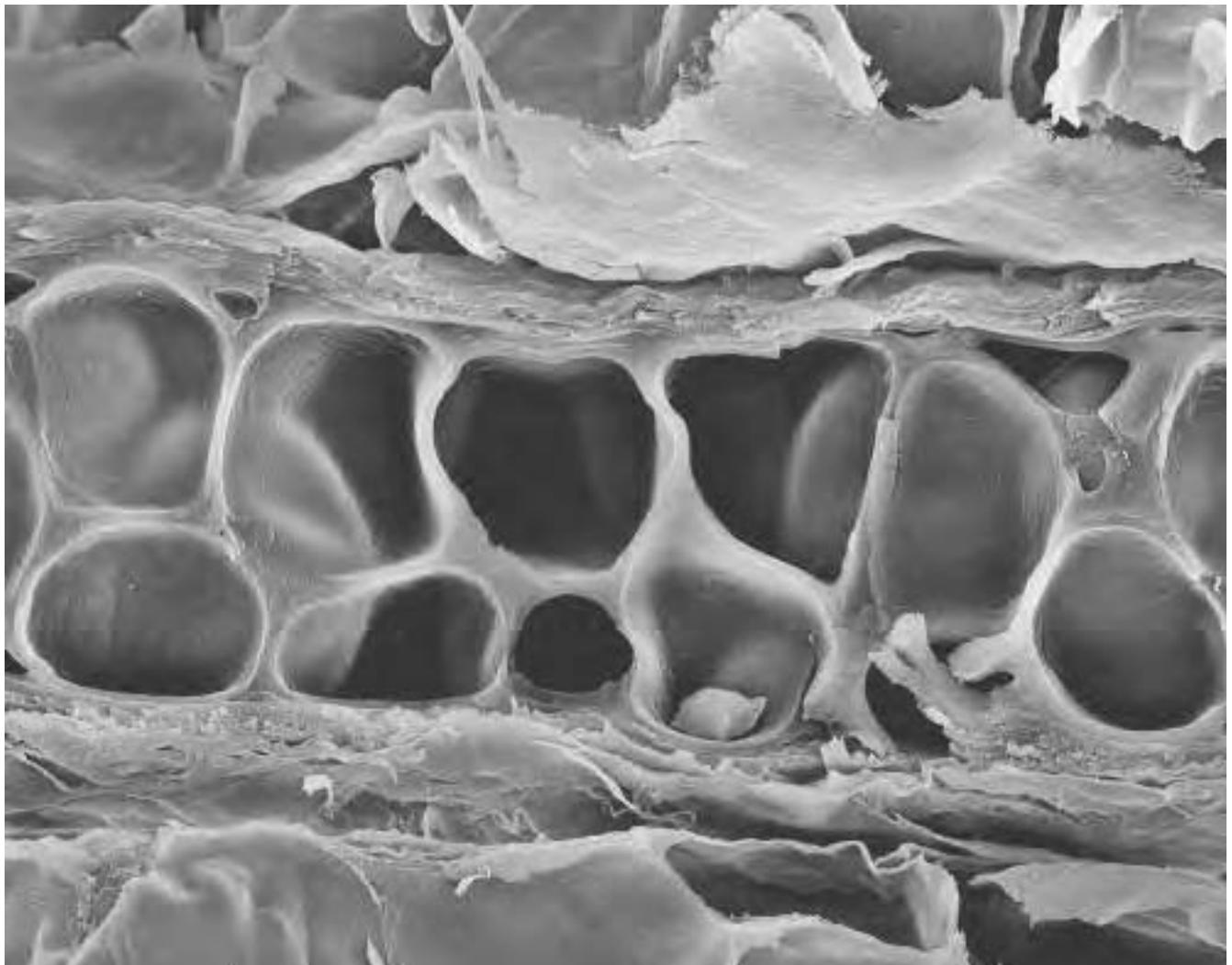
carrier An individual who is heterozygous for a recessive disease-causing trait but who does not necessarily show any symptoms and can pass the mutant gene to offspring. If both parents are homozygous for the trait, the chance that a newborn child will be affected is one out of four.

carrier-linked prodrug (carrier prodrug) A PRO-DRUG that contains a temporary linkage of a given active substance with a transient carrier group that provides improved physicochemical or pharmacokinetic properties and that can be easily removed in vivo, usually by a hydrolytic cleavage.

carrying capacity A population's maximum capacity within a habitat that a single species can maintain before the habitat degrades or becomes destroyed. While a species may go over the carrying capacity, the long-term viability of the habitat is destined to lessen or be depleted.

cartilage A rubbery but firm and flexible shock-absorber tissue that cushions bones at the joints and

can be found in other areas like the spine, throat, ears, and nose. Made up of cells called chondroblasts that secrete a cartilage matrix (containing cells called chondrocytes when surrounded by a matrix), an intracellular substance. Cartilage is covered by a membrane called perichondrium that serves for nutrition and growth of the cartilage. Osteoarthritis can occur when cartilage is worn away faster than it is replaced. The underlying bones then start to rub against each other.



Elastic cartilage. Colored scanning electron micrograph (SEM) of a section through elastic cartilage (central horizontal strip) from a pinna (external ear). Elastic cartilage maintains the semirigid, flexible shape of the ear. It contains fibers of the protein elastin. Cartilage is a firm and flexible connective tissue. It is composed of chondrocyte cells embedded in holes (black) in an extracellular matrix (brown). The layers of skin (top and bottom) enclosing the cartilage are also seen. The pinna channels sound waves into the internal ear. Magnification unknown. (Courtesy © Science Photo Library/Photo Researchers, Inc.)

cascade prodrug A PRODRUG for which the cleavage of the carrier group becomes effective only after unmasking an activating group.

casparian strip A band of suberin, a waxy substance that waterproofs the walls of each plant's root cells; prevents and controls passive water and mineral uptake into the central vascular tube of roots (steles).

caste Morphologically distinct individuals within a colony, e.g., ants, that are also behaviorally specialized such as queens, workers, soldiers, etc.

catabolic pathway The process for taking large complex organic molecules and breaking them down into smaller ones, which release energy that can be used for metabolic processes.

catabolism Reactions involving the breaking down of organic SUBSTRATES, typically by oxidative breakdown, to provide chemically available energy (e.g., adenosine triphosphate [ATP]) and/or to generate metabolic intermediates.

catabolite A naturally occurring METABOLITE.

catabolite activator protein (CAP) A protein that binds cyclic adenosine monophosphate (cAMP), a regulatory molecule, to DNA in organisms. When this interaction takes place, the gene promoter is made accessible to the enzyme RNA polymerase, and transcription of the gene can begin.

catalase A HEME protein that catalyzes the DISPROPORTIONATION of dihydrogen peroxide to O_2 and water. It also catalyzes the oxidation of other compounds, such as ethanol, by dihydrogen peroxide. A nonheme protein containing a dinuclear manganese CLUSTER with catalase activity is often called pseudocatalase.

catalyst Any substance that speeds up a chemical reaction without itself being consumed by the reaction.

catalytic antibody (abzyme) An ANTIBODY that catalyzes a chemical reaction analogous to an enzymatic reaction, such as an ester hydrolysis. It is obtained by using a hapten that mimics the transition state of the reaction.

See also ENZYME.

cataract The clouding of the natural lens of the eye or surrounding membrane, making it difficult to see.

catecholamine A class of hormones, two of which are known to be important in a medical emergency. These are epinephrine and norepinephrine. Dopamine and dopa are also catecholamines. All the catecholamines stimulate high blood pressure and can trigger symptoms usually associated with threatening situations leading to a panic attack.

Epinephrine (adrenaline). A hormone released by the adrenal gland, which is the drug of choice for the treatment of anaphylaxis. Indeed, those who are allergic to insect stings and certain foods should always carry a self-injecting syringe of epinephrine.

Epinephrine increases the speed and force of heartbeats and, therefore, the work that can be done by the heart. It dilates the airways to improve breathing and narrows blood vessels in the skin and intestine so that an increased flow of blood reaches the muscles and allows them to cope with the demands of exercise. Usually treatment with this hormone stops an anaphylactic reaction. Epinephrine has been produced synthetically as a drug since 1900.

Norepinephrine (noradrenaline). A hormone released by the adrenal gland. Norepinephrine is released, along with epinephrine, from the adrenals and from nerves when heart failure takes place. These hormones are the first line of defense during any sudden stress. The release of these hormones cause the heart to pump faster, making up for the pumping problem caused by heart failure.

cation A positively charged ION.

cation exchange The ability of soils to attract and exchange cations with cations of soil solutions; high for clays and humus and low for sand.

catkin A hanging group of unisexual flowers (either male or female) without petals, e.g., willows.

Caucasian A member of the human race that is white skinned.

caudal A fin, or direction toward a tail.

CBS (colloidal bismuth subcitrate) *See* DE-NOL.

CD *See* CIRCULAR DICHROISM.

celiac disease (celiac sprue) Celiac disease is a malabsorption disorder characterized by a permanent gluten-sensitive enteropathy resulting in malabsorption, failure to thrive, and other gastrointestinal manifestations. However, it should not be confused with a food allergy or hypersensitivity to food products.

Celiac disease is an inherited cell-mediated hypersensitivity involving a tissue-bound immune cell, often resulting in delayed reaction to a food allergen such as wheat, rye, oats, or barley. Gluten, a protein in these grains, is thought to be the offending agent. The disease has also been referred to as gluten enteropathy, gluten intolerance, gluten intolerant enteropathy, gluten-sensitive enteropathy, nontropical sprue, and wheat allergy.

The onset of the disease has no age restriction, but there are many hypotheses related to possible causative factors. In some adults, symptoms leading to a diagnosis of celiac sprue have been observed to appear following severe emotional stress, pregnancy, an operation, or a viral infection.

cell The basic unit of life, capable of growing and multiplying. All living things are either single, independent cells or aggregates of cells. A cell is usually composed of cytoplasm and a nucleus, and it is surrounded

by a membrane or wall. Cells can be categorized by the presence of specific cell surface markers called clusters of differentiation.

cell center (centrosome) The organelle centrally located near the nucleus where the microtubules are organized and the location of the spindle pole during mitosis. A pair of centrioles, arrays of microtubules, are found in the center in the cells of animals.

cell cycle The reproductive cycle of the eukaryotic cell: the orderly sequence of events (M, G₁, S, and G₂ phases) when a cell duplicates its contents and divides into two.

See also CELL-CYCLE PHASES; MITOSIS.

cell-cycle phases The sequence of events that cells go through between mitotic divisions. The cycle is divided into gap 0 (G₀), gap 1 (G₁), synthesis phase (S) when DNA is replicated, Gap 2 (G₂), and mitosis (M).

G₀ phase Period of time when the cell pauses in cell division between M (mitosis) and S (synthesis) phases. Normal cells in this phase have exactly one set of chromosome pairs.

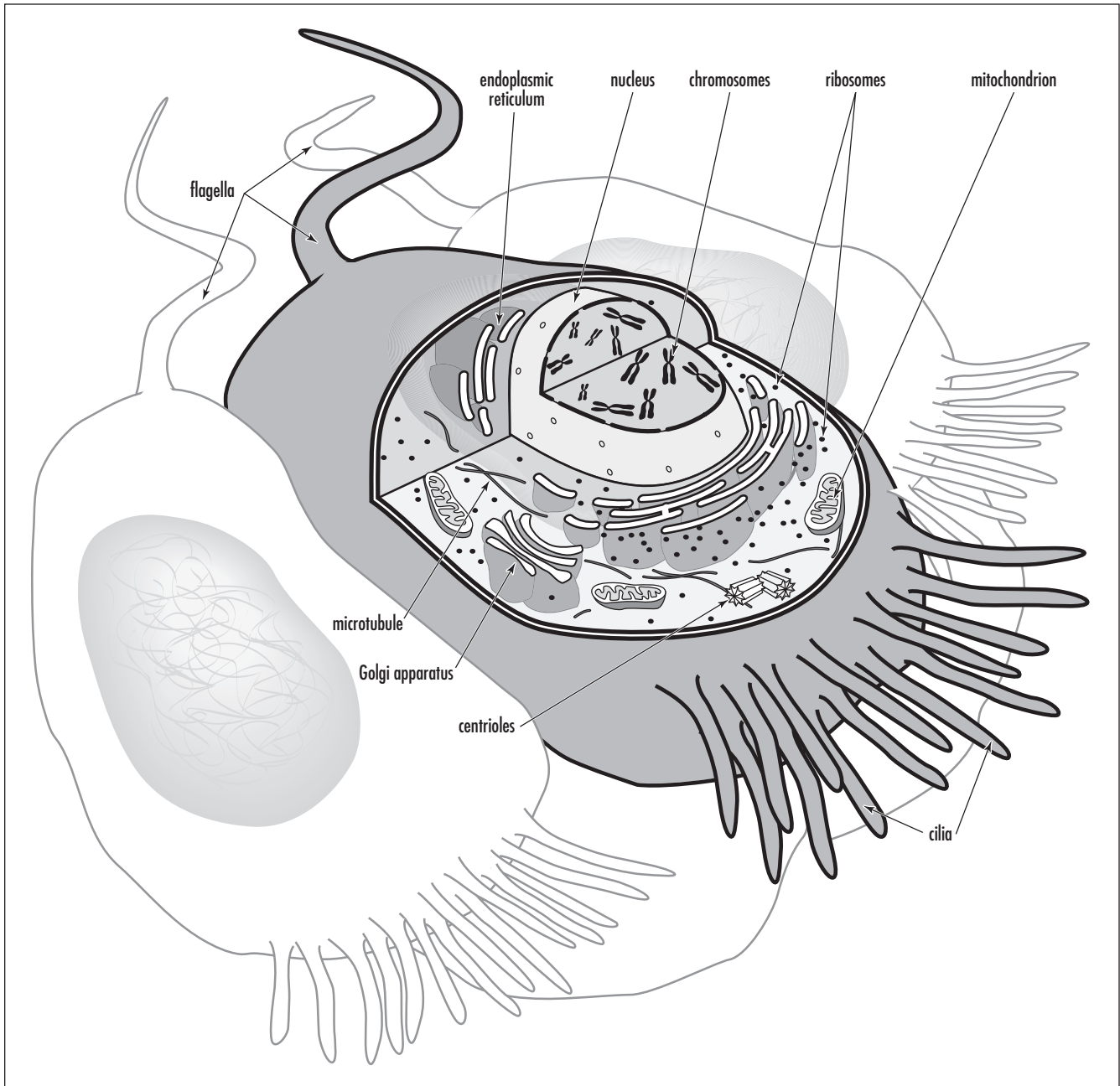
G₁ phase Period of time after mitosis but before S phase of the cell-division cycle; the cell is making preparations for DNA synthesis.

G₂ phase Period of time after the S phase and before mitosis of the cell-division cycle. In this phase, the cells have duplicated their DNA and formed two sets of chromosome pairs, in preparation for division. G₂ follows the S phase and precedes the M (mitosis) phase.

See also MITOSIS.

cell division When two daughter cells are created from one cell.

cell fractionation Separation of a cell's individual subcellular components (membranes, nucleus, cytoplasm, mitochondria) by the use of centrifuges, which allows closer study of individual cellular components.



The cell is the basic unit of any living organism. It is a small, watery compartment filled with chemicals and a complete copy of the organism's genome. (Courtesy of Darryl Leja, NHGRI, National Institutes of Health)

cell-mediated immunity (CMI; cellular immunity)
The branch of the immune system in which the reaction to foreign material is performed by specific defense cells (killer cells, macrophages, and other white blood cells) rather than antibodies.

cell membrane A two-layered structure of material surrounding living cells. Most cell membranes have proteins, such as receptors and enzymes, embedded in them. The membrane holds the cell together, controls which substances go in or out, and maintains homeostasis.

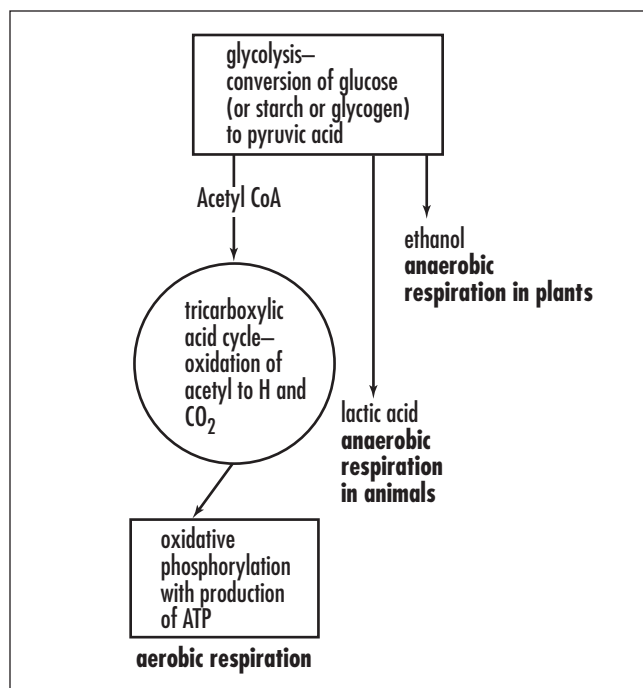
cell plate A membrane that forms in an area of the cytoplasm from the fusion of vesicles (which flatten) of a dividing plant cell during cytokinesis and which will develop into a new cell wall.

cellular differentiation The process of embryonic cells developing into their destined specific forms and functions as an organism develops; a result of gene expression. The process by which different cells, all sharing the same DNA, are capable of performing different tasks.

cellular respiration The process in which adenosine triphosphate (ATP) is created by metabolizing glucose and oxygen with the release of carbon dioxide. Occurs in the mitochondria of eukaryotes and in the cytoplasm of prokaryotes.

See also ATP.

cellulose A polysaccharide (polymer of glucose) that is found in the cell walls of plants. A fiber that is used in many commercial products like paper.



Cellular respiration is the process in which ATP is created by metabolizing glucose and oxygen with the release of carbon dioxide.

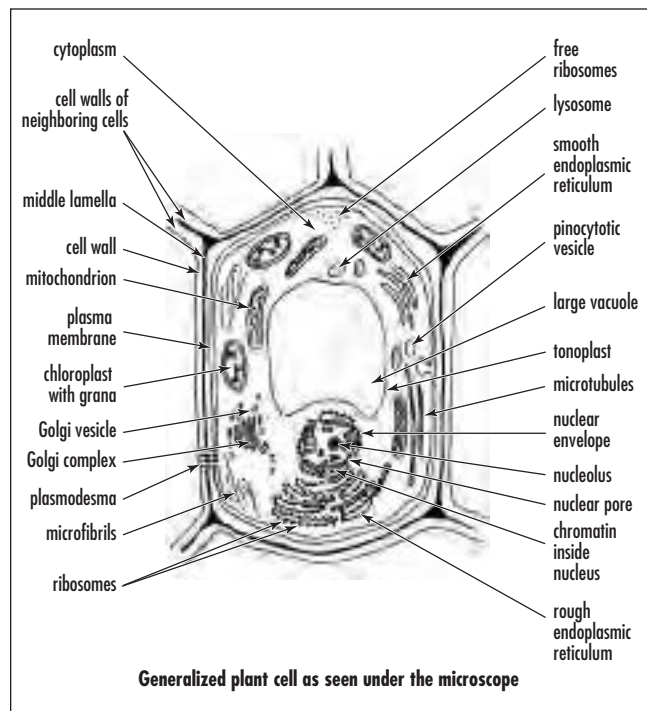
cell wall A tough surrounding layer of a cell. In plant cells, it is formed of cellulose embedded in a polysaccharide-protein matrix and is composed of primary and secondary cell walls: the primary is flexible, while the secondary is more rigid. The cell wall provides structural support and protection.

Celsius, Anders (1701–1744) Swedish *Astronomer, Physicist* Anders Celsius was a Swedish astronomer, physicist, and mathematician who introduced the Celsius temperature scale that is used today by scientists in most countries. He was born in Uppsala, Sweden, a city that has produced six Nobel Prize winners. Celsius was born into a family of scientists, all originating from the province of Hälsingland. His father Nils Celsius was a professor of astronomy, as was his grandfather Anders Spole. His other grandfather, Magnus Celsius, was a professor of mathematics. Both grandfathers were at the university in Uppsala. Several of his uncles were also scientists.

Celsius's important contributions include determining the shape and size of the Earth; gauging the magnitude of the stars in the constellation Aries; publication of a catalog of 300 stars and their magnitudes; observations on eclipses and other astronomical events; and a study revealing that the Nordic countries were slowly rising above the sea level of the Baltic. His most famous contribution falls in the area of temperature, and the one he is remembered most for is the creation of the Celsius temperature scale.

In 1742 he presented to the Swedish Academy of Sciences his paper, "Observations on Two Persistent Degrees on a Thermometer," in which he presented his observations that all thermometers should be made on a fixed scale of 100 divisions (centigrade) based on two points: 0° for boiling water, and 100° for freezing water. He presented his argument on the inaccuracies of existing scales and calibration methods and correctly presented the influence of air pressure on the boiling point of water.

After his death, the scale that he designed was reversed, giving rise to the existing 0° for freezing and 100° for boiling water, instead of the reverse. It is not known if this reversal was done by his student Martin Stromer; or by botanist Carolus Linnaeus, who in 1745 reportedly showed the senate at Uppsala University a thermometer so calibrated; or if it was done by Daniel Ekström, who manufactured most of the thermometers



All cells have cell walls that provide a tough surrounding layer for a cell.

used by both Celsius and Linneaus. However, Jean Christin from France made a centigrade thermometer with the current calibrations (0° freezing, 100° boiling) a year after Celsius and independent of him, and so he may therefore equally claim credit for the existing “Celsius” thermometers.

For years Celsius thermometers were referred to as “centigrade” thermometers. However, in 1948, the Ninth General Conference of Weights and Measures ruled that “degrees centigrade” would be referred to as “degrees Celsius” in his honor. The Celsius scale is still used today by most scientists.

Anders Celsius was secretary of the oldest Swedish scientific society, the Royal Society of Sciences in Uppsala, between 1725–44 and published much of his work through that organization, including a math book for youth in 1741. He died of tuberculosis on April 25, 1744, in Uppsala.

Celsius scale (centigrade scale) A temperature scale with the range denoted by °C. The normal freezing

point of water is 0°C, and the normal boiling point of water is 100°C. The scale was named after Anders Celsius, who proposed it in 1742 but designated the freezing point to be 100 and the boiling point to be 0 (reversed after his death).

See also CELSIUS, ANDERS.

Cenozoic era Age of the mammals. The present geological era, beginning directly after the end of the Mesozoic era, 65 million years ago, and divided into the Quaternary and Tertiary periods.

See also GEOLOGIC TIME.

central atom The atom in a COORDINATION entity that binds other atoms or group of atoms (LIGANDS) to itself, thereby occupying a central position in the coordination entity.

central nervous system That part of the nervous system that includes the brain and spinal cord. The brain receives and processes signals delivered through the spinal cord, where all signals are sent and received from all parts of the body, and in turn the brain then sends directions (signals) to the body.

centriole A pair of short, cylindrical structures composed of nine triplet microtubules in a ring; found at the center of a centrosome; divides and organizes spindle fibers during MITOSIS and MEIOSIS.

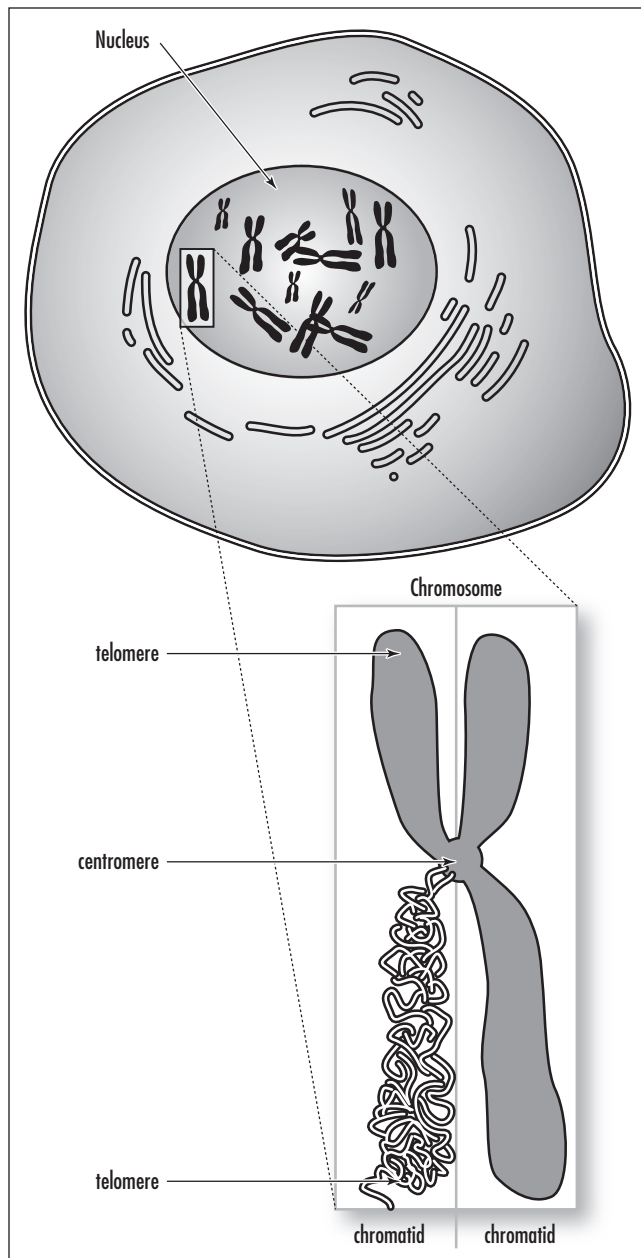
See also CENTROSOME.

centromere A specialized area, the constricted region, near the center of a chromosome to which spindle fibers attach during cell division; the location where the two sister chromatids are joined to one another.

centrosome (microtubule organizing center) The structural organizing center in cell cytoplasm, near the nucleus, where all microtubules originate; if folded it can become a centriole or a basal body for cilia and flagella.

cephalic Pertains to the head.

cephalochordate A chordate with no backbone (subphylum Cephalochordata), eg., lancelets.



The centromere is the constricted region near the center of a human chromosome. This is the region of the chromosome where the two sister chromatids are joined to one another. (Courtesy of Darryl Leja, NHGRI, National Institutes of Health)

cerebellum A part of the vertebrate hindbrain; controls muscular coordination in both locomotion and balance.

cerebral cortex The outer surface (3–5 mm) of the cerebrum and the sensory and motor nerves. It controls most of the functions that are controlled by the cerebrum (consciousness, the senses, the body's motor skills, reasoning, and language) and is the largest and



Scanning electron micrograph (SEM) of neurons (nerve cells) from the human cerebral cortex (the outer, heavily folded, grey matter of the brain). Neurons exist in varying sizes and shapes throughout the nervous system, but all have a similar basic structure: a large central cell body (large, light-gray bodies) containing a nucleus and two types of processes. These are a single axon (a nerve fiber), which is the effector part of the cell that terminates on other neurons (or organs), and one or more dendrites, smaller processes that act as sensory receptors. Similar types of neurons are arranged in layers within the cerebral cortex. Magnification: $\times 3,000$ at 8×8 in. $\times 890$ at 6×6 cm size. (Courtesy © CNRI/Photo Researchers, Inc.)

most complex part of the mammalian brain. The cortex is broken up into five lobes, each separated by an indentation called a fissure: the frontal lobe, the parietal lobe, the temporal lobe, the occipital lobe, and the insula. It is composed of six layers that have different densities and neuron types from the outermost to innermost: molecular layer, external granular layer, external pyramidal layer, internal granular layer, internal pyramidal layer, and the multiform layer. Vertical columns of neurons run through the layers.

See also BRAIN STEM.

cerebrum The largest part of the brain; divided into two hemispheres (right and left) that are connected by nerve cells called the corpus callosum. It is the most recognized part of the brain and comprises 85 percent of its total weight. The cerebrum is where consciousness, the senses, the body's motor skills, reasoning, and language take place.

See also BRAIN STEM.

ceruloplasmin A copper protein present in blood plasma, containing TYPE 1, TYPE 2, and TYPE 3 COPPER centers, where the type 2 and type 3 are close together, forming a trinuclear copper CLUSTER.

See also MULTICOPPER OXIDASES.

Chain, Ernst Boris (1906–1979) German *Biochemist* Ernst Boris Chain was born on June 19, 1906, in Berlin, to Dr. Michael Chain, a chemist and industrialist. He was educated at the Luisen gymnasium, Berlin, with an interest in chemistry. He attended the Friedrich-Wilhelm University, Berlin, and graduated in chemistry in 1930. After graduation he worked for three years at the Charité Hospital, Berlin, on enzyme research. In 1933, after the rise of the Nazi regime in Germany, he left for England.

In 1935 he was invited to Oxford University, and in 1936 he became a demonstrator and lecturer in chemical pathology. In 1948 he was appointed scientific director of the International Research Centre for Chemical Microbiology at the Istituto Superiore di Sanità, Rome. He became professor of biochemistry at Imperial College, University of London, in 1961, serving in that position until 1973. Later, he became a pro-

fessor emeritus and a senior research fellow (1973–76) and a fellow (1978–79).

From 1935 to 1939 he worked on snake venoms, tumor metabolism, the mechanism of lysozyme action, and the invention and development of methods for biochemical microanalysis. In 1939 he began a systematic study of antibacterial substances produced by microorganisms and the reinvestigation of penicillin. Later he worked on the isolation and elucidation of the chemical structure of penicillin and other natural antibiotics.

With pathologist Howard Walter FLOREY (later Baron Florey), he isolated and purified penicillin and performed the first clinical trials of the antibiotic. For their pioneering work on penicillin Chain, Florey, and FLEMING shared the 1945 Nobel Prize in physiology or medicine.

Later his research topics included the carbohydrate-amino acid relationship in nervous tissue, a study of the mode of action of insulin, fermentation technology, 6-aminopenicillanic acid and penicillinase-stable penicillins, lysergic acid production in submerged culture, and the isolation of new fungal metabolites.

Chain was the author of many scientific papers and a contributor to important monographs on penicillin and antibiotics, and was the recipient of many awards including being knighted in 1969. He died on August 12, 1979.

channels Transport proteins that act as gates to control the movement of sodium and potassium ions across the plasma membrane of a nerve cell.

See also ACTIVE TRANSPORT.

chaparral Dense vegetation of fire-adapted thick shrubs and low trees living in areas of little water and extreme summer heat in the coastal and mountainous regions of California. Similar community types exist in the coastal and mountainous regions of South Africa (fynbos), Chile (matorral), Spain (maquis), Italy (macchia), and Western Australia (kwongan). Also referred to as coastal sagebrush.

chaperonin A member of the set of molecular chaperones, located in different organelles of the cell and

involved either in transport of proteins through BIOMEMBRANES (by unfolding and refolding the proteins) or in assembling newly formed POLYPEPTIDES.

character A synonym for a trait in TAXONOMY.

character displacement The process whereby two closely related species interact in such a way, such as intense competition between species, as to cause one or both to diverge still further. This is most often apparent when the two species are found together in the same environment, e.g., large and small mouth bass.

charge-transfer complex An aggregate of two or more molecules in which charge is transferred from a donor to an acceptor.

charge-transfer transition An electronic transition in which a large fraction of an electronic charge is transferred from one region of a molecular entity, called the electron donor, to another, called the electron acceptor (intramolecular charge transfer), or from one molecular entity to another (intermolecular charge transfer).

chelation Chelation involves COORDINATION of more than one sigma-electron pair donor group from the same LIGAND to the same CENTRAL ATOM. The number of coordinating groups in a single chelating ligand and is indicated by the adjectives didentate, tridentate, tetradentate, etc.

chelation therapy The judicious use of chelating (metal binding) agents for the removal of toxic amounts of metal ions from living organisms. The metal ions are sequestered by the chelating agents and are rendered harmless or excreted. Chelating agents such as 2,3-dimercaptopropan-1-ol, ethylenediaminetetraacetic acid, DESFERRIOXAMINE, and D-penicillamine have been used effectively in chelation therapy for arsenic, lead, iron, and copper, respectively.

See also CHELATION.

chemical equilibrium The condition when the forward and reverse reaction rates are equal and the concentrations of the products remain constant. Called the law of chemical equilibrium.

chemical shift *See* NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY.

chemiosmosis A method of making ATP that uses the electron transport chain and a proton pump to transfer hydrogen protons across certain membranes and then utilize the energy created to add a phosphate group (phosphorylate) to ADP, creating ATP as the end product.

chemoautotroph (chemolithotroph) An organism that uses carbon dioxide as its carbon source and obtains energy by oxidizing inorganic substances.

chemoheterotroph Any organism that derives its energy by oxidizing organic substances for both a carbon source and energy.

chemoreceptor A sense organ, cell, or structure that detects and responds to chemicals in the air or in solution.

chemotherapy The treatment of killing cancer cells by using chemicals.

See also CANCER.

chiasma The x-shaped point or region where homologous chromatids have exchanged genetic material through crossing over during MEIOSIS. The term is also applied to the site where some optic nerves from each eye cross over to the opposite side of the brain, forming the optic tract.

chigger Red, hairy, very small mites (arachnids) of the family Trombiculidae, such as *Trombicula alfreddu-*