

## Glossary of Biological Terms

**ABC model** Model for the genetic basis of flower formation; products of three master genes (*A*, *B*, *C*) control the development of sepals, petals, and stamens and carpels from meristematic tissue.

**ABC transporter** One of a distinct class of membrane proteins, each a channel or pump for a specific hydrophobic substance (e.g., ions, sugars, amino acids).

**ABO blood typing** Method of identifying which self-recognition proteins of types *A* and *B* are at the surface of an individual's red blood cells; the absence of either type is designated *O*.

**abortion** Premature expulsion of embryo or fetus from the uterus; called miscarriage when spontaneous rather than induced.

**abscisic acid** Plant hormone; stimulates stomatal closure in response to water stress, protein storage in seeds, maturation of embryo sporophyte; possibly induces and maintains dormancy in some plants.

**abscission** (ab-SIH-zhun) The dropping of leaves, flowers, fruits, or other parts from a plant in response to seasonal change, drought, injury, or nutrient deficiencies.

**absorption** Of pigments, interception of photon energy. Of cells, uptake of water and solutes from the surroundings. Of digestion, uptake of water and solutes into the internal environment.

**absorption spectrum** Range of wavelengths that a given type of pigment can absorb.

**accessory pigment** A pigment that absorbs and transfers light energy to a photosystem; extends the range of light wavelengths for photosynthesis; e.g., a carotenoid.

**acclimatization** Processes by which the body adjusts in physiology and behavior to a new environment; e.g., after moving from sea level to a high-altitude habitat.

**acetylation** The attachment of an acetyl group ( $\text{CH}_3\text{CO}$ ) to an organic compound.

**acetylcholine** (ACh) Neurotransmitter with stimulatory or inhibitory effects in the brain, spinal cord, glands, and muscles.

**acetyl-CoA** Coenzyme A bound to a two-carbon fragment from pyruvate, which it transfers to oxaloacetate for Krebs cycle.

**acid** [L. *acidus*, sour] Any water-soluble substance that releases hydrogen ions ( $\text{H}^+$ ) in water, yielding a pH below 7.0.

**acid-base balance** Outcome of control over solute concentrations; extracellular fluid is neither too acidic nor too basic (alkaline).

**acidity** A solution with a pH of less than 7.

**acid rain** Acidic precipitation; rain or snow with high levels of sulfur and nitrogen oxides.

**acoelomate animal** Any invertebrate with no fluid-filled cavity between its gut and body wall; e.g., a flatworm.

**acoustical receptor** Any mechanoreceptor sensitive to sound.

**acoustical signal** A sound or sounds used in intraspecific communication.

**actin** Protein monomer of microfilaments that functions in contraction, cell division, and reinforcing or reconfiguring the shape of a cell or its contents.

**action potential** Of excitable cells, a self-propagating, abrupt reversal in the voltage difference across the plasma membrane.

**activation energy** Minimum amount of energy required to start a reaction; enzyme action lowers this energy barrier. Reactions differ in the amount required.

**activator** A regulatory molecule that binds to specific sequences in DNA and thereby promotes transcription.

**active site** Chemically stable crevice in an enzyme where substrates bind and a reaction can be catalyzed repeatedly.

**active transport** Pumping of a specific solute across a cell membrane against its concentration gradient, through the interior of a transport protein. Requires energy input, as from ATP.

**adaptation, evolutionary** [L. *adaptare*, to fit] Any long-term, heritable aspect of form, function, or behavior that improves an individual's chances of surviving and reproducing; outcome of natural selection and other microevolutionary processes.

**adaptation, sensory** Of sensory neurons, a decline or cessation of action potentials when a stimulus of constant strength does not end.

**adaptive immunity** The mechanisms that defend the vertebrate body against specific threats to health, as characterized by self/nonself recognition, specificity, diversity, and memory. All antibody-mediated and cell-mediated responses to antigen.

**adaptive radiation** A macroevolutionary pattern. A burst of genetic divergences from a lineage that gives rise to many species, each able to use a novel resource or to move into a new, or newly vacated, habitat.

**adaptive trait** An aspect of form, function, or behavior that helps an individual survive and reproduce under prevailing conditions.

**adaptive zone** A set of different niches that become be filled by a group of species.

**adenine** One of four nitrogen-containing bases in nucleotide monomers of DNA or RNA; also refers to a nucleotide having an adenine base component.

**ADH** Antidiuretic hormone. Hypothalamic hormone released by the posterior pituitary that induces water conservation by kidneys.

**adhering junction** Complex of adhesion proteins that anchors cells to each other and to extracellular matrixes.

**adhesion protein** Of multicelled species, a plasma membrane protein that helps cells stick together in tissues and to extracellular matrixes such as basement membrane.

**adipose tissue** Type of connective tissue having an abundance of fat-storing cells.

**ADP** Adenosine diphosphate (ah-DEN-uh-seen die-FOSS-fate). A nucleotide with an adenine base and two phosphate groups.

**adrenal cortex** Outer zone of the adrenal gland; secretes cortisol and aldosterone.

**adrenal gland** Endocrine gland located on top of the kidney; regulates stress responses and influences glucose metabolism.

**adrenal medulla** Inner zone of adrenal gland that secretes epinephrine and norepinephrine.

**aerobic respiration** (air-OH-bik) [Gk. *aer*, air, + *bios*, life] Oxygen-requiring pathway of ATP formation in mitochondria: from glycolysis, to Krebs cycle and electron transport phosphorylation. Typical net energy yield: 36 ATP per glucose molecule.

**African emergence model** Model for the origin of modern humans; *Homo sapiens* is said to have originated in Africa, then replaced by archaic *Homo* populations in different parts of the world.

**age structure** Of a population, the number of individuals in each age category.

**agglutination** (ah-glue-tin-AY-shun) A vertebrate defense response; antibodies bind antigen and form insoluble clumps that attract phagocytes.

**aging** Of complex multicelled organisms, a time-dependent progressive deterioration of molecules, cells, tissues, and organs that weakens the body's capacity to function.

**AIDS** Acquired immune deficiency syndrome. A set of chronic disorders that develops after prolonged infection by HIV has weakened the immune system.

**alcohol** Organic compound having one or more hydroxyl groups that dissolves easily in water; e.g., ethanol.

**alcoholic fermentation** An anaerobic ATP-forming pathway using pyruvate and NADH from glycolysis. NADH transfers electrons to an intermediate, acetaldehyde, forming ethanol. Occurs in cytoplasm only. The net yield is 2 ATP from glycolysis; the steps remaining only regenerate  $\text{NAD}^+$ .

**aldosterone** (al-DOSS-tuh-rohn) Adrenal cortex hormone; acts in kidneys to promote sodium retention.

**alga**, plural **algae** Informal term for groups of single-celled or multicelled eukaryotic photoautotrophs, mostly aquatic; e.g., kelps.

**algal bloom** Rapid, huge increases in algal population sizes after nutrient enrichment of an aquatic habitat.

**alkylation** Of a molecule, replacement of a hydrogen atom by a hydrocarbon group.

**allantois** (ah-LAN-twahz) [Gk. *allas*, sausage] One of four extraembryonic membranes of amniote eggs. In reptiles, birds, and some mammals, it exchanges gases and stores metabolic wastes; in humans, it helps form placental blood vessels, urinary bladder.

**allele** One of two or more molecular forms of a gene at a given locus; alleles arise by mutation and encode slightly different versions of the same trait.

**allele frequency** Abundance of one allele relative to others at a gene locus among individuals of a population.

**allergen** A normally harmless substance that can provoke immune responses.

**allergy** Hypersensitivity to an allergen.

**allopatric speciation** [Gk. *allos*, different, + *L. patria*, native land] Speciation model. A physical barrier arises and separates populations or subpopulations of a species, ends gene flow, and so favors divergences that result in new species.

**alternation of generations** The alternation of haploid (gamete-producing) and diploid (spore-producing) phases in the life cycle of an organism.

**alternative splicing** Event by which the same gene can specify two or more slightly different proteins. All exons in a pre-mRNA transcript of the gene are retained or some are removed and the rest spliced in various combinations for the mature transcript.

**altruism** (AL-true-IZ-um) Social behavior that decreases the individual's chance of reproductive success while improving the chances for others of its species.

**alveolate** A type of single-celled eukaryote that has many tiny, membrane-bound sacs just beneath the plasma membrane; e.g., a ciliate, apicomplexan, or dinoflagellate.

**alveolus** (ahl-VEE-uh-lus), plural **alveoli** At the endings of respiratory bronchioles, one of great numbers of thin-walled, cup-shaped outpouching where air in the lungs exchange gases with blood.

**amino acid** (uh-MEE-no) A small organic compound with a carboxylic acid group, an amino group, and a characteristic side group (R); monomer of polypeptide chains.

**ammonification** (uh-moan-ih-fih-KAY-shun) Part of the nitrogen cycle; soil fungi and bacteria decompose nitrogen-containing compounds, the result being ammonia and ammonium ions that plant roots can absorb.

**amnion** One of the four extraembryonic membranes of amniote eggs; the boundary layer of a fluid-filled, cushioning sac in which the embryo develops.

**amniote** Type of tetrapod that produces amniote eggs. Major groups are synapsids (mammals and early mammal-like reptiles) and sauropsids ("reptiles" and birds).

**amniote egg** An egg, often shelled, with four extraembryonic membranes (amnion, chorion, yolk sac, allantois). Pivotal factor in the early evolution of reptiles, birds, and mammals in habitats on land.

**amoeba** A single-celled amoebozoan that moves on pseudopods. All are predatory or parasitic; none forms colonies.

**amphibian** A tetrapod, or a descendant of one, having a body plan and reproductive mode between fishes and reptiles.

**anaerobic electron transfer** (an-uh-ROW-bik) [Gk. *an*, without, + *aer*, air] Of some bacteria and archaeans, ATP formation by way of a flow of electrons through transfer chains in the plasma membrane to a final electron acceptor that is not oxygen.

**anaerobic pathway** Any set of metabolic reactions for which a substance other than oxygen is the final acceptor of electrons stripped from substrates.

**anagenesis** A major pattern of speciation. Directional changes in allele frequencies and morphology are confined within a single lineage, and in time a new type differs so much from the ancestral type that it is classified as a separate species.

**analogous structures** (an-AL-uh-gus) [Gk. *analogos*, similar to one another] Dissimilar body parts that have become similar in structure, function, or both in lineages that are not closely related but were subjected to similar pressures.

**anaphase, meiosis** Nuclear division stage. In anaphase I, each chromosome and its homologue move to opposite poles; both are still duplicated. In anaphase II, sister chromatids of each chromosome separate from each other, move to opposite poles.

**anaphase, mitosis** (AN-uh-faze) Nuclear division stage. Sister chromatids of each chromosome are separated from each other and move to opposite spindle poles.

**anatomy** Study of the internal parts of an organism to ascertain their structure and positions relative to one another. Now conducted at levels of organization from molecules through organ systems.

**anemia** Type of disorder resulting from having too few functional red blood cells.

**aneuploidy** (AN-yoo-ploy-dee) A type of chromosome abnormality in which body (somatic) cells have one extra or one less chromosome relative to the parental chromosome number.

**angiosperm** [Gk. *angeion*, vessel + *spermia*, seed] A flowering plant; its egg-containing ovules mature into seeds within closed, protected chambers called ovaries.

**angiotensin II** Plasma protein that helps constrict arterioles and stimulates ADH and aldosterone secretion.

**animal** Any multicelled heterotroph that ingests other organisms or their tissues, develops through a series of embryonic stages, and is motile during part or all of the life cycle. Most species have epithelial tissues and extracellular matrixes.

**animal behavior** A coordinated response to stimuli that involves motor, neural, and endocrine components. Animal behavior has a genetic basis, it can evolve, and it can be modified by learning.

**Animalia** Kingdom of animals.

**annelid** A bilateral invertebrate having a highly segmented body; major groups are polychaetes, oligochaetes, and leeches. Except in leeches, segments have clusters of chitin-reinforced bristles.

**annual** A plant having a life cycle that starts and ends in one growing season.

**anthocyanin** One of a class of accessory pigments that reflect red to blue light.

**anthropoid** One of a group of primates; a monkey, ape, or human.

**antibiotic** [Gk. *anti*, against] In nature, a metabolic product of certain bacteria and fungi in soil that is toxic to their microbial competitors for nutrients.

**antibody** Antigen-binding glycoprotein made and secreted only by B cells; during adaptive immunity, activates complement, neutralizes toxins, enhances phagocytosis, immobilizes internal pathogens or parasites.

**antibody-mediated immune response** One of two arms of adaptive immunity in which antibodies are produced in response to a specific antigen; mediated by B cells.

**anticodon** Series of three nucleotide bases in tRNA that can base-pair with mRNA codons.

**antigen** (AN-tih-jen) Any molecular pattern that triggers an immune response.

**antigen-MHC complex** Fragment(s) of antigen bound to MHC markers at a cell's plasma membrane; recognized by T cells.

**antigen-presenting cell** Lymphocyte that binds and processes antigen to present to T cells as antigen-MHC complexes; secretes cytokines that stimulate proliferation and differentiation of lymphocytes.

**antioxidant** Any enzyme or cofactor that helps neutralize free radicals before they damage tissues.

**anus** The terminal opening of a complete digestive system.

**aorta** (ay-OR-tah) Of vertebrates, the main artery of systemic circulation.

**apical dominance** (AY-pih-kul) Growth-inhibiting effect on lateral (axillary) buds, caused by auxin diffusing down a shoot tip from the terminal bud.

**apical meristem** (MARE-ih-stem) [L. *apex*, top, + Gk. *meristos*, divisible] Mass of dividing cells at root tips and shoot tips.

**apicomplexan** A parasitic alveolate having a unique microtubular device at its anterior end; the device attaches to and penetrates a host cell.

**apoptosis** (APP-oh-TOE-sis) Programmed cell death. A cell is induced to commit suicide as part of growth, development, and maintenance of a multicelled body.

**appendicular skeleton** (ap-en-DIK-yoo-lahr) Bones of limbs, hips, and shoulders.

**appendix** Small, narrow outpouching from the cecum, vulnerable to infection.

**aquaporin** A type of passive transporter that assists diffusion of water molecules across the plasma membrane.

**Archaea** Domain of prokaryotic species; one of two lineages that evolved shortly after life originated. Archaeans have many unique molecular and biochemical traits but also share some traits with bacteria and other traits with eukaryotic species.

**Archean** Eon extending from the time that life originated, 3.8 billion years ago, to 2.5 billion years ago.

**archipelago** A chain or cluster of islands, often of volcanic origin in the open ocean.

**area effect** Biogeographical pattern; larger islands support more species than smaller ones at equivalent distances from sources of colonizer species.

**arteriole** (ar-TEER-ee-ole) The type of blood vessel in between arteries and capillaries. Selectively distributing more of the total blood volume to different organs in a given interval requires controls over dilation and constriction of the diameter of arterioles.

**arteriosclerosis** Chronic disease in which the wall of arteries thickens abnormally, hardens, and loses its elasticity.

**artery** A thick-walled, muscular, rapid-transport vessel that smooths out pulses of pressure generated by heartbeats.

**arthropod** Type of invertebrate having a hardened exoskeleton and specialized segments with jointed appendages; e.g., millipedes, spiders, lobsters, insects.

**artificial selection** Manipulation of the reproduction of a species as by breeding practices. Only individuals of a captive population that display a valued trait are allowed to reproduce, the goal being to increase the trait's magnitude and frequency over the generations.

**ascospore** Sexual spore of sac fungi.

**asexual reproduction** Any reproductive mode by which offspring arise from one parent and inherit that parent's genes only; e.g., prokaryotic fission, transverse fission, budding, vegetative propagation.

**atherosclerosis** A medical condition in which arteries narrow in diameter as lipids and other deposits accumulate in their wall.

**atmosphere, Earth's** The volume of gases, water vapor, and airborne particles that envelopes Earth's surface.

**atom** The smallest unit of an element that still retains the element's properties.

**atomic number** The number of protons in the nucleus of atoms of a given element.

**ATP** Adenosine triphosphate (ah-DEN-uh-seen try-FOSS-fate). A type of nucleotide that functions as the main energy carrier between reaction sites in cells. Consists of the base adenine, the five-carbon sugar ribose, and three phosphate groups.

**ATP/ADP cycle** How a cell regenerates its ATP supply. ADP forms when ATP gives up a phosphate group, then ATP forms as ADP binds to inorganic phosphate or a phosphate group split from a molecule.

**ATP synthase** A type of membrane-bound active transport protein that also catalyzes the formation of ATP.

**australopith** (OHSS-trah-low-pith) [L. *australis*, southern, + Gk. *pithekos*, ape] One of the early hominids of Africa.

**autoimmune response** Inappropriate lymphocyte attack on normal body cells.

**automated DNA sequencing** Extremely rapid, robotic method of identifying the nucleotide sequence of a region of DNA. Gel electrophoresis and laser detection of fluorescent tracers are part of method.

**autonomic nerve** (AH-toe-NOM-ik) One of the nerves from the central nervous system that helps control smooth muscle, cardiac muscle, and glands of viscera.

**autosome** Of a sexually reproducing species, any chromosome of a type that is the same in both males and females.

**autotroph** [Gk. *auto*, self, and *trophos*, feeder] An organism that synthesizes its own food from simple inorganic compounds in its environment with energy captured from the sun or from oxidizing inorganic substances; e.g., a photoautotroph or chemoautotroph.

**auxin** (OX-in) A type of plant hormone that stimulates lengthening of shoots and coleoptiles, vascular cambium activity, and vascular tissue differentiation; also inhibits lateral bud formation, abscission, and fruit formation; responsive to gravity and light.

**axial skeleton** (AX-ee-uhl) Skull, backbone, ribs, and breastbone (sternum).

**axon** A neuron's signal-conducting zone; action potentials typically self-propagate away from the cell body on this slender, typically long process.

**B lymphocyte** B cell. Type of white blood cell central to immune responses; only cell that makes antibodies.

**bacillus** Rod-shaped prokaryotic cell.

**Bacteria** Domain of prokaryotic species; the first kinds of cells that formed after life originated. Collectively, bacteria are the most metabolically diverse organisms. Most kinds are chemoheterotrophs.

**bacterial chromosome** A circular, double-stranded molecule of prokaryotic DNA.

**bacteriophage** (bak-TEER-ee-oh-fahj) One of a class of viruses that infects bacteria.

**balanced polymorphism** An outcome of natural selection against homozygotes, so that two or more alleles for a trait are being maintained in the population.

**bark** Of woody plants, all tissues that are external to the vascular cambium.

**Barr body** Of the two X chromosomes in the somatic cells of female mammals, the one that has been condensed.

**basal body** An organelle that started out as a centriole, the source of a 9+2 array of microtubules in a cilium or flagellum. It remains below the finished array.

**base** Any water-soluble substance that releases hydroxyl ions in water to yield a pH greater than 7.0. Also the nitrogen-containing component of a nucleotide.

**base-pair substitution** Mutation in which one nucleotide is wrongly substituted for another during DNA replication.

**base sequence** Linear order of nucleotides that compose a DNA or RNA strand.

**basidiospore** Sexual spore of club fungi.

**basophil** White blood cell circulating in blood that secretes histamine and other substances with roles in inflammation.

**bell curve** Idealized statistical distribution of the continuous variation in a population for a trait of interest.

**biennial** (bi-EN-yul) A flowering plant that requires two growing seasons to complete its life cycle; flowers and fruits form in the second season.

**big bang** Model for the origin of universe, by a nearly instantaneous distribution of all matter and energy through all of space.

**bilateral symmetry** Body plan in which the main axis divides the body into two halves that are mirror images of one another.

**bile** Mix of salts, cholesterol, and pigments made by the liver and used in fat digestion.

**binary fission** Asexual reproductive mode of certain invertebrates; the body splits spontaneously, then both parts grow what is missing. *See also* Prokaryotic fission.

**binding energy** Energy released as weak bonds form between a substrate, enzyme, and any cofactor.

**binomial system** A scientific system of naming species, whereby each kind of organism receives a two-part name. The first part indicates the genus; the second part is the species epithet (descriptor).

**biodiversity** [Gk. *bios*, life] Biological diversity in an environment, as measured by the number of species and their relative abundances.

**biofilm** Large microbial populations that anchored themselves to epithelium, rocks, or other surfaces by their own secretions.

**biogeochemical cycle** Slow movement of an element from environmental reservoirs, through food webs, then back.

**biogeographic realm** [Gk. *bios*, life, + *geographain*, to describe Earth's surface] One of many vast expanses of land where one can expect to find communities of certain types of plants and animals.

**biogeography** Scientific study of patterns in the geographic distribution of species and communities.

**biological clock** Internal time-measuring mechanism by which individuals adjust their activities seasonally, daily, or both in response to environmental cues.

**biological magnification** Ever increasing concentration of a slowly degradable or nondegradable substance in body tissues as it is passed along food chains.

**biological species concept** Definition of a sexually reproducing species as one or more populations of individuals that interbreed under natural conditions, produce fertile offspring, and are reproductively isolated from other such populations.

**biology** The scientific study of life.

**bioluminescence** Fluorescent light formed when certain organisms convert chemical bond energy to photon energy.

**biomass** Of an ecosystem, the combined weight of all organisms at a trophic level.

**biomass pyramid** Chart in which the size of successive tiers depicts the measured

biomass (dry weight) of an ecosystem's producers, consumers, and decomposers.

**biome** One of the finer subdivisions of a biogeographic realm.

**biosphere** [Gk. *bios*, life, + *sphaira*, globe] All regions of Earth's waters, crust, and atmosphere in which organisms live.

**biosynthetic pathway** Any metabolic pathway by which one or more organic compounds are synthesized.

**biotic potential** The maximum rate of increase per individual for any population that is growing under ideal conditions.

**bipedalism** Habitually walking upright on two feet, as by ostriches and hominids.

**bipolar spindle** Of eukaryotic cells, a dynamic array of microtubules that moves chromosomes with respect to its two poles during mitosis or meiosis.

**bird** A warm-blooded, feathered amniote classified as a sauropsid; the dinosaurs and crocodilians are its closest relatives.

**blastocyst** (BLASS-tuh-sist) A type of blastula with a surface layer of blastomeres, a cavity filled with their secretions, and an inner cell mass; e.g., a human blastocyst.

**blastomere** One of the small, nucleated cells that forms during the cleavage stage of animal development.

**blastula** A ball of blastomeres and a cavity filled with their own secretions; outcome of the cleavage stage of animal development.

**blood** A fluid connective tissue that is the transport medium of circulatory systems. Mostly water in which ions, molecules, blood cells, and platelets are dissolved.

**blood-brain barrier** Specialized blood capillaries that protect the brain and spinal cord by exerting some control over which solutes enter the cerebrospinal fluid.

**blood pressure** Fluid pressure generated by heartbeats that causes blood circulation.

**bone** Type of vertebrate organ consisting of mineral-hardened connective tissue. Functions in movement, mineral storage, and protection; blood cells form in some.

**bone remodeling** Ongoing depositions and withdrawals of mineral ions from bone by certain bone cells; their antagonistic actions adjust bone strength as well as calcium and phosphorus levels in blood.

**bone tissue** Of vertebrate skeletons, a tissue of osteoblast secretions, which have become hardened with mineral ions.

**bony fish** Aquatic vertebrate that has an endoskeleton, including a cranium, mostly of bone tissue.

**boreal forest** *Taiga*. One of the extensive northern coniferous forests of Europe, Asia, and North America.

**bottleneck** Severe reduction in the size of a population, brought about by intense selection pressure or a natural calamity.

**Bowman's capsule** First part of a nephron, where its wall balloons back on itself in the shape of a double-layer cup; under the force of blood pressure, water and solutes are filtered out of blood and into the cup.

**brain** Of most nervous systems, a major integrating center that receives, processes, and often stores sensory input, and issues coordinated commands for responses.

**brain stem** The most ancient nerve tissue in all three divisions of a vertebrate brain.

**bronchiole** Finely branched airway that is part of the bronchial tree inside a lung.

**bronchus**, plural **bronchi** (BRONG-cuss, BRONG-kee) [Gk. *bronchos*, windpipe] A tubular airway that starts at the trachea and becomes the main branch into a lung.

**brown alga** A stramenopile; a multicelled marine photoautotroph with an abundance of the pigment fucoxanthin; e.g., kelps.

**bryophyte** Nonvascular land plant. The haploid stage dominates its life cycle, and its sperm require standing water to reach eggs. A moss, liverwort, or hornwort.

**bud** A dormant shoot, mostly meristematic tissue and often sheathed in small, young leaves. A lateral (axillary) bud forms in a leaf axil; a terminal bud forms at a shoot tip and is the main zone of primary growth.

**buffer system** A weak acid and the salt that forms when it dissolves. The two work as a pair to counter slight shifts in pH.

**bulk** Of the vertebrate gut, the volume of undigested material in the small intestine that cannot be decreased by absorption.

**bulk flow** The mass movement of one or more substances in the same direction, most often in response to pressure.

**C3 plant** Type of plant in which three-carbon PGA is the first stable intermediate to form after carbon fixation.

**C4 plant** Type of plant in which four-carbon oxaloacetate is the first stable intermediate to form after initial carbon fixation; in these plants, carbon is fixed twice, in two different types of photosynthetic cells.

**calcium pump** Active transport protein; pumps calcium ions across a cell membrane against their concentration gradient.

**Calvin-Benson cycle** Cyclic reactions that form sugar and regenerate RuBP in the second stage of photosynthesis. The reactions require carbon (from carbon dioxide). They use energy from ATP and hydrogens and electrons from NADPH, both of which form in the first stage.

**CAM plant** Type of plant that conserves water by opening stomata only at night, when it fixes carbon by repeated turns of the C<sub>4</sub> pathway; stands for crassulacean acid metabolism.

**camera eye** A camera-like eyeball having an inner darkened chamber, one opening for light, and a retina (like film) on which visual stimuli are focused. Cephalopods and vertebrates have camera eyes.

**camouflage** Body coloration, patterning, form, or behavior that helps predators or prey blend with the surroundings and possibly escape detection.

**cancer** A malignant neoplasm; a mass of abnormally dividing cells that can leave their home tissue and invade and form new masses in other parts of the body.

**capillary, blood** Smallest diameter blood vessel; the exchanges between interstitial fluid and blood occur across its wall, which is only one cell thick.

**capillary bed** One of the diffusion zones for circulatory systems; great numbers of blood capillaries exchange substances with interstitial fluid.

**capture-recapture method** Individuals of a mobile species are captured (or selected) at random, marked, then released so they can mix with unmarked individuals. One or more samples are taken. The ratio of marked to unmarked individuals is used for estimating the size of the population.

**carbamino hemoglobin** HbCO<sub>2</sub>, the form in which 30 percent or so of the CO<sub>2</sub> in blood is transported.

**carbohydrate** Any molecule of carbon, hydrogen, and oxygen typically in a 1:2:1 ratio. Main kinds are monosaccharides, oligosaccharides, and polysaccharides. They serve as structural materials, energy stores, and transportable energy forms.

**carbon cycle** Atmospheric cycle. Carbon moves from its environmental reservoirs (sediments, rocks, the ocean), through the atmosphere (mostly as CO<sub>2</sub>), food webs, and back to the reservoirs.

**carbon fixation** Process by which any autotrophic cell incorporates carbon atoms into a stable organic compound. Different cells get carbon dioxide from the air or dissolved in water.

**carbonic anhydrase** Enzyme in red blood cells that speeds formation of bicarbonate from CO<sub>2</sub> and water.

**carcinogen** (kar-SIN-uh-jen) Any agent or substance that can cause cancer.

**cardiac conduction system** [Gk. *kardia*, heart, + *kyklos*, circle] A set of specialized cardiac muscle cells that initiate and send signals that make regular cardiac muscle cells contract. The SA node, AV node, and junctional fibers that link them.

**cardiac cycle** A recurring sequence of muscle contraction and relaxation that corresponds to one heartbeat.

**cardiac muscle tissue** A contractile tissue present only in the heart wall.

**cardiac pacemaker** Sinoatrial (SA) node; a cluster of self-excitatory cardiac muscle cells that spontaneously started contracting first; they continue to set the normal rate of heartbeat.

**carnivore** An animal that eats primarily the flesh of other animals.

**carnivorous plant** A plant that traps and digests insects and other small animals, and absorbs the released nutrients, which are otherwise scarce in its habitat.

**carotenoid** One of a class of accessory pigments in photosynthesis that reflect red, orange, and yellow light. One kind, beta-carotene, is a precursor of vitamin A.

**carpel** (KAR-pul) Female reproductive parts of flowers; a sticky or hairlike stigma, often stalked, above a chamber (ovary) in which one or more ovules mature into seeds.

**carrying capacity** Maximum number of individuals in a population or species that a given environment can sustain indefinitely.

**cartilage** Connective tissue consisting of fine collagen fibers packed in a secreted, rubbery matrix that resists compression.

**cartilaginous fish** Jawed fish having an endoskeleton, including a cranium, of cartilage and large fins; e.g., sharks.

**Casparian strip** A waxy, impermeable band that seals abutting cell walls of endodermis (and exodermis) in roots; forces water and solutes to pass through cells, which helps control the type and amount of solutes that enter the vascular cylinder.

**catastrophism** Idea that abrupt changes in the geologic and fossil records are evidence of divinely invoked catastrophes.

**cDNA** DNA synthesized from an mRNA transcript through the use of the enzyme reverse transcriptase.

**cell** Smallest unit that still displays the properties of life; it has the capacity to survive and reproduce on its own.

**cell communication** How free-living cells or cells of a multicelled species coordinate activities; they send, receive, transduce, and respond to signaling molecules.

**cell cortex** A dynamic mesh of crosslinked cytoskeletal elements just underneath the plasma membrane and attached to it.

**cell count** The number of cells of a given type present in one microliter of blood.

**cell cycle** Of eukaryotic cells, a series of events from the time a cell forms until it reproduces. A cycle consists of interphase, mitosis, and cytoplasmic division.

**cell differentiation** In developing embryos of multicelled organisms, the process by which different cell lineages selectively express a different fraction of their genome and thereby become specialized in their composition, structure, and function.

**cell junction** Of a tissue, any molecular structure that connects adjoining cells physically, chemically, or both at their plasma membranes.

**cell-mediated immune response** Actions of sensitized phagocytes and cytotoxic T cells that directly destroy infected or cancerous body cells.

**cell plate formation** The mechanism of cytoplasmic division in plant cells. After nuclear division, vesicles derived from Golgi bodies deposit the material for a cross-wall that cuts through the cytoplasm and connects to the parent cell wall.

**cell theory** All organisms consist of one or more cells, the cell is the smallest unit of organization still displaying the properties of life, and life's continuity arises directly from growth and division of single cells.

**cell wall** Of many cells (not animal cells), a semirigid but permeable structure that surrounds the plasma membrane; helps a cell retain its shape and resist rupturing.

**Cenozoic** The modern geologic era, from 65 million years ago to the present.

**centipede** Venomous predatory arthropod with many segments having paired legs.

**central nervous system** Of vertebrates, the brain and spinal cord.

**central vacuole** In many mature, living plant cells, an organelle that stores amino acids, sugars, and some wastes; when it enlarges during growth, it forces the cell to enlarge and increase its surface area.

**centriole** A barrel-shaped structure that arises from a centrosome and organizes newly forming microtubules into a 9+2 array inside a cilium or flagellum.

**centromere** Of a eukaryotic chromosome, a constricted region having binding sites (kinetochores) for spindle microtubules.

**centrosome** Dense mass of material in the cytoplasm of eukaryotic cells from which microtubules start to grow.

**cephalization** (SEF-ah-lah-ZAY-shun) [Gk. *kephalikos*, head] During the evolution of most kinds of animals, the increasing concentration of sensory structures and nerve cells at the anterior end of the body.

**cephalochordate** Lancelet. A filter-feeding invertebrate chordate with tapered ends.

**cephalopod** Soft-bodied mollusk with a closed circulatory system. Moves by jet propulsion of water from a siphon; e.g., squids, octopuses, chambered nautilus.

**cerebellum** (ser-ah-BELL-um) Hindbrain region with reflex centers that maintain posture and smoothing limb movements.

**cerebral cortex** Thin surface layer of two cerebral hemispheres; its interneurons receive, integrate, and store sensory information and coordinate responses.

**cerebrospinal fluid** Clear extracellular fluid that bathes and protects the brain and spinal cord; contained in a system of canals and chambers.

**cerebrum** (suh-REE-bruhm) A forebrain region concerned with olfactory input and motor responses. In mammals, it evolved into the most complex integrating center.

**charophyte** A type of photoautotroph once grouped with other green algae but now known to be more closely related to land plants; e.g., desmids, stoneworts.

**checkpoint gene** A gene that encodes a protein that can help delay, advance, or block the cell cycle when something goes wrong during DNA replication or repair.

**chemical bond** A union between the electron structures of two or more atoms.

**chemical energy** Potential energy in the bonds between atoms in molecules.

**chemical equilibrium** No net change in concentrations of reactants and products in a reversible chemical reaction.

**chemical synapse** (SIN-aps) A cleft between a presynaptic neuron and postsynaptic cell that neurotransmitters diffuse across.

**chemiosmotic theory** Well-supported but confusingly named theory of ATP formation by way of an electrochemical gradient. The action of electron transfer chains causes H<sup>+</sup> to accumulate inside a membrane-bound compartment. ATP forms as H<sup>+</sup> follows the resulting concentration/electric gradients across the membrane through ATP synthases.

**chemoautotroph** (KEE-moe-AH-toe-trofe) Any prokaryotic cell that makes its own food by oxidizing inorganic substances.

**chemoreceptor** Sensory receptor; detects dissolved ions or molecules in fluid.

**chlamydia** A group of bacteria; all are intracellular parasites that cannot make ATP; they pilfer it from animal cells.

**chlorofluorocarbon** (KLORE-oh-FLOOR-oh-car-bun) CFC; an organic compound that contains chlorine and fluorine; contributes to ozone thinning in the atmosphere.

**chlorophyll a** (KLORE-uh-fill) [Gk. *chloros*, green, + *phyllon*, leaf] In plants and algae, a pigment that is a receptor for the photon energy required to start photosynthesis; it absorbs mainly violet and red light and reflects or transmits green light.

**chlorophyll b** An accessory pigment that absorbs mainly blue and orange light.

**chlorophyte** Formal taxon for most species of green algae. Single-celled, multicelled, and colonial photoautotrophs of mostly aquatic habitats, closely related to land plants; e.g., *Ulva*, *Chlamydomonas*, *Chlorella*.

**chloroplast** Organelle of photosynthesis in plants and algae. Two outer membranes enclose a semifluid interior, the stroma. A third membrane forms a compartment inside that functions in ATP and NADPH formation; sugars form in the stroma.

**choanoflagellate** Single-celled eukaryote having a microvilli collar around a single flagellum at their anterior end. A sister taxon of animals and fungi.

**cholecystokinin** (CCK) A hormone that stimulates gallbladder contractions and the secretion of pancreatic enzymes; also may suppress appetite.

**chordate** Animal with a notochord, dorsal hollow nerve cord, pharynx, gill slits in the pharynx wall, and a tail that extends past the anus. These traits develop in embryos but some may not persist in the adult form.

**chorion** (CORE-ee-on) An extraembryonic membrane of amniote eggs; becomes part of the placenta. Villi form at its surface and facilitate the exchange of substances between the embryo and mother.

**chromatid** One of the two DNA molecules of a duplicated chromosome that remain attached to each other at the centromere region during nuclear division.

**chromatin** All of the DNA molecules and associated proteins in a nucleus.

**chromosome** In eukaryotic cells, a linear DNA double helix with many histones and other proteins attached. *See also* Bacterial chromosome.

**chromosome number** The sum of all of the chromosomes in cells of a given type.

**chrysophyte** One of the stramenopiles; most are single-celled photoautotrophs and components of phytoplankton; e.g., coccolithophores, diatoms.

**chyme** Semidigested food in the gut.

**chytrid** A flagellated intracellular parasite of a fungal group, the microsporidians.

**ciliate** An alveolate having arrays of cilia at its surface; traditionally called a ciliated protozoan. Most are free-living predators.

**cilium**, plural **cilia** A motile structure with a 9+2 array of microtubules that projects from the plasma membrane of certain eukaryotic cells. Modified cilia, such as those of hair cells, have sensory functions.

**circadian rhythm** (ser-KAYD-ee-un) [L. *circa*, about, + *dies*, day] Any biological activity repeated in cycles, each about twenty-four hours long, independently of any shifts in environmental conditions.

**circulatory system** Organ system that rapidly transports substances to and from cells; typically consists of a heart, blood vessels, and blood. Helps stabilize body temperature and pH in some animals.

**clade** [Gk. *klados*-, branch] All species that share a unique trait, being descended from an ancestral species in which the trait first evolved.

**cladogenesis** One speciation pattern. A lineage branches when one or more of its populations or subpopulations become reproductively isolated, and then genetic divergences result in new species.

**cladogram** Evolutionary tree diagram that depicts relative relatedness among groups. Each branch is monopyletic; it includes only an ancestral species in which a unique trait first evolved and all of its descendants.

**classification system** A way to organize and retrieve information about species.

**cleavage** Early stage of development in animals. Mitotic cell divisions cut up a fertilized egg into many smaller, nucleated cells (blastomeres); the original volume of egg cytoplasm does not increase.

**climate** Prevailing weather conditions of a region; e.g., temperature, cloud cover, wind speed, rainfall, and humidity.

**climax community** An array of species that develops by ecological succession. By a traditional model, it has stabilized under prevailing habitat conditions.

**cloaca** (kloe-AY-kuh) Last gut chamber or duct of some animals, roles in excretion, reproduction, and sometimes respiration.

**clone** A genetically identical copy of DNA, a cell, or a multicelled organism.

**cloning** A method used in recombinant DNA technology to make multiple copies of a DNA fragment. Also, manipulated reproductive interventions that bypass sexual reproduction; e.g., embryo cloning, adult cloning, and therapeutic cloning.

**cloning vector** Any DNA molecule that can accept foreign DNA and that can be replicated inside a host cell.

**club fungus** Fungus that produces sexual spores in a club-shaped cell, a basidium.

**cnidarian** (nye-DAR-ee-un) A type of radial invertebrate having epithelial tissues and a saclike gut. The only animal that makes nematocysts.

**coal** A nonrenewable energy source that formed more than 280 million years ago from submerged, undecayed, and slowly compacted plant remains.

**coccolithophore** A single-celled marine autotroph having calcium carbonate plates; one of the chrysophytes that are abundant in phytoplankton and the leading source of calcium deposits on the seafloor.

**coccus** A spherical prokaryotic cell.

**cochlea** [Gk. *kokliās*, snail] A fluid-filled, coiled structure in the inner ear; transduces sound waves into action potentials.

**codominance** A condition in which a pair of nonidentical alleles that influence two different phenotypes are expressed at the same time in heterozygotes.

**codon** A base triplet; a linear sequence of three nucleotides in an mRNA transcript; a code for an amino acid or a termination signal that gets translated during protein synthesis.

**coelom** (SEE-lum) Between the gut and body wall, a cavity lined with peritoneum.

**coenzyme** An organic molecule that is a necessary participant in some enzymatic reactions; helps catalysis by donating or accepting electrons or functional groups; e.g., a vitamin, ATP, NAD<sup>+</sup>.

**coevolution** The joint evolution of two species interacting so closely that a change in the structure, function, or behavior of one exerts selection pressure on the other over the generations.

**cofactor** A metal ion or a coenzyme that assists an enzyme in catalysis by accepting or donating electrons or functional groups.

**cohesion** A capacity to resist rupturing when placed under tension (stretched).

**cohesion-tension theory** Explanation of how water is transported from roots to leaves in plants. Water evaporation from leaves pulls water up in xylem by creating a continuous negative pressure (tension) that extends to roots.

**cohort** Group of individuals of the same age.

**coitus** Sexual intercourse.

**coleoptile** A thin tissue sheath that forms in embryo sporophytes of grasses; protects a primary shoot while growth is pushing it through soil after a seed germinates.

**collar cell** A sponge cell having a ring of food-trapping villi around a flagellum.

**collecting duct** A small tube into which as many as eight nephrons drain and that in turn drains into the renal pelvis.

**collenchyma** (coll-ENG-kih-mah) One of three simple plant tissues. Flexibly supports rapidly growing plant parts. Its elongated cells, alive at maturity, have a pectin-rich primary wall that is thickened where three or more collenchyma cells abut.

**colon** (CO-lun) Large intestine.

**commensalism** An ecological interaction in which one species benefits directly and one or more others are affected little, if at all.

**communication display** A social signal, often ritualized with intended changes in functions of common patterns.

**communication protein** A membrane protein that helps form an open channel between the cytoplasm of adjoining cells.

**communication signal** A social cue that is encoded in stimuli, such as the body's surface coloration or patterning, odors, sounds, and postures.

**community** All populations of all species in a habitat.

**community structure** The number of species and their relative abundances in a habitat, which shift over time.

**companion cell** Specialized parenchyma cell that helps load sugars into conducting cells of phloem.

**comparative morphology** [Gk. *morph*, form] Scientific study of comparable external body parts of embryonic stages and adult forms of major lineages.

**compartmentalization** In some plants, a defense response to attack, including secretion of sticky resins and toxins.

**competition, exploitative** An ecological interaction in which different species have equal access to a resource but one is better at exploiting it.

**competition, interference** An ecological interaction in which one species restricts or blocks access of another species to a resource regardless of its abundance.

**competition, interspecific** An ecological interaction in which the individuals of different species are competing for a share of resources.

**competition, intraspecific** An ecological interaction in which individuals of a population compete for resources.

**competitive exclusion** Theory that two or more species that require identical resources cannot coexist indefinitely.

**complement system** Set of proteins that circulate in inactive form in blood. Active kinds attract phagocytes and enhance their binding to antigen, promote inflammation, and induce lysis of pathogens during both innate and adaptive immune responses.

**complete digestive system** A tubular digestive system having a mouth at one end and an anus at the other.

**composite signal** A communication signal with more than one information-laden cue.

**compound** Molecule consisting of two or more elements in proportions that do not vary, as they can in mixtures.

**compound eye** Crustacean or insect eye having multiple rodlike units, each of which samples part of the visual field.

**concentration gradient** Difference in the number of molecules or ions of any one substance between two adjoining regions.

**condensation reaction** Type of chemical reaction in which two molecules become covalently bonded as a larger molecule; water often forms as a by-product.

**conduction, heat** Of two objects in contact with each other, an exchange of heat as a result of a thermal gradient between them.

**cone** Reproductive structure of certain seed-bearing plants; has clusters of scales with exposed ovules on their surface.

**cone cell** A vertebrate photoreceptor that responds to intense light and contributes to sharp daytime vision and color perception.

**conifer** A type of gymnosperm adapted to conserve water through droughts and cold winters. Cone-producing woody trees or shrubs with thickly cuticled needlelike or scalelike leaves.

**conjugation** Among prokaryotic species, a mode of gene transfer that is possible when one of the cells has an F plasmid. Also a sexual reproductive mode among some single-celled eukaryotes.

**connective tissue** Most abundant type of animal tissue. Soft connective tissues differ in the amounts and arrangements of fibroblasts, fibers, ground substance. Adipose tissue, cartilage, bone tissue, and blood are specialized types.

**conservation biology** An international field of inquiry. Biodiversity, as measured by species richness and abundances, is being surveyed and its evolutionary and ecological origins are being identified. Methods to maintain and use biodiversity for the benefit of the human population are being identified.

**conservation of mass, law of** The total mass of all substances entering a reaction equals the total mass of all products.

**consumer** Type of heterotroph that feeds on the tissues of other organisms as its source of carbon and energy.

**continuous variation** Of individuals of a population, a range of small differences in the phenotypic expression of a trait.

**contractile cell** A cell having cytoskeletal elements that help it contract (shorten) in response to stimulation and then lengthen (relax) and return to a resting position.

**contractile ring mechanism** Mechanism of cytoplasmic division of animal cells. Just beneath the plasma membrane, a thin band of contractile filaments around the cell midsection contracts and pinches the cytoplasm in two.

**contractile vacuole** [L. *contractus*, to draw together] Organelle in some single-celled eukaryotes that collects excess water in the cell body and then expels it.

**control group** In experimental tests, a group used as a standard for comparison against one or more experimental groups.

**convection** Air or water movement driven by a temperature gradient; also the transfer of heat by moving molecules.

**convergent evolution** In response to similar environmental pressures, evolutionarily distant lineages slowly evolve in similar ways and end up alike in some aspect of biochemistry, morphology, or behavior.

**coral reef** A formation of accumulated hard parts of corals and other organisms in warm, clear waters between latitudes 25° north and south.

**core temperature** The internal temperature of a large-bodied animal.

**cork** Tissue component of bark with many suberized layers; waterproofs, insulates, and protects woody stem and root surfaces.

**cork cambium** A lateral meristem, the descendants of which replace epidermis with cork on woody plant parts.

**cornea** Transparent, light-admitting part of the outer layer of a vertebrate eyeball.

**corpus luteum** (CORE-pus LOO-tee-um) A glandular structure that forms from cells of a ruptured follicle after ovulation; its progesterone and estrogen secretions help thicken the endometrium in preparation for a pregnancy.

**cortex** Generally, a rindlike layer. In cells, a mesh of cytoskeletal elements beneath the plasma membrane. In vascular plants, a ground tissue, mostly parenchyma, that supports parts and stores food.

**cortisol** A hormone that helps maintain the blood level of glucose between meals; its level rises when the body is stressed.

**cotyledon** (KOT-uhl-EE-dun) Seed leaf; part of a flowering plant embryo. In eudicots, two cotyledons absorb nutrients from endosperm, emerge aboveground as the seed germinates, and transfer nutrients that sustain early growth; photosynthetic before true leaves form. In most monocots, one small cotyledon helps transfer nutrients from endosperm to the embryo, but it remains underground when a seed germinates and is never photosynthetic.

**countercurrent exchange** In fish gills, the exchange of gases between blood flowing one way in blood vessels and water that is flowing over the vessels in the opposite direction. At membrane proteins of the ascending and descending limbs of the loop of Henle of a nephron, the pumping of specific solutes into and out of interstitial fluid in ways that alter its composition.

**countercurrent flow** Any movement of two fluids in opposing directions.

**courtship display** A pattern of ritualized social behavior between potential mates.

**covalent bond** (koe-VAY-lunt) [L. *con*, together, + *valere*, to be strong] A sharing

of one or more electrons between two atoms. In a polar covalent bond, the atoms share electrons unequally; in a nonpolar covalent bond, each atom gets an equal share of the electrons.

**craniate** A vertebrate that has its brain protected inside a cranium; all modern fishes, amphibians, reptiles, birds, and mammals are craniates.

**creatine phosphate** Organic compound that can transfer phosphate to ADP in a fast, short-term, ATP-generating pathway.

**CRH** Corticotropin-releasing hormone; a hypothalamic releaser that stimulates the secretion of ACTH from the adrenal gland.

**cross-bridge formation** In sarcomeres of muscle fibers, a reversible, ATP-driven interaction between an actin filament and myosin head that results in a short power stroke; the basis of muscle contraction.

**crossing over** At prophase I of meiosis, reciprocal exchange of segments between two nonsister chromatids of a pair of homologous chromosomes. Puts novel combinations of alleles in gametes.

**crust, Earth's** Outer zone of low-density rocks resting on Earth's mantle.

**crustacean** One of the abundant "insects of the seas," mostly marine arthropods having a hardened, flexible exoskeleton and pairs of jointed appendages.

**culture** Sum of behavior patterns of a social group, passed between generations by learning and symbolic behavior.

**cuticle** (KEW-tih-kull) Of plants, a cover of transparent waxes and cutin on the outer wall of epidermal cells. Of annelids, a thin, flexible coat. Of arthropods, a lightweight exoskeleton hardened with chitin.

**cutin** Lipid polymer synthesized by land plants and deposited in cell walls and on the outer surface of epidermal cells.

**cyanobacterium** A type of single-celled photoautotroph; the first to use a noncyclic pathway of photosynthesis, which slowly enriched the early atmosphere with oxygen.

**cycad** A gymnosperm of subtropical or tropical habitats; pollen-bearing and seed-bearing strobili on separate plants.

**cyclic AMP** (sik-lik) A nucleotide that is often a second messenger; relays a signal from outside through the cytoplasm.

**cyclic pathway of ATP formation** Oldest photosynthetic pathway. Photon energy forces electrons out of membrane-bound photosystems to transfer systems, which return them to the photosystems. Electron flow across the membrane sets up H<sup>+</sup> gradients that drive ATP formation.

**cyst** Of many microbes, a resting stage with a secreted cover. Also an abnormal, fluid-filled sac in skin with no opening.

**cytochrome** (SIGH-toe-krome) An iron-containing protein molecule of electron transfer systems.

**cytokinesis** (SIGH-toe-kih-NEE-sis) [Gk. *kinesis*, motion] Cytoplasmic division.

**cytokinin** (SIGH-toe-KYE-nin) A type of plant hormone; promotes cell division and leaf expansion, and retards leaf aging.

**cytoplasm** (SIGH-toe-plaz-um) All cell parts, particles, and semifluid substances between the plasma membrane and the nucleus or nucleoid.

**cytoplasmic division** Cytokinesis. After nuclear division, a splitting of the parent cell cytoplasm that completes formation of daughter cells.

**cytoplasmic localization** The accumulation of different kinds of proteins or RNAs in specific regions of the egg cytoplasm. These "maternal messages" are partitioned into different blastomeres at the cleavage stage of animal development.

**cytosine** (SIGH-toe-seen) One of the four nitrogen-containing bases in nucleotide monomers of DNA or RNA; also applies to a nucleotide that contains a cysteine base.

**cytoskeleton** In a eukaryotic cell, the dynamic framework of diverse protein filaments that structurally support, organize, and move the cell and internal structures. Prokaryotic cells have a few similar protein filaments.

**cytotoxic T cell** T lymphocyte that acts in adaptive immune responses; touch-kills infected or cancerous body cells.

**day-neutral plant** A plant that flowers when mature, independently of seasons.

**decomposer** [L. *dis-*, to pieces] One of the prokaryotic or fungal heterotrophs that obtains carbon and energy by breaking down wastes or remains of organisms. The collective action of decomposers helps cycle nutrients to producers in ecosystems.

**deforestation** Removal of all trees from a large tract of land.

**degradative pathway** Any of the stepwise series of metabolic reactions that break down organic compounds.

**deletion** Loss of a chromosome segment; often leads to genetic disorders. Also the loss of one or more nucleotide bases from a DNA molecule.

**demographics** The vital statistics of a population; e.g., size, age structure.

**demographic transition model** Model that correlates changes in population growth with stages of economic development; may no longer apply to developing countries, which now compete in a global market.



**denaturation** (deh-NAY-chur-AY-shun)

Disruption of hydrogen bonds and other interactions holding a molecule in its three-dimensional shape, which thereby changes. Increases in temperature, shifts in pH, and detergents can cause it.

**dendrite** (DEN-drite) [Gk. *dendron*, tree]

Short, slender extension from cell body of a neuron; commonly a signal input zone.

**dendritic cell** Phagocytic white blood cell; mainly presents antigen to naive T cells.

**denitrification** (DEE-nite-rih-fih-KAY-shun)

Conversion of nitrate or nitrite to gaseous nitrogen (N<sub>2</sub>) or nitrogen oxide (NO<sub>2</sub>) by metabolic activity of certain bacteria in soil.

**dense, irregular connective tissue** A type of animal tissue with fibroblasts and many fibers asymmetrically arrayed in a matrix. In skin and some capsules around organs.

**dense, regular connective tissue** A type of animal tissue with rows of fibroblasts between parallel bundles of fibers. In tendons, elastic ligaments.

**density-dependent control** Any factor that comes into play in an overcrowded population; reduces birth rate or raises death and dispersal rates, as by intensified predation, parasitism, disease, competition.

**density-independent factor** Any factor that causes fewer births or more deaths in a population regardless of its density; e.g., a severe storm or flood.

**dentition** (den-TIH-shun) The type, size, and number of an animal's teeth.

**deoxyribonucleic acid** See DNA.

**derived trait** A novel feature shared only by descendants of an ancestral species in which it originated.

**dermal tissue system** Tissues that cover and protect all exposed plant surfaces.

**dermis** Skin layer beneath the epidermis; mostly dense connective tissue.

**desalinization** Removal of salt from water.

**desert** Biome of areas where the potential for evaporation greatly exceeds rainfall, where soil is thin and vegetation sparse.

**desertification** (dez-urt-ih-fih-KAY-shun)

Conversion of grassland or irrigated or rain-fed cropland to desertlike conditions.

**detrital food web** (dih-TRY-tul) Cross-connecting food chains in which energy flows mainly from plants through arrays of detritivores and decomposers.

**detritivore** Any animal that feeds on decomposing particles of organic matter; e.g., a crab, earthworm, or roundworm.

**deuterostome** (DUE-ter-oh-stome) [Gk. *deuteros*, second, + *stoma*, mouth] A bilateral animal of a lineage characterized in part by

events of embryonic development, as when the second indentation to appear on the early embryo's surface becomes the mouth; e.g., an echinoderm or a chordate.

**development** Of complex multicelled species, a series of stages from formation of gametes, then fertilization, and on through embryonic and adult forms.

**diaphragm** [Gk. *diaphragma*, to partition] A muscular partition between the thoracic and abdominal cavities. Also a fertility control device inserted into the vagina to prevent sperm from entering uterus.

**diatom** A single-celled photoautotroph with a perforated silica shell, which has two overlapping parts that fit together like a pillbox; one of the chrysophytes.

**dicot** See eudicot.

**diffusion** Net movement of like ions or molecules from a region where they are most concentrated to an adjoining region where they are less concentrated; they move down their concentration gradient.

**digestive system** Body sac or tube, often having specialized regions where food is ingested, digested, and absorbed, and undigested residues expelled. Incomplete systems have one opening; the complete systems have two (mouth and anus).

**dihybrid experiment** Type of experiment that starts with a cross between two true-breeding, homozygous parents that differ in two traits governed by alleles of two genes. The actual experiment is a cross between two of their F<sub>1</sub> offspring that are identically heterozygous for alleles of the two genes; e.g., *AaBb* × *AaBb*.

**dimorphism** Persistence of two forms of the same trait in a population.

**dinoflagellate** One of the alveolates that deposits cellulose in alveoli, often as thick protective plates. Predators, parasites and photoautotrophs; some cause red tides.

**dinosaur** One of a group of reptiles that arose in the Triassic and became dominant land vertebrates for 125 million years.

**diploid chromosome number** (DIP-loyd) Of many sexually reproducing species, having two chromosomes of each type, or pairs of homologues, in somatic cells.

**diplomonad** A flagellated heterotroph with no mitochondria and three flagella at its anterior end and one at its trailing end. Belongs to one of earliest lineages of single-celled eukaryotes; e.g., *Giardia*.

**directional selection** Mode of natural selection by which forms at one end of a range of phenotypic variation are favored.

**disaccharide** (die-SAK-uh-ride) [Gk. *di*, two, + *sakcharon*, sugar] A carbohydrate composed of two sugar monomers.

**disease** Condition that arises when the body's defenses cannot overcome infection and activities of the pathogen or parasite interfere with normal body functions.

**disruptive selection** Mode of natural selection that favors different forms of a trait at both ends of a range of variation; intermediate forms are selected against.

**distal tubule** Tubular part of nephron where water and sodium reabsorption are adjusted by hormonal controls.

**distance effect** A major biogeographic pattern. Only species adapted for long-distance dispersal are potential colonists of islands far from their home range.

**diversity of life** Sum of all variations in form, function, and behavior in all lineages, from life's origin to the present.

**division of labor** Of multicelled species, a splitting up of tasks among different types of cells, tissues, and often organs, and organ systems, which collectively help the whole organism survive. Also a splitting up of tasks among different stages of the life cycle, as in insects.

**DNA** Deoxyribonucleic acid (dee-ox-ee-rye-bow-new-CLAY-ik). Double-stranded nucleic acid twisted into a helical shape; its base sequence encodes the primary hereditary information for all living organisms and many viruses.

**DNA chip** Microarray of thousands of gene sequences that represents a large subset of a genome; stamped onto a glass plate and used to study gene expression.

**DNA clone** Fragment of DNA inserted into a vector such as a plasmid and introduced into a host organism; used to make many copies of a particular segment of DNA.

**DNA fingerprinting** A way to distinguish one individual from all others based on unique differences in parts of their DNA; fragments cut from an individual's DNA (RFLPs) have a unique pattern of sizes.

**DNA ligase** (LYE-gaze) Type of enzyme that catalyzes the sealing of short stretches of DNA into a continuous strand during replication; also seals strand breaks.

**DNA polymerase** Type of enzyme that catalyzes the addition of free nucleotides to new DNA strands during replication; also proofreads and corrects mismatches.

**DNA proofreading mechanism** Any enzyme-mediated process that fixes DNA replication errors or strand breaks.

**DNA replication** Process by which a cell duplicates its DNA molecules before it divides into daughter cells.

**domain** Of protein structure, part or all of a polypeptide chain that is a structurally stable, functional unit. Of one classification system, the most inclusive taxon.

**dominance hierarchy** Social organization in which some individuals of the group have a subordinate status to others.

**dominant allele** Of diploid cells, an allele that masks the phenotypic effect of any recessive allele paired with it.

**dopamine** Neurotransmitter that affects fine motor control, pleasure-seeking behavior.

**dormancy** [L. *dormire*, to sleep] Of many spores, cysts, seeds, perennials, and some animals, a predictable time of metabolic inactivity during the life cycle.

**dosage compensation** A gene control mechanism in female mammals in which most genes on one of two X chromosomes in somatic cells are inactivated; ensures that X chromosome genes are expressed at the same levels as in males (XY).

**double-blind study** A study in which neither the subjects nor the experimenter know if any particular subject is in the experimental group or the control group; minimizes bias.

**double fertilization** Of flowering plants only, fusion of a sperm and egg nucleus, and the fusion of another sperm nucleus with nuclei of a cell that gives rise to the endosperm, a nutritive tissue in seeds.

**doubling time** The time it takes for a population to double in size.

**downwelling** Water forced down and away from a coast after winds shift and make a surface current pile into the coast.

**drug addiction** Dependence on a drug, which assumes an "essential" biochemical role following habituation and tolerance.

**dry acid deposition** Airborne oxides of sulfur, nitrogen fall during dry weather.

**dry shrubland** Biome of areas that get less than 25 to 60 centimeters of rain; short, multibranched woody shrubs dominate.

**dry woodland** Biome of areas that get about 40 to 100 centimeters of rain may have many tall trees but no dense canopy.

**duplication** Base sequence in DNA that has been repeated two or more times.

**ecdysone** Hormone of many insect life cycles; roles in metamorphosis, molting.

**echinoderm** One of the protostomes; a radial invertebrate with some bilateral features and calcified spines or plates on the body wall; e.g., sea stars.

**echolocation** Use of echoes from self-generated ultrasounds as a navigational mechanism, as by bats and dolphins.

**ecological succession** Traditional view that a community arises by species interactions and in time forms a stable array of species, a climax community. Primary succession

starts with pioneer species that colonize a barren habitat; secondary succession is the recovery of a disturbed climax community. *See* Intermediate disturbance hypothesis.

**ecology** [Gk. *oikos*, home, + *logos*, reason] Scientific study of how organisms interact with one another and the environment.

**ecoregion** Broad land or ocean province influenced by abiotic and biotic factors.

**ecosystem** Array of organisms, together with their environment, interacting by a flow of energy and cycling of materials.

**ecosystem modeling** Analytical method; computer programs and models predict effects of disturbances to an ecosystem.

**ectoderm** [Gk. *ecto*, outside, + *derma*, skin] First-formed, outer primary tissue layer of animal embryos; gives rise to nervous tissues and outer layer of the integument.

**ectotherm** An animal that can stay warm mainly by absorbing environmental heat, as from the sun's rays.

**Ediacaran** One of a diverse collection of tiny multicelled precambrian species having a highly flattened body, sometimes with many unspecialized segments.

**effector** Muscle (or gland); helps bring about movement (or chemical change) in response to neural or endocrine signals.

**effector cell** Antigen-sensitized B cell or T cell that carries out adaptive immunity.

**egg** Mature female gamete, or ovum.

**El Niño** Massive eastward flow of warm surface waters of the western equatorial Pacific that displaces cool water off South America. Recurs, disrupts global climates.

**electric gradient** A difference in electric charge between adjoining regions.

**electromagnetic spectrum** All wavelengths of photon energy from gamma rays less than  $10^{-5}$  nanometers long to radio waves more than 10 kilometers long.

**electron** Negatively charged subatomic particle. Electrons occupy orbitals around the atomic nucleus.

**electron transfer chain** Array of enzymes and other molecules in a cell membrane that accept and give up electrons in sequence; operation of chain releases the energy of the electrons in small, usable increments.

**electron transfer phosphorylation** Final stage of aerobic respiration; electron flow through electron transfer chains in inner mitochondrial membrane sets up  $H^+$  concentration and electric gradients that drives ATP formation. Oxygen accepts electrons at the end of the chain.

**element** Fundamental form of matter that cannot be degraded to a simpler form by ordinary means. All atoms of an element have the same atomic number.

**embryo** Of animals, a new individual that forms by cleavage, gastrulation, and other early stages of development. Of plants, a young sporophyte until germination.

**embryonic induction** A change in the composition, structure, or both of cells in an embryo by exposure to signals from cells of nearby tissues; basis of pattern formation.

**emergent property** With respect to life's levels of organization, a new property that emerges through interactions of entities at lower levels, none of which displays the property; e.g., living cells that emerge from "lifeless" molecules.

**emerging pathogen** A newly mutated or opportunistic strain of a deadly pathogen.

**emigration** Permanent move of one or more individuals out of a population.

**emulsification** In the gut, the coating of fat droplets with bile salts so that fats remain suspended in chyme.

**encapsulated receptor** A type of skin mechanoreceptor that detects pressure, temperature, and low vibrations.

**endangered species** A species endemic (native) to a habitat, found nowhere else, and highly vulnerable to extinction.

**endergonic reaction** (en-dur-GONE-ik) A chemical reaction that requires a net energy input and converts more stable reactants into less stable products; not spontaneous.

**endocrine gland** A ductless gland that secretes hormone molecules, which typically travel in blood to target cells.

**endocrine system** Control system of cells, tissues, and organs that interacts intimately with the nervous system; secretes hormones and other signaling molecules.

**endocytosis** (EN-doe-sigh-TOE-sis) Cell uptake of substances by forming vesicles from patches of plasma membrane. Three modes are receptor-mediated endocytosis, phagocytosis, and the bulk transport of extracellular fluid.

**endoderm** Inner primary tissue layer of animal embryos; source of the inner gut lining and organs derived from it.

**endodermis** Cylindrical, sheetlike cell layer around the root vascular cylinder; helps control water and solute uptake.

**endomembrane system** Endoplasmic reticulum, Golgi bodies, and transport vesicles concerned with modification of many new proteins, lipid assembly, and their transport within the cytoplasm or to the plasma membrane for export.

**endometrium** [Gk. *metrios*, of the womb] Inner lining of the uterus.

**endophytic fungus** A fungal symbiont in leaves and stems of most plants. Helpful, neutral, or sometimes harmful effects.

**endoplasmic reticulum** ER. Organelle that extends from the nuclear envelope through cytoplasm. Ribosomes coat the cytoplasmic side of rough ER, which modifies many new polypeptide chains in its lumen. Membrane lipids are assembled, fatty acids are broken down, and some toxins are inactivated in the lumen of smooth ER.

**endorphin** One of the neuromodulators that is a natural painkiller.

**endoskeleton** Of chordates, an internal framework consisting of cartilage, bone, or both; works with skeletal muscle to position, support, and move the body.

**endosperm** Nutritive tissue in the seeds of flowering plants only.

**endospore** Of certain bacteria, a resting structure enclosing a bit of cytoplasm and the DNA; resists heat, irradiation, drying, acids, disinfectants, and boiling water. It germinates when conditions favor growth and a bacterium emerges from it.

**endosymbiosis** [*Endo-*, within + *symbiosis*, living together] An intimate, permanent ecological interaction in which one species lives and reproduces in the other's body to the benefit of one or both.

**endotherm** An animal that can stay warm mainly by metabolically generated heat.

**energy** A capacity to do work.

**energy carrier** A molecule that delivers chemical energy from one reaction site to another; mainly ATP.

**energy pyramid** Diagram that depicts the energy stored in the tissues of organisms at each trophic level in an ecosystem. Lowest tier of the pyramid, consisting of primary producers, is always the largest.

**enhancer** A small sequence in DNA that binds transcription-regulating molecules; enhances transcription rates.

**enkephalin** A neuromodulator that is a natural painkiller.

**ENSO** El Niño Southern Oscillation. A recurring seesaw of atmospheric pressure in the western equatorial Pacific that has global repercussions on climates.

**entropy** Measure of how much and how far a concentrated form of energy has been dispersed after an energy change.

**enzyme** A type of protein that catalyzes (speeds) a chemical reaction. Some RNAs also show catalytic activity.

**eosinophil** A white blood cell that, during inflammatory responses, secretes enzymes and toxins that target extracellular parasites too large for phagocytosis.

**epidemic** Rapid spread, then subsidence, of a disease within a population.

**epidermis** Outermost tissue layer of plants and nearly all animals.

**epiglottis** Flaplike structure between the pharynx and larynx; controlled positional changes direct air into the trachea or food into the esophagus.

**epinephrine** (ep-ih-NEF-rin) A signaling molecule of the adrenal medulla that acts as a hormone or neurotransmitter on different targets; affects metabolism, heart function; works with norepinephrine in the fight-flight response. Also known as adrenaline.

**epistasis** (eh-PISS-tah-sis) An interaction among products of two or more gene pairs that influence the same trait.

**epitheliomuscular cell** Of structurally simple invertebrates, an epithelial cell with elongated extensions that contain parallel arrays of contractile filaments. Muscle fibers evolved from such cells.

**epithelium** (EP-ih-THEE-lee-um) Animal tissue covering external and internal body surfaces. A key innovation that favored larger, more complex bodies; cells started interacting as functional units.

**EPSP** Excitatory postsynaptic potential. Graded potential that drives an excitable cell's membrane toward threshold.

**equilibrium model of island biogeography** A model describing the number of species expected to inhabit a habitat island of a particular size and distance from colonists.

**ER** See endoplasmic reticulum.

**erosion, soil** Wearing away of land surface by wind, running water, and ice.

**erythropoietin** Kidney hormone; induces stem cells in bone marrow to give rise to red blood cells.

**esophagus** (ee-SOF-uh-gus) A muscular tube between the pharynx and stomach.

**essential amino acid** Any amino acid that an organism cannot synthesize for itself and must obtain from food.

**essential fatty acid** Any fatty acid that an organism cannot synthesize for itself and must obtain from food.

**estrogen** A female sex hormone. It helps oocytes mature and prime the endometrium for pregnancy; affects growth, development, and female secondary sexual traits.

**estuary** Partly enclosed coastal region where seawater mixes with fresh water and runoff from land, as in rivers.

**ethylene** Plant hormone; promotes fruit ripening and leaf, flower, fruit abscission.

**eudicot** (YOO-dih-kot) Flowering plant characterized by having embryos with two cotyledons; net-veined leaves; and floral parts in fours, fives, or multiples of these.

**euglenoid** A single eukaryotic cell with a crystalline rod reinforcing a thick flagellum. Different kinds are colorless heterotrophs or photoautotrophs of aquatic habitats.

**Eukarya** Domain of eukaryotic species; all "protists," plants, fungi, and animals.

**eukaryotic cell** Type of cell that starts life with a nucleus and other membrane-bound organelles.

**eutherian** Placental mammal.

**eutrophication** Nutrient enrichment of a body of water that promotes population growth of phytoplankton and opacity.

**evaporation** Process of conversion of a liquid to a gas; requires energy input.

**evolution, biological** [*L. evolutio*, an unrolling] Genetic change in a line of descent by microevolutionary events (gene mutation, natural selection, genetic drift, and gene flow); basis of large-scale patterns, rates, and trends in the history of life.

**evolutionary tree** A treelike diagram in which each branch point represents a divergence from a shared ancestor; each branch is a separate line of descent.

**excretion** Removal of excess water and solutes by urinary system or glands.

**exercise** Increased contractile activity.

**exergonic reaction** (EX-ur-GONE-ik) Any chemical reaction with a net energy loss.

**exocrine gland** Glandular structure that secretes products, usually through ducts or tubes, to a free epithelial surface.

**exocytosis** Fusion of a cytoplasmic vesicle with the plasma membrane; as it becomes part of the membrane, its contents are released to extracellular fluid.

**exodermis** Cylindrical sheet of cells close to root epidermis of most flowering plants; helps control uptake of water and solutes.

**exon** A base sequence in eukaryotic DNA that is part or all of a protein-encoding gene; may or may not be excised from a pre-mRNA during transcript processing.

**exoskeleton** [*Gk. sklēros*, hard, stiff] An external skeleton; e.g., a hardened cuticle.

**exotic species** Species that has become established in a new community after dispersing from its home range.

**experiment, scientific** A test that simplifies observation in nature or the laboratory by manipulating and controlling conditions under which observations are made.

**experimental group** A group of objects or individuals that display or are exposed to the variable under investigation. Test results for this group are compared against the results for a control group.

**exponential growth** (EX-PO-NEN-shul) Any quantity that is growing at a rate proportional to its size. For populations, it plots out as a J-shaped curve.

**external ear** The sound-collecting flap of cartilage-reinforced skin of many ears.

**extinction** Irrevocable loss of a species.

**extracellular digestion, absorption** Mode of nutrition; the organism grows in or on organic matter, digests it with secreted enzymes, and absorbs digested bits.

**extracellular fluid** All fluid not in cells; e.g., blood's plasma and interstitial fluid.

**extracellular matrix** Secretions and other deposits on or between cells of a tissue.

**extreme halophile** Bacterium or archaean adapted to an extremely salty habitat.

**extreme thermophile** Bacterium or archaean adapted to a hot aquatic habitat; e.g., a hot spring or hydrothermal vent.

**eye** Sensory organ that incorporates a dense array of photoreceptors.

**F<sub>1</sub>, F<sub>2</sub>** The first and second generation offspring of experimental crosses.

**FAD** Flavin adenine dinucleotide. A type of nucleotide coenzyme; transfers electrons and H<sup>+</sup> from one reaction site to another.

**fall overturn** Vertical mixing of a body of water in fall. Its upper oxygenated layer cools, gets dense, and sinks; nutrient-rich water from the bottom moves up.

**fat** Type of lipid with one, two, or three fatty acid tails attached to a glycerol head.

**fate map** Surface diagram of certain early embryos (e.g., *Drosophila*) showing where differentiated cells of the adult originate.

**fatty acid** Organic compound having a carboxyl group and a backbone of as many as thirty-six carbon atoms; saturated types have single bonds only; unsaturated types include one or more double covalent bonds.

**feather** Of birds, lightweight structures used in flight, as body insulation, and often in courtship displays.

**feedback inhibition** Mechanism by which a change that results from some cellular activity triggers responses that decrease or shut down the activity.

**fermentation** See alcoholic fermentation, lactate fermentation.

**fern** A seedless vascular plant having fronds that often are divided in leaflets.

**fertilization** Fusion of a sperm nucleus and an egg nucleus, the result being a single-celled zygote.

**fetus** In mammalian development, the stage after all major organ systems have formed until time of birth.

**fever** An internally induced rise in core body temperature above a set point in the hypothalamic temperature control center.

**fibrous, irregular connective tissue** One of the soft connective tissues; its matrix is

packed with fibroblasts and collagen fibers oriented in all directions.

**fibrous, regular connective tissue** One of the soft connective tissues, with orderly rows of fibroblasts in between parallel, tightly packed bundles of fibers.

**fibrous root system** Lateral branchings of adventitious roots arising from a new stem.

**Fick's law** The rate at which a gas will diffuse across a respiratory surface is proportional to its partial pressure and the surface area.

**filter feeder** Animal that filters food from a current of water that flows through pores or slits of some body structure.

**filtration** See Glomerular filtration and Ultrafiltration.

**fin** An appendage that helps stabilize, orient, and propel most fishes in water.

**first law of thermodynamics** Energy cannot be created or destroyed.

**fish** An aquatic animal of the oldest and most diverse vertebrate lineage; a jawless, jawed cartilaginous, or jawed bony fish.

**fitness** The degree of adaptation to the environment, as measured by the relative genetic contribution to future generations.

**fixation** Of a population, the loss of all alleles but one at a gene locus; all individuals have become homozygous for the allele.

**fixed action pattern** Instinctual program of coordinated, stereotyped movements that runs its course independently of any feedback from environment.

**flagellum, plural flagella** Of many eukaryotic cells, a long, whip-like motile structure with an inner 9+2 array of microtubules. Prokaryotic flagella do not have this array and are not whiplike; they rotate like a propeller.

**flatworm** One of the simplest existing animals with organ systems that form from three primary tissue layers.

**flavoprotein** A plant pigment that absorbs blue light and can induce phototropism.

**flower** A reproductive structure of fertile parts (stamens, carpels) nonfertile parts (sepals, petals), and a receptacle (modified base of floral shoot).

**flowering plant** A magnoliid, eudicot, or monocot. The most successful group of plants; most coevolved with pollinators.

**fluid mosaic model** A cell membrane has a mixed composition (mosaic) of lipids and proteins, the interactions and motions of which impart fluidity to it.

**fluorescence** Light that may become visible after a molecule has absorbed a photon, then emits another photon of lower energy.

**folate** Water-soluble B vitamin especially essential for embryonic development.

**follicle** (FOLL-ih-kul) Small sac, pit, or cavity, as around a hair; a mammalian oocyte with its surrounding layer of cells.

**food chain** Linear sequence of steps by which energy stored in autotroph tissues enters higher trophic levels.

**food pyramid** Chart of a purportedly well-balanced diet; continually updated.

**food web** Cross-connecting food chains consisting of producers, consumers, and decomposers, detritivores, or both.

**foramen magnum** Opening in the skull where the spinal cord and brain connect. Its position relative to the skull's base helps researchers determine whether a fossilized animal was bipedal or a tetrapod.

**foraminiferan** Single-celled, predatory eukaryote with a richly perforated shell through which thin pseudopods project.

**forebrain** Part of vertebrate brain that includes the cerebrum, olfactory lobes, and hypothalamus.

**forest** A community in which tall trees grow close enough together to form a fairly continuous canopy.

**fossil** Recognizable, physical evidence of an organism that lived in the distant past.

**fossil fuel** Coal, petroleum, or natural gas; nonrenewable energy source that formed long ago from remains of swamp forests.

**fossilization** How fossils form over time. An organism or evidence of it gets buried in sediments or volcanic ash; water slowly infiltrates the remains, and metal ions and other inorganic compounds dissolved in it replace the minerals in bones and other hardened tissues.

**founder effect** A form of bottlenecking. By chance, a few individuals that establish a new population differ in allele frequencies relative to the original population.

**free nerve ending** One of the simplest sensory receptors in skin, internal tissues; unmyelinated or thinly myelinated.

**free radical** Any unbound molecular fragment with an unpaired electron.

**fruit** [L. after *frui*, to enjoy] Mature ovary, often with accessory parts, from a flower.

**fruiting body** Spore-bearing structures formed by some bacteria, fungi.

**FSH** Follicle-stimulating hormone of the anterior lobe of pituitary gland; has reproductive roles in both sexes.

**functional group** An atom or a group of atoms with characteristic properties that is covalently bonded to the carbon backbone of an organic compound.

**functional-group transfer** One molecule donates a functional group to another.

**Fungi** Kingdom of fungi.

**fungus**, plural **fungi** Type of eukaryotic heterotroph that obtains nutrients by extracellular digestion and absorption; fungi are notable for being prolific spore producers and major decomposers.

**GABA** Gamma amino butyric acid. A neuromodulator that blocks neurotransmitter release by other neurons in the brain.

**gallbladder** Organ that stores bile from the liver; its duct connects to the small intestine.

**gamete** (GAM-eet) Haploid cell formed by meiotic cell division of a reproductive cell; required for sexual reproduction.

**gamete formation** Formation of cells used in sexual reproduction; e.g., sperm or eggs.

**gametophyte** (gam-EET-oh-fite) [Gk. *phyton*, plant] A haploid multicelled body in which haploid gametes form during the life cycle of plants and some algae.

**ganglion** (GANG-lee-on), plural **ganglia** Distinct cluster of cell bodies of neurons.

**gap junction** Cylindrical arrays of proteins in the plasma membrane of adjoining cells; they pair up as open channels for rapid flows of ions and small molecules.

**gastric fluid** Extremely acidic mixture of secretions from the stomach lining.

**gastrodermis** Glandular epithelium that lines the gut of many invertebrates.

**gastrula** Early animal embryo with two or three primary tissue layers (germ layers).

**gastrulation** (gas-tru-LAY-shun) Stage of animal development; the reorganization of embryonic cells that formed by cleavage into two or three primary tissue layers.

**gel electrophoresis** Method of separating DNA molecules according to length, or protein molecules according to size and charge. The molecules move apart while migrating through a gel matrix in response to a weak electric current.

**gene** Unit of heritable information in DNA, transmissible from parents to offspring.

**gene control** A molecular mechanism that governs if, when, or how a specific gene is transcribed or translated.

**gene expression** Conversion of heritable information in a gene into a product; e.g., from DNA to mRNA to a structural or functional protein.

**gene flow** Microevolutionary process; alleles enter and leave a population by immigration and emigration. Counters mutation, natural selection, and genetic drift, hence reproductive isolation.

**gene library** Collection of host cells that contain different cloned DNA fragments representing all or most of a genome.

**gene locus** A gene's location along the length of a chromosome.

**gene mutation** Small-scale change in the nucleotide sequence of a gene; can result in an altered protein product.

**gene pair** Two alleles at the same locus on a pair of homologous chromosomes.

**gene pool** All genotypes in a population; a pool of genetic resources.

**gene therapy** Generally, a transfer of one or more normal genes into an organism to correct or minimize a genetic disorder.

**genetic abnormality** A less common or rare version of a heritable trait.

**genetic code** Correspondence between triplets of nucleotides in DNA and mRNA, and specific sequences of amino acids in a polypeptide chain; near-universal language of protein synthesis; mitochondria and a few species have a few variant code words.

**genetic disorder** An inherited condition causing mild to severe medical problems.

**genetic divergence** An accumulation of differences in the gene pools of two or more populations or subpopulations of a species after gene flow stops entirely; mutation, natural selection, and genetic drift operate independently in each one.

**genetic drift** Change in allele frequencies over generations due to chance alone. Most pronounced effects in small populations.

**genetic engineering** Manipulation of an organism's DNA, usually to alter at least one aspect of phenotype.

**genetic equilibrium** In theory, a state in which a population is not evolving with respect to a specified gene locus. *Compare* Hardy-Weinberg rule.

**genetic recombination** Outcome of any process that puts new genetic information in a DNA molecule; e.g., by crossing over.

**genome** All DNA in a haploid number of chromosomes for a species.

**genomics** The study of genes and gene function in humans and other organisms.

**genotype** (JEEN-oh-type) Genetic makeup of an individual; a single gene pair or the sum total of an individual's genes.

**genus**, plural **genera** (JEEN-US, JEN-er-ah) [L. *genus*, race or origin] A grouping of species more closely related to one another in morphology, ecology, and history than to others at the same taxonomic level.

**geographic dispersal** A movement of individuals out of their home range and their integration in a new community.

**geologic time scale** Time scale for Earth's history; major subdivisions correspond to mass extinctions. Dates are now absolute as a result of radiometrically dating.

**germ cell** Animal cell set aside for sexual reproduction; gives rise to gametes.

**germination** (jur-mih-NAY-shun) Of a seed or a spore, the resumption of growth after dormancy, dispersal, or both.

**ghrelin** Hormone secreted from cells of the stomach lining that stimulates an appetite control center.

**gibberellin** (JIB-er-ELL-un) Plant hormone; induces stem elongation, helps seeds break dormancy, role in flowering in some species.

**gill** Respiratory organ with a thin, moist, vascularized layer for gas exchange.

**gill slit** One of the openings in a thin-walled pharynx that functions in food-trapping, respiration, or both.

**ginkgo** A deciduous gymnosperm; its ancestors were diverse in dinosaur times.

**gland** A saclike, secretory organ that opens onto a free epithelial surface. Hormone-secreting endocrine glands have ducts; exocrine glands are ductless.

**gland cell** A cell that secretes products unrelated to its own metabolism.

**global broiling hypothesis** An asteroid impact caused the K-T mass extinction, the debris from which raised the global air temperature by thousands of degrees.

**global warming** Long-term increase in temperature of Earth's lower atmosphere.

**glomerular capillary** (glow-MARE-you-lar) [L. *glomus*, ball] A set of blood capillaries in Bowman's capsule of nephron.

**glomerular filtration** First step in urine formation, when blood pressure forces water out of glomerular capillaries.

**glomerulus** Bowman's capsule and the glomerular capillaries that it cups around.

**glottis** Opening between the vocal cords.

**glucagon** Pancreatic hormone; stimulates conversion of glycogen and amino acids to glucose when blood glucose levels fall.

**glyceride** (GLISS-er-ide) Molecule of one, two, or three fatty acid tails attached to a glycerol backbone; one of the fats or oils.

**glycerol** Three-carbon compound having three hydroxyl groups; in fats and oils.

**glycocalyx** Sticky meshlike capsule or slime layer around a prokaryotic cell wall.

**glycogen** (GLY-kuh-jen) Highly branched polysaccharide of glucose monomers; the main storage carbohydrate in animals.

**glycolysis** Breakdown of glucose or another organic compound to two pyruvates. First

stage of aerobic respiration, fermentation, or anaerobic electron transfer. Oxygen has no role in glycolysis, which takes place in the cytoplasm of all cells. Two NADH form. Net yield: 2 ATP per glucose molecule.

**glycoprotein** Protein with linear or branched oligosaccharides covalently bonded to it.

**gnetophyte** A type of woody, vinelike or shrubby gymnosperm.

**GnRH** Gonadotropin-releasing hormone, induces the anterior pituitary to release LH and FSH.

**golden alga** A chrysophyte with silica scales or other hard parts and fucoxanthin.

**Golgi body** Organelle of endomembrane system; its enzymes modify many new polypeptide chains, assemble lipids, and package both inside vesicles for secretion or for use inside cell.

**gonad** (GO-nad) Primary reproductive organ in animals; produces gametes.

**Gondwana** Paleozoic supercontinent that later became part of Pangea.

**graded potential** Of excitable cells, a change in the resting membrane potential at an input zone; can vary in magnitude.

**gradual model, speciation** Addresses the rate of speciation and cites fossil evidence that morphological changes accumulate slowly over great time spans.

**Gram-positives** Informal name for mostly chemoheterotrophic bacteria that have a multilayered wall; not a monophyletic group.

**Gram stain** Microbiology diagnostic tool. Cells are exposed to purple dye, iodine, an alcohol wash, and then counterstain. Cell walls of Gram-positive species stay purple; Gram-negative species turn pink.

**granum, plural grana** Of chloroplasts, one portion of the thylakoid membrane in the shape of a stack of flattened disks.

**grassland** Biome in flat or rolling interiors of continents with warm summers, 25–100 centimeters of rain, and recurring natural fires that regenerate the dominant plants.

**gravitropism** (GRAV-ih-TROPE-izm) Growth in a direction influenced by gravity.

**gray crescent** Of amphibian eggs, partially pigmented region of cell cortex; establishes the embryo's anterior–posterior axis.

**gray matter** Areas of neuron cell bodies, dendrites, and unmyelinated axons, plus neuroglia, in the brain and spinal cord.

**grazing food web** Cross-connecting food chains in which energy flows from plants to an array of herbivores, then carnivores.

**green alga** See charophyte; chlorophyte.

**green revolution** Use of improved crop strains and modern equipment to increase crop yields in the developing countries.

**greenhouse effect** Trapping of heat near Earth's surface by the action of atmospheric gases. The gases absorb infrared wavelengths (heat) from the sun-warmed surface, and then radiate some wavelengths downward.

**ground tissue system** Parenchyma and other tissues; the bulk of a plant body.

**groundwater** Water in soil and aquifers.

**growth** Of multicelled species, increases in the number, size, and volume of cells. Of single-celled prokaryotes, increases in the number of cells of a population.

**growth factor** A protein that stimulates increases in size; e.g., by inducing mitosis.

**growth ring** One of the alternating bands of early and late wood; a "tree ring."

**growth, tissue specialization** Stage of animal development; new organs enlarge and assume specialized functions. This stage continues into adulthood.

**guanine** One of four nitrogen-containing bases in nucleotide monomers of DNA or RNA; also may refer to a nucleotide that contains a guanine base.

**guard cell** One of two cells that define a stoma across leaf or stem epidermis.

**gut** A sac or tube in which food is digested. Also the gastrointestinal tract from the stomach onward.

**gymnosperm** (JIM-noe-sperm) [Gk. *gymnos*, naked, + *sperma*, seed] A vascular plant that forms seeds on exposed surfaces of spore-producing structures; e.g., conifers, cycads.

**habitat** [L. *habitare*, to live in] The place where an organism or species normally lives, characterized by its physical and chemical features and its array of species.

**habitat fragmentation** The break-up of a habitat into patches too small to support successful breeding; may make species more vulnerable to losses.

**habitat island** An area of endemic species that is surrounded by a "sea" of habitats unsuitable for sustaining the species; e.g., a lake surrounded by a forest.

**habitat loss** Reduction in suitable living space and closure of part of a habitat as an outcome of chemical pollution.

**hair** A flexible structure rooted in skin, with a shaft above the skin's surface.

**hair cell** Hairlike mechanoreceptor; it is activated when sufficiently bent or tilted.

**half-life** The unvarying time it takes for half of a quantity of any radioisotope to decay into a more stable form.

**haploid chromosome number** The sum of all chromosomes in cells with one of each type of chromosome characteristic of the species; e.g., in a gamete.

**hardwood** Strong, dense wood with many vessels, tracheids, and fibers in xylem.

**Hardy–Weinberg rule** Theoretical baseline for tracking changes in allele frequencies over the generations. Frequencies do not change as long as there is no mutation, the population is infinitely large and isolated from other populations, and all individuals are reproducing equally and randomly.

**HCG** Human chorionic gonadotropin; secreted by blastocyst; helps maintain the endometrium until placenta secretes it, about eleven weeks later.

**HDL** A high-density lipoprotein in blood; it transports dietary cholesterol to the liver, which metabolizes it.

**hearing** Perception of sound.

**heart** Muscular pump; its contractions circulate blood through the animal body.

**heartwood** Dense, dry tissue at the core of aging tree stems and roots; helps trees defy gravity and store metabolic wastes.

**heat** A transfer of thermal energy.

**HeLa cell** Cancer cell of a lineage used in research laboratories around the world.

**helicase** Type of enzyme that catalyzes breaking of hydrogen bonds during DNA replication so the two strands of double helix can unwind from each other.

**helper T cell** CD4 lymphocyte. Central to adaptive immunity; induces responsive T and B cells to form antigen-sensitive armies.

**heme** Oxygen-transporting cofactor of many enzymes and pigments; one iron atom at the center of an organic ring structure.

**hemoglobin** (HEEM-oh-glow-bin) [Gk. *haima*, blood, + L. *globus*, ball] A heme-containing protein produced by red blood cells; carries most of the oxygen in blood.

**hemostasis** (HEE-mow-STAY-sis) [Gk. *stasis*, standing] Process that stops blood loss from a damaged blood vessel by coagulation, spasm, and other mechanisms.

**herbicide** Natural or synthetic toxin that can kill or inhibit growth of target plants.

**herbivore** [L. *herba*, grass, + *vovare*, to devour] Plant-eating animal.

**hermaphrodite** (her-MAH-froe-dyte) An individual with male and female gonads.

**heterocyst** (HET-er-oh-sist) Self-modified cyanobacterial cell; synthesizes nitrogen-fixing enzyme when nitrogen is scarce.

**heterotherm** An animal that maintains its core temperature by controlling metabolic activity some of the time and allowing it to rise or fall at other times.

**heterotroph** (HET-er-oh-trofe) [Gk. *heteros*, other, + *trophos*, feeder] Organism that cannot make its own food; feeds on other organisms, their wastes, or their remains.

**heterozygous condition** (HET-er-oh-ZYE-guss) [Gk. *zygoun*, join together] Having nonidentical alleles at a given gene locus on a pair of homologous chromosomes.

**higher taxon**, plural **taxa** One of ever more inclusive groupings of species; e.g., family, order, class, phylum, kingdom.

**hindbrain** Medulla oblongata, cerebellum, and pons. Its reflex centers are vital for respiration and other basic functions, and for coordinating motor responses.

**histamine** Local signaling molecule that stimulates inflammation; makes arterioles vasodilate and capillaries more permeable.

**histone** Type of structural protein that helps organize and condense eukaryotic chromosomes and control access to genes during interphase.

**HLA** Human leukocyte antigens. See MHC.

**homeostasis** (HOE-me-oh-STAY-sis) [Gk. *homo*, same, + *stasis*, standing] State in which physical and chemical aspects of internal environment (blood, interstitial fluid) are being maintained within ranges that are tolerable for cell activities.

**homeotic gene** One of a class of master genes; helps determine identity of body parts during embryonic development.

**hominid** [L. *homo*, man] All humanlike and human species.

**hominoid** Apes, humans, and their most recent ancestors.

**homologous chromosome** (huh-MOLL-uh-gus) [Gk. *homologia*, correspondence] One of a pair of chromosomes in body cells of diploid organisms; except for a pairing of nonidentical sex chromosomes, a pair has the same size, shape, and gene sequence.

**homozygous dominant condition** Having a pair of dominant alleles at a gene locus on homologous chromosomes; e.g., AA.

**homozygous recessive condition** Having a pair of recessive alleles at a gene locus on homologous chromosomes; e.g., Aa.

**hormone** [Gk. *hormon*, stir up] Signaling molecule secreted by one cell that can alter activities of any cell with receptors for it.

**hornwort** Bryophyte having a horn-shaped sporophyte attached to a flat gametophyte.

**horsetail** Seedless vascular plant having rhizomes, scale-like leaves, and hollow stems with silica-reinforced ribs.

**host, of parasite** Living organism in or on which a parasite must complete its life cycle. A definitive host harbors the mature stage. Intermediate hosts harbor immature stages.

**host, of symbiont** The larger, stronger, or more dominant partner of two symbionts.

**hot spot** A region where human activities are driving many species to extinction. Also

a region where superplumes have ruptured the crust; e.g., at the Hawaiian Archipelago.

**human** Primate of species *Homo sapiens*.

**human gene therapy** The transfer of one or more normal or modified genes into a person to correct a genetic defect, or to boost resistance to a disease.

**humus** Variably thick layer of organic matter that is decomposing in soil.

**hybrid** Individual having a nonidentical pair of alleles for a trait being studied.

**hydrocarbon** Organic compound with only hydrogen bonded to its carbon backbone.

**hydrogen bond** A weak attraction that has formed between a covalently bonded hydrogen atom and an electronegative atom taking part in another covalent bond.

**hydrogen ion** Free (or unbound) proton; one hydrogen atom that lost its electron and now bears a positive charge (H<sup>+</sup>).

**hydrologic cycle** Biogeochemical cycle driven by solar energy; water moves through atmosphere, on or through land, to the ocean, and back to the atmosphere.

**hydrolysis** (high-DRAWL-ih-sis) [L. *hydro*, water, + Gk. *lysis*, loosening] A cleavage reaction; an enzyme splits a molecule, then the components of water (—OH and —H) are attached to the fragments.

**hydrophilic substance** [Gk. *philos*, loving] A polar molecule that dissolves easily in water; e.g., glucose.

**hydrophobic substance** [Gk. *phobos*, dreading] A nonpolar molecule that resists dissolving in water; e.g., oil.

**hydrostatic pressure** Pressure exerted by a volume of fluid against a cell wall, membrane, or some other structure that contains it; also called turgor pressure.

**hydrostatic skeleton** A fluid-filled cavity against which a contractile force can act.

**hydrothermal vent** A steaming fissure on the ocean floor; has unique ecosystems.

**hypertonic solution** Of two fluids, the one with the higher solute concentration.

**hypha** (HIGH-fuh), plural **hyphae** Fungal filament having chitin-reinforced walls; component of a mycelium.

**hypothalamus** [Gk. *hypo*, under, + *thalamos*, inner chamber] Forebrain region; a center of homeostatic control of internal environment (e.g., salt–water balance, core temperature); influences hunger, thirst, sex, other viscera-related behaviors, and emotions.

**hypothesis, scientific** An explanation of a phenomenon, one that has the potential to be proven false by experimental tests.

**hypotonic solution** Of two fluids, the one with the lower solute concentration.

**imbibition** Water molecules move into a seed, attracted by hydrophilic groups of proteins; assists in germination.

**immigration** One or more individuals move and take up residence in another population of its species.

**immune system** White blood cells and signaling molecules of vertebrate adaptive immunity; they recognize self and nonself and have the potential to target a billion specific antigens, with lasting effect.

**immunity** The body's ability to resist and combat infections.

**immunization** A process that promotes immunity from disease; e.g., vaccination.

**immunoglobulin** One of five classes of antibodies, each with antigen-binding and class-specific structural components.

**implantation** A process in pregnancy; a blastocyst burrows into the endometrium; it establishes connections by which the embryo that forms from its inner cell mass will exchange substances with the mother.

**imprinting** A form of learning triggered by exposure to sign stimuli; time-dependent, often in a young animal's sensitive period.

**in vitro fertilization** Conception outside the body, "in glass" petri dishes or tubes.

**inbreeding** Nonrandom mating among very close relatives that share many identical alleles; may fix harmful alleles.

**inclusive fitness theory** Idea that genes associated with caring for relatives may be favored in some situations.

**incomplete digestive system** Saclike gut in which both food intake and waste output occur through a single opening.

**incomplete dominance** Condition in which one allele of a pair is not fully dominant; the heterozygous phenotype is somewhere between both homozygous phenotypes.

**independent assortment** An outcome of random alignments at metaphase I of meiosis. Each homologous chromosome and its partner—and the genes they carry—are assorted into different gametes independently of the other pairs. Crossing over can affect the outcome.

**indicator species** Any species which, by its abundance or scarcity, is a measure of the health or degradation of its habitat.

**induced-fit model** Explanation of how some enzymes work; their shape changes and fits a bound substrate more closely, and the tension destabilizes substrate bonds so that they can break.

**infection** Invasion and multiplication of a pathogen or parasite in a host. Disease follows if defenses are not mobilized fast enough against the tissue disruptions.

**inflammation, acute** Rapid, nonspecific response to tissue invasion or injury. White blood cells release the cytokines that attract phagocytes and cause local vasodilation. Signs include redness, heat, swelling, pain.

**inheritance** Transmission, from parents to offspring, of genes that underlie the traits characteristic of their species.

**inhibin** Hormone that inhibits secretion of GnRH and FSH from the hypothalamus and pituitary gland.

**inhibiting hormone** Signaling molecule from the hypothalamus that suppresses release of an anterior pituitary hormone.

**inhibitor** Any substance that binds to a molecule and interferes with its function.

**innate immunity** Immediate, off-the-shelf set of responses to tissue invasion that rid the body of most pathogens. Recognition of a fixed set of conserved pathogen-associated molecular patterns triggers phagocytosis, inflammation, and complement activation.

**inner ear** Of vertebrates, the primary organ of equilibrium and hearing; includes a vestibular apparatus and cochlea.

**insertion** A mutation by which one or more bases are introduced into a DNA strand. Also a movable attachment of muscle to bone.

**instinctive behavior** Behavior performed without having first been learned through actual experience in the environment.

**insulin** Pancreatic hormone. Its actions lower the blood level of glucose.

**integrator** A control center that receives, processes, and stores sensory input, and coordinates the responses; e.g., a brain.

**integument** Of animals, a protective body covering; e.g., skin. Of seed-bearing plants, one of the layers around an ovule that mature into a seed coat.

**integumentary exchange** Of some animals, gas exchange across thin, moistened skin or some other external body surface.

**interleukin** A type of cytokine; a signaling molecule of cells of immune system.

**intermediate** A substance formed between the start and end of a metabolic pathway.

**intermediate disturbance hypothesis** An explanation of community structure; holds that species richness is greatest in between disturbances that are moderate in intensity, frequency, or both.

**intermediate filament** Cytoskeletal element that mechanically strengthens some cells.

**internal environment** The body fluid *not* inside cells, or extracellular fluid; in most animals, blood and interstitial fluid.

**interneuron** Any of the diverse neurons of the brain or spinal cord.

**internode** Plant stem between two nodes.

**interphase** In a eukaryotic cell cycle, the interval between mitotic divisions when a cell grows in mass, roughly doubles the number of its cytoplasmic components, and replicates its DNA.

**interstitial fluid** (IN-ter-STISH-ul) All fluid in spaces between cells of all tissues except the connective tissue called blood.

**intertidal zone** Between low and high water marks of a rocky or sandy shore.

**intervertebral disk** In between vertebrae, a cartilaginous flex point and shock absorber.

**intron** One of the noncoding sequences in eukaryotic genes; it is excised from the pre-mRNA transcripts before translation.

**inversion** A chromosomal alteration; part of the DNA sequence gets oriented in the reverse direction, with no molecular loss.

**invertebrate** Animal without a backbone.

**ion** Atom having an unequal number of protons and electrons; it carries a positive or negative electric charge.

**ion exchange** pH-dependent process; ions dissociate from soil particles, then other ions dissolved in soil water replace them.

**ionic bond** Ions interacting through the attraction of their opposite charges.

**ionizing radiation** Form of radiation with enough energy to eject electrons from atoms.

**IPSP** An inhibitory postsynaptic potential; a type of graded potential at an input zone of an excitable cell that drives its membrane away from threshold.

**isotonic solution** Any fluid having the same solute concentration as another fluid to which it is being compared.

**isotope** One of two or more atoms of the same element (same number of protons) that differ in their number of neutrons.

**jaw** Paired, hinged cartilaginous or bony feeding structures of most chordates. Many invertebrates have hinged feeding structures but not of bone or cartilage.

**joint** Area of contact between bones.

**J-shaped curve** Diagrammatic curve that emerges as unrestricted exponential growth of a population is plotted against time.

**juvenile** Post-embryonic stage of certain animals; it changes in size and proportion before adulthood, with no metamorphosis.

**karyotype** Preparation of an individual's metaphase chromosomes arranged by length, centromere location, and shape.

**keratinocyte** Skin cell that makes keratin, a tough, water-insoluble protein.

**key innovation** A chance modification in some body structure or function that gives a species the opportunity to exploit the environment more efficiently or in a novel way; e.g., modifications of the forelimbs of amniotes into diverse legs and wings during radiations into adaptive zones.

**keystone species** A species that influences community structure in disproportionately large ways relative to its abundance.

**kidney** One of a pair of vertebrate organs that filter ions and other substances from blood; it controls the amounts returned to help maintain the internal environment.

**kilocalorie** 1,000 calories of heat energy; amount needed to raise the temperature of 1 kilogram of water by 1°C. Standard unit of measure for food's caloric content.

**kinase** Type of enzyme that transfers a phosphate-group to an organic molecule.

**kinetic energy** Energy of motion.

**kinetochore** A mass of protein and DNA in the centromere to which microtubules of the spindle attach.

**kinetoplastid** A colorless flagellate; the only eukaryote with mitochondrial DNA massed inside a mitochondrion almost as long as the cell; e.g., *Trypanosoma*.

**knockout experiment** An experiment in which a living organism is engineered so that one of its genes does not function.

**Krebs cycle** The second stage of aerobic respiration in which many coenzymes form as pyruvate from glycolysis is fully broken down to CO<sub>2</sub> and H<sub>2</sub>O. Two ATP also form. Occurs only in mitochondria.

**K-T asteroid impact theory** A massive asteroid struck Earth 65 million years ago and caused a mass extinction; casualties included the last of the dinosaurs.

**K-T boundary** The boundary between the Cretaceous and Tertiary periods.

**La Niña** Cooler climatic event between ENSOs; disrupts global climates.

**labor** Time of childbirth.

**lactate fermentation** One of the anaerobic pathways of ATP formation. NADH from glycolysis donates hydrogen and electrons to pyruvate, converting it to three-carbon lactate, and regenerating NAD<sup>+</sup>. The net energy yield is 2 ATP (from glycolysis).

**lactation** Milk production and secretion by hormone-primed mammary glands.

**lake** A body of standing fresh water in a basin characterized by light penetration, temperature gradients, and other features.

**Langerhans cell** Antigen-presenting cell in skin; engulfs viruses and bacteria.



**large intestine** Colon. The bacteria-rich region of the vertebrate gut that absorbs water and mineral ions and also compacts undigested food residues for elimination.

**larva**, plural **larvae** An immature stage between the embryo and adult in the life cycle of many animals.

**larynx** (LARE-inks) Tubular airway leading to lungs; has vocal cords in some animals.

**lateral bud** Axillary bud. A dormant shoot that forms in a leaf axil.

**lateral meristem** Vascular cambium or cork cambium. A sheetlike cylinder of meristem inside older stems and roots.

**lateral root** Outward branching from the first (primary) root of a taproot system.

**LDL** Low-density lipoprotein; transports cholesterol; excess amounts in blood may contribute to atherosclerosis.

**leaching** Removal of some nutrients from soil as water percolates through it.

**leaf** Chlorophyll-rich plant organ of sunlight interception and photosynthesis.

**learned behavior** Enduring modification of a behavior as an outcome of experience in the environment.

**lek** A communal courtship display ground.

**lens** Of camera eyes, a transparent body that bends light rays so they all converge suitably onto photoreceptors of a retina.

**leptin** An appetite-suppressing hormone produced mainly by adipose tissue.

**lethal mutation** Mutation having drastic effects on phenotype; usually causes death.

**Leydig cell** Testosterone-secreting cell in mammalian testes.

**LH** Luteinizing hormone. An anterior pituitary hormone; roles in reproductive function of male and female mammals.

**lichen** (LY-kun) Mutualism between a fungus and one or more photoautotrophs.

**life cycle** A series of stages through which an individual passes from the time it forms by way of a mode of sexual or asexual reproduction until its own reproduction. Among complex species, the individual typically ages and dies at some time after it has reproduced.

**life history pattern** Of many species, the pattern of when and how many offspring are produced during a typical lifetime.

**ligament** A strap of dense connective tissue that bridges a skeletal joint.

**light-dependent reactions** First stage of photosynthesis. Pigments trap photon energy, which is transduced to ATP chemical energy. In a noncyclic pathway, a reduced coenzyme, NADPH, also forms.

**light-independent reactions** Second stage of photosynthesis. Involves carbon fixation and cyclic reactions that form sugars and regenerate an organic compound that is the cycle's entry point. ATP from the first stage delivers energy that drives the reactions. NADPH from the first stage donates electrons and hydrogen building blocks. The carbon and nitrogen come from CO<sub>2</sub>.

**lignin** Gluelike polymer deposited in secondary cell walls; makes some plant parts stronger, more waterproof, and less vulnerable to attacks.

**limbic system** Centers in cerebrum that govern emotions; roles in memory.

**limiting factor** Any essential resource that limits population growth when scarce.

**lineage** (LIN-ee-edge) Line of descent.

**linkage group** All genes on a chromosome.

**lipid** One of the nonpolar hydrocarbons; e.g., a fat, oil, wax, sterol, phospholipid, or glycolipid. Cells use as storage forms of energy and building blocks.

**lipid bilayer** Structural basis of all cell membranes; mainly phospholipids arranged tail-to-tail in two layers, with hydrophilic heads of one dissolved in cytoplasmic fluid and heads of the other in extracellular fluid.

**lipoprotein** A protein complexed with cholesterol, triglycerides, or phospholipids that were absorbed from the small intestine.

**liver** A large gland that stores, converts, and helps maintain blood levels of organic compounds; also inactivates most hormone molecules after signaling ends as well as compounds that are toxic at high levels.

**liverwort** One of the bryophytes.

**loam** Soil best for plant growth; roughly the same proportions of sand, silt, clay.

**lobe-finned fish** Only bony fish having ventral fins with fleshy extensions and internal skeletal elements.

**local signaling molecule** One of many cell secretions into extracellular fluid. All have potent effects but are inactivated so fast that the signal is confined to local tissues; e.g., prostaglandins.

**logistic growth** (low-JISS-tik) Population growth pattern. A low-density population slowly increases in size, enters a phase of rapid growth, then levels off in size once the carrying capacity has been reached.

**long-day plant** A plant that flowers in spring, when nights are shorter (and days longer) than some critical value.

**loop of Henle** Hairpin-shaped, tubular part of a nephron where water and solutes are reabsorbed from interstitial fluid.

**loose connective tissue** Animal tissue with fibers and fibroblasts loosely arrayed in a semifluid matrix of cell secretions.

**lung** One of a pair of internal sac-shaped respiratory surfaces that originated in oxygen-poor aquatic habitats. Exclusive organs of respiration in birds, reptiles, and mammals; supplements respiration in some fishes and most amphibians.

**lungfish** A type of bony fish having both gills and one or two lung-like outpouchings of the gut wall that assist in respiration.

**lycophyte** A type of seedless vascular plant, typically with true leaves, roots, and stems; e.g., a club moss.

**lymph** Interstitial fluid that has entered vessels of the lymphatic system.

**lymph node** Lymphoid organ that is a key site for immune responses, as executed by its organized arrays of lymphocytes.

**lymph vascular system** The portion of the lymphatic system that takes up and conducts excess tissue fluid, absorbed fats, and reclaimable solutes to blood.

**lymphatic system** Organ system with vessels that return excess interstitial fluid and reclaimable solutes to blood and with lymphoid organs that function in defense.

**lymphocyte** A class of white blood cells. *See* B lymphocyte, T lymphocyte, NK cell.

**lysis** Gross damage to a cell wall, plasma membrane, or both that lets cytoplasm leak out; causes cell death.

**lysogenic pathway** A latent period that extends many viral replication cycles. Viral genes are integrated into host chromosome and may remain inactivated through many host cell divisions before being replicated.

**lysosome** Vesicle filled with enzymes that functions in intracellular digestion.

**lysozyme** Infection-fighting enzyme in mucous membranes; e.g., of mouth.

**lytic pathway** A rapid viral replication pathway that ends with lysis of host cell.

**macroevolution** Large-scale patterns, rates of change, and trends among lineages.

**macrophage** Phagocytic white blood cell; in vertebrates, it takes part in nonspecific defenses and adaptive immunity.

**magnoliid** One of three major flowering plant groups; e.g., magnolias, avocados.

**malpighian tubule** One of many small tubes that help insects on land dispose of toxic wastes without losing body water.

**mammal** Only amniote that makes hair and nourishes offspring with milk from the female's mammary glands.

**mangrove wetland** Tidal flat community at tropical latitudes; rich in nutrients.

**mantle** Of mollusks, a tissue draped over the visceral mass. Of Earth, a rocky zone of intermediate density under the crust.

**marine snow** Organic matter drifting down from ultraplankton to mid-oceanic water; supports food webs and marine biodiversity only now being explored.

**marsupial** Pouched mammal.

**mass extinction** Catastrophic event or phase in geologic time when families or other major groups are lost.

**mass number** Sum of protons and neutrons in the nucleus of an element's atoms.

**mast cell** White blood cell in connective tissue; secretes most of the cytokines during an innate immune response.

**master gene** One of the genes encoding products that map out the body plan in developing embryos. Gene products form gradients by diffusing from a source tissue. Cells along the gradient differentiate in ways that give rise to tissues and organs in expected places.

**mechanoreceptor** Sensory cell that detects mechanical energy (a change in pressure, position, or acceleration).

**medulla oblongata** Hindbrain region. Its reflex centers control respiration and other basic tasks; coordinate motor responses with complex reflexes; e.g., coughing.

**medusa** (meh-DOO-sah) [Gk. *Medousa*, one of three sisters in Greek mythology with snake-entwined hair] Of cnidarian life cycles, a free-swimming, bell-shaped stage, often with oral lobes and tentacles.

**megaspore** Haploid meiotic spore in ovary of seed-bearing plants; gives rise to a female gametophyte with egg cell.

**meiosis** (my-OH-sis) [Gk. *meioun*, to diminish] A nuclear division process that halves the parental chromosome number, to a haploid ( $n$ ) number. Prerequisite to the formation of gametes and sexual spores.

**melanin** A brownish-black pigment.

**melanocyte** A skin cell that produces and releases melanin to keratinocytes.

**memory** A capacity to store and retrieve information about sensory experiences.

**memory cell** A sensitized B or T cell that forms in a primary immune response but is reserved for recurrence of the same antigen.

**menstrual cycle** Recurring cycle in adult human females and some other primates. A secondary oocyte is released from an ovary and the uterine lining is primed for pregnancy, all under hormonal control.

**meristem** [Gk. *meristos*, divisible] One of the localized zones where dividing cells gives rise to differentiated cell lineages that form all mature plant tissues.

**mesoderm** (MEH-zoe-derm) Primary tissue layers gives rise to many internal organs and part of the integument; pivotal in the evolution of large, complex animals.

**mesoglea** Of cnidarians, a gelatinous matrix with scattered cells between the epidermis and gastrodermis; functions as a buoyant, deformable skeleton.

**mesophyll** (MEH-zoe-fill) Photosynthetic parenchyma with many air spaces.

**Mesozoic** Era of spectacular expansion in the range of global diversity; lasted from 240 million to 65 million years ago.

**messenger RNA** mRNA. A single strand of ribonucleotides transcribed from DNA; the only type of RNA that carries protein-building information to ribosomes.

**metabolic pathway** A stepwise sequence of enzyme-mediated reactions.

**metabolism** (meh-TAB-oh-lizm) All the controlled, enzyme-mediated chemical reactions by which cells acquire and use energy as they synthesize, store, degrade, and eliminate substances.

**metamorphosis** (me-tuh-MOR-foe-sis) [Gk. *meta*, change, + *morphe*, form] Major changes in body form of certain animals. Hormonally controlled growth, tissue reorganization, and remodeling of body parts leads to adult form.

**metaphase** Of meiosis I, stage when all pairs of homologues are positioned at the equator of a bipolar spindle. Of mitosis or meiosis II, the stage when all duplicated chromosomes are positioned at the equator.

**metastasis** Abnormal migration of cancer cells that break away from home tissues and may start colonies in other tissues.

**methanogen** Any bacterium or archaean that produces methane gas as by-product of anaerobic reactions.

**methylation** Attachment of a methyl group to an organic compound; also a common gene control mechanism.

**MHC molecule** Also called HLA. Type of proteins at the surface of body cells that T cells recognize as self-markers. Sounds the immune alarm when it becomes complexed with antigen fragments.

**micelle formation** The combining of bile salts with fatty acids into tiny droplets.

**microevolution** Of a population, a small-scale change in allele frequencies resulting from mutation, genetic drift, gene flow, natural selection, or a combination of them.

**microfilament** The thinnest cytoskeletal element; consists of actin subunits that function in cell contraction, movement, and structural support.

**micrograph** Photograph of an image formed with the aid of a microscope.

**microorganism** Microbe. Any organism, usually single celled, that is too small to be observed without a microscope.

**microspore** Type of walled haploid spore of gymnosperms and angiosperms that gives rise to pollen grains.

**microsporidian** Intracellular fungal parasite of aquatic habitats that forms flagellated spores; belongs to one of the most ancient eukaryotic lineages.

**microtubular spindle** See Bipolar spindle.

**microtubule** Largest cytoskeletal element; a filament of tubulin subunits. Contributes to cell shape, growth, and motion.

**microtubule organizing center** MTOC. Of eukaryotic cells, a mass of cytoplasmic substances, the number, type, and location of which dictate how microtubules will be organized and oriented in a given type of cell; e.g., a centrosome.

**microvillus** (MY-crow-VILL-us) [L. *villus*, shaggy hair] Slender extension from free surface of certain cells; arrays of many microvilli greatly increase the absorptive or secretory surface area of a cell.

**midbrain** A vertebrate brain region with centers for coordinating reflex responses to visual and auditory input; also relays signals to forebrain.

**middle ear** The eardrum and ear bones that transmit air waves to the inner ear.

**migration** Of many animals, a recurring pattern of movement between two or more regions in response to seasonal change or other environmental rhythms.

**millipede** An arthropod with a great many unspecialized segments and paired legs; scavenges decaying plant material.

**mimicry** (MIM-ik-ree) A case of one species (the mimic) closely resembling another (its model) in form, behavior, or both.

**mineral** Element or inorganic compound required for normal cell functioning.

**mitochondrion** (MY-toe-KON-dree-on) Double-membraned organelle of ATP formation; only site of the second and third stages of aerobic respiration.

**mitosis** (my-TOE-sis) [Gk. *mitos*, thread] Type of nuclear division that maintains the parental chromosome number. The basis of growth in size, tissue repair, and often asexual reproduction for eukaryotes.

**mixture** Two or more types of molecules intermingled in proportions that can and usually do vary.

**model** Theoretical explanation of any object or event that has not been or cannot be directly observed.

**molar** Tooth with cusps that crush, grind, and shear food; one of the cheek teeth.

**molecular clock** Model used to calculate the time of origin of one lineage relative to others; assumes that a group of genes accumulates mutations at a constant rate, measurable as a series of predictable ticks back through time. The last tick stops close to the time the lineage originated.

**molecule** Two or more covalently bonded atoms of the same or different elements.

**mollusk** Only invertebrate with a mantle draped over a soft, fleshy visceral mass; most have an external or internal shell; e.g., gastropods, bivalves, cephalopods.

**molting** Periodic shedding of worn-out or too-small body structures. Permits an animal to grow in size or renew parts.

**monocot** (MON-oh-kot) Monocotyledon; flowering plant characterized by embryo sporophytes having one cotyledon; floral parts usually in threes (or multiples of three); and often parallel-veined leaves.

**monohybrid experiment** An experiment that starts with a cross between two true-breeding, homozygous parents that differ in a trait governed by alleles of one gene. The experiment is a cross between two F<sub>1</sub> offspring that are identically heterozygous for the two genes; e.g., *Aa* × *Aa*.

**monomer** Any small molecule that is a repeating subunit in a polymer; e.g., the sugar monomers of starch.

**monophyletic group** A set of species that share a derived trait, a novel feature that evolved in one species and is present only in its descendants; all of the evolutionary branchings from a single stem.

**monosaccharide** [Gk. *monos*, alone, single, + *sakcharon*, sugar] A simple sugar.

**monotreme** Egg-laying mammal.

**monsoon** Air circulation pattern; moves moisture-laden air above warm oceans to continents north or south of them.

**morphogen** An inducer molecule. Diffuses through embryonic tissues; the resulting gradient sequentially activates master genes.

**morphogenesis** (MORE-foe-JEN-ih-sis) [Gk. *morphe*, form, + *genesis*, origin] Orderly, genetically programmed changes in size, proportion, and shape of body parts of an animal embryo through which specialized tissues and organs form.

**morphological convergence** A pattern of macroevolution. In response to similar environmental pressures, body parts of evolutionarily distant lineages slowly evolve in similar ways and end up being alike in function, appearance, or both.

**morphological divergence** Pattern of macroevolution. One or more body parts of genetically diverging lineages undergo structural and functional changes from the parts in the common ancestor.

**mosaic tissue effect** In female mammals, an outcome of random X chromosome inactivation; different patches of tissue are expressing different X-linked alleles.

**mosaicism** Two or more genetically distinct cell lineages in an individual.

**moss** Most common kind of bryophyte.

**motor neuron** Neuron that relays signals from the brain or spinal cord to muscle cells or gland cells.

**motor protein** A type of accessory protein that interacts with microfilaments or with microtubules to move cell structures or the whole cell; e.g., myosin.

**motor unit** One motor neuron and all muscle cells that form junctions with its axon endings.

**multicelled organism** Organism that consists of many cells that, at the least, have formed layers; most have many differentiated cells that have formed true tissues, organs, and organ systems.

**multiple allele system** Three or more slightly different molecular forms of a gene that persists among the individuals of a population.

**multiregional model** Idea that modern humans evolved from *Homo erectus* groups that spread through much of the world by about 1 million years ago and evolved into regionally distinctive "races."

**muscle fatigue** Decline in muscle tension when tetanic contraction is continuous.

**muscle fiber** A group of muscle cells in parallel array. Each large, multinucleated fiber of skeletal and cardiac muscles formed when a group of undifferentiated muscle cells fused during embryonic development. Smooth muscle fibers are shorter, and each cell has retained its own nucleus.

**muscle spindle** A sensory organ that detects muscle stretching; its input zones are enclosed in a sheath that runs parallel with the muscle.

**muscle tension** Mechanical force exerted by a contracting muscle; resists opposing forces; e.g., weight of an object being lifted.

**muscle tissue** Tissue with muscle fibers arranged in parallel to bring about the directional contraction of a body part.

**muscle twitch** A sequence of muscle contraction and relaxation in response to a brief stimulus.

**mushroom** Aboveground reproductive structure produced by many club fungi.

**mutation** [L. *mutatus*, a change, + *-ion*, act, result, or process] Heritable change in DNA's molecular structure. Original source of new alleles and life's diversity.

**mutation rate** Of a given gene locus, the probability that a spontaneous mutation will happen in a specified interval.

**mutualism** [L. *mutuus*, reciprocal] A type of symbiotic interaction that benefits both participants.

**mycelium** (my-SEE-lee-um), plural **mycelia** [Gk. *mykes*, fungus] Underground mesh of tiny, branching filaments (hyphae); the food-absorbing portion of most fungi.

**mycorrhiza** (MY-coe-RIZE-uh) "Fungus-root." A form of mutualism between a fungus and young plant roots. Hyphae withdraw some carbohydrates from the plant, which withdraws some absorbed mineral ions from hyphae.

**myelin sheath** Lipid-rich wrappings of oligodendrocytes around axons of many sensory and motor neurons; enhances long-distance propagation of action potentials.

**myofibril** (MY-oh-FY-brill) One of many long, thin structures divided into contractile units that run parallel with the long axis of a muscle fiber.

**myoglobin** A pigment that is structurally similar to a hemoglobin chain but stores oxygen; abundant in some muscle fibers.

**myosin** (MY-uh-sin) An ATP-energized motor protein that moves cell components on cytoskeletal tracks. Interacts with actin in sarcomeres to bring about contraction.

**NAD<sup>+</sup>** Nicotinamide adenine dinucleotide. A nucleotide coenzyme; after it accepts electrons and H<sup>+</sup>, abbreviated as NADH.

**NADP<sup>+</sup>** Nicotinamide adenine dinucleotide phosphate. A phosphorylated nucleotide coenzyme; after it accepts electrons and H<sup>+</sup>, abbreviated NADPH<sub>2</sub>.

**nannoplankton** Coccolithophores and other marine photoautotrophs from five to fifty micrometers across.

**natural selection** Microevolutionary process; the outcome of differences in survival and reproduction among individuals of a population that differ in the details of their heritable traits.

**necrosis** (neh-CROW-sis) Passive death of many cells after severe tissue damage.

**nectar** Dilute, sucrose-rich fluid secreted from a nectary that connects to phloem; attracts pollinators.

**negative control** Control mechanism by which one or more regulatory proteins slow down a cell activity.

**negative feedback mechanism** A main homeostatic mechanism by which some activity changes conditions in a cell or multicelled organism and thereby triggers a response that reverses the change.

**nematocyst** (NEM-at-uh-sist) [Gk. *nema*, thread + *kystis*, pouch] A fluid-filled, jack-in-the-box capsule housed in one of three types of sensory-effector cells in cnidarians. It has a mechanoreceptor projecting above the cell surface and a dischargeable, tubular thread, often with barbs or toxin-drenched. Only cnidarians make nematocysts.

**neoplasm** Mass of cells (tumor) that lost control over the cell cycle.

**nephridium**, plural **nephridia** Of some invertebrates, one of many water-regulating units that help control the composition and volume of tissue fluid.

**nephron** (NEFF-ron) [Gk. *nephros*, kidney] One of millions of tubules in kidneys; it filters water and solutes from blood, then reabsorbs adjusted amounts of both.

**nerve** A sheathed, cordlike communication line that holds bundled fibers of sensory neurons, motor neurons, or both.

**nerve cell** A neuron.

**nerve cord** Of bilateral animals, a line of communication, usually paired, that runs parallel with the anterior-posterior axis. In large or long invertebrates, it often has one or more large axons. In chordates, it develops as a hollow, neural tube that gives rise to the spinal cord and brain.

**nerve net** Nervous system of cnidarians and some other invertebrate groups; an asymmetrical mesh of sensory and motor neurons that controls simple movements. It activates epitheliomuscular cells arrayed as sheets or rings in the body wall.

**nervous system** Organ system of neurons and, in many animals, neuroglia. Detects, distributes, processes, and issues signals for responses to sensory information; also stores information in complex species.

**nervous tissue** Tissue consisting of neurons and often neuroglia.

**net ecosystem production** All the energy the primary producers have accumulated during growth, reproduction in a specified interval (net primary production), *minus* energy that producers, and decomposers, have used.

**neural tube** Embryonic and evolutionary forerunner of the brain and spinal cord.

**neuroglia** (NUR-oh-GLEE-uh) Collectively, cells that structurally and metabolically support neurons; about half the volume of nervous tissue in vertebrates.

**neuromodulator** Any signaling molecule that reduces or magnifies the influence of a neurotransmitter on target cells.

**neuromuscular junction** A chemical synapse between a motor neuron's axon endings and a muscle fiber.

**neuron** (NUR-on) A nerve cell; the basic communication unit in nervous systems.

**neurotransmitter** Any of a diverse class of signaling molecules that are secreted by neurons. It acts in a synaptic cleft, then is rapidly degraded or recycled.

**neutral mutation** A mutation with no effect on phenotype; natural selection thus cannot change its frequency in a population.

**neutron** Type of subatomic particle in the nucleus of all atoms except hydrogen; has mass but no charge.

**neutrophil** Abundant circulating white blood cell; mainly phagocytic in innate immunity; its enzymes kill extracellular microbes and stimulate inflammation.

**niche** (NITCH) [L. *nidas*, nest] Sum total of all activities and relationships in which individuals of a species engage as they secure and use the resources required to survive and reproduce.

**nitrification** (nye-trih-fih-KAY-shun) One stage of the nitrogen cycle. Soil bacteria break down ammonia or ammonium to nitrite, then other bacteria break down nitrite to nitrate, which plants can absorb.

**nitrogen cycle** An atmospheric cycle. Nitrogen moves from its largest reservoir (atmosphere), then through the ocean, ocean sediments, soils, and food webs, then back to the atmosphere.

**nitrogen fixation** One stage of the nitrogen cycle process. Bacteria convert gaseous nitrogen to ammonia, which dissolves in their cytoplasm to form ammonium for use in biosynthesis.

**NK cell** Natural killer cell. One of the cytotoxic lymphocytes of innate and adaptive immunity; touch-kills tumor cells and virus-infected cells.

**node** A location along the length of a stem where one or more leaves form.

**noncyclic pathway of ATP formation** (non-sik-lik) [L. *non*, not, + Gk. *kyllos*, circle] The light-dependent reactions of photosynthesis that produce both ATP and NADPH; its oxygen by-product is the basis of Earth's oxygen-rich atmosphere.

**nondisjunction** Failure of sister chromatids or homologous chromosomes to move apart in meiosis or mitosis. Daughter cells get too many or too few chromosomes.

**nonionizing radiation** Form of radiation that carries enough energy to boost electrons to higher energy levels but not enough to eject them from an atom.

**nonshivering heat production** Increase in metabolically generated heat in response to prolonged or severe cold exposure.

**norepinephrine** (NOR-epih-NEF-rin) A stress hormone released from the adrenal medulla and released as a neurotransmitter from sympathetic neurons and the brain. Affects metabolic rates, heart function; acts with epinephrine in the fight-flight response.

**notochord** (KNOW-toe-kord) A rod of stiffened tissue, neither cartilage nor bone, that develops in chordate embryos and that may or may not persist as a supporting structure for the adult body.

**nuclear envelope** A double membrane that is the outer boundary of the nucleus.

**nucleic acid** Single-stranded or double-stranded molecule of nucleotides joined at phosphate groups; e.g., DNA, RNA.

**nucleic acid hybridization** Any base-pairing between DNA or RNA strands from different sources.

**nucleoid** (NEW-KLEE-oid) The portion of a prokaryotic cell where DNA is physically organized but not enclosed in a membrane.

**nucleolus** (new-KLEE-oh-lus) [L. *nucleolus*, tiny kernel] In an interphase nucleus, a mass of material from which RNA and proteins are assembled into the subunits of ribosomes.

**nucleosome** Small stretch of eukaryotic DNA wound twice around a spool of proteins called histones.

**nucleotide** Small organic compound with a five-carbon sugar, a nitrogen-containing base, and a phosphate group. Functions as coenzymes or monomers of nucleic acids.

**nucleus** Large organelle with an outer envelope of two pore-ridden lipid bilayers that separates eukaryotic chromosomes from the cytoplasm.

**numerical taxonomy** In microbiology, a method of classifying an unidentified microbe by comparing it with a known group on the basis of shape, wall staining attributes, and other observable traits; the more traits shared, the closer is the inferred relatedness.

**nutrient** Any element having a direct or indirect role in metabolism that no other element can fulfill.

**nutrition** Collectively, processes by which an organism takes in, digests, absorbs, and converts food into organic compounds.

**nymph** Immature, post-embryonic stage of some insect life cycles.

**obesity** Having an excessive amount of fat in adipose tissue; caloric intake has exceeded the body's energy output.

**ocean** A continuous body of water that covers more than 71 percent of Earth; its currents distribute nutrients in marine ecosystems and affect regional climates.

**olfactory receptor** Chemoreceptor for a water-soluble or volatile substance.

**oligosaccharide** (oh-LIG-oh-SAC-uh-rid) Short-chain carbohydrate of two or more covalently bonded sugar monomers; e.g., sucrose and other disaccharides.

**omnivore** [L. *omnis*, all, + *vovare*, to devour] A type of animal that eats other organisms at more than one trophic level.

**oncogene** (ON-koe-jeen) A gene which, when mutated or expressed at abnormal levels, is associated with cancer.

**oocyte** A type of immature egg.

**oomycote** "Egg fungus." Heterotrophic stramenopile, once wrongly grouped with fungi. Many are pathogens of plants; e.g., water molds, downy mildews.

**operator** Part of an operon; a DNA binding site for a regulatory protein.

**operon** Group of bacterial genes together with a promoter-operator DNA sequence that controls their transcription.

**organ** Body structure with definite form and function made of more than one tissue.

**organ formation** Developmental stage in which primary tissue layers give rise to differentiated cell lineages, the descendants of which form all organs of the adult.

**organ system** A set of organs that are interacting chemically, physically, or both in a common task.

**organelle** One of the membrane-bound compartments that carry out specialized metabolic functions in eukaryotic cells; e.g., a nucleus, mitochondria.

**organic compound** Any carbon-based molecule that also incorporates atoms of hydrogen and, often, oxygen, nitrogen, and other elements; e.g., fats, proteins.

**osmoreceptor** Type of sensory receptor that detects shifts in water volume.

**osmosis** Diffusion of water across a selectively permeable membrane from a region where the water concentration is higher to a region where it is lower.

**osmotic pressure** The amount of pressure which, when applied to a hypertonic fluid, will stop osmosis from occurring across a semipermeable membrane.

**osteoblast** Bone-forming cell; it secretes organic substances that get mineralized.

**osteoclast** Bone-digesting cell; it secretes enzymes that digest bone's organic matrix, which releases calcium and phosphorus for uptake by blood when metabolism requires more of these ions.

**osteocyte** A mature bone cell, imprisoned in its own secretions.

**ostracoderm** An early craniate; a filter-feeding bottom-dwelling jawless fish that became extinct after jawed fishes evolved.

**ovary** (OH-vuh-ree) Of animals, a female gonad. Of flowering plants, the enlarged base of a carpel in which one or more ovules develop into seeds.

**oviduct** (OH-vih-dukt) Duct between the ovary and uterus where fertilization most often occurs. Also called a Fallopian tube.

**ovulation** (OHV-you-LAY-shun) Release of a secondary oocyte from an ovary.

**ovule** (OHV-youl) [L. *ovum*, egg] Of seed-bearing plants, an egg-containing female gametophyte surrounded by tissue layers; a mature ovule is a seed.

**ovum** Mature secondary oocyte.

**oxaloacetate** (ox-AL-oh-ASS-ih-tate) A four-carbon compound with roles in metabolism; e.g., the point of entry into the Krebs cycle.

**oxidation-reduction reaction** Transfer of electrons between reactant molecules.

**oxidized molecule** A molecule that has lost one or more electrons.

**oxygen debt** A lower O<sub>2</sub> level in blood after muscle cells use up more ATP than they have formed by aerobic respiration.

**oxyhemoglobin** In red blood cells only, oxygen bound to hemoglobin; HbO<sub>2</sub>.

**oxytocin** Animal hormone with roles in labor, lactation, and recovery of uterus after pregnancy. In many animals, also guides social behavior; e.g., pair bonding.

**ozone thinning** Pronounced seasonal thinning of the atmosphere's ozone layer.

**P<sub>i</sub>** Abbreviation for inorganic phosphate.

**pain** Perception of injury to a body region.

**pain receptor** A nociceptor; a sensory receptor that detects tissue damage.

**Paleozoic** Era from 544 million to 248 million years ago; Cambrian through Permian.

**PAN** Peroxylacetyl nitrate. An oxidant in photochemical smog.

**pancreas** (PAN-cree-us) Glandular organ. Secretes enzymes and bicarbonate that help digestion in the small intestine; secretes insulin and glucagon that have central roles in organic metabolism, glucose especially.

**pancreatic islet** Any of 2 million or so clusters of endocrine cells of the pancreas.

**pandemic** An epidemic that breaks out in several countries at the same time.

**Pangea** Paleozoic supercontinent; the first land plants and animals evolved on it.

**parabasalid** A flagellated heterotroph with bundled microtubules as long as the cell and giving rise to four to thousands of flagella; one of the earliest lineages of single-celled eukaryotes; e.g., *Trichomonas*.

**parapatric speciation** A speciation model. Populations in contact along a common border evolve into new species; hybrids that form in the contact zone are less fit than individuals on either side of it and thereby act as a reproductive isolating mechanism.

**parasite** [Gk. *para*, alongside, + *sitos*, food] Organism that withdraws nutrients from a living host, which it usually does not kill outright.

**parasitism** Symbiotic interaction in which a parasitic species benefits as it exploits and harms (but usually does not kill) the host.

**parasitoid** A type of insect that, in a larval stage, grows inside a host (usually another insect), feeds on its soft tissues, and kills it.

**parasympathetic neuron** A neuron of the autonomic nervous system. Its signals slow overall activities and divert energy to basic tasks; also works in opposition with sympathetic neurons to make small ongoing adjustments in the activities of internal organs that they both innervate.

**parathyroid gland** One of four small glands embedded in the back of the thyroid gland; their secretions trigger increases in blood calcium levels.

**parenchyma** (par-EN-kih-mah) One of the simple plant tissues; makes up the bulk of the plant. Its living cells have roles in photosynthesis, storage, and other tasks.

**parthenogenesis** (par-THEN-oh-GEN-uh-sis) The development of an embryo from an unfertilized egg.

**partial pressure** Contribution of one gas to the total pressure of a mixture of gases.

**passive transport** Diffusion of a solute across a cell membrane, through the interior of a transport protein.

**pathogen** [Gk. *pathos*, suffering, + *genēs*, origin] A virus, bacterium, fungus, protist, or parasitic worm that infects an organism and multiplies in it, thus causing disease.

**pattern formation** In animal embryonic development, the sculpting of specialized tissues and organs from clumps of cells in the proper places, in the proper order by way of embryonic induction.

**PCR** Polymerase chain reaction. A method to rapidly copy DNA fragments.

**peat bog** Compressed, soggy, acidic mat of accumulated remains of peat mosses.

**pedigree** Chart of connections among individuals related by descent.

**pellicle** A thin, flexible, protein-rich body covering of some single-celled eukaryotes.

**peptide hormone** A hormone that binds to a membrane receptor, which activates enzymes and often a second messenger in the cytoplasm.

**per capita** [L. *capita*, head] A term used in head counts of a population.

**perception** Understanding of a stimulus.

**perennial** [L. *per-*, throughout, + *annus*, year] Plant having a life cycle that extends through three or more growing seasons.

**pericarp** The fleshy part of a fruit; the endocarp, mesocarp, and exocarp.

**pericycle** (PARE-ih-sigh-kul) [Gk. *peri-*, around, + *kyklos*, circle] One or more cell layers inside the endodermis; gives rise to lateral roots and also contributes to secondary growth.

**periderm** Protective cover that replaces plant epidermis on older stems and roots.

**periodic table of the elements** Tabular arrangement of elements in order of their increasing atomic number.

**peripheral nervous system** (per-IF-ur-uhl) [Gk. *peripherein*, to carry around] All nerves leading into and out of the spinal cord and brain, plus their ganglia.

**peripheral vasoconstriction** Diameters of arterioles constrict, decreasing blood's delivery of heat to body surface.

**peripheral vasodilation** Blood vessels in the skin dilate; more blood flows to skin, which then dissipates excess body heat.

**peristalsis** (pare-ih-STAL-sis) Recurring waves of contraction of muscles in the wall of a tubular or saclike organ.

**peritoneum** (pare-ih-tuh-NEE-um) The membrane that lines the coelom.

**peritubular capillaries** A set of blood capillaries around the tubular parts of a nephron that reabsorbs water and solutes; and that excretes excess  $H^+$ , other solutes.

**permafrost** An impermeable, perpetually frozen layer, sometimes 500 meters thick, that underlies arctic tundra.

**peroxisome** Enzyme-filled vesicle that breaks down amino acids, fatty acids, and toxic substances such as ethanol.

**PGA** Phosphoglycerate. During glycolysis, the intermediate that results after ATP has formed by substrate-level phosphorylation; also the first stable intermediate of the Calvin-Benson cycle of photosynthesis.

**PGAL** Phosphoglyceraldehyde. During glycolysis, the intermediate that gives up electrons and hydrogen to form NADH. During turns of the Calvin-Benson cycle, two PGALs form one sugar; rearrangements of ten others regenerate a compound that is the entry point for the cycle.

**pH scale** Measure of the  $H^+$  concentration of a solution. pH 7 is neutral.

**phagocytosis** [Gk. *phagein*, to eat] "Cell eating," a common endocytic pathway by which various cells engulf food bits, microbes, and cellular debris.

**pharynx** A muscular tube. Invertebrate chordates use theirs in filter-feeding and respiration. In land vertebrates, it is the entrance to the esophagus and trachea.

**phenotype** (FEE-no-type) [Gk. *phainein*, to show + *typos*, image] Observable trait or traits of an individual.

**pheromone** Nearly odorless exocrine gland secretion. A hormone-like signaling molecule between individuals of the same species that integrates social behavior.

**phloem** (FLOW-um) Plant vascular tissue that distributes photosynthetic products through the plant body. Its conducting tubes are interconnecting, living cells assisted by companion cells that help load solutes into the tubes.

**phospholipid** A lipid with a phosphate group in its hydrophilic head. The main constituent of cell membranes.

**phosphorus cycle** A sedimentary cycle. Phosphorus (mainly phosphate) moves from land, through food webs, to ocean sediments, then back to land.

**phosphorylation** Enzyme-mediated transfer of a phosphate group to an organic compound.

**photoautotroph** Any photosynthetic autotroph; e.g., nearly all plants, most algae, and a few bacteria.

**photolysis** (foe-TALL-ih-sis) [Gk. *photos*, light, + *-lysis*, breaking apart] Reactions that split water molecules, which release electrons for the noncyclic pathway of photosynthesis; oxygen is a by-product.

**photon** Unit of electromagnetic energy; has wave-like and particle-like properties.

**photoperiodism** Biological response to change in the relative lengths of daylight and darkness.

**photoreceptor** A light-sensitive sensory cell of invertebrates and vertebrates.

**photosynthesis** The process by which photoautotrophs capture sunlight energy and use it in the formation of ATP and NADPH, then in the formation of sugars from carbon dioxide and water. ATP gives up energy that drives the sugar-building reactions, and NADPH donates electrons and hydrogen building blocks.

**photosystem** In photosynthetic cells, a cluster of membrane-bound pigments and other molecules; it converts light energy to chemical energy.

**phototropism** Change in the direction of cell movement or growth in response to a light source.

**photovoltaic cell** Unit in a device that converts sunlight energy into electricity.

**phycobilin** One of a class of accessory pigments in cyanobacteria and red algae that reflects red to blue light.

**phylogeny** Evolutionary relationships among species.

**physiology** Study of how the multicelled body functions in its environment; more specifically, of the mechanisms by which its component parts grow, develop, and are maintained and reproduced.

**phytochrome** A light-sensitive pigment that helps set plant circadian rhythms based on length of night. Influences stem lengthening and branching, leaf expansion, and often flowering.

**phytoplankton** (FIE-toe-PLANK-tun) [Gk. *phyton*, plant, + *planktos*, wandering] An aquatic community of floating or weakly swimming photoautotrophs.

**pigment** Any light-absorbing molecule.

**pilomotor response** Formation of a layer of still air next to skin as hairs or feathers become erect.

**pilus** Among prokaryotic cells, a short, filamentous protein that projects above the cell wall and can adhere to surfaces; a sex pilus functions in conjugation.

**pineal gland** Light-sensitive, melatonin-secreting endocrine gland. Seasonal change in melatonin levels affect biological clocks, overall activity, and reproductive cycles.

**pioneer species** An opportunistic colonizer of barren or disturbed habitats. Adapted for rapid growth and dispersal.

**pith** Of most eudicot stems, ground tissue inside the ring of vascular bundles.

**pituitary gland** Vertebrate endocrine gland; interacts with the hypothalamus to control many physiological functions, including activity of many other glands. Its posterior lobe stores and secretes hormones from the hypothalamus; its anterior lobe produces and secretes its own hormones.

**placenta** (plah-SEN-tuh) Of pregnant female placental mammals, a blood-engorged organ that forms from endometrial tissue and extraembryonic membranes. Lets a mother exchange substances with a fetus but keeps their blood circulation separate.

**placoderm** An early jawed craniate with paired fins, armor plates on head; extinct.

**placozoan** An asymmetric, soft-bodied animal with two simple tissues around a thin, inner matrix.

**plankton** Aquatic community of mostly microscopic autotrophs and heterotrophs.

**plant** A multicelled photoautotroph, most with well-developed roots and shoots (e.g., stems, leaves), as well as photosynthetic cells that include starch grains as well as chlorophylls *a* and *b*, and polysaccharides such as cellulose, pectin, and lignin in cell walls. The primary producers on land.

**Plantae** Kingdom of plants.

**planula** Of cnidarians, a type of swimming or creeping larva, usually with a ciliated epidermis.

**plasma** (PLAZ-muh) Liquid portion of blood; mainly water and dissolved ions, proteins, sugars, gases, and other solutes.

**plasma membrane** Outer cell membrane; the structural and functional boundary between cytoplasm and extracellular fluid.

**plasmid** A small, circular bacterial DNA molecule having a few genes; replicated independently of the bacterial chromosome.

**plasmodesma** (PLAZ-moe-DEZ-muh), plural **plasmodesmata** A plant cell junction that connects the cytoplasm of adjoining cells.

**plasmodium** Of plasmodial slime molds, a multinucleated mass that forms when a single diploid cell undergoes rounds of mitosis without cytoplasmic division.

**plate tectonics** Theory that great slabs or plates of Earth's outer layer float on a hot, semi-molten mantle. All plates are moving slowly and have rafted continents to new positions over time.

**platelet** A megakaryocyte fragment; it releases substances that help form clots.

**pleiotropy** A case of alleles at a single gene locus having positive or negative impact on two or more traits.

**polar body** One of four cells that form by meiotic cell division of an oocyte but that does not become the ovum.

**pollen grain** [L. *pollen*, fine dust] A tiny structure that forms from microspores; consists of a sturdy wall around a few cells that will develop into a mature, sperm-bearing, male gametophyte.

**pollination** Arrival of pollen on a carpel's stigma in a flower of the same species.

**pollinator** Any agent that delivers pollen grains to the egg-containing structures in flowers of the same species; e.g., wind, water, or birds, bats, and other animals.

**pollutant** Natural or synthetic substance of types or in amounts that are novel in the history of an ecosystem, so there is no evolved mechanism that can prevent the substance from accumulating to harmful or disruptive levels.

**polygenic inheritance** Inheritance of multiple genes that affect the same trait.

**polymer** Large molecule of multiple linked monomers.

**polymorphism** (poly-MORE-fizz-um) [Gk. *polus*, many, + *morphe*, form] Persistence of two or more qualitatively different forms of a trait, or morphs, in a population.

**polyp** (POH-lip) Vase-shaped, sedentary stage of cnidarian life cycles.

**polypeptide chain** Three or more amino acids linked by peptide bonds.

**polyploidy** A case of somatic cells having three or more of each type of chromosome characteristic of the species.

**polysaccharide** [Gk. *polus*, many, + *sakcharon*, sugar] Straight or branched

chain of covalently bonded monomers of the same or different kinds of sugars; e.g., cellulose, starch, and glycogen.

**polysome** A series of ribosomes that are all translating the same mRNA molecule at the same time.

**polytene chromosome** Of some insects, a chromosome consisting of many parallel copies of the same DNA molecule.

**pons** Hindbrain traffic center for signals between the cerebellum and forebrain.

**population** All individuals of the same species living in a specified area.

**population density** Count of individuals of a population in a specified area or volume of a habitat.

**population distribution** The pattern in which individuals of a population are dispersed through their habitat.

**population size** The total number of individuals that make up a population.

**positive control** Use of regulatory proteins to promote gene expression.

**positive feedback mechanism** Major form of homeostatic control; initiates a chain of events that intensify a change in conditions; e.g., a complement cascade.

**potential energy** A object's capacity to do work owing to its position in space or the arrangement of its parts.

**predation** Ecological interaction in which a predator feeds on a prey organism.

**predator** [L. *prehendere*, to grasp, seize] A heterotroph that eats other living organisms (its prey), does not live in or on them, and most often kills them.

**prediction** A statement, based on a hypothesis, about what you expect to observe in nature; the "if-then process."

**pressure flow theory** In vascular plants, organic compounds flow through phloem in response to pressure and concentration gradients between sources (e.g., leaves) and sinks (use or storage in growing parts).

**pressure gradient** Difference in pressure between two adjoining regions.

**prey** Any organism that another organism captures as a food source.

**primary growth** Plant growth originating at root tips and shoot tips.

**primary oocyte** Of human females, an immature egg that is arrested in prophase I of meiosis until eight to ten hours before being released from an ovary.

**primary producer** An autotroph at the first trophic level of an ecosystem.

**primary productivity** The rate at which an ecosystem's primary producers secure and store energy in tissues in a given interval.

**primary root** First root of a seed plant.

**primary succession** See ecological succession.

**primary wall** The first thin, pliable wall of young plant cells.

**primate** A type of mammal; a prosimian, a tarsoid, or an anthropoid.

**primer** Short nucleotide sequence that researchers design as an initiation site for synthesis of a DNA strand on a DNA or RNA template.

**prion** A type of protein particle normally in vertebrate nervous systems that turns infectious when its shape changes.

**probability** The odds that each outcome of an event will occur is proportional to the total number of ways in which that outcome can be reached.

**probe** Short nucleotide sequence that has been labeled with a tracer; designed to hybridize with part of a gene or mRNA.

**producer** An autotrophic organism.

**product** A substance remaining at the end of a reaction.

**progesterone** (pro-JESS-tuh-rown) One of the sex hormones; ovaries and the corpus luteum secrete it.

**proglottid** One of many tapeworm body units that bud behind the scolex.

**progymnosperm** Among earliest plants to produce seedlike structures or seeds.

**prokaryotic cell** [L. *pro*, before, + Gk. *karyon*, kernel] A single-celled organism, often walled, that does not have the organelles characteristic of eukaryotic cells. Only bacteria and archaeans are prokaryotic.

**prokaryotic fission** Cell reproduction mechanism of prokaryotic cells only.

**prolactin** Hormone that induces synthesis of enzymes used in milk production.

**promoter** Short stretch of DNA to which RNA polymerase binds. Transcription then begins at the gene closest to the promoter.

**prophase, meiosis** In prophase I in a germ cell, all duplicated chromosomes condense, typically undergo crossing over with their homologue, then get tethered to a spindle and move to its equator. In prophase II, one member of each pair of homologous chromosomes is tethered to the opposite spindle pole and moved to the equator.

**prophase, mitosis** All of the duplicated chromosomes in a cell condense and get attached to a newly forming spindle.

**protein** Organic compound consisting of one or more polypeptide chains. Diverse kinds have structural, functional, and regulatory roles in all organisms.

**proteobacteria** A group of Gram-negative bacteria; the most diverse monophyletic group of prokaryotic cells.

**Proterozoic** Era between 2.5 million to 544 million years ago. An oxygen-rich early atmosphere formed, sparking the Cambrian explosion of biodiversity.

**“protist”** Informal name for all structurally simple eukaryotes, which are now being classified as monophyletic groups.

**proto-cell** Presumed stage of chemical evolution that preceded living cells.

**proton** Positively charged subatomic particle in the nucleus of all atoms.

**protostome** (PRO-toe-stome) [Gk. *proto*, first, + *stoma*, mouth] A bilateral animal of a branching lineage characterized partly by events in embryonic development, as when the first indentation to form on the early embryo's surface becomes a mouth; e.g., mollusks, annelids, arthropods.

**protozoan** Traditional name for one of the motile predatory or parasitic species of single-celled eukaryotes.

**proximal tubule** Tubular portion of a nephron closest to Bowman's capsule.

**pseudocoel** False coelom; a main body cavity incompletely lined with tissue derived from mesoderm.

**pseudopod** A dynamic lobe of membrane-enclosed cytoplasm; functions in motility and phagocytosis by amoebas, amoeboid cells, and many white blood cells.

**puberty** Of humans, the post-embryonic stage when gametes start to mature and secondary sexual traits emerge.

**pulmonary circuit** Cardiovascular route in which oxygen-poor blood flows to lungs from the heart, gets oxygenated, then flows back to the heart.

**punctuation model, speciation** Addresses the rate of speciation; cites fossil evidence that morphological changes required for reproductive isolation evolve in a relatively brief time span, within the tens to hundreds of thousands of years when two or more populations are diverging from each other.

**Punnett-square method** A simple way to predict the probable outcomes of a genetic cross by constructing and filling in a diagram of all possible combinations of genotypes, phenotypes, or both.

**pupa**, plural **pupae** An immature, post-embryonic stage of many insect life cycles.

**purine** A nucleotide base with a double ring structure; e.g., adenine or guanine.

**pyrimidine** A nucleotide base with a single ring structure; e.g., cytosine, thymine, uracil.

**pyruvate** Three-carbon compound that forms as an end product of glycolysis.

**quadrat** One of a number of sampling areas of the same size and shape used to estimate population size.

**r** Net reproduction per individual per unit time; a variable in population growth equations for which birth and death rates are assumed to remain constant.

**radial symmetry** Animal body plan with four or more roughly equivalent parts around an anterior–posterior axis.

**radiation** Any form of radiant energy.

**radioactive decay** Natural, inevitable process by which an atom emits energy as subatomic particles and x-rays as its unstable nucleus spontaneously breaks apart; transforms one element into another in a predictable time span.

**radioisotope** Any isotope that has an unstable nucleus.

**radiolarian** A single-celled predatory eukaryote that has pseudopods projecting from a perforated shell and a cell cortex with buoyancy-imparting vacuoles.

**radiometric dating** Method of measuring proportions of a radioisotope in a mineral trapped long ago in newly formed rock and a daughter isotope that formed from it by radioactive decay in the same rock. Used to assign absolute dates to fossil-containing rocks and to the geologic time scale.

**rain shadow** Reduction in rainfall on the leeward side of a high mountain range that results in arid or semiarid conditions.

**ray-finned fish** A bony fish having fin supports derived from skin, a swim bladder, and thin, flexible scales.

**reabsorption** At a capillary bed, osmotic movement of some interstitial fluid into plasma. *See also* tubular reabsorption.

**reactant** Substance that enters a reaction.

**reaction center** At a photosystem's center, a special pair of chlorophyll *a* molecules; the center loses electrons on absorption of photon energy, thereby initiating the light-dependent reactions of photosynthesis.

**rearrangement, molecular** Conversion of one organic compound to another through changes in its internal bonds.

**receptor, molecular** A protein or some other molecule with a binding site for a specific signaling molecule.

**receptor, sensory** Sensory cell or a specialized ending of one that detects a particular kind of stimulus.

**recessive allele** Allele whose expression in heterozygotes is fully or partially masked by expression of a dominant partner allele. It is fully expressed only in homozygous recessives.

**reciprocal cross** A paired cross that may identify the role of parental sex on the inheritance of a trait. In the second cross, a trait characteristic of each sex is reversed compared to the original cross.

**recognition protein** One of a class of glycoproteins or glycolipids that project above the plasma membrane and that identify a cell as *nonself* (foreign) or *self* (belonging to one's own body tissue).

**recombinant DNA** A DNA molecule that contains genetic material from more than one organism of the same species or from different species.

**recombinant DNA technology** Techniques by which DNA molecules from different species can be cut into fragments, spliced together into cloning vectors, and then amplified to useful quantities.

**recombination, genetic** Introduction of nonparental combinations of alleles in chromosomes, as by crossing over.

**rectum** Last part of the mammalian gut that briefly stores feces before their expulsion.

**red alga** An aquatic, mostly multicelled photoautotroph having an abundance of phycobilins that masks its chlorophyll *a*.

**red blood cell** Erythrocyte; functions in the efficient transport of oxygen in blood.

**red marrow** Site of blood cell formation in the spongy tissue of many bones.

**red tide** An algal bloom that turns the water near coasts rust-red or brown.

**reduced molecule** A molecule to which one or more electrons were transferred.

**reflex** [L. *reflectere*, to bend back] Simple, stereotyped movement in response to a stimulus; sensory neurons synapse on motor neurons in the simplest reflex arcs.

**regulatory protein** Part of mechanisms that control transcription, translation, and gene products by interacting with DNA, RNA, new polypeptide chains, or proteins such as enzymes.

**releaser** Hypothalamic signaling molecule that enhances or slows the secretion of a specific anterior pituitary hormone.

**renal corpuscle** Bowman's capsule and the glomerular capillaries it cups around.

**renal failure** Condition in which nephrons of both kidneys no longer function.

**repair enzyme** Type of enzymes that repairs nucleotide mismatches in a DNA strand.

**repressor** Type of protein that can block transcription of a prokaryotic gene by binding to an operator.

**reproduction** Any asexual or sexual process by which a parent cell or organism produces offspring.



**reproductive base** The number of actually and potentially reproducing individuals of a population.

**reproductive isolating mechanism** Any heritable feature of body form, function, or behavior that prevents interbreeding between two or more populations; sets the stage for genetic divergences.

**reproductive success** Of individuals, the production of viable, fertile offspring.

**“reptile”** No longer a formal taxon; not a monophyletic group. The name persists as a means to refer to sauropsid lineages other than birds that show basic amniote features but not derived traits that define birds or mammals; e.g., a turtle, crocodile.

**resource partitioning** The sharing of a resource in different ways or at different times that permits two or more species to coexist in a habitat.

**respiration** [L. *respirare*, to breathe] The sum of physiological processes that move O<sub>2</sub> from the surroundings to metabolically active tissues in the animal body and CO<sub>2</sub> from tissues to the outside.

**respiratory cycle** One in-and-out breath.

**respiratory membrane** Fused-together alveolar and blood capillary epithelial and the basement membrane in between; a respiratory surface in the human lung.

**respiratory pigment** A protein complexed with one or more metal ions that binds O<sub>2</sub> in oxygen-rich animal tissues and gives it up where O<sub>2</sub> levels are lowest.

**respiratory surface** Any thin, moist body surface that functions in gas exchange.

**respiratory system** Animal organ system that takes in O<sub>2</sub> for aerobic respiration and rids the body of its CO<sub>2</sub> wastes.

**resting membrane potential** The voltage difference across the plasma membrane of a neuron or other excitable cell that is not receiving outside stimulation.

**restoration ecology** Work to reestablish biodiversity in ecosystems severely altered by mining, agriculture, other disturbances.

**restriction enzyme** One of hundreds of proteins that recognize and cut specific base sequences in double-stranded DNA.

**reticular formation** Mesh of interneurons that is a low-level pathway of information flow through the upper spinal cord, brain stem, and cerebral cortex.

**retina** Of vertebrate and many invertebrate eyes, a tissue packed with photoreceptors and interwoven with sensory cells.

**reverse transcriptase** A viral enzyme that catalyzes the assembly of free nucleotides into a strand of DNA on an RNA template.

**Rh blood typing** Method of determining whether Rh<sup>+</sup>, a type of surface recognition protein, is present on an individual's red blood cells; if absent, the cell is Rh<sup>-</sup>.

**rhizoid** A rootlike absorptive structure.

**rhizome** A short absorptive stem that grows underground in a horizontally branching pattern, most often.

**rhyniophyte** The first seedless vascular plants; originated in Gondwana lowlands.

**ribosomal RNA** rRNA. A class of RNA that becomes complexed with proteins to form ribosomes; some catalyze assembly of polypeptide chains.

**ribosome** The site of polypeptide chain synthesis in all cells. An intact ribosome has two subunits of rRNA and proteins.

**riparian zone** The narrow corridor of vegetation along a stream or river.

**RNA** Ribonucleic acid. Any of a class of single-stranded nucleic acids involved in gene transcription and translation; some RNAs show enzyme activity.

**RNA polymerase** Enzyme that catalyzes transcription of DNA into RNA.

**RNA world** Model for a time prior to the evolution of DNA; a self-replicating system chemically evolved in which RNA strands were templates for protein synthesis.

**rod cell** Vertebrate photoreceptor that detects very dim light; contributes to the coarse perception of movement.

**root** Typically belowground plant part. It absorbs water and dissolved minerals, often anchors aboveground parts and stores food.

**root hair** Hairlike, absorptive extension of a young, specialized root epidermal cell.

**root nodule** Mutualistic association of nitrogen-fixing bacteria and roots of some legumes and other plants; infection leads to a localized tissue swelling.

**root system** Underground vascular plant structures that absorb water, mineral ions.

**rotifer** Bilateral, cephalized animal with a false coelom and a crown of cilia.

**roundworm** Bilateral invertebrate with a false coelom and complete digestive system in a cylindrical body. Most are decomposers; many are parasites.

**rubisco** RuBP carboxylase. Carbon-fixing enzyme of the C<sub>3</sub> photosynthesis pathway.

**RuBP** Ribulose biphosphate. A five-carbon organic compound; the entry point for the Calvin-Benson cycle, which regenerates it.

**ruminant** Hoofed, herbivorous mammal that has multiple stomach chambers.

**sac fungus** Fungus that produces sexual spores in sac-shaped cells; e.g., truffles.

**salinization** Salt buildup in soil by poor drainage, evaporation, or heavy irrigation.

**saliva** Salivary gland secretion into the mouth that starts starch breakdown.

**salt** Any compound that releases ions other than H<sup>+</sup> and OH<sup>-</sup> in solution.

**saltatory conduction** Of a myelinated neuron, a rapid form of action potential propagation. Excitation hops node to node between jellyrolled membranes of neuroglial cells of the myelin sheath.

**sampling error** Using a sample or subset of a population, an event, or some other aspect of nature as an experimental group that is not large enough to be representative of the whole.

**saprobe** Heterotroph that extracts energy and carbon from nonliving organic matter and so causes its decay.

**sapwood** Of an older stem or root, the moist secondary growth between the vascular cambium and heartwood.

**sarcomere** (SAR-koe-meer) One of many basic units of contraction, defined by Z lines, along the length of a muscle fiber. It shortens by ATP-driven interactions between its parallel arrays of actin and myosin components.

**sarcoplasmic reticulum** Specialized ER that forms flattened, membrane-bound chambers around muscle fibers; takes up, stores, and releases Ca<sup>++</sup> for contraction.

**sauropsid** A “reptile” or a bird.

**savanna** Broad belt of warm grassland with a smattering of shrubs and trees.

**scale** Of a fish, one of a number of small, bony plates that protect the body without weighing it down.

**Schwann cell** Type of neuroglial cell that myelinates many axons.

**scientific theory** See Theory, scientific.

**sclerenchyma** (skler-ENG-kih-mah) One of three simple plant tissues; supports mature parts and often protects seeds. Lignin often thickens and reinforces its cell walls.

**second law of thermodynamics** Energy tends to flow from concentrated to less concentrated forms.

**second messenger** Molecule in a cell that relays a hormonal signal; e.g., cyclic AMP.

**secondary growth** A thickening of older stems and roots; wood when extensive.

**secondary oocyte** A haploid cell which, with a first polar body, is produced by the first meiotic division of a primary oocyte; the cell released from the ovary of a female vertebrate at ovulation.

**secondary sexual trait** A trait associated with maleness or femaleness but with no direct role in reproduction (e.g., body hair distribution). The primary sexual trait is the presence of male or female gonads.

**secondary succession** See Ecological succession.

**secondary wall** A rigid, permeable wall inside the primary wall of many plant cells; forms after the first growing season.

**secretion** Release of a substance from a cell or gland to its surroundings.

**sedimentary cycle** Any biogeochemical cycle in which an element having no gaseous phase moves from land, through food webs, to the seafloor, then back to land through long-term uplifting.

**seed** A mature ovule.

**seed bank** A storage facility where genes of diverse plant lineages are preserved.

**seed fern** One of the earliest plants to make seedlike structures, or seeds.

**segmentation** Of animal body plans, a series of units that may or may not be similar in appearance. Of tubular organs, an oscillating movement produced by rings of circular muscle in the tube wall.

**segregation, theory of** Mendelian theory that two genes of a pair on homologous chromosomes are separated from each other at meiosis, eventually to end up in different gametes.

**selective gene expression** Outcome of controls over which gene products a cell makes or activates in a specified interval. Basis of cell differentiation.

**selective permeability** Built-in capacity of a cell membrane to prevent or allow specific substances from crossing it at certain times, in certain amounts.

**selfish behavior** An individual increases its own chance to reproduce regardless of the biological costs to its social group.

**selfish herd** Social group held together by reproductive self-interest.

**semen** (SEE-mun) Sperm-bearing fluid expelled from a penis during sex.

**semiconservative replication** [Gk. *semi-*, half, + L. *conservare*, to keep] Mechanism by which a DNA molecule is duplicated. The double helix unzips along its length, exposed bases of each strand are a template upon which a new strand is assembled, then each conserved strand and its new partner wind up in a double helix. Two double helices, each with a parental strand and new strand of DNA, result.

**seminiferous tubule** One of the coiled tubes in testes where sperm start forming.

**senescence** (sen-ESS-cents) [L. *senescere*, to grow old] Of differentiated multicelled organisms, the phase in a life cycle from maturity until death; also applies to death of parts, such as plant leaves.

**sensation** Conscious awareness of a stimulus.

**sensory neuron** Type of neuron that detects a stimulus and relays information about it toward an integrating center.

**sensory system** Collectively, all sensory cells of a nervous system that detect and report information about external and internal stimuli to integrating centers.

**serotonin** A neurotransmitter that affects mood, memory, and sleep behavior.

**Sertoli cell** A type of cell in seminiferous tubules with FSH receptors; helps nourish and support developing sperm.

**sessile animal** (SESS-ihl) Animal that is attached to a substrate during part of the life cycle; e.g., an adult barnacle.

**sex chromosome** One of two kinds of homologous chromosomes that, in certain combinations, dictate the gender of the new individual. Also has genes unrelated to sexual traits.

**sexual dimorphism** A notable difference between female and male phenotypes of a population.

**sexual reproduction** Production of genetically variable offspring by meiosis, gamete formation, and fertilization.

**sexual selection** A category of natural selection; an outcome of differences in success at attracting mates and reproducing among individuals of a population.

**shell model** Model for how electrons are distributed in an atom; all of the orbitals are shown as a nested series of shells.

**shifting cultivation** A practice of cutting and burning trees, then tilling ashes into the soil of a small plot of land. Once called slash-and-burn agriculture.

**shivering response** Rhythmic tremors in response to cold; raises heat production.

**shoot system** Aboveground plant parts; e.g., stems, leaves, flowers.

**short-day plant** Plant that flowers in late summer or early fall, when night length is longer than a critical value.

**sieve tube** A conducting tube in phloem.

**sieve-tube member** A living cell that helps form a conducting tube in phloem.

**sign stimulus** Simple environmental cue that triggers a response to a stimulus; the nervous system is prewired to recognize it.

**signal reception** Activation of a molecular or sensory receptor when a hormone or another signaling molecule binds to it.

**signal transduction** Conversion of an extracellular signal into a molecular or chemical form that causes a change in some activity inside a target cell.

**signaling molecule** Any secretion from one cell type that can alter the behavior of a different cell that bears a receptor for it; a means of cell communication.

**sister chromatid** (CROW-mah-tid) One of the two attached members of a duplicated eukaryotic chromosome.

**six-kingdom classification system** The grouping of all organisms into kingdoms: Bacteria, Archaea, Protista, Fungi, Plantae, and Animalia.

**skeletal muscle** Organ of many muscle fibers bundled inside a connective tissue sheath and attached to bone by tendons.

**skeletal muscle tissue** Contractile tissue that is the functional partner of bone.

**skin** Vertebrate integument and diverse structures derived from it.

**sliding-filament model** Model for how the sarcomeres of muscle fibers contract. ATP-activated myosin heads repeatedly bind actin filaments (tethered to Z lines) and tilt in short power strokes that slide the actin toward the sarcomere's center.

**slime mold** An amoebozoan; one of the free-living, amoebalike cells that also cluster into a migrating mass, differentiate, and form reproductive structures.

**small intestine** Part of the vertebrate gut in which digestion is completed and from which most dietary nutrients are absorbed.

**smog** Atmospheric condition in which winds cannot disperse airborne pollutants that have become trapped under a thermal inversion.

**smooth muscle tissue** Contractile tissue in the wall of soft internal organs.

**social behavior** Interacting individuals of a species that display, send, and respond to shared forms of communication.

**social parasite** Species that completes its life cycle by taking advantage of the social behavior of a host species, thus harming it.

**sodium-potassium pump** Cotransporter that, when energized, actively transports sodium out of a cell and helps potassium passively diffuse into it at the same time.

**softwood** Wood with tracheids, no fibers or vessels; less dense than hardwood.

**soil** Mix of mineral particles of variable sizes, decomposing organic material, and air and water in spaces between particles.

**solar-hydrogen energy** Sunlight energy is used to convert water to H<sub>2</sub> as a fuel source.

**solar tracking** A photoperiodic response to sun's changing angle through the day.

**solute** (SOL-yoot) [L. *solvere*, to loosen] Any substance dissolved in a solution.

**solvent** Any fluid (e.g., water) in which one or more substances are dissolved.

**somatic cell** (SO-MAT-ik) [Gk. *soma-*, body] Any body cell that is not a germ cell.

**somatic nervous system** The nerves that connect the vertebrate central nervous system and skeletal muscles.

**somatic sensation** Perception of touch, pain, pressure, temperature, motion, or positional changes of body parts.

**somatosensory cortex** Part of the outer gray matter of the cerebral hemispheres.

**somite** One of many paired segments in a vertebrate embryo that gives rise to most bones, skeletal muscles of the head and trunk, and the dermis.

**special sense** Vision, hearing, olfaction, or another sensation involving receptors that are restricted to certain body parts.

**speciation** (spee-see-AY-shun) One of the macroevolutionary processes; formation of daughter species from a population or subpopulation of a parent species; the routes vary in their details and duration.

**species** (SPEE-sheez) [L. *species*, a kind] Of sexually reproducing species, one or more natural populations of individuals that successfully interbreed and are isolated reproductively from other such groups. By a cladistic definition, one or more natural populations of individuals with at least one unique trait derived a common ancestor that occurs in no other groups.

**specific epithet** The last part of a two-part species name; the genus is first.

**sperm** Mature male gamete.

**sphere of hydration** A clustering of water molecules around molecules or ions of a solute by positive and negative interactions.

**sphincter** A ring of muscles that alternately contract and relax, which closes and opens a passageway between two organs.

**spinal cord** The part of a central nervous system inside a vertebral canal. Basic reflex centers, and tracts to and from the brain.

**spindle, microtubular** See Bipolar spindle.

**spirillum** A spiral-shaped prokaryotic cell.

**spirochaete** A motile, parasitic or symbiotic bacterium that looks like a stretched spring.

**spleen** The largest lymphoid organ, with phagocytic white blood cells and B cells; filters antigen and used-up platelets and worn-out or dead red blood cells. In embryos only, a site of red blood cell formation.

**sponge** Structurally, the simplest existing animal. Its asymmetrical body has a spicule-reinforced matrix in two cell layers (not epithelium). Its phagocytic collar cells trap

food from water flowing through pores in its wall.

**spore** A structure of one or a few cells, often walled or coated, that protects and/or disperses a new sexual or asexual generation. Many bacteria as well as apicomplexans, fungi, and plants form spores.

**sporophyte** [Gk. *phyton*, plant] A spore-producing vegetative body of a plant or multicelled alga that grows by mitotic cell divisions from a zygote.

**sporozoan** See Apicomplexan.

**spring overturn** Of large bodies of water, a downward movement of oxygenated surface water and an upward movement of nutrient-rich water from below during spring; fans primary productivity.

**S-shaped curve** Type of diagrammatic curve that emerges when plotting logistic population growth against time.

**stabilizing selection** Mode of natural selection; intermediate phenotypes are favored over extremes at both ends of the range of variation.

**stamen** (STAY-mun) An anther, typically raised on a stalked filament.

**statolith** A cluster of particles that acts as a gravity-sensing mechanism.

**STD** A sexually transmitted disease.

**stem cell** Self-perpetuating, undifferentiated animal cell. A portion of its daughter cells becomes specialized; e.g., red blood cells from stem cells in bone marrow.

**steroid hormone** Cholesterol-derived, lipid-soluble hormone.

**sterol** Any lipid consisting of a rigid backbone of four fused carbon rings.

**stigma** Sticky or hairy surface tissue on the top of a carpel or fused carpels; captures pollen and promotes its germination.

**stimulus** [L. *stimulus*, goad] A specific form of energy that activates a sensory receptor able to detect it; e.g., pressure.

**stoma**, plural **stomata** A gap between two plumped guard cells that lets water vapor and gases diffuse across the epidermis of a leaf or primary stem; diffusion stops when the cells lose water and collapse.

**stomach** Muscular, stretchable sac; mixes and stores ingested food and helps break it apart mechanically and chemically.

**strain** A type of organism which, when compared against an organism of known type, has differences that are too minor to classify it as a separate species.

**stramenopile** A single-celled or multicelled eukaryote with four outer membranes and thin tinsel-like filaments projecting from one of two flagella; e.g., a photosynthetic chrysophyte or a colorless oomycote.

**stratification** Stacks of sedimentary rock layers, built up by deposition of silt and other materials over time.

**stream** A flowing-water ecosystem that starts out as a freshwater spring or seep.

**strip logging** A way to minimize erosion from deforestation; a narrow corridor that parallels contours of sloped land is cleared; the upper part is used as a log-hauling road then is reseeded from intact forest above it.

**strobilus** Of certain nonflowering plants, a cluster of spore-producing structures.

**stroma** The semifluid matrix between the thylakoid membrane system and two outer membranes of a chloroplast where sucrose, starch, cellulose, and other end products of photosynthesis are built.

**stromatolite** Fossilized remains of dome-shaped mats of shallow-water communities, cyanobacterial species especially, that were infiltrated with dissolved minerals and fine sediments. Some are 3 billion years old.

**substance P** A neuromodulator that enhances pain perception.

**substrate** A reactant molecule that is specifically acted upon by an enzyme.

**substrate-level phosphorylation** Direct, enzyme-mediated transfer of a phosphate group from a substrate to another molecule.

**succession** See ecological succession.

**suppressor T cell** Type of lymphocyte that helps end an immune response.

**surface-to-volume ratio** A relationship in which the volume of an object increases with the cube of the diameter, but the surface area increases with the square.

**survivorship curve** Plot of age-specific survival of a cohort, from the time of birth until the last individual dies.

**swim bladder** Adjustable flotation sac that helps many fishes maintain neutral buoyancy in water; its volume changes as it exchanges gases with blood.

**symbiosis** [Gk. *sym*, together, + *bios*, life, mode of life] An ecological interaction in which one or more individuals interact closely with individuals of a different species for some or all of the life cycle; e.g., mutualism, predation, parasitism.

**sympathetic neuron** A neuron of the autonomic nervous system. Its signals cause increases in overall activities in times of stress or heightened awareness. Also works in opposition with sympathetic neurons to make small ongoing adjustments in activities of internal organs they both innervate.

**sympatric speciation** [Gk. *sym*, together, + *patria*, native land] A speciation model. Occurs inside the home range of a species in the absence of a physical barrier; e.g., by way of polyploidy in flowering plants.

**synapsid** An amniote lineage of early mammal-like reptiles and mammals.

**synaptic integration** (sin-AP-tik) The summation of excitatory and inhibitory signals that are arriving at an excitable cell's input zone at the same time.

**syndrome** The set of symptoms that characterize a medical condition.

**system acquired resistance** Of many plants, a mechanism that induces cells to produce and release compounds that will protect tissues from attack.

**systemic circuit** Cardiovascular route in which oxygenated blood flows from the heart through the rest of the body, where it gives up oxygen and takes up carbon dioxide, then flows back to the heart.

**T lymphocyte** T cell. White blood cell that regulates vertebrate immune responses by way of cytokines; cytotoxic T cells carry out cell-mediated immunity.

**tactile display** A type of ritualized social interaction involving physical contact.

**tandem repeat** One of many copies of short base sequences positioned one after another on a chromosome; used in DNA fingerprinting.

**taproot system** A primary root and all of its lateral branchings.

**target cell** Any cell that has molecular receptors for a signaling molecule.

**taste receptor** A type of chemoreceptor that detects solutes in the fluid bathing it.

**taxon, plural taxon** A set of organisms of a given type.

**taxonomy** Field of biology that identifies, names, and classifies species.

**TCR** Antigen-binding receptor of T cells.

**tectum** Midbrain's roof. In fishes and amphibians, coordinates most sensory inputs and initiates motor responses. In most vertebrates (not mammals), a reflex center; relays sensory input to forebrain.

**telomere** A cap of repetitive DNA sequences on the end of a chromosome. Each nuclear division, enzymes digest a bit of it; cells stop dividing when only a nubbin remains.

**telophase** (TEE-low-faze) Of meiosis I, a stage when one member of each pair of homologous chromosomes has arrived at a spindle pole. Of mitosis and of meiosis II, the stage when chromosomes typically decondense into threadlike structures and two daughter nuclei form.

**temperature** Measure of molecular motion.

**temperature zone** Globe-spanning bands of temperature defined by latitude; e.g., cool temperate, equatorial.

**tendon** A cord or strap of dense connective tissue that attaches a muscle to bone.

**terminal bud** See Bud.

**territory** An area that an animal defends against competitors for food, water, living space, mates, and other resources.

**test, scientific** Any standardized or innovative means by which a prediction based on a hypothesis might be disproved; often requires designing and conducting experiments, making observations, or developing models.

**testcross** A cross that might reveal the (unknown) genotype of an individual showing dominance for a trait; the individual is crossed with a known homozygous recessive individual.

**testis, plural testes** A type of gonad where male gametes and sex hormones form.

**testosterone** (tess-TOSS-tuh-rown) A sex hormone necessary for the development and functioning of the male reproductive system of vertebrates.

**tetanus** (TET-uh-nuss) A large muscle contraction. Repeated stimulation of a motor unit causes muscle twitches to run together. In the disease tetanus, muscles cannot be released from contraction.

**tetrapod** A vertebrate that is a four-legged walker or a descendant of one.

**thalamus** (THAL-uh-muss) Forebrain region; a coordinating center for sensory input and a relay station for signals to the cerebrum.

**theory, scientific** A time-tested, widely accepted intellectual framework used to interpret a broad range of observations and data about some aspect of nature. Tested rigorously but is still open to tests, revision, and tentative acceptance or rejection.

**thermal inversion** A layer of dense, cool air trapped beneath a layer of warm air.

**thermal radiation** Emission of radiant energy (heat) from any object.

**thermocline** Thermal stratification in a large body of water; a cool midlayer stops vertical mixing between warm surface water above it and cold water below it.

**thermoreceptor** Type of sensory cell that detects radiant energy (heat).

**thigmotropism** (thig-MOE-truh-pizm) [Gk. *thigm*, touch] Redirected growth in response to physical contact with a solid object; e.g., a vine curling around a post.

**thirst center** Part of the hypothalamus; promotes water-seeking behavior when osmoreceptors in the brain detect a rise in the blood level of sodium.

**threat display** Ritualized intraspecific signal conveying intent to attack.

**three-domain system** A classification system that groups all organisms into domains Bacteria, Archaea, and Eukarya.

**thylakoid membrane** A chloroplast's inner membrane system, often folded as flattened sacs, that forms a continuous compartment in the stroma. In the first stage of photosynthesis, pigments and enzymes in the membrane function in the formation of ATP and NADPH.

**thymine** (THY-meen) One of four nitrogen-containing bases in nucleotide monomers of DNA; also applies to a nucleotide with a thymine base component.

**thymus gland** Lymphoid organ; secretes hormones that influence the maturation of T cells that circulate to this gland right after they have formed in bone marrow.

**thyroid gland** Endocrine gland; secretes hormones that influence overall growth, development, and rates of metabolism.

**tidal volume** Volume of air flowing in and out of lungs in one respiratory cycle.

**tight junction** An array of many strands of fibrous proteins collectively joining the sides of cells that make up an epithelium; the array prevents solutes from leaking between the cells.

**tissue** Of multicelled organisms, a group of cells and matrixes interacting in the performance of one or more tasks.

**tissue culture propagation** Inducing the vegetative growth of a plant fragment or cell in a culture medium.

**titin** Elastic protein that keeps myosin filaments centered in a sarcomere and lets relaxed muscles passively resist stretching.

**tongue** A vertebrate organ of membrane-covered skeletal muscles used to position food and swallow, also to make sounds.

**tonicity** (toe-NISS-ih-TEE) Relative solute concentrations of two fluids.

**tooth** A hardened appendage used to cut, shred, pierce, or pummel food.

**topsoil** Uppermost soil layer with the most nutrients for plant growth.

**torsion** A drastic twisting of the body, including the visceral mass, as certain molluscan embryos develop.

**total fertility rate** TFR. Of humans, the average number of children born to females during their reproductive years.

**touch-killing** Mechanism by which a cytotoxic T cell kills target cells; it directly releases perforins and toxins onto them.

**toxin** Normal metabolic product that can damage or kill cells of a different species.

**trace element** Any element making up less than 0.01 percent of body weight.

**tracer** Any substance with a radioisotope attached; researchers can track it after delivering it into a cell, a multicelled body, ecosystem, or some other system.

**trachea** (TRAY-kee-uh), plural **tracheae** An air-conducting tube used in respiration. Of land vertebrates, the windpipe.

**tracheal system** Finely branching tubes for respiration that start at openings across the integument and dead-end in body tissues of arthropods; e.g., grasshoppers.

**tracheid** (TRAY-kid) A type of cell in xylem that conducts water and mineral ions.

**tract** Cordlike bundle of axons of sensory neurons, motor neurons, or both in the brain or spinal cord.

**transcription** [L. *trans*, across, + *scribere*, to write] First stage of protein synthesis. An RNA strand is assembled from nucleotides using a gene region in DNA as a template.

**transfer RNA** tRNA. One of a class of small RNA molecules that delivers amino acids to a ribosome. Its anticodon pairs with an mRNA codon during translation.

**transition state** A fleeting point when a chemical reaction can run to product or back to reactant.

**translation** Second stage of protein synthesis. At ribosomes, information encoded in an mRNA transcript guides the synthesis of a new polypeptide chain from amino acids.

**translocation** Attachment of a piece of a broken chromosome to another chromosome. Also, a mechanism by which organic compounds are conducted in phloem.

**transpiration** Evaporative water loss from a plant's aboveground parts.

**transport protein** Membrane protein that passively or actively assists specific ions or molecules into or out of a cell. The solutes move through the protein's interior.

**transposon** Transposable element. A stretch of DNA that jumps spontaneously and randomly to a different location in the genome and may mutate a gene.

**triglyceride** A lipid with three fatty acid tails attached to a glycerol backbone.

**trisomy** Having one extra chromosome in somatic cells; e.g., trisomy 21 ( $2n + 1$ ).

**trophic level** (TROE-fik) All organisms the same number of transfer steps away from the energy input into an ecosystem.

**tropical rain forest** A biome in regions of regular, heavy rainfall, an annual mean temperature of 25°C, and humidity greater than 80 percent. Rich in biodiversity but low in topsoil; decomposition is too fast.

**tropism** (TROE-pizm) Directional growth response to an environmental factor; e.g., a shoot bending toward a light source.

**true breeding lineage** A group consisting of parents and their offspring in which only one version of a trait persists over time.

**tubular reabsorption** A process by which peritubular capillaries reclaim water and solutes that leak or are pumped out of a nephron's tubular regions.

**tubular secretion** Transport of H<sup>+</sup>, urea, other solutes out of peritubular capillaries and into nephrons for excretion.

**tumor** Tissue mass of cells dividing at an abnormally high rate. Benign tumor cells stay in their home tissue; malignant ones metastasize, or slip away and invade other places in the body, where they may start new tumors. *See also* neoplasm.

**tundra** Biome of high-latitudes or high elevations with poor drainage, very little decomposition, very low temperatures, and a short growing season.

**tunicate** One of the baglike, filter-feeding urochordates.

**turgor pressure** (TUR-gore) Hydrostatic pressure. The pressure that any volume of fluid exerts against a wall, membrane, or some other structure containing it.

**ultrafiltration** Bulk flow of some protein-free plasma out of a blood capillary when outward-directed blood pressure exceeds the inward-directed osmotic movement of interstitial fluid.

**ultraplankton** Photosynthetic bacteria less than five micrometers across that help form "pastures of the seas."

**uniformity theory** Theory that Earth's surface has changed in slow, uniformly repetitive ways except for expected annual catastrophes, such as big floods. Changed Darwin's view of evolution; has since been discredited by plate tectonics theory.

**upwelling** Upward movement of deep, often nutrient-rich water near a coastline; replaces a mass of surface ocean water forced away by prevailing winds.

**uracil** (YUR-uh-sill) One of four nitrogen-containing bases in nucleotide monomers of RNA; also applies to a nucleotide with a uracil base component. Like thymine, uracil can base-pair with adenine.

**urea** Waste product formed in the liver from ammonia (derived from protein breakdown) and CO<sub>2</sub>; excreted in urine.

**ureter** A urine-conducting tube from each kidney to the urinary bladder.

**urethra** A tube that drains the urinary bladder and opens at the body surface.

**urinary bladder** Distensible sac in which urine is stored before being excreted.

**urinary excretion** Mechanism by which excess water and solutes are removed from the body by the urinary system.

**urinary system** Vertebrate organ system that adjusts blood's volume and composition; helps maintain extracellular fluid.

**urine** Fluid consisting of excess water, wastes, and solutes that forms in kidneys by filtration, reabsorption, and secretion.

**urochordate** A bag-shaped chordate with larvae that have a firm, flexible notochord extending through a tail; e.g., a tunicate.

**uterus** (YOU-tur-us) [L. *uterus*, womb] Of a female placental mammal, a muscular, pear-shaped organ in which embryos are housed and nurtured during pregnancy.

**vaccination** Immunization procedure against a specific pathogen.

**vaccine** A type of antigen-containing preparation introduced into the body to prime the immune system to recognize the threat before actual infection.

**vagina** Of female mammals, the organ that receives sperm, forms part of birth canal, and channels menstrual flow.

**variable** Of experimental tests, a specific aspect of an object or event of interest that may differ over time and among individuals. A single variable is directly manipulated in an experimental group.

**vascular bundle** Multistranded, sheathed bundle of primary xylem and phloem in the ground tissue system of a stem or leaf.

**vascular cambium** A lateral meristem that forms in older stems or roots.

**vascular cylinder** Multistranded, sheathed, cylindrical array of primary xylem and phloem inside a root.

**vascular plant** Plant with xylem, phloem, and usually well-developed roots, stems, and leaves.

**vascular tissue system** All xylem and phloem in plants that are structurally more complex than bryophytes.

**vasoconstriction** A decrease in blood vessel diameter, arterioles especially.

**vasodilation** An increase in blood vessel diameter, arterioles especially.

**vegetative growth** Growth of a new plant from an extension or fragment of another.

**vein** Of a cardiovascular system, any of the large-diameter vessels that lead back to the heart. Of leaves, a vascular bundle threading through photosynthetic tissue.

**venule** A small blood vessel that connects several capillaries to a vein.

**vernalization** Stimulation of flowering in spring by low temperature in the season preceding it.

**vertebra**, plural **vertebrae** One of a series of hard bones that protects the spinal cord and forms the structural backbone for the anterior-posterior body axis.

**vertebrate** Animal having a backbone.

**vesicle** A small, membrane-bound sac in the cytoplasm; different sacs transport or store substances or hold enzymes that digest their contents.

**vessel member** Type of cell in xylem, dead at maturity; its wall becomes part of a water-conducting vessel.

**vestibular apparatus** Of vertebrates, an organ of equilibrium.

**vestigial** (ves-TIDJ-ul) A small body part, tissue, or organ that developed abnormally or degenerated over the generations and is unable to function as it normally might; e.g., vestigial wings of mutant fruit flies and human "tail bones."

**villus** (VIL-us), plural **villi** A fingerlike absorptive structure projecting from the free surface of some epithelia; e.g., the profusion of intestinal villi.

**viroid** Infectious particle of short, tightly folded strands or circles of RNA.

**virus** A noncellular infectious agent of DNA or RNA, a protein coat and, in some types, an outer lipid envelope; it can be replicated only after its genetic material enters a host cell and subverts the host's metabolic machinery.

**viscera** All soft organs inside an animal body; e.g., heart, lungs, and stomach.

**vision** Perception of visual stimuli based on light focused on a retina and image formation in the brain.

**visual accommodation** Light-focusing adjustments in a lens position or shape.

**visual field** The portion of the outside world that an animal sees.

**visual signal** An observable action or cue that functions as a communication signal.

**vital capacity** Air volume leaving lungs in one breath after maximum inhalation.

**vitamin** Any organic substance that an organism requires in trace amounts for metabolism but that it generally cannot synthesize for itself. Many coenzymes function as vitamins.

**vitamin D** A fat-soluble vitamin; helps the body absorb dietary calcium.

**vocal cord** One of the thick, muscular folds of the larynx that help some animals produce sound waves for vocalization.

**warning coloration** Of many toxic species and their mimics, strong colors, patterns, and other signals that predators learn to recognize and avoid.

**wastewater treatment** Removal of toxins, sludge, organic matter from liquid wastes.

**water mold** A stramenopile; most are saprobic decomposers or opportunistic parasites, of aquatic habitats.

**water table** Upper limit at which ground in a region is fully saturated with water.

**watershed** A region of any specified size in which all precipitation drains into one stream or river.

**water-vascular system** Of echinoderms, a system of tube feet connected to canals, through which controlled water flow can extend the feet in coordinated ways.

**wavelength** The distance between the crests of two successive wavelike forms of energy in motion.

**wax** A lipid with long-chain fatty acids attached to an alcohol other than glycerol.

**whisk fern** Seedless vascular plant having a branching form and no true roots; e.g., *Psilotum*.

**white blood cell** Leukocyte. A participant in innate or adaptive immunity, or both; e.g., an eosinophil, neutrophil, basophil, macrophage, T cell, B cell.

**white matter** Tracts of myelinated axons in the brain and spinal cord.

**wild-type allele** Of a given gene locus, the allele that occurs normally or with the greatest frequency among individuals of a population.

**wind farm** Collection of turbines used to convert mechanical energy into electricity.

**wing** A body part that functions in flight, as among birds, bats, and many insects.

**X chromosome** A type of sex chromosome that influences sex determination; e.g., XX mammalian embryo becomes female; an XY pairing causes it to develop into a male.

**X chromosome inactivation** In a female mammalian embryo, the programmed painting of special RNAs over most of one of the two X chromosomes, which cuts off access to the majority of its genes. Which X chromosome gets painted in each cell is a random event, so tissues of adult female mammals are a mosaic of traits. *See also* Dosage compensation.

**xanthophyll** One of a class of accessory pigments in photosynthesis that reflects yellow to orange light.

**xenotransplantation** Surgical transfer of an organ from one species to another.

**X-linked gene** Any gene on an X chromosome.

**X-linked recessive inheritance** Recessive condition in which the responsible, mutated gene is on the X chromosome.

**x-ray diffraction image** Film image of x-rays scattered by a crystalline sample; the resulting pattern of streaks and dots can be used to calculate the spacing between the atoms in the crystal lattice.

**xylem** (ZYE-lum) [Gk. *xylon*, wood] Of vascular plants, a complex tissue that conducts water and solutes through tubes of interconnected walls of cells that are dead at maturity.

**Y chromosome** Distinctive chromosome in males or females of many species (not both); e.g., human males XY, females, XX.

**yellow-green alga** A chrysophyte that does not make fucoxanthin; species are common in salt marshes.

**yellow marrow** Of most mature bones, a fatty tissue that produces red blood cells when blood loss from the body is severe.

**Y-linked gene** Gene on a Y chromosome.

**yolk** Protein- and lipid-rich substance that nourishes embryos in animal eggs.

**yolk sac** Extraembryonic membrane. In most shelled eggs, it holds nutritive yolk; in humans, part becomes a blood cell formation site, and some cells give rise to forerunners of gametes.

**zero population growth** No net increase or decrease in population size during a specified interval.

**zooplankton** A community of mostly microscopic heterotrophs suspended or weakly swimming in an aquatic habitat.

**zygomycetes** Type of parasitic or saprobic fungus in which diploid zygotes develop into zygospores, a type of thick-walled sexual spore in a thin, clear covering.

**zygospore** Sexual spore of zygomycetes.

**zygote** (ZYE-goat) A fertilized egg.