

Glossary

A

α -actinin An actin-binding protein that cross-links actin filaments into contractile bundles.

α -helix A coiled secondary structure of a polypeptide chain formed by hydrogen bonding between amino acids separated by four residues.

ABC transporter One of a large family of membrane transport proteins characterized by a highly conserved ATP binding domain.

abl A proto-oncogene that encodes a tyrosine kinase and is activated by chromosome translocation in chronic myeloid leukemia.

abscisic acid A plant hormone.

actin An abundant 43-kd protein that polymerizes to form cytoskeletal filaments.

actin-binding protein A protein that binds actin and regulates the assembly, disassembly, and organization of actin filaments.

actin bundle Actin filaments that are cross-linked into closely packed arrays.

actin-bundling protein A protein that cross-links actin filaments into bundles.

actin network Actin filaments that are cross-linked into loose three-dimensional meshworks.

action potential Nerve impulses that travel along axons.

activation energy The energy required to raise a molecule to its transition state to undergo a chemical reaction.

activation-induced deaminase (AID) An enzyme expressed in B lymphocytes that deaminates cytosine in DNA to form uracil in the variable regions of immunoglobulin genes. AID is required for both class switch recombination and somatic hypermutation.

active site The region of an enzyme that binds substrates and catalyzes an enzymatic reaction.

active transport The transport of molecules in an energetically unfavorable direction across a membrane coupled to the hydrolysis of ATP or other source of energy.

adenine A purine that base-pairs with either thymine or uracil.

adenoma A benign tumor arising from glandular epithelium.

adenosine 5'-triphosphate (ATP) See *ATP*.

adenovirus A widely studied DNA tumor virus.

adenylyl cyclase An enzyme that catalyzes the formation of cyclic AMP from ATP.

adherens junction A region of cell–cell adhesion at which the actin cytoskeleton is anchored to the plasma membrane.

adhesion belt A beltlike structure surrounding epithelial cells in which an underlying bundle of actin filament is linked to the plasma membrane.

Akt A serine/threonine kinase that is activated by PIP₃ and plays a key role in signaling cell survival.

allele One copy of a gene.

allosteric regulation The regulation of enzymes by small molecules that bind to a site distinct from the active site, changing the conformation and catalytic activity of the enzyme.

alternative splicing The generation of different mRNAs by varying the pattern of pre-mRNA splicing.

amino acid Monomeric building blocks of proteins, consisting of a carbon atom bound to a carboxyl group, an amino group, a hydrogen atom, and a distinctive side chain.

aminoacyl tRNA synthetase An enzyme that joins a specific amino acid to a tRNA molecule carrying the correct anticodon sequence.

amphipathic A molecule that has both hydrophobic and hydrophilic regions.

amyloid A fibrous aggregate of misfolded protein.

amyloplast A plastid that stores starch.

anabolism The synthesis of more complex organic compounds from simpler ones.

anaphase The phase of mitosis during which sister chromatids separate and move to opposite poles of the spindle.

anaphase A The movement of daughter chromosomes toward the spindle poles during mitosis.

anaphase B The separation of the spindle poles during mitosis.

anaphase-promoting complex/cyclosome (APC/C) A ubiquitin ligase that triggers progression from metaphase to anaphase by signaling the degradation of cyclin B and cohesins.

angiogenesis The formation of new blood vessels.

ankyrin A protein that binds spectrin and links the actin cytoskeleton to the plasma membrane.

- antibody** A protein (also called immunoglobulin) produced by B lymphocytes that binds to a foreign molecule.
- anticodon** The nucleotide sequence of transfer RNA that forms complementary base pairs with a codon sequence on messenger RNA.
- antigen** A molecule against which an antibody is directed.
- antisense nucleic acid** A nucleic acid (either RNA or DNA) that is complementary to an mRNA of interest and is used to block gene expression.
- AP endonuclease** A DNA repair enzyme that cleaves next to apyrimidinic or apurinic sites in DNA.
- apical domain** The exposed free surface of a polarized epithelial cell.
- apoptosis** An active process of programmed cell death, characterized by cleavage of chromosomal DNA, chromatin condensation, and fragmentation of both the nucleus and the cell.
- apoptosome** A protein complex in which caspase-9 is activated to initiate apoptosis following the release of cytochrome *c* from mitochondria.
- aquaporin** A channel protein through which water is able to rapidly cross the plasma membrane.
- Arabidopsis thaliana*** A small flowering plant used as a model for plant molecular biology and development.
- Archaea** One of two major domains of prokaryotes; many species live in extreme conditions similar to those prevalent on primitive Earth.
- Arp2/3 complex** A protein complex that binds actin filaments and initiates the formation of branches.
- astral microtubule** A microtubule of the mitotic spindle that extends to the cell periphery.
- ATM** A protein kinase that recognizes damaged DNA and leads to cell cycle arrest.
- ATP (adenosine 5'-triphosphate)** An adenine-containing nucleoside triphosphate that serves as a store of free energy in the cell.
- ATP synthase** A membrane-spanning protein complex that couples the energetically favorable transport of protons across a membrane to the synthesis of ATP.
- ATR** A protein kinase related to ATM that leads to cell cycle arrest in response to DNA damage.
- Aurora kinase** A protein kinase family involved in mitotic spindle formation, kinetochore function, and cytokinesis.
- autocrine growth stimulation** Stimulation of cell proliferation as a result of growth factor production by a responsive cell.
- autocrine signaling** A type of cell signaling in which a cell produces a growth factor to which it also responds.
- autonomously replicating sequence (ARS)** An origin of DNA replication in yeast.
- autophagosome** A vesicle containing internal organelles enclosed by fragments of cytoplasmic membranes that fuses with lysosomes.
- autophagy** The degradation of cytoplasmic proteins and organelles by their enclosure in cytoplasmic vesicles that fuse with lysosomes.
- autophosphorylation** A reaction in which a protein kinase catalyzes its own phosphorylation.
- auxin** A plant hormone that controls many aspects of plant development.
- axonemal dynein** The type of dynein found in cilia and flagella.
- axoneme** The fundamental structure of cilia and flagella composed of a central pair of microtubules surrounded by nine microtubule doublets.
- ## B
- β barrel** A transmembrane domain formed by the folding of β sheets into a barrel-like structure.
- β sheet** A sheetlike secondary structure of a polypeptide chain, formed by hydrogen bonding between amino acids located in different regions of the polypeptide.
- Bacteria** One of two major domains of prokaryotes, including most common species.
- bacterial artificial chromosome (BAC)** A type of vector used for cloning large fragments of DNA in bacteria.
- basal body** A structure similar to a centriole that initiates the growth of axonemal microtubules and anchors cilia and flagella to the surface of the cell.
- basal lamina** A sheetlike extracellular matrix that supports epithelial cells and surrounds muscle cells, adipose cells, and peripheral nerves.
- base-excision repair** A mechanism of DNA repair in which single damaged bases are removed from a DNA molecule.
- basolateral domain** The surface region of a polarized epithelial cell that is in contact with adjacent cells or the extracellular matrix.
- Bcl-2** A member of a family of proteins that regulate programmed cell death.
- benign tumor** A tumor that remains confined to its site of origin.
- bioinformatics** The use of computational methods to analyze large amounts of biological data, such as genome sequences.
- bone marrow transplantation** A clinical procedure in which transplantation of bone marrow stem cells is used in the treatment of cancer and diseases of the hematopoietic system.
- bright-field microscopy** The simplest form of light microscopy in which light passes directly through a cell.
- ## C
- cadherin** A cell adhesion molecule that forms stable cell-cell junctions at adherens junctions and desmosomes.
- Caenorhabditis elegans*** A nematode used as a simple multicellular model for development.
- Cajal body** A nuclear body involved in assembly of snRNPs and other RNA-protein complexes.
- calmodulin** A calcium-binding protein.
- Calvin cycle** A series of reactions by which six molecules of CO₂ are converted into glucose.
- cAMP-dependent protein kinase** See *protein kinase A*.
- cAMP phosphodiesterase** An enzyme that degrades cyclic AMP.

- cAMP response element (CRE)** A regulatory sequence that mediates the transcriptional response of target genes to cAMP.
- cancer** A malignant tumor.
- carbohydrate** A molecule with the formula $(\text{CH}_2\text{O})_n$. Carbohydrates include both simple sugars and polysaccharides.
- carcinogen** A cancer-inducing agent.
- carcinoma** A cancer of epithelial cells.
- cardiolipin** A phospholipid containing four hydrocarbon chains.
- carrier protein** A protein that selectively binds and transports small molecules across a membrane.
- CAR-T cell therapy** A type of immunotherapy in which a patient's T cells are genetically engineered to attack cancer cells.
- caspase** A member of a family of proteases that bring about programmed cell death.
- catabolism** The breakdown of complex organic molecules to simpler ones.
- catalase** An enzyme that decomposes hydrogen peroxide.
- catenin** A group of cytoplasmic proteins (including α -catenin and β -catenin) that link actin filaments to cadherins at adherens junctions.
- caveolae** Small invaginations of the plasma membrane that may be involved in endocytosis.
- CCND1** The gene encoding cyclin D1, which is an oncogene in a variety of human cancers.
- Cdk** A member of a family of cyclin-dependent protein kinases that control the cell cycle of eukaryotes.
- Cdk1** A serine/threonine kinase that is a key regulator of mitosis in eukaryotic cells.
- Cdk inhibitor (CKI)** Member of a family of proteins that bind Cdk's and inhibit their activity.
- cdNA** A DNA molecule that is complementary to an mRNA molecule, synthesized *in vitro* by reverse transcriptase.
- cell adhesion molecule** A transmembrane protein that mediates cell–cell interactions.
- cell cortex** The actin network underlying the plasma membrane.
- cell cycle checkpoint** A regulatory point that prevents entry into the next phase of the cell cycle until the events of the preceding phase have been completed.
- cell line** Cells that can proliferate indefinitely in culture.
- cell transformation** The conversion of normal cells to tumor cells in culture.
- cell wall** A rigid, porous structure forming an external layer that provides structural support to bacteria, fungi, and plant cells.
- cellulose** The principal structural component of the plant cell wall, a linear polymer of glucose residues linked by β -1,4 glycosidic bonds.
- cellulose synthase** An enzyme that catalyzes the synthesis of cellulose.
- CENP-A** A variant of histone H3 that is present at centromeres.
- central dogma** The concept that genetic information flows from DNA to RNA to proteins.
- centriole** A cylindrical structure consisting of nine triplets of microtubules in the centrosomes of most animal cells.
- centromere** A specialized chromosomal region that connects sister chromatids and attaches them to the mitotic spindle.
- centrosome** The microtubule-organizing center in animal cells.
- channel protein** A protein that forms pores through a membrane.
- chaperone** A protein that facilitates the correct folding or assembly of other proteins.
- checkpoint kinase** A protein kinase (Chk1 or Chk2) that brings about cell cycle arrest in response to damaged DNA.
- chemiosmotic coupling** The generation of ATP from energy stored in a proton gradient across a membrane.
- chitin** A polymer of *N*-acetylglucosamine residues that is the principal component of fungal cell walls.
- chlorophyll** The major photosynthetic pigment of plant cells.
- chloroplast** The organelle responsible for photosynthesis in the cells of plants and green algae.
- cholesterol** A lipid consisting of four hydrocarbon rings. Cholesterol is a major constituent of animal cell plasma membranes and the precursor of steroid hormones.
- chromatin** The fibrous complex of eukaryotic DNA and histone proteins.
- chromatin immunoprecipitation** A method for determining regions of DNA that bind transcription factors within a cell.
- chromatin remodeling factor** A protein that disrupts chromatin structure by altering the contacts between DNA and histones.
- chromatosome** A chromatin subunit consisting of 166 base pairs of DNA wrapped around a histone core and held in place by a linker histone.
- chromoplast** A plastid that contains carotenoids.
- chromosome** A carrier of genes, consisting of long DNA molecules and associated proteins.
- chromosome confirmation capture** A method in which adjacent regions of chromosomes are identified by cross-linking.
- cilium** A microtubule-based projection of the plasma membrane that moves a cell through fluid or fluid over a cell.
- cis-acting control element** A regulatory DNA sequence that serves as a protein binding site and controls the transcription of adjacent genes.
- citric acid cycle** A series of reactions (also called the Krebs cycle) in which acetyl CoA is oxidized to CO_2 . The central pathway of oxidative metabolism.
- class switch recombination** A type of region-specific recombination responsible for the association of rearranged immunoglobulin V(D)J regions with different heavy-chain constant regions.
- clathrin** A protein that coats the cytoplasmic surface of cell membranes and assembles into basketlike lattices that drive vesicle budding.

- clathrin-coated pit** A specialized region of the plasma membrane that contains receptors for macromolecules to be taken up by endocytosis.
- clathrin-coated vesicle** A transport vesicle coated with clathrin.
- clathrin-independent endocytosis** One of several pathways of endocytosis not mediated by specific plasma membrane receptors or the formation of coated vesicles.
- clathrin-mediated endocytosis** The selective uptake of specific macromolecules by receptors that concentrate in clathrin-coated pits.
- Cln** A yeast cyclin (also called G₁ cyclin) that controls passage through START.
- clonal selection** The process by which new clones of tumor cells evolve on the basis of increased growth rate or other properties (such as survival, invasion, or metastasis) that confer a selective advantage.
- c-myc** A proto-oncogene that encodes a transcription factor and is frequently activated by chromosome translocation or gene amplification in human tumors.
- coactivator** A protein that interacts with a transcription factor to stimulate transcription.
- codon** The basic unit of the genetic code; one of the 64 nucleotide triplets that code for an amino acid or stop sequence.
- coenzyme** Low-molecular-weight organic molecules that work together with enzymes to catalyze biological reactions.
- coenzyme A (CoA-SH)** A coenzyme that functions as a carrier of acyl groups in metabolic reactions.
- coenzyme Q** A small lipid-soluble molecule (also called ubiquinone) that carries electrons between protein complexes in the mitochondrial electron transport chain.
- cofilin** An actin-binding protein that severs actin filaments.
- cohesin** A protein that encircles two strands of DNA to form chromatin loops and maintain the connection between sister chromatids.
- colcemid** A drug that inhibits the polymerization of microtubules.
- colchicine** A drug that inhibits the polymerization of microtubules.
- collagen** The major structural protein of the extracellular matrix.
- collagen fibril** A fibril formed by the assembly of collagen molecules in a regularly staggered array.
- condensin** A protein complex that drives metaphase chromosome condensation.
- confocal microscopy** A form of microscopy in which fluorescence microscopy is combined with electronic image analysis to obtain images with increased contrast and detail.
- connexin** A member of a family of transmembrane proteins that form gap junctions.
- connexon** A cylinder formed by six connexins in the plasma membrane.
- contact inhibition** The inhibition of movement or proliferation of normal cells that results from cell–cell contact.
- contractile ring** A structure of actin and myosin II that forms beneath the plasma membrane during mitosis and mediates cytokinesis.
- COPI and COPII** The two proteins other than clathrin that coat transport vesicles (COP indicates coat protein).
- COPI-coated vesicle** A transport vesicle coated with COPI that mediates retrieval from the Golgi apparatus to the endoplasmic reticulum.
- COPII-coated vesicle** A transport vesicle coated with COPII that mediates transport from the endoplasmic reticulum to the Golgi apparatus.
- corepressor** A protein that associates with repressors to inhibit gene expression, often by modifying chromatin structure.
- corticosteroid** Steroid hormone produced by the adrenal gland.
- covalent bond** A type of chemical bond in which two atoms share electrons.
- CREB** Cyclic AMP response element-binding protein. A transcription factor that is activated by cAMP-dependent protein kinase.
- CRISPR/Cas system** A system for introducing targeted mutations into mammalian genes. It consists of CRISPR RNAs that recognize specific target sequences and Cas proteins that cleave the targeted DNA.
- cristae** Folds in the inner mitochondrial membrane extending into the matrix.
- crosstalk** A regulatory mechanism in which one signaling pathway controls the activity of another.
- CTCF** An architectural protein involved in regulating the organization of chromatin.
- cyanobacteria** The largest and most complex prokaryotes in which photosynthesis is believed to have evolved.
- cyclic AMP (cAMP)** Adenosine monophosphate in which the phosphate group is covalently bound to both the 3' and 5' carbon atoms, forming a cyclic structure and an important second messenger in the response of cells to a variety of hormones.
- cyclic electron flow** An electron transport pathway associated with photosystem I that produces ATP without the synthesis of NADPH.
- cyclic GMP (cGMP)** Guanosine monophosphate in which the phosphate group is covalently bound to both the 3' and 5' carbon atoms, forming a cyclic structure and an important second messenger in the response of cells to a variety of hormones, and in vision.
- cyclin** Member of a family of proteins that regulate the activity of Cdk's and control progression through the cell cycle.
- cytochalasin** A drug that blocks the elongation of actin filaments.
- cytochrome *bf* complex** A protein complex in the thylakoid membrane that carries electrons during photosynthesis.
- cytochrome *c*** A mitochondrial peripheral membrane protein that carries electrons during oxidative phosphorylation.

cytochrome oxidase A protein complex in the electron transport chain that accepts electrons from cytochrome *c* and transfers them to O₂.

cytokine A growth factor that regulates blood cells and lymphocytes.

cytokine receptor superfamily A family of cell surface receptors that act by stimulating the activity of intracellular tyrosine kinases.

cytokinesis Division of a cell following mitosis or meiosis.

cytokinin A plant hormone that regulates cell division.

cytoplasmic dynein The form of dynein associated with microtubules in the cytoplasm.

cytosine A pyrimidine that base-pairs with guanine.

cytoskeleton A network of protein filaments that extends throughout the cytoplasm of eukaryotic cells. It provides the structural framework of the cell and is responsible for cell movements.

D

2'-deoxyribose The five-carbon sugar found in DNA.

dark reactions The series of reactions that convert carbon dioxide and water to carbohydrates during photosynthesis. See *Calvin cycle*.

density-dependent inhibition The cessation of the proliferation of normal cells in culture at a finite cell density.

density-gradient centrifugation A method of separating particles by centrifugation through a gradient of a dense substance, such as sucrose or cesium chloride.

deoxyribonucleic acid (DNA) The genetic material of the cell.

desmin An intermediate filament protein expressed in muscle cells.

desmosome A region of contact between epithelial cells at which keratin filaments are anchored to the plasma membrane. See also *hemidesmosome*.

dideoxynucleotide A nucleotide that lacks the normal 3' hydroxyl group of deoxyribose and is used as a chain-terminating nucleotide in DNA sequencing.

differential centrifugation A method used to separate the components of cells on the basis of their size and density.

differential interference-contrast microscopy A type of microscopy in which variations in density or thickness between parts of the cell are converted to differences in contrast in the final image.

diploid An organism or cell that carries two copies of each chromosome.

DNA-affinity chromatography A method used to isolate DNA-binding proteins based on their binding to specific DNA sequences.

DNA damage checkpoint A cell cycle checkpoint that ensures that damaged DNA is not replicated and passed on to daughter cells.

DNA glycosylase A DNA repair enzyme that cleaves the bond linking a purine or pyrimidine to the deoxyribose of the backbone of a DNA molecule.

DNA ligase An enzyme that seals breaks in DNA strands.

DNA microarray A glass slide or membrane filter onto which oligonucleotides or fragments of cDNAs are printed at a high density, allowing simultaneous analysis of thousands of genes by hybridization of the microarray with fluorescent probes.

DNA polymerase An enzyme catalyzing the synthesis of DNA.

DNase hypersensitive site A nucleosome-free region of chromatin, characteristic of promoters and enhancers, that is sensitive to digestion by DNase.

DNA transposon A transposable element that moves via a DNA intermediate.

dolichol phosphate A lipid molecule in the endoplasmic reticulum upon which oligosaccharides are assembled for the glycosylation of proteins.

domain A folded three-dimensional region of a protein that forms the basic unit of tertiary structure.

dominant The allele that determines the phenotype of an organism when more than one allele is present.

double bond A type of covalent bond in which atoms share two pairs of electrons.

double-strand break Damage that results in breaks in both complementary strands of DNA.

Drosophila melanogaster A species of fruit fly commonly used for studies of animal genetics and development.

dynamic instability The alternation of microtubules between cycles of growth and shrinkage.

dynamain A membrane-associated GTPase involved in vesicle budding.

dynein A motor protein that moves along microtubules towards the minus end.

dystrophin A cytoskeletal protein of muscle cells.

E

E2F A family of transcription factors that regulate the expression of genes involved in cell cycle progression and DNA replication.

elaioplast A plastid that stores lipids.

elastic fiber A protein fiber present in the extracellular matrix of connective tissues in organs that stretch and then return to their original shape.

elastin The principal component of elastic fibers.

electrical synapse A specialized assembly of gap junctions that allows the rapid passage of ions between nerve cells.

electrochemical gradient A difference in chemical concentration and electric potential across a membrane.

electron microscopy A type of microscopy that uses an electron beam to form an image. In transmission electron microscopy, a beam of electrons is passed through a specimen stained with heavy metals. In scanning electron microscopy, electrons scattered from the surface of a specimen are analyzed to generate a three-dimensional image.

electron tomography A method used to generate three-dimensional images by computer analysis of multiple two-dimensional images obtained by electron microscopy.

- electron transport chain** A series of carriers through which electrons are transported from a higher to a lower energy state.
- electronegativity** The extent to which electrons are attracted to the nucleus of an atom.
- electrophoretic-mobility shift assay** An assay for the binding of a protein to a specific DNA sequence.
- electroporation** The introduction of DNA into cells by exposure to a brief electric pulse.
- Elk-1** A transcription factor that is activated by ERK phosphorylation and induces expression of immediate early genes.
- elongation factor** A protein involved in the elongation phase of transcription or translation.
- embryonic stem (ES) cell** A stem cell cultured from an early embryo.
- endocrine signaling** A type of cell–cell signaling in which endocrine cells secrete hormones that are carried by the circulation to distant target cells.
- endocytosis** The uptake of extracellular material in vesicles formed from the plasma membrane.
- endoplasmic reticulum (ER)** An extensive network of membrane-enclosed tubules and sacs involved in protein sorting and processing as well as in lipid synthesis.
- endorphin** A neuropeptide that acts as a natural analgesic.
- endosome** A vesicular compartment involved in the sorting and transport to lysosomes of material taken up by endocytosis.
- endosymbiosis** A symbiotic relationship in which one cell resides within a larger cell.
- enhancer** A transcriptional regulatory sequence that can be located at a site distant from the promoter.
- enkephalin** A neuropeptide that acts as a natural analgesic.
- enthalpy** The heat released during a chemical reaction.
- entropy** The degree of disorder in a system.
- enzyme** A protein or RNA that catalyzes a biological reaction.
- epidermal growth factor (EGF)** A growth factor that stimulates cell proliferation.
- epigenetic inheritance** The transmission of information from parent to progeny that is not contained within the sequence of DNA.
- epithelial cell** A type of cell that forms sheets (epithelial tissue) that cover the surface of the body and line internal organs.
- Epstein-Barr virus** A human herpesvirus that causes B-cell lymphomas.
- equilibrium centrifugation** The separation of particles on the basis of density by centrifugation to equilibrium in a gradient of a dense substance.
- ER-associated degradation (ERAD)** A process in which misfolded proteins in the ER are identified and returned to the cytosol for degradation by the ubiquitin-proteasome system.
- erbB-2** A proto-oncogene encoding a receptor tyrosine kinase that is frequently amplified in breast and ovarian carcinomas.
- ErbA** A proto-oncogene protein corresponding to the thyroid hormone receptor.
- ERK** A member of the MAP kinase family that plays a central role in growth factor-induced cell proliferation.
- erythrocyte** A red blood cell.
- Escherichia coli (E. coli)** A species of bacteria that has been extensively used as a model system for molecular biology.
- estrogen** A steroid hormone produced by the ovaries.
- ethylene** A plant hormone responsible for fruit ripening.
- etioplast** An intermediate stage of chloroplast development in which chlorophyll has not been synthesized.
- euchromatin** Decondensed, transcriptionally active interphase chromatin.
- Eukarya** The third domain of life, defined by cells that contain nuclei.
- eukaryotic cell** A cell that has a nuclear envelope, cytoplasmic organelles, and linear chromosomes.
- excinuclease** The protein complex that excises damaged DNA during nucleotide-excision repair in bacteria.
- exon** A segment of a gene that is included in a spliced mRNA.
- exonuclease** An enzyme that hydrolyzes DNA molecules in either the 5' to 3' or 3' to 5' direction.
- exportin** A karyopherin that recognizes nuclear export signals and directs transport from the nucleus to the cytosol.
- expression vector** A vector used to direct expression of a cloned DNA fragment in a host cell.
- extracellular matrix** Secreted proteins and polysaccharides that fill spaces between cells and bind cells and tissues together.

F

- facilitated diffusion** The transport of molecules across a membrane by carrier or channel proteins.
- FADH₂** See *flavin adenine dinucleotide*.
- FAK (focal adhesion kinase)** A nonreceptor tyrosine kinase that plays a key role in integrin signaling.
- fats** See *triacylglycerols*.
- fatty acid** A long hydrocarbon chain usually linked to a carboxyl group (COO⁻).
- feedback inhibition** A type of allosteric regulation in which the product of a metabolic pathway inhibits the activity of an enzyme involved in its synthesis.
- feedback loop** A regulatory mechanism in which a downstream element of a signaling pathway controls the activity of an upstream component of the pathway.
- feedforward relay** A regulatory mechanism in which one element of a signaling pathway stimulates a downstream component.
- fertilization** The union of a sperm and an egg.
- fibroblast** A cell type found in connective tissue.
- fibronectin** The principal adhesion protein of the extracellular matrix.
- filamentous [F] actin** Actin monomers polymerized into filaments.
- filopodium** A thin projection of the plasma membrane supported by actin bundles.

fimbrin An actin-bundling protein involved in formation of cell surface projections.

flagellum A microtubule-based projection of the plasma membrane that is responsible for cell movement.

flavin adenine dinucleotide (FADH₂) A coenzyme that functions as an electron carrier in oxidation/reduction reactions.

flippase A protein that catalyzes the translocation of lipids across the membrane of the endoplasmic reticulum.

flow cytometer An instrument that measures the fluorescence intensity of individual cells.

fluid mosaic model A model of membrane structure in which proteins are inserted in a fluid phospholipid bilayer.

fluorescence-activated cell sorter An instrument that sorts individual cells on the basis of their fluorescence intensity.

fluorescence *in situ* hybridization A method for detection of RNA or DNA molecules within cells by hybridization with fluorescent probes.

fluorescence microscopy Type of microscopy in which molecules are detected based on the emission of fluorescent light.

fluorescence recovery after photobleaching (FRAP) A method used to study the movement of proteins within living cells.

fluorescence resonance energy transfer (FRET) A method used to study protein interactions within living cells.

focal adhesion A site of attachment of cells to the extracellular matrix at which integrins are linked to bundles of actin filaments.

formin An actin-binding protein that nucleates and polymerizes actin filaments.

Fos A transcription factor, encoded by a proto-oncogene, that is induced in response to growth factor stimulation.

G

γ -tubulin ring complex A protein complex that nucleates the formation of microtubules.

G protein A family of cell signaling proteins regulated by guanine nucleotide binding.

G protein-coupled receptor A receptor characterized by seven membrane-spanning α helices. Ligand binding causes a conformational change that activates a G protein.

G₀ A quiescent state in which cells remain metabolically active but do not proliferate.

G₁ cyclin A yeast cyclin (also called Cln) that controls passage through START.

G₁ phase The phase of the cell cycle between the end of mitosis and the beginning of DNA synthesis.

G₂ phase The phase of the cell cycle between the end of S phase and the beginning of mitosis.

gap junction A plasma membrane channel forming a direct cytoplasmic connection between adjacent cells.

gel electrophoresis A method in which molecules are separated based on their migration in an electric field.

gene A functional unit of inheritance, corresponding to

a segment of DNA that encodes a polypeptide or RNA molecule.

gene amplification An increase in the number of copies of a gene resulting from the repeated replication of a region of DNA.

gene family A group of related genes that have arisen by duplication of a common ancestor.

gene transfer The introduction of foreign DNA into a cell.

general transcription factor A transcription factor that is part of the general transcription machinery.

genetic code The correspondence between nucleotide triplets and amino acids in proteins.

genomic imprinting The regulation of genes whose expression depends on whether they are maternally or paternally inherited, controlled by DNA methylation.

genotype The genetic composition of an organism.

gibberellin A plant hormone.

Gibbs free energy (G) The thermodynamic function that combines the effects of enthalpy and entropy to predict the energetically favorable direction of a chemical reaction.

globular [G] actin Monomers of actin that have not been assembled into filaments.

glucocorticoid A steroid produced by the adrenal gland that acts to stimulate production of glucose.

gluconeogenesis The synthesis of glucose.

glycerol phospholipid A phospholipid consisting of two fatty acids bound to a glycerol molecule.

glycocalyx A carbohydrate coat covering the cell surface.

glycogen A polymer of glucose residues that is the principal storage form of carbohydrates in animals.

glycolipid A lipid consisting of two hydrocarbon chains linked to a polar head group containing carbohydrates.

glycolysis The anaerobic breakdown of glucose.

glycoprotein A protein linked to oligosaccharides.

glycosaminoglycan (GAG) A gel-forming polysaccharide of the extracellular matrix.

glycosidic bond The bond formed between sugar residues in oligosaccharides or polysaccharides.

glycosylation The addition of carbohydrates to proteins.

glycosylphosphatidylinositol (GPI) anchor A glycolipid containing phosphatidylinositol that anchors proteins to the external face of the plasma membrane.

glyoxylate cycle The conversion of fatty acids to carbohydrates in plants.

Golgi apparatus A cytoplasmic organelle involved in the processing and sorting of proteins and lipids. In plant cells, it is also the site of the synthesis of cell wall polysaccharides.

Golgi complex See *Golgi apparatus*.

granulocyte A type of blood cell involved in inflammatory reactions.

green fluorescent protein (GFP) A protein from jellyfish that is commonly used as a marker for fluorescence microscopy.

growth factor A polypeptide that controls animal cell growth and differentiation.

GTPase-activating protein (GAP) A protein that stimulates GTP hydrolysis by the small GTP-binding proteins.

guanine A purine that base-pairs with cytosine.

guanine nucleotide exchange factor (GEF) A protein that acts on small GTP-binding proteins to stimulate the exchange of bound GDP for GTP.

guanylyl cyclase An enzyme that catalyzes the formation of cyclic GMP from GTP.

H

haploid An organism or cell that has one copy of each chromosome.

helicase An enzyme that catalyzes the unwinding of DNA.

hematopoietic stem cell transplantation A clinical procedure in which transplantation of hematopoietic stem cells is used in the treatment of cancer and diseases of the hematopoietic system.

hemicellulose A polysaccharide that cross-links cellulose microfibrils in plant cell walls.

hemidesmosome A region of contact between cells and the extracellular matrix at which keratin filaments are attached to integrin.

hepatitis B virus Member of a family of DNA viruses that infect liver cells and can lead to the development of liver cancer.

hepatitis C virus Member of a family of RNA viruses that infect liver cells and can lead to the development of liver cancer.

herpesvirus Member of a family of DNA viruses, some members of which induce cancer.

heterochromatin Condensed, transcriptionally inactive chromatin.

heterophilic interaction An interaction between two different types of cell adhesion molecules.

heterotrimeric G protein A guanine nucleotide-binding protein consisting of three subunits.

high-energy bond A chemical bond that releases a large amount of free energy when it is hydrolyzed.

histone acetylation The modification of histones by the addition of acetyl groups to specific lysine residues.

histone Member of a family of proteins that package DNA in eukaryotic chromosomes.

homologous recombination Recombination between segments of DNA with homologous nucleotide sequences.

homophilic interaction An interaction between cell adhesion molecules of the same type.

hormone A signaling molecule produced by an endocrine gland that acts on cells at distant body sites.

hydrophilic Soluble in water.

hydrophobic Not soluble in water.

hydrophobic interactions The association of hydrophobic molecules with one another to minimize their interaction with water.

I

IAP Inhibitor of *apoptosis*. A member of a family of proteins that inhibit apoptosis by interacting with caspases.

I κ B An inhibitory subunit of NF- κ B transcription factors.

immediate early gene A gene whose transcription is rapidly induced in response to growth factor stimulation.

immortal cell line Cells that can proliferate indefinitely in culture.

immunoblotting A method that uses antibodies to detect proteins separated by SDS-polyacrylamide gel electrophoresis. Also called Western blotting, it is a variation of Southern blotting.

immunoglobulin See *antibody*.

immunoglobulin (Ig) superfamily A family of cell adhesion molecules containing structural domains similar to immunoglobulins.

immunoprecipitation The use of antibodies to isolate proteins.

immunotherapy Treatment of cancer by stimulating the patient's immune system.

importin A karyopherin that recognizes nuclear localization signals and directs nuclear import.

induced fit A model of enzyme action in which the configurations of both the enzyme and the substrate are altered by substrate binding.

induced pluripotent stem cell An adult somatic cell that has been reprogrammed in culture to resemble an embryonic stem cell.

initiation factor A protein that functions in the initiation stage of translation.

in situ hybridization The use of radioactive or fluorescent probes to detect RNA or DNA sequences in chromosomes or intact cells.

in vitro mutagenesis The introduction of mutations into cloned DNA *in vitro*.

in vitro translation Protein synthesis in a cell-free extract.

integral membrane protein A protein embedded within the lipid bilayer of cell membranes.

integrin A transmembrane protein that mediates the adhesion of cells to the extracellular matrix.

intermediate filament A cytoskeletal filament about 10 nm in diameter that provides mechanical strength to cells in tissues. See also *keratin* and *neurofilament*.

interphase The period of the cell cycle between mitoses that includes G₁, S, and G₂ phases.

interpolar microtubule One of a class of microtubules of the mitotic spindle that overlap in the center of the cell and push the spindle poles apart.

intracellular signal transduction A chain of reactions that transmits chemical signals from the cell surface to their intracellular targets.

intron A noncoding sequence that interrupts exons in a gene.

ion channel A protein that mediates the rapid passage of ions across a membrane by forming open pores through the phospholipid bilayer.

ion pump A protein that couples ATP hydrolysis to the transport of ions across a membrane.

J

Janus kinase (JAK) A family of nonreceptor tyrosine kinases associated with cytokine receptors.

Jun A transcription factor, encoded by a proto-oncogene, that is activated in response to growth factor stimulation.

junctional complex A region of cell–cell contact containing a tight junction, an adherens junction, and a desmosome.

K

Kaposi's sarcoma-associated herpesvirus A human herpesvirus that causes Kaposi's sarcoma.

karyopherin A nuclear transport receptor.

keratin A type of intermediate filament protein of epithelial cells.

kilobase (kb) One thousand nucleotides or nucleotide base pairs.

kinesin A motor protein that moves along microtubules, usually toward the plus end.

kinetochore A specialized structure consisting of proteins attached to a centromere that mediates the attachment and movement of chromosomes along the mitotic spindle.

kinetochore microtubule A microtubule of the mitotic spindle that attaches to condensed chromosomes at their centromeres.

knockout Inactivation of a chromosomal gene by homologous recombination with a cloned mutant allele.

Krebs cycle See *citric acid cycle*.

L

lagging strand The strand of DNA synthesized opposite to the direction of movement of the replication fork by ligation of Okazaki fragments.

lamellipodium A broad, actin-based extension of the plasma membrane involved in the movement of fibroblasts.

lamin An intermediate filament protein that forms the nuclear lamina.

lamina-associated domain (LAD) A region of heterochromatin associated with the nuclear lamina.

laminin The principal adhesion protein of basal laminae.

leading strand The strand of DNA synthesized continuously in the direction of movement of the replication fork.

leucoplast A plastid that stores energy sources in non-photosynthetic plant tissues.

leukemia Cancer arising from the precursors of circulating blood cells.

leukotriene An eicosanoid synthesized from arachidonic acid.

ligand-gated channel An ion channel that opens in response to the binding of signaling molecules.

light reactions The reactions of photosynthesis in which solar energy drives the synthesis of ATP and NADPH.

LINE (long interspersed element) Member of a family of highly repeated retrotransposons in mammalian genomes.

lipid Member of a group of hydrophobic molecules that function as energy storage molecules, signaling molecules, and the major components of cell membranes.

lipid raft A discrete plasma membrane domain formed as a cluster of cholesterol and sphingolipids.

liposome A lipid vesicle used to introduce DNA into mammalian cells.

long noncoding RNA (lncRNA) An RNA longer than 200 nucleotides that regulates gene expression.

low-density lipoprotein (LDL) A lipoprotein particle that transports cholesterol in the circulation.

lymphocyte A blood cell that functions in the immune response. B lymphocytes produce antibodies and T lymphocytes are responsible for cell mediated immunity.

lymphoma A cancer of lymphoid cells.

lysosomal storage disease A family of diseases characterized by the accumulation of undegraded material in the lysosomes of affected individuals.

lysosome A cytoplasmic organelle containing enzymes that break down biological polymers.

M

7-methylguanosine cap A structure consisting of GTP and methylated sugars that is added to the 5' ends of eukaryotic mRNAs.

M phase The mitotic phase of the cell cycle.

macrophage A type of white blood cell specialized for phagocytosis.

macropinocytosis The uptake of fluids in large vesicles.

malignant tumor A tumor that invades normal tissue and spreads throughout the body.

mannose-6-phosphate A modified mannose residue that targets proteins to lysosomes.

MAP kinase A family of mitogen-activated protein-serine/threonine kinases that are ubiquitous regulators of cell growth and differentiation.

mass spectrometry A method for identifying compounds based on accurate determination of their mass. Mass spectrometry is commonly used for protein identification.

matrix The inner mitochondrial space.

matrix processing peptidase (MPP) The protease that cleaves presequences from proteins imported to the matrix of mitochondria.

maturation promoting factor (MPF) A complex of Cdk1 and cyclin B that promotes entry into the M phase of either mitosis or meiosis.

Mediator A complex of proteins that stimulates transcription of eukaryotic protein-coding genes and allows them to respond to gene-specific regulatory factors.

meiosis The division of diploid cells to haploid progeny, consisting of two sequential rounds of nuclear and cellular division.

MEK (MAP kinase/ERK kinase) A dual-specificity protein kinase that phosphorylates and activates members of the ERK family of MAP kinases.

membrane-anchored growth factor A growth factor associated with the plasma membrane that functions as a signaling molecule during cell–cell contact.

Merkel cell polyomavirus A papillomavirus that causes a rare skin cancer (Merkel cell carcinoma) in humans.

- messenger RNA (mRNA)** See *mRNA*.
- messenger RNP (mRNP)** See *mRNP*.
- metaphase** The phase of mitosis during which the chromosomes are aligned on a metaphase plate in the center of the cell.
- metastasis** Spread of cancer cells through the blood or lymphatic system to other organ sites.
- microfilament** A cytoskeleton filament composed of actin.
- microRNA (miRNA)** A naturally occurring short noncoding RNA that acts to regulate gene expression.
- microsome** A small vesicle formed from the endoplasmic reticulum when cells are disrupted.
- microtubule** A cytoskeletal component formed by the polymerization of tubulin into rigid, hollow rods about 25 nm in diameter.
- microtubule-associated protein (MAP)** A protein that binds to microtubules and modifies their stability.
- microtubule-organizing center** An anchoring point near the center of the cell from which most microtubules extend outward.
- microvillus** An actin-based protrusion of the plasma membrane, abundant on the surfaces of cells involved in absorption.
- middle lamella** A region of the plant cell wall that acts as a glue to hold adjacent cells together.
- mismatch repair** A repair system that removes mismatched bases from newly synthesized DNA strands.
- mitochondria** Cytoplasmic organelles responsible for synthesis of most of the ATP in eukaryotic cells by oxidative phosphorylation.
- mitochondrial replacement therapy** Prevention of the inheritance of mitochondrial diseases by replacing a patient's mitochondria with mitochondria from a normal donor, in concert with *in vitro* fertilization
- mitosis** Nuclear division. The most dramatic stage of the cell cycle, corresponding to the separation of daughter chromosomes and usually ending with cell division (cytokinesis).
- mitotic checkpoint complex (MCC)** A complex of proteins that is formed at unattached kinetochores and inhibits progression to anaphase until all chromosomes are aligned on the metaphase spindle.
- mitotic spindle** An array of microtubules extending from the spindle poles that is responsible for separating daughter chromosomes during mitosis. See also *kinetochore microtubule*, *interpolar microtubule*, and *astral microtubule*.
- molecular clone** See *recombinant molecule*.
- molecular cloning** The insertion of a DNA fragment of interest into a DNA molecule (vector) that is capable of independent replication in a host cell.
- molecular motor** A protein that generates force and movement by converting chemical energy to mechanical energy.
- monocistronic** Messenger RNAs that encode a single polypeptide chain.
- monoclonal antibody** An antibody produced by a clonal line of B lymphocytes.
- monocyte** A type of blood cell involved in inflammatory reactions.
- monosaccharide** A simple sugar with the basic formula of $(\text{CH}_2\text{O})_n$.
- motile cilia** Type of cilia responsible for cell movement. See also *cilia*.
- mRNA** An RNA molecule that serves as a template for protein synthesis.
- mRNP** Messenger ribonucleoprotein particles, consisting of mRNA associated with proteins.
- mTOR** A protein kinase involved in regulation of protein synthesis and autophagy in response to growth factors, nutrients, and energy availability.
- multiphoton microscopy** A form of fluorescence microscopy in which the specimen is illuminated with a wavelength of light such that excitation of the fluorescent dye requires the simultaneous absorption of two or more photons.
- muscle fiber** A large cell of skeletal muscle, formed by the fusion of many individual cells during development.
- mutation** A genetic alteration.
- myofibril** A bundle of actin and myosin filaments in muscle cells.
- myosin** A protein that interacts with actin as a molecular motor.
- myosin I** A type of myosin that acts to transport cargo along actin filaments.
- myosin II** A type of myosin that produces contraction by sliding actin filaments.
- myosin light-chain kinase** A protein kinase that activates myosin II by phosphorylating its regulatory light chain.
- ## N
- Na⁺-K⁺ ATPase** See *Na⁺-K⁺ pump*.
- Na⁺-K⁺ pump** An ion pump that transports Na⁺ out of the cell and K⁺ into the cell.
- NADH** See *nicotinamide adenine dinucleotide*.
- NADP reductase** An enzyme that transfers electrons from ferredoxin to NADP⁺, yielding NADPH.
- necroptosis** A form of necrotic cell death that is induced as a programmed response to stimuli such as infection or DNA damage.
- necrosis** Accidental death of cells resulting from an acute injury.
- Nernst equation** The relationship between ion concentration and membrane potential.
- nerve growth factor (NGF)** A polypeptide growth factor that regulates the development and survival of neurons.
- nested gene** A gene contained within an intron of a larger gene.
- network** An array of metabolic or regulatory pathways that interact within a cell.
- neurofilament (NF) protein** A member of a family of intermediate filament proteins of many types of mature nerve cells.
- neuron** A nerve cell specialized to receive and transmit signals throughout the body.

- neuropeptide** A peptide signaling molecule secreted by neurons.
- neurotransmitter** A small, hydrophilic molecule that carries a signal from a stimulated neuron to a target cell at a synapse.
- nexin** A protein that links microtubule doublets to each other in the axoneme.
- next-generation sequencing** New methods that allow rapid sequencing of billions of bases of DNA.
- NF- κ B** A family of transcription factors that are activated in response to a variety of stimuli.
- niche** A microenvironment that maintains stem cells in tissues.
- nicotinamide adenine dinucleotide (NADH)** A coenzyme that functions as an electron carrier in oxidation/reduction reactions.
- nidogen** An extracellular matrix protein that interacts with laminins and type IV collagen in basal laminae.
- nitrogen fixation** The reduction of atmospheric nitrogen (N_2) to NH_3 .
- N-myristoylation** The addition of myristic acid (a 14-carbon fatty acid) to the N-terminal glycine residue of a polypeptide chain.
- nonpolar** A covalent bond in which the atomic nuclei attract electrons to similar extents.
- nonreceptor tyrosine kinase** An intracellular tyrosine kinase.
- Northern blotting** A method in which mRNAs are separated by gel electrophoresis and detected by hybridization with specific probes.
- Notch** A transmembrane receptor in a signaling pathway that regulates cell fate as a result of cell–cell interactions during development.
- nuclear body** A discrete organelle within the nucleus.
- nuclear envelope** The barrier separating the nucleus from the cytoplasm, composed of an inner and outer membrane, a nuclear lamina, and nuclear pore complexes.
- nuclear export signal** An amino acid sequence that targets proteins for transport from the nucleus to the cytosol.
- nuclear lamina** A meshwork of lamin filaments providing structural support to the nucleus.
- nuclear localization signal** An amino acid sequence that targets proteins for transportation from the cytoplasm to the nucleus.
- nuclear membrane** One of the membranes forming the nuclear envelope; the outer nuclear membrane is continuous with the endoplasmic reticulum and the inner nuclear membrane is adjacent to the nuclear lamina.
- nuclear pore complex** A large structure forming a transport channel through the nuclear envelope.
- nuclear receptor superfamily** A family of transcription factors that includes the receptors for steroid hormones, thyroid hormone, retinoic acid, and vitamin D_3 .
- nuclear transport receptor** A protein that recognizes nuclear localization signals and mediates transport across the nuclear envelope.
- nucleic acid hybridization** The formation of double-stranded DNA and/or RNA molecules by complementary base pairing.
- nucleoid** The region of a prokaryotic cell containing its DNA.
- nucleolar organizing region** A chromosomal region containing the genes for ribosomal RNAs.
- nucleolus** The nuclear site of rRNA transcription, processing, and ribosome assembly.
- nucleolus-associated domain (NAD)** A region of heterochromatin associated with the nucleolus.
- nucleoside** A purine or pyrimidine base linked to a sugar (ribose or deoxyribose).
- nucleosome** The basic structural unit of chromatin consisting of DNA wrapped around a histone core.
- nucleosome core particle** Particle containing 146 base pairs of DNA wrapped around an octamer consisting of two molecules each of histones H2A, H2B, H3, and H4.
- nucleotide** A phosphorylated nucleoside.
- nucleotide-excision repair** A mechanism of DNA repair in which oligonucleotides containing damaged bases are removed from a DNA molecule.
- nucleus** The most prominent organelle of eukaryotic cells; contains the genetic material.
- O**
- Okazaki fragment** A short DNA fragment synthesized to form the lagging strand of DNA.
- oligonucleotide** A short polymer of only a few nucleotides.
- oligosaccharide** A short polymer of only a few sugars.
- oncogene** A gene capable of inducing one or more characteristics of cancer cells.
- oncogene addiction** The dependence of cancer cells on the continuing activity of oncogenes.
- open-reading frame** A stretch of nucleotide sequence that does not contain stop codons and can encode a polypeptide.
- operator** A regulatory sequence of DNA that controls transcription of an operon.
- operon** A group of adjacent genes transcribed as a single mRNA.
- origin of replication** A specific DNA sequence that serves as a binding site for proteins that initiate replication.
- origin recognition complex (ORC)** A protein complex that initiates DNA replication at eukaryotic origins.
- oxidative metabolism** The use of molecular oxygen as an electron acceptor in the breakdown of organic molecules.
- oxidative phosphorylation** The synthesis of ATP from ADP, coupled to the energetically favorable transfer of electrons to molecular oxygen as the final acceptor in an electron transport chain.
- P**
- p53** A transcription factor (encoded by the *p53* tumor suppressor gene) that arrests the cell cycle in G_1 in response

- to damaged DNA and is required for apoptosis induced by a variety of stimuli.
- p53** Tumor suppressor gene encoding the p53 protein.
- palmitoylation** The addition of palmitic acid (a 16-carbon fatty acid) to cysteine residues of a polypeptide chain.
- papillomavirus** A member of a family of DNA viruses, some of which cause cervical and other anogenital cancers in humans.
- paracrine signaling** Local cell–cell signaling in which a molecule released by one cell acts on a neighboring target cell.
- passive transport** The transport of molecules across a membrane in the energetically favorable direction.
- pectin** A gel-forming polysaccharide in plant cell walls.
- peptide bond** The bond joining amino acids in polypeptide chains.
- peptide hormone** A signaling molecule composed of amino acids.
- peptidoglycan** The principal component of bacterial cell walls consisting of linear polysaccharide chains cross-linked by short peptides.
- peptidyl prolyl isomerase** An enzyme that facilitates protein folding by catalyzing the *cis-trans* isomerization of prolyl peptide bonds.
- pericentriolar material** The material in the centrosome that initiates microtubule assembly.
- peripheral membrane protein** A protein that is indirectly associated with cell membranes by protein-protein interactions.
- peroxin** A peroxisome transmembrane protein that is involved in peroxisome assembly. A Pex protein.
- peroxisome** A cytoplasmic organelle specialized for carrying out oxidative reactions.
- peroxisome biogenesis disorder** A disease resulting from a mutation in one of the peroxins responsible for peroxisome assembly.
- Pex protein** A peroxisome transmembrane protein that is involved in peroxisome assembly. A peroxin.
- phagocytosis** The uptake of large particles, such as bacteria, by a cell, sometimes called “cell eating.”
- phagolysosome** A lysosome that has fused with a phagosome or autophagosome.
- phagosome** A vacuole containing a particle taken up by phagocytosis.
- phase-contrast microscopy** A type of microscopy in which variations in density or thickness between parts of the cell are converted to differences in contrast in the final image.
- phenotype** The physical appearance of an organism.
- phosphatidylcholine** A glycerol phospholipid with a head group formed from choline.
- phosphatidylethanolamine** A glycerol phospholipid with a head group formed from ethanolamine.
- phosphatidylinositide (PI) 3-kinase** An enzyme that phosphorylates PIP₂, yielding the second messenger phosphatidylinositol 3,4,5-trisphosphate (PIP₃).
- phosphatidylinositol** A glycerol phospholipid with a head group formed from inositol.
- phosphatidylinositol 3,4,5-trisphosphate (PIP₃)** A second messenger formed by phosphorylation of PIP₂.
- phosphatidylinositol 4,5-bisphosphate (PIP₂)** A phospholipid component of the inner leaflet of the plasma membrane. Hormones and growth factors stimulate its hydrolysis by phospholipase C, yielding the second messengers diacylglycerol and inositol trisphosphate, and its phosphorylation by PI 3-kinase, yielding the second messenger PIP₃.
- phosphatidylserine** A glycerol phospholipid with a head group formed from serine.
- phosphodiester bond** A bond between the 5'-phosphate of one nucleotide and the 3'-hydroxyl of another.
- phospholipid** One of a family of molecules that are the principal components of cell membranes, consisting of two hydrocarbon chains (usually fatty acids) joined to a polar head group containing phosphate.
- phospholipid bilayer** The basic structure of biological membranes in which the hydrophobic tails of phospholipids are buried in the interior of the membrane and their polar head groups are exposed to the aqueous solution on either side.
- phospholipid transfer protein** A protein that transports phospholipid molecules between cell membranes.
- phosphorylation** The addition of a phosphate group to a molecule.
- photocenter** An assembly of photosynthetic pigments in the thylakoid membrane of chloroplasts.
- photoactivation** A mechanism of DNA repair in which solar energy is used to split pyrimidine dimers.
- photorespiration** A process that metabolizes a byproduct of photosynthesis.
- photosynthesis** The process by which cells harness energy from sunlight and synthesize glucose from CO₂ and water.
- photosystem I** A protein complex in the thylakoid membrane that uses energy absorbed from sunlight to synthesize NADPH.
- photosystem II** A protein complex in the thylakoid membrane that uses energy absorbed from sunlight to synthesize ATP.
- PI 3-kinase** See *phosphatidylinositide (PI) 3-kinase*.
- plakin** A member of a family of proteins that link intermediate filaments to other cellular structures.
- plant hormone** Member of a group of small molecules that coordinate the responses of plant tissues to environmental signals.
- plasma membrane** A phospholipid bilayer with associated proteins that surrounds the cell.
- plasmalogen** A phospholipid that has an ether bond and an ester bond.
- plasmid** A small, circular DNA molecule capable of independent replication in a host cell.
- plasmodesma** A cytoplasmic connection between adjacent plant cells formed by a continuous region of the plasma membrane.
- plastid** Member of a family of plant organelles including chloroplasts, chromoplasts, leucoplasts, amyloplasts, and elaioplasts.

- platelet-derived growth factor (PDGF)** A growth factor released by platelets during blood clotting to stimulate the proliferation of fibroblasts.
- pluripotency** The capacity to develop into all of the different types of cells in adult tissues and organs.
- PML/RAR α** An oncogene protein formed by translocation of the retinoic acid receptor in acute promyelocytic leukemia.
- polar** A covalent bond between atoms that differ in electronegativity, in which the shared electrons are unevenly distributed.
- Polo-like kinase** A protein kinase involved in mitotic spindle formation, kinetochore function, and cytokinesis.
- poly-A tail** A tract of about 200 adenine nucleotides added to the 3' ends of eukaryotic mRNAs.
- polyadenylation** The process of adding a poly-A tail to a pre-mRNA.
- polycistronic** Messenger RNAs that encode multiple polypeptide chains.
- Polycomb body** A nuclear body enriched in Polycomb proteins.
- Polycomb proteins** A complex of repressor proteins that methylate histone H3 lysine 27.
- polymerase chain reaction (PCR)** A method for amplifying a region of DNA by repeated cycles of DNA synthesis *in vitro*.
- polynucleotide** A polymer containing up to millions of nucleotides.
- polyomavirus** A widely studied DNA tumor virus.
- polyp** A benign tumor projecting from an epithelial surface.
- polypeptide** A polymer of amino acids.
- polysaccharide** A polymer containing hundreds or thousands of sugars.
- ribosome** A series of ribosomes translating a messenger RNA.
- porin** A member of a class of proteins that cross membranes as β barrels and form channels in the outer membranes of some bacteria, mitochondria, and chloroplasts.
- pre-mRNA** The primary transcript, which is processed to form messenger RNAs in eukaryotic cells.
- pre-rRNA** The primary transcript, which is cleaved to form individual ribosomal RNAs (the 28S, 18S, and 5.8S rRNAs of eukaryotic cells).
- pre-tRNA** The primary transcript, which is cleaved to form transfer RNAs.
- prenylation** The addition of specific types of lipids (prenyl groups) to C-terminal cysteine residues of a polypeptide chain.
- presequence** An amino-terminal sequence that targets proteins to mitochondria.
- primary cilia** Type of cilia found on most animal cells and involved in sensing extracellular signals.
- primary culture** The initial cell culture established from a tissue.
- primary structure** The sequence of amino acids in a polypeptide chain.
- primase** An RNA polymerase used to initiate DNA synthesis.
- prion** A misfolded protein capable of self-replication.
- processed pseudogene** A pseudogene that has arisen by reverse transcription of mRNA.
- procollagen** Soluble precursor to the fibril-forming collagens.
- product** A compound formed as a result of an enzymatic reaction.
- profilin** An actin-binding protein that stimulates the assembly of actin monomers into filaments.
- progesterone** A steroid hormone produced by the ovaries.
- programmed cell death** A normal physiological form of cell death characterized by apoptosis.
- prokaryotic cell** A cell lacking a nuclear envelope and cytoplasmic organelles.
- prometaphase** A transition period between prophase and metaphase during which the microtubules of the mitotic spindle attach to the kinetochores and the chromosomes shuffle until they align in the center of the cell.
- promoter** A DNA sequence at which RNA polymerase binds to initiate transcription.
- pronucleus** One of the two haploid nuclei in a newly fertilized egg.
- proofreading** The selective removal of mismatched bases by DNA polymerase.
- prophase** The beginning phase of mitosis, marked by the appearance of condensed chromosomes and the development of the mitotic spindle.
- proplastid** A small undifferentiated organelle that can develop into different types of mature plastids.
- prosthetic group** A small molecule bound to a protein.
- proteasome** A large protease complex that degrades proteins tagged by ubiquitin.
- protein** A polypeptide with a unique amino acid sequence.
- protein disulfide isomerase (PDI)** An enzyme that catalyzes the formation and breakage of disulfide (S-S) linkages.
- protein kinase** An enzyme that phosphorylates proteins by transferring a phosphate group from ATP.
- protein kinase A** A protein kinase (also called cAMP-dependent protein kinase) regulated by cyclic AMP.
- protein misfolding disease** A disease resulting from defective protein folding.
- protein phosphatase** An enzyme that reverses the action of protein kinases by removing phosphate groups from phosphorylated amino acid residues.
- proteoglycan** A protein linked to glycosaminoglycans.
- proteolysis** Degradation of polypeptide chains.
- proteome** All of the proteins expressed in a given cell.
- proteomics** Large-scale analysis of cell proteins.
- proto-oncogene** A normal cell gene that can be converted into an oncogene.
- pseudogene** A nonfunctional gene copy.
- pseudopodium** An actin-based extension of the plasma membrane responsible for phagocytosis and amoeboid movement.

PTEN A lipid phosphatase that dephosphorylates PIP₃ and acts as a tumor suppressor.

purine One of the types of bases present in nucleic acids. The purines are adenine and guanine.

pyrimidine One of the types of bases present in nucleic acids. The pyrimidines are cytosine, thymine, and uracil.

pyrimidine dimer A common form of DNA damage caused by UV light in which adjacent pyrimidines are joined to form a dimer.

Q

quaternary structure The interactions between polypeptide chains in proteins consisting of more than one polypeptide.

R

Rab A family of small GTP-binding proteins that play key roles in vesicular transport.

Rad51 The eukaryotic homolog of RecA.

Raf A serine/threonine kinase (encoded by the *raf* oncogene) that is activated by Ras and leads to activation of the ERK MAP kinase.

raf Gene encoding Raf proteins.

Ran A small GTP-binding protein involved in nuclear import and export.

Ras A family of small GTP binding proteins (encoded by the *ras* oncogenes) that couple growth factor receptors to intracellular targets, including the Raf serine/threonine kinase and the ERK MAP kinase pathway.

ras Gene encoding Ras proteins.

Rb Tumor suppressor gene that encodes the Rb protein.

Rb A transcriptional regulatory protein that controls cell cycle progression and is encoded by a tumor suppressor gene that was identified by the genetic analysis of retinoblastoma.

real-time PCR A method in which the polymerase chain reaction (PCR) is used to quantitate the amount of target DNA or RNA present in a sample.

RecA A protein that promotes the exchange of strands between homologous *E. coli* DNA molecules during recombination.

receptor tyrosine kinase A membrane-spanning tyrosine kinase that is a receptor for extracellular ligands.

recessive An allele that is masked by a dominant allele.

recombinant molecule A DNA insert joined to a vector.

recombinational repair The repair of damaged DNA by recombination with an undamaged homologous DNA molecule.

release factor A protein that recognizes stop codons and terminates translation of mRNA.

replication factory A large complex containing clustered sites of DNA replication in eukaryotic cells.

replication fork The region of DNA synthesis where the parental strands separate and two new daughter strands elongate.

repressor A regulatory molecule that blocks transcription.

reproductive cloning The use of nuclear transfer to create a cloned organism.

resolution The ability of a microscope to distinguish objects separated by small distances.

restriction endonuclease An enzyme that cleaves DNA at a specific sequence.

restriction point A regulatory point in animal cell cycles that occurs late in G₁. After this point, a cell is committed to entering S and undergoing one cell division cycle.

retinoic acid A signaling molecule synthesized from vitamin A.

retinoid A molecule related to retinoic acid.

retrotransposition Movement of a transposable element via reverse transcription of an RNA intermediate.

retrotransposon A transposable element that moves via reverse transcription of an RNA intermediate.

retrovirus A virus that replicates by making a DNA copy of its RNA genome by reverse transcription.

retrovirus-like element A retrotransposon that is structurally similar to a retrovirus.

reverse transcriptase A DNA polymerase that uses an RNA template.

reverse transcription Synthesis of DNA from an RNA template.

Rho A family of small GTP-binding proteins involved in regulation of the cytoskeleton.

ribonucleic acid (RNA) A polymer of ribonucleotides.

ribose The five-carbon sugar found in RNA.

ribosomal RNA (rRNA) The RNA component of ribosomes.

ribosome A particle composed of RNA and proteins that is the site of protein synthesis.

ribozyme An RNA enzyme.

RNA editing RNA processing events other than splicing that alter the protein coding sequences of mRNAs.

RNA interference (RNAi) The degradation of mRNAs by short complementary double-stranded RNA molecules.

RNA polymerase An enzyme that catalyzes the synthesis of RNA.

RNA-seq Global analysis of RNAs by next-generation sequencing.

RNA splicing The joining of exons in a precursor RNA molecule.

RNase H An enzyme that degrades the RNA strand of RNA-DNA hybrid molecules.

RNase P A ribozyme that cleaves the 5' end of pre-tRNAs.

RNA world An early stage of evolution based on self-replicating RNA molecules.

rough ER The region of the endoplasmic reticulum covered with ribosomes and involved in protein metabolism.

Rous sarcoma virus (RSV) An acutely transforming retrovirus in which the first oncogene was identified.

rRNA See *ribosomal RNA*.

S

S phase The phase of the cell cycle during which DNA replication occurs.

Saccharomyces cerevisiae A frequently studied budding yeast.

- sarcoma** A cancer of cells of connective tissue.
- sarcomere** The contractile unit of muscle cells composed of interacting myosin and actin filaments.
- sarcoplasmic reticulum** A specialized network of membranes in muscle cells that stores a high concentration of Ca^{2+} .
- satellite DNA** Simple-sequence repetitive DNA with a buoyant density differing from the bulk of genomic DNA.
- scaffold protein** A protein that binds to components of signaling pathways, leading to their organization in specific signaling cassettes.
- scanning electron microscopy** See *electron microscopy*.
- SDS-polyacrylamide gel electrophoresis (SDS-PAGE)** A commonly used method to separate proteins by gel electrophoresis on the basis of size.
- second messenger** A compound whose metabolism is modified as a result of a ligand-receptor interaction; it functions as a signal transducer by regulating other intracellular processes.
- secondary response gene** A gene whose induction following growth factor stimulation of a cell requires protein synthesis.
- secondary structure** The regular arrangement of amino acids within localized regions of a polypeptide chain. See α *helix* and β *sheet*.
- secretory pathway** The movement of secreted proteins from the endoplasmic reticulum to the Golgi apparatus and then, within secretory vesicles, to the cell surface.
- secretory vesicle** A membrane-enclosed sac that transports proteins from the Golgi apparatus to the cell surface.
- selectin** A type of cell adhesion molecule that recognizes oligosaccharides exposed on the cell surface.
- self-splicing** The ability of some RNAs to catalyze the removal of their own introns.
- semiconservative replication** The process of DNA replication in which the two parental strands separate and serve as templates for the synthesis of new progeny strands.
- serine/threonine kinase** A protein kinase that phosphorylates serine and threonine residues.
- serum response element (SRE)** A regulatory sequence that is recognized by the serum response factor and mediates the transcriptional induction of many immediate early genes in response to growth factor stimulation.
- serum response factor (SRF)** A transcription factor that binds to the serum response element.
- SH2 domain** A protein domain of approximately 100 amino acids that binds phosphotyrosine-containing peptides.
- Shine-Dalgarno sequence** The sequence prior to the initiation site that correctly aligns bacterial mRNAs on ribosomes.
- short interfering RNA (siRNA)** A short noncoding double-strand RNA that acts in the RNA interference pathway.
- signaling network** The interconnected network formed by the interactions of multiple signaling pathways within a cell.
- signal peptidase** An enzyme that removes the signal sequence of a polypeptide chain by proteolysis.
- signal recognition particle (SRP)** A particle composed of proteins and RNA that binds to signal sequences and targets polypeptide chains to the endoplasmic reticulum.
- signal sequence** A hydrophobic sequence at the amino terminus of a polypeptide chain that targets it for secretion in bacteria or incorporation into the endoplasmic reticulum in eukaryotic cells.
- signal transduction** A chain of reactions that transmits chemical signals from the cell surface to their intracellular targets.
- simian virus 40 (SV40)** A widely studied DNA tumor virus.
- simple-sequence repeat** Member of a class of repeated DNA sequences consisting of tandem arrays of thousands of copies of short sequences.
- SINE (short interspersed element)** Member of a family of highly repeated retrotransposons in mammalian genomes.
- single bonds** Type of chemical bond in which atoms share a single pair of electrons.
- single-stranded DNA-binding protein** A protein that stabilizes unwound DNA by binding to single-stranded regions.
- siRNA** See *short interfering RNA*.
- sliding filament model** The model of muscle contraction in which contraction results from the sliding of actin and myosin filaments relative to each other.
- Smad** A family of transcription factors activated by TGF- β receptors.
- small nuclear ribonucleoprotein particle (snRNP)** Complex of an snRNA with proteins.
- small nuclear RNA (snRNA)** A nuclear RNA ranging in size from 50 to 200 bases.
- small nucleolar RNA (snoRNA)** A small RNA present in the nucleolus that functions in pre-rRNA processing.
- smooth ER** The region of the endoplasmic reticulum that is the major site of lipid synthesis in eukaryotic cells.
- SNARE** A transmembrane protein that mediates fusion of vesicle and target membranes.
- snoRNPs** Complex of a snoRNA with proteins.
- somatic cell nuclear transfer** The basic procedure of animal cloning in which the nucleus of an adult somatic cell is transferred to an enucleated egg.
- somatic hypermutation** The introduction of multiple mutations within rearranged immunoglobulin variable regions to increase antibody diversity.
- Southern blotting** A method in which radioactive or fluorescent probes are used to detect specific DNA fragments that have been separated by gel electrophoresis.
- speckle** A nuclear body that contains components of the mRNA splicing machinery.
- spectrin** A major actin-binding protein of the cell cortex.

sphingomyelin A phospholipid consisting of two hydrocarbon chains bound to a polar head group containing serine.

spindle assembly checkpoint A cell cycle checkpoint that monitors the alignment of chromosomes on the metaphase spindle.

spliceosome A large complex of snRNAs and proteins that catalyzes the splicing of pre-mRNAs.

src 1. Gene encoding Src protein. 2. The oncogene of Rous sarcoma virus.

Src A nonreceptor tyrosine kinase encoded by *src*.

SRP receptor A protein on the membrane of the endoplasmic reticulum that binds the signal recognition particle (SRP).

SRP RNA The small cytoplasmic RNA component of SRP.

stability gene A gene that acts to maintain the integrity of the genome and whose loss can lead to the development of cancer.

starch A polymer of glucose residues that is the principal storage form of carbohydrates in plants.

START A regulatory point in the yeast cell cycle that occurs late in G₁. After this point a cell is committed to entering S and undergoing one cell division cycle.

STAT protein Member of a family of transcription factors that have an SH2 domain and are activated by tyrosine phosphorylation, which promotes their translocation from the cytoplasm to the nucleus.

stem cell A cell that divides to produce daughter cells that can either differentiate or remain as stem cells.

stereocilium A specialized microvillus of auditory hair cells.

steroid hormone A member of a group of hydrophobic hormones, including estrogen and testosterone, that are derivatives of cholesterol.

stress fiber A bundle of actin filaments anchored at sites of cell adhesion to the extracellular matrix.

stroma The compartment of chloroplasts that lies between the envelope and the thylakoid membrane.

stromal processing peptidase (SPP) The protease that cleaves transit peptides from proteins imported to the chloroplast stroma.

substrate A molecule acted upon by an enzyme.

super-resolution light microscopy New techniques that break the diffraction barrier of the light microscope and increase the resolution of fluorescence microscopy to the range of 10-100 nm.

synapse The junction between a neuron and another cell, across which information is carried by neurotransmitters.

synaptic vesicle A secretory vesicle that releases neurotransmitters at a synapse.

synthetic biology An engineering approach to design and create new biological systems.

systems biology A new field of biology in which large-scale experimental approaches are combined with quantitative analysis and modeling to study complex biological systems.

T

T cell receptor A T lymphocyte surface protein that recognizes antigens expressed on the surface of other cells.

talin A protein that mediates the association of actin filaments with integrins at focal adhesions.

tandem mass spectrometry A method in which sequential analyses by mass spectrometry is used to determine the amino acid sequence of a peptide.

TATA box A regulatory DNA sequence found in the promoters of many eukaryotic genes transcribed by RNA polymerase II.

TATA-binding protein (TBP) A basal transcription factor that binds directly to the TATA box.

taxol A drug that binds to and stabilizes microtubules.

TBP-associated factor (TAF) A polypeptide associated with TBP in the general transcription factor TFIID.

telomerase A reverse transcriptase that synthesizes telomeric repeat sequences at the ends of chromosomes from its own RNA template.

telomere A repeat of simple-sequence DNA that maintains the ends of linear chromosomes.

telophase The final phase of mitosis, during which the nuclei re-form and chromosomes decondense.

tertiary structure The three-dimensional folding of a polypeptide chain that gives the protein its functional form.

testosterone A steroid hormone produced by the testes.

tethering factor A protein that mediates the initial interactions between transport vesicles and their target membranes.

therapeutic cloning A procedure in which nuclear transfer into oocytes could be used to produce embryonic stem cells for use in transplantation therapy.

thylakoid membrane The innermost membrane of chloroplasts that is the site of electron transport and ATP synthesis.

thymine A pyrimidine found in DNA that base-pairs with adenine.

thyroid hormone A hormone synthesized from tyrosine in the thyroid gland.

Tic complex The protein translocation complex of the chloroplast inner membrane.

tight junction A continuous network of protein strands around the circumference of epithelial cells, sealing the space between cells and forming a barrier between the apical and basolateral domains.

Tim complex The protein translocation complex of the mitochondrial inner membrane.

Toc complex The protein translocation complex of the chloroplast outer membrane.

Toll-like receptor Member of a family of receptors that recognize a variety of molecules associated with pathogenic bacteria and viruses.

Tom complex The protein translocation complex of the mitochondrial outer membrane.

topoisomerase An enzyme that catalyzes the reversible breakage and rejoining of DNA strands.

trans Golgi network The Golgi compartment within which proteins are sorted and packaged to exit the Golgi apparatus.

transcription The synthesis of an RNA molecule from a DNA template.

transcription factor A protein that regulates the activity of RNA polymerase.

transcription factory A clustered site in the nucleus where transcription of multiple genes occurs.

transcriptome All of the RNAs that are transcribed in a cell.

transcriptional activator A transcription factor that stimulates transcription.

transdifferentiation Differentiation of one type of somatic cell into another differentiated cell type.

transfection The introduction of a foreign gene into eukaryotic cells.

transfer RNA (tRNA) An RNA molecule that functions as an adaptor between amino acids and mRNA during protein synthesis.

transformation The transfer of DNA between genetically distinct bacteria. See also *cell transformation*.

transforming growth factor β (TGF- β) A polypeptide growth factor that generally inhibits animal cell proliferation.

transgenic mouse A mouse that carries foreign genes that are incorporated into the germ line.

transient expression The expression of unintegrated plasmid DNAs that have been introduced into cultured cells.

transition state A high energy state through which substrates must pass during the course of an enzymatic reaction.

transit peptide An N-terminal sequence that targets proteins for import into chloroplasts.

translation The synthesis of a polypeptide chain from an mRNA template.

translesion DNA synthesis A form of repair in which specialized DNA polymerases replicate across a site of DNA damage.

translocon The membrane channel through which polypeptide chains are transported into the endoplasmic reticulum.

transmembrane protein An integral membrane protein that spans the lipid bilayer and has portions exposed on both sides of the membrane.

transmission electron microscopy See *electron microscopy*.

transposable element A DNA sequence that can move to different positions in the genome.

treadmilling A dynamic behavior of actin filaments and microtubules in which the loss of subunits from one end of the filament is balanced by their addition to the other end.

triacylglycerol Three fatty acids linked to a glycerol molecule.

triglyceride See triacylglycerol.

tRNA See *transfer RNA*.

tropomyosin A fibrous protein that binds actin filaments and regulates contraction by blocking the interaction of actin and myosin.

troponin A complex of proteins that binds to actin filaments and regulates skeletal muscle contraction.

tubulin A cytoskeletal protein that polymerizes to form microtubules.

tumor Any abnormal proliferation of cells.

tumor initiation The first step in tumor development, resulting from abnormal proliferation of a single cell.

tumor necrosis factor (TNF) A polypeptide growth factor that induces inflammation and programmed cell death.

tumor progression The accumulation of mutations within cells of a tumor population, resulting in increasingly rapid growth and malignancy.

tumor promoter A compound that leads to tumor development by stimulating cell proliferation.

tumor suppressor gene A gene whose inactivation leads to tumor development.

tumor virus A virus capable of causing cancer in animals or humans.

turgor pressure The internal hydrostatic pressure within plant cells.

tyrosine kinase A protein kinase that phosphorylates tyrosine residues.

U

3' untranslated region (UTR) A noncoding region at the 3' end of mRNA.

5' untranslated region (UTR) A noncoding region at the 5' end of mRNA.

ubiquinone See *coenzyme Q*.

ubiquitin A highly conserved protein that acts as a marker to target other cellular proteins for rapid degradation.

ubiquitin-proteasome pathway Major cellular pathway for regulated protein degradation.

ultracentrifuge A centrifuge that rotates samples at high speeds

unconventional myosin A type of myosin other than that found in muscle cells (myosin II).

unfolded protein response (UPR) A cellular stress response in which an excess of unfolded proteins in the endoplasmic reticulum leads to general inhibition of protein synthesis, increased expression of chaperones, and increased proteasome activity.

uracil A pyrimidine found in RNA that base-pairs with adenine.

V

vacuole A large membrane-enclosed sac in the cytoplasm of eukaryotic cells. In plant cells, vacuoles function to store nutrients and waste products, to degrade macromolecules, and to maintain turgor pressure.

van der Waals interaction A weak interaction that occurs when any two atoms are close together.

vector A DNA molecule used to direct the replication of a cloned DNA fragment in a host cell.

velocity centrifugation The separation of particles based on their rates of sedimentation.

video-enhanced microscopy The combined use of video cameras with the light microscope to allow the visualization of small objects.

villin The major actin-bundling protein of intestinal microvilli.

vimentin An intermediate filament protein found in a variety of different kinds of cells.

vinblastine A drug that inhibits microtubule polymerization.

vincristine A drug that inhibits microtubule polymerization.

vinculin A protein that mediates the association of actin filaments with integrins at focal adhesions.

vitamin D₃ A vitamin that regulates calcium metabolism and bone growth by stimulating the activity of a member of the nuclear receptor superfamily.

voltage-gated channel An ion channel that opens in response to changes in electric potential.

W

WASP A protein that stimulates actin filament branching.

Western blotting See *immunoblotting*.

Wnt A secreted signaling molecule that stimulates a pathway regulating cell fate during embryonic development.

X

X chromosome inactivation A dosage compensation mechanism in which most of the genes on one X chromosome are inactivated in female cells.

X-ray crystallography A method in which the diffraction pattern of X-rays is used to determine the arrangement of individual atoms within a molecule.

Xenopus laevis An African clawed frog used as a model system for developmental biology.

Y

yeast The simplest unicellular eukaryotes. Yeasts are important models for studies of eukaryotic cells.

yeast artificial chromosome (YAC) A vector that can replicate as a chromosome in yeast cells and can accommodate very large DNA inserts (hundreds of kb).

yeast two-hybrid system A method in which yeast genetics is used to identify proteins that interact with one another.

Z

zebrafish A species of small fish used for genetic studies of vertebrate development.