**AN AGRICULTURAL AND ENVIRONMENTAL BIOTECHNOLOGY ANNOTATED DICTIONARY**

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**A**

**Abiotic stress.** Outside (nonliving) factors which can cause harmful effects to plants, such as soil conditions, drought, extreme temperatures.

**Abzyme.** See Catalytic antibody.

**Adaptive radiation.** The evolution of new species or sub- species to fill unoccupied ecological niches.

**Aerobe.** A microorganism that grows in the presence of oxygen. See Anaerobe.

**Agarose gel electrophoresis.** A matrix composed of a highly purified form of agar that is used to separate larger DNA and RNA molecules ranging 20,000 nucleotides. (See Electrophoresis.)

**Alleles.** Alternate forms of a gene or DNA sequence, which occur on either of two homologous chromosomes in a diploid organism. (See DNA polymorphism.)

**Alternative mRNA splicing.** The inclusion or exclusion of different exons to form different mRNA transcripts. (See RNA.)

**Amino acid.** Any of 20 basic building blocks of proteins-- composed of a free amino (NH2) end, a free carboxyl (COOH) end, and a side group (R).

**Ampicillin (beta-lactamase).** An antibiotic derived from penicillin that prevents bacterial growth by interfering with cell wall synthesis.

**Amplify.** To increase the number of copies of a DNA sequence, in vivo by inserting into a cloning vector that replicates within a host cell, or in vitro by polymerase chain reaction (PCR).

**Anaerobe.** An organism that grows in the absence of oxygen. See Aerobe.

**Anneal.** The pairing of complementary DNA or RNA sequences, via hydrogen bonding, to form a double-stranded polynucleotide. Most often used to describe the binding of a short primer or probe.

**Antibiotic.** A class of natural and synthetic compounds that inhibit the growth of or kill other microorganisms. (See Antibiotic resistance, Bacteriocide, Bacteriostat.)

**Antibiotic resistance.** The ability of a microorganism to produce a protein that disables an antibiotic or prevents transport of the antibiotic into the cell.

**Antibody.** An immunoglobulin protein produced by B- lymphocytes of the immune system that binds to a specific antigen molecule. (See monoclonal antibodies, polyclonal antibodies.)

**Anticodon.** A nucleotide base triplet in a transfer RNA molecule that pairs with a complementary base triplet, or codon, in a messenger RNA molecule. See Codon, Messenger RNA, RNA.

**Antigen.** Any foreign substance, such as a virus, bacterium, or protein, that elicits an immune response by stimulating the production of antibodies. (See Antigenic determinant, antigenic switching.)

**Antigenic determinant.** A surface feature of a microorganism or macromolecule, such as a glycoprotein, that elicits an immune response.

**Antigenic switching.** The altering of a microorganism's surface antigens through genetic rearrangement, to elude detection by the host's immune system.

**Antimicrobial agent.** Any chemical or biological agent that harms the growth of microorganisms.

**Anti-oncogene.** See Recessive oncogene.

**Antisense RNA.** A complementary RNA sequence that binds to a naturally occurring (sense) mRNA molecule, thus blocking its translation. (See RNA.)

**Asexual reproduction.** Nonsexual means of reproduction which can include grafting and budding.

**Autosome.** A chromosome that is not involved in sex determination.

**B**

**beta-DNA.** The normal form of DNA found in biological systems, which exists as a right-handed helix.

**beta-Lactamase.** Ampicillin resistance gene. (See Selectable marker.)

**Bacillus.** A rod-shaped bacterium.

**Bacillus thuringiensis (Bt).** A bacterium that kills insects; a major component of the microbial pesticide industry.

**Backcross.** Crossing an organism with one of its parent organisms.

**Bacteriocide.** A class of antibiotics that kills bacterial cells.

**Bacteriophage (phage or phage particle).** A virus that in- fects bacteria. Altered forms are used as vectors for cloning DNA.

**Bacteriostat.** A class of antibiotics that prevents growth of bacterial cells.

**Bacterium.** A single-celled, microscopic prokaryotic organism: a single cell organism without a distinct nucleus.

**Base pair (bp).** A pair of complementary nitrogenous bases in a DNA molecule--adenine-thymine and guanine-cytosine. Also, the unit of measurement for DNA sequences.

**Bioaugmentation.** Increasing the activity of bacteria that decompose pollutants; a technique used in bioremediation.

**Biodiversity.** The wide diversity and interrelatedness of earth organisms based on genetic and environmental factors.

**Bioenrichment.** Adding nutrients or oxygen to increase microbial breakdown of pollutants.

**Biofilms.** See Microbial mats.

**Biologics.** Agents, such as vaccines, that give immunity to diseases or harmful biotic stresses.

**Biomass.** The total dry weight of all organisms in a particular sample, population, or area.

**Bioremediation.** The use of microorganisms to remedy environmental problems. See Bioaugmentation, Bioenrichment.

**Biotechnology.** The scientific manipulation of living organ- isms, especially at the molecular genetic level, to produce useful products. Gene splicing and use of recombinant DNA (rDNA) are major techniques used.

**Biotic stress.** Living organisms which can harm plants , such as viruses, fungi, and bacteria, and harmful insects. See Abiotic stress.

**bP.** See Base pair.

**Bt.** See Bacillus thuringiensis.

**C**

**Capsid.** See Coat protein.

**Carcinogen.** A substance that induces cancer.

**Carcinoma.** A malignant tumor derived from epithelial tissue, which forms the skin and outer cell layers of internal organs.

**Catalyst.** A substance that promotes a chemical reaction by lowering the activation energy of a chemical reaction, but which itself remains unaltered at the end of the reaction. (See Catalytic antibody, Catalytic RNA.)

**Catalytic antibody (abzyme).** An antibody selected for its ability to catalyze a chemical reaction by binding to and stabilizing the transition state intermediate.

**Catalytic RNA (ribozyme).** A natural or synthetic RNA molecule that cuts an RNA substrate.

**Cation.** A positively charged ion.

**cDNA.** DNA synthesized from an RNA template using reverse transcriptase.

**cDNA library.** A library composed of complementary copies of cellular mRNAs. (See Library.)

**Cellular oncogene (proto-oncogene).** A normal gene that when mutated or improperly expressed contributes to the development of cancer. (See Oncogene.)

**Centers of origin.** Usually the location in the world where the oldest cultivation of a particular crop has been identified.

**Central dogma.** Francis Crick's seminal concept that in nature genetic information generally flows from DNA to RNA to protein.

**Centrifugation.** Separating molecules by size or density using centrifugal forces generated by a spinning rotor. G forces of several hundred thousand times gravity are generated in ultracentrifugation. (See Density gradient centrifugation.)

**Centromere.** The central portion of the chromosome to which the spindle fibers attach during mitotic and meiotic division.

**Chemotherapy.** A treatment for cancers that involves ad- ministering chemicals toxic to malignant cells.

**Chloramphenicol.** An antibiotic that interferes with protein synthesis.

**Chromatid.** Each of the two daughter strands of a duplicated chromosome joined at the centromere during mitosis and meiosis.

**Chromosome.** A single DNA molecule, a tightly coiled strant of DNA, condensed into a compact structure in vivo by complexing with accessory histones or histone-like proteins. Chromosomes exist in pairs in higher eukaryotes. (See Chromosome walking.)

**Chromosome walking.** Working from a flanking DNA marker, overlapping clones are successively identified that span a chromosomal region of interest. (See Chromosome.)

**Cistron.** A DNA sequence that codes for a specific polypeptide; a gene. See DNA, Gene.

**Clone.** An exact genetic replica of a specific gene or an entire organism. See Cloning.

**Cloning.** The mitotic division of a progenitor cell to give rise to a population of identical daughter cells or clones. (See Directional cloning, Megabase cloning, Molecular cloning, Subcloning.)

**Coat protein (capsid).** The coating of a protein that enclosed the nucleic acid core of a virus.

**Codon.** A group of three nucleotides that specifies addition of one of the 20 amino acids during translation of an mRNA into a polypeptide. Strings of codons form genes and strings of genes form chromosomes. (See Initiation codon, Termination codon.)

**Coenzyme (cofactor).** An organic molecule, such as a vitamin, that binds to an enzyme and is required for its catalytic activity.

**Cofactor.** See Coenzyme.

**Colony.** A group of identical cells (clones) derived from a single progenitor cell.

**Commensalism.** The close association of two or more dissimilar organisms where the association is advantageous to one and doesn't affect the other(s). See Parasitism, Symbiosis.

**Competency.** An ephemeral state, induced by treatment with cold cations, during which bacterial cells are capable of uptaking foreign DNA.

**Complementary DNA or RNA.** The matching strand of a DNA or RNA molecule to which its bases pair. (See DNA, RNA.)

**Complementary nucleotides.** Members of the pairs adenine-thymine, adenine-uracil, and guaninecytosine that have the ability to hydrogen bond to one another. (See nucleotide.)

**Concatemer.** A DNA segment composed of repeated sequences linked end to end.

**Conjugation.** The joining of two bacteria cells when genetic material is transferred from one bacterium to another.

**Constitutive promoter.** An unregulated promoter that allows for continual transcription of its associated gene. (See Promoter.)

**Contiguous (contig) map.** The alignment of sequence data from large, adjacent regions of the genome to produce a continuous nucleotide sequence across a chromosomal region. (See Mapping.)

**Copy DNA.** See cDNA.

**Cross-hybridization.** The hydrogen bonding of a single- stranded DNA sequence that is partially but not entirely complementary to a singlestranded substrate. Often, this involves hybridizing a DNA probe for a specific DNA sequence to the homologous sequences of different species.

**Cross-pollination.** Fertilization of a plant from a plant with a different genetic makeup.

**Crossing-over.** The exchange of DNA sequences between chromatids of homologous chromosomes during meiosis.

**Culture.** A particular kind of organism growing in a laboratory medium.

**Cyclic AMP (cyclic adenosine monophosphate).** A second messenger that regulates many intracellular reactions by transducing signals from extracellular growth factors to cellular metabolic pathways.

**Cytogenetics.** Study that relates the appearance and behavior of chromosomes to genetic phenomenon.

**D**

**Dalton.** A unit of measurement equal to the mass of a hydrogen atom, 1.67 x 10E-24 gram/L (Avogadro's number).

**Death phase.** The final growth phase, during which nutrients have been depleted and cell number decreases. (See Growth phase).

**Denature.** To induce structural alterations that disrupt the biological activity of a molecule. Often refers to breaking hydrogen bonds between base pairs in double-stranded nucleic acid molecules to produce in single-stranded polynucleotides or altering the secondary and tertiary structure of a protein, destroying its activity.

**Density gradient centrifugation.** High-speed centrifugation in which molecules "float" at a point where their density equals that in a gradient of cesium chloride or sucrose. (See Centrifugation.)

**Deoxyribonucleic acid.** See DNA, nuclease.

**Diabetes.** A disease associated with the absence or reduced levels of insulin, a hormone essential for the transport of glucose to cells.

**Dideoxynucleotide (didN).** A deoxynucleotide that lacks a 3' hydroxyl group, and is thus unable to form a 3'-5' phosphodiester bond necessary for chain elongation. Dideoxynucleotides are used in DNA sequencing and the treatment of viral diseases. (See Nucleotide.)

**didN.** See Dideoxynucleotide.

**Digest.** To cut DNA molecules with one or more restriction endonucleases.

**Diploid cell.** A cell which contains two copies of each chromosome. See Haploid cell.

**Directional cloning.** DNA insert and vector molecules are digested with two different restriction enzymes to create noncomplementary sticky ends at either end of each restriction fragment. This allows the insert to be ligated to the vector in a specific orientation and prevents the vector from recircularizing. (See Cloning.)

**DNA (Deoxyribonucleic acid).** An organic acid and polymer composed of four nitrogenous bases--adenine, thymine, cytosine, and guanine linked via intervening units of phosphate and the pentose sugar deoxyribose. DNA is the genetic material of most organisms and usually exists as a double-stranded molecule in which two antiparallel strands are held together by hydrogen bonds between adeninethymine and cytosine-guanine. (See b-DNA, cDNA, Complementary DNA or RNA, DNA polymorphism, DNA sequencing, Double-stranded complementary DNA, Duplex DNA, Z-DNA.)

**DNA diagnosis.** The use of DNA polymorphisms to detect the presence of a disease gene.

**DNA fingerprint.** The unique pattern of DNA fragments identified by Southern hybridization (using a probe that binds to a polymorphic region of DNA) or by polymerase chain reaction (using primers flanking the polymorphic region).

**DNA ligase.** See Ligase.

**DNA polymerase.** See Polymerase.

**DNA polymorphism.** One of two or more alternate forms (alleles) of a chromosomal locus that differ in nucleotide sequence or have variable numbers of repeated nucleotide units. (See Allele.)

**DNA polymerase.** See Polymerase.

**DNA sequencing.** Procedures for determining the nucleotide sequence of a DNA fragment.

**DNase (deoxyribonuclease).** See Nuclease.

**Dominant.** An allele is said to be dominant if it expresses its phenotype even in the presence of a recessive allele. See Allele, Phenotype, Recessive.

**Dominant gene.** A gene whose phenotype is when it is present in a single copy.

**Dominant(-acting) oncogene.** A gene that stimulates cell proliferation and contributes to oncogenesis when present in a single copy. (See Oncogene.)

**Dormancy.** A period in which a plant does not grow, awaiting necessary environmental conditions such as temperature, moisture, nutrient availability.

**Double helix.** Describes the coiling of the antiparallel strands of the DNA molecule, resembling a spiral staircase in which the paired bases form the steps and the sugar-phosphate backbones form the rails.

**Double-stranded complementary DNA (dscDNA).** A duplex DNA molecule copied from a cDNA template.

**Downstream.** The region extending in a 3' direction from a gene.

**dscDNA.** See double-stranded complementary DNA.

**Duplex DNA.** Double-stranded DNA.

**E**

**Ecology.** The study of the interactions of organisms with their environment and with each other.

**Ecosystem.** The organisms in a plant population and the biotic and abiotic factors which impact on them. See abiotic factors; Biotic factors.

**Electrophoresis.** The technique of separating charged mol- ecules in a matrix to which is applied an electrical field. (See Agarose gell electrophoresis, Polycrylamide gell electrophoresis.)

**Electroporation.** A method for transforrning DNA, especially useful for plant cells, in which high voltage pulses of electricity are used to open pores in cell membranes, through which foreign DNA can pass.

**Encapsidation.** Process by which a virus' nucleic acid is enclosed in a capsid. See Coat protein.

**Endonuclease.** See Nuclease.

**Endophyte.** An organism that lives inside another.

**Environmental Protection Agency (EPA).** The U.S. regulatory agency for biotechnology of microbes. The major laws under which the agency has regulatory powers are the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); and the Toxic Substances Control Act (TSCA).

**Enzymes.** Proteins that control the various steps in all chemical reactions.

**EPA.** See Environmental Protection Agency.

**Escherichia coli.** A commensal bacterium inhabiting the human colon that is widely used in biology, both as a simple model of cell biochemical function and as a host for molecular cloning experiments.

**Ethidium bromide.** A fluorescent dye used to stain DNA and RNA. The dye fluoresces when exposed to UV light.

**Eukaryote.** An organism whose cells possess a nucleus and other membrane-bound vesicles, including all members of the protist, fungi, plant and animal kingdoms; and excluding viruses, bacteria, and blue-green algae. See Prokaryote.

**Evolution.** The long-term process through which a population of organisms accumulats genetic changes that enable its members to successfully adapt to environmental conditions and to better exploit food resources.

**Exon.** A DNA sequence that is ultimately translated into protein. See DNA.

**Exonuclease.** See Nuclease.

**Express.** To translate a gene's message into a molecular product.

**Expression library.** (See Library.)

**F**

**FDA.** See Food and Drug Administration.

**Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).** See Environmental Protection Agency.

**Federal Plant Pest Act (PPA).** See U.S. Department of Agriculture.

**Federal Seed Act.** See U.S. Department of Agriculture.

**FIFRA.** The Federal Insecticide, Fungicide, and Rodenticide Act. See Environmental Protection Agency.

**Flanking region.** The DNA sequences extending on either side of a specific locus or gene.

**Food and Drug Administration (FDA).** The U.S. agency responsible for regulation of biotechnology food products. The major laws under which the agency has regulatory powers include the Food, Drug, and Cosmetic Act; and the Public Health Service Act.

**Food, Drug, and Cosmetic Act.** See Food and Drug Administration.

**Fungicide.** An agent, such as a chemical, that kills fungi.

**Fungus.** A microorganism that lacks chlorophyll.

**Fusion gene.** A hybrid gene created by joining portions of two different genes (to produce a new protein) or by joining a gene to a different promoter (to alter or regulate gene transcription).

**G**

**Gamete.** A haploid sex cell, egg or sperm, that contains a single copy of each chromosome.

**GEM.** A genetically engineered microorganism.

**Gene.** A locus on a chromosome that encodes a specific protein or several related proteins. It is considered the functional unit of heredity. (See Dominant gene, Fusion gene, Gene amplification, Gene expression, Gene flow, Gene pool, Gene splicing, Gene translocation, Recessive gene, Regulatory gene.)

**Gene amplification.** The presence of multiple genes. Amplification is one mechanism through which proto-oncogenes are activated in malignant cells.

**Gene cloning.** The process of synthesizing multiple copies of a particular DNA sequence using a bacteria cell or another organism as a host. See DNA, Host.

**Gene expression.** The process of producing a protein from its DNA- and mRNA-coding sequences.

**Gene flow.** The exchange of genes between different but (usually) related populations.

**Gene frequency.** The percentage of a given allele in a population of organisms. See Allele.

**Gene insertion.** The addition of one or more copies of a normal gene into a defective chromosome.

**Gene linkage.** The hereditary association of genes located on the same chromosome.

**Gene modification.** The chemical repair of a gene's defective DNA sequence. See DNA.

**Gene pool.** The totality of all alleles of all genes of all individuals in a particular population.

**Gene splicing.** Combining genes from different organisms into one organism. See recombinant DNA.

**Gene translocation.** The movement of a gene fragment from one chromosomal location to another, which often alters or abolishes expression.

**Genetic assimilation.** Eventual extinction of a natural species as massive pollen flow occurs from another related species and the older crop becomes more like the new crop. See Gene flow.

**Genetic code.** The three-letter code that translates nucleic acid sequence into protein sequence. The relationships between the nucleotide base-pair triplets of a messenger RNA molecule and the 20 amino acids that are the building blocks of proteins. See Base pair, Nucleic acid, Nucleotide.

**Genetic disease.** A disease that has its origin in changes to the genetic material, DNA. Usually refers to diseases that are inherited in a Mendelian fashion, although noninherited forms of cancer also result from DNA mutation.

**Genetic drift.** Random variation in gene frequency from one generation to another.

**Genetic engineering.** The manipulation of an organism's genetic endowment by introducing or eliminating specific genes through modern molecular biology techniques. A broad definition of genetic engineering also includes selective breeding and other means of artificial selection.

**Genetic linkage map.** A linear map of the relative positions of genes along a chromosome. Distances are established by linkage analysis, which determines the frequency at which two gene loci become separated during chromosomal recombination. (See Mapping.)

**Genetic marker.** A gene or group of genes used to "mark" or track the action of microbes.

**Genome.** The genetic complement contained in the chromosomes of a given organism, usually the haploid chromosome state.

**Genomic library.** A library composed of fragments of genomic DNA. (See Library.)

**Genotype.** The structure of DNA that determines the expression of a trait. See Phenotype.

**Genus.** A category including closely related species. Interbreeding between organisms within the same category can occur.

**GEO.** Genetically engineered organism.

**Germ cell.** Reproductive cell. See Somatic cell.

**Germ cell (germ line) gene therapy.** The repair or re- placement of a defective gene within the gamete-forming tissues, which produces a heritable change in an organism's genetic constitution.

**GMO.** Genetically modified organism.

**Green revolution.** Advances in genetics, petrochemicals, and machinery that culminated in a dramatic increase in crop productivity during the third quarter of the 20th century.

**Growth curve.** See Growth phase.

**Growth factor.** A serum protein that stimulates cell division when it binds to its cell-surface receptor.

**Growth phase (curve).** The characteristic periods in the growth of a bacterial culture, as indicated by the shape of a graph of viable cell number versus time. (See Death phase, Lag phase, Logarithmic phase, Stationary phase.)

**H**

**Haploid cell.** A cell containing only one set, or half the usual (diploid) number, of chromosomes.

**Hemophilia.** An X-linked recessive genetic disease, caused by a mutation in the gene for clotting factor VIII (hemophilia A) or clotting factor IX (hemophilia B), which leads to abnormal blood clotting.

**Herbicide.** Any substance that is toxic to plants; usually used to kill specific unwanted plants.

**Heterochromatin.** Dark-stained regions of chromosomes thought to be for the most part genetically inactive.

**Heteroduplex.** A double-stranded DNA molecule or DNA-RNA hybrid, where each strand is of a different origin.

**Heterogeneous nuclear RNA (hnRNA).** The name originally given to large RNA molecules found in the nucleus, which are now known to be unedited mRNA transcripts, or pre-mRNAs. (See RNA.)

**HGH.** See Human growth hormone.

**hnRNA.** See Heterogeneous nuclear RNA.

**Homologous chromosomes.** Chromosomes that have the same linear arrangement of genes--a pair of matching chromosomes in a diploid organism. See Chromosomes.

**Homologous recombination.** The exchange of DNA fragments between two DNA molecules or chromatids of paired chromosomes (during crossing over) at the site of identical nucleotide sequences.

**Homozygote.** An organism whose genotype is characterized by two identical alleles of a gene. See Allele, Genotype.

**Host.** An organism that contains another organism.

**Human Genome Project.** A project coordinated by the National Institutes of Health (NIH) and the Department of Energy (DOE) to determine the entire nucleotide sequence of the human chromosomes. (See NIH.)

**Human growth hormone (HGH, somatotrophin).** A protein produced in the pituitary gland that stimulates the liver to produce somatomedins, which stimulate growth of bone and muscle.

**Hybrid.** The offspring of two parents differing in at least one genetic characteristic (trait). Also, a heteroduplex DNA or DNA-RNA molecule.

**Hybridization.** The hydrogen bonding of complementary DNA and/or RNA sequences to form a duplex molecule. (See Northern hybridization, Southern hybridization.)

**Hybridoma.** A hybrid cell, composed of a B Iymphocyte fused to a tumor cell, which grows indefinitely in tissue culture and is selected for the secretion of a specific antibody of interest.

**Hydrogen bond.** A relatively weak bond formed between a hydrogen atom (which is covalently bound to a nitrogen or oxygen atom) and a nitrogen or oxygen with an unshared electron pair.

**Hydrolysis.** A reaction in which a molecule of water is added at the site of cleavage of a molecule to two products.

**I**

**Immortalizing oncogene.** A gene that upon transfection enables a primary cell to grow indefinitely in culture. (See Oncogene.)

**Incomplete dominance.** A condition where a heterozygous off- spring has a phenotype that is distinctly different from, and intermediate to, the parental phenotypes. See Heterozygote, Phenotype.

**Initiation codon.** The mRNA sequence AUG, coding for methionine, which initiates translation of mRNA.

**Inositol lipid.** A membrane-anchored phospholipid that transduces hormonal signals by stimulating the release of any of several chemical messengers. (See Phospholipid.)

**Insertion mutations.** Changes in the base sequence of a DNA molecule resulting from the random integration of DNA from another source. See DNA, Mutation.

**In situ.** Refers to performing assays or manipulations with intact tissues.

**Insulin.** A peptide hormone secreted by the islets of Langerhans of the pancreas that regulates the level of sugar in the blood.

**Interferon.** A family of small proteins that stimulate viral resistance in cells.

**Intergenic regions.** DNA sequences located between genes that comprise a large percentage of the human genome with no known function.

**Introgression.** Backcrossing of hybrids of two plant populations to introduce new genes into a wild population.

**Intron.** A noncoding DNA sequence within a gene that is initially transcribed into messenger RNA but is later snipped out. See Coding, DNA, Messenger RNA, Transcription.

**Invasiveness.** Ability of a plant to spread beyond its introduction site and become established in new locations where it may provide a deliterious effect on organisms already existing there.

**In vivo.** Refers to biological processes that take place within a living organism or cell.

**Ion.** A charged particle.

**Isotope.** One of two or more forms of an element that have the same number of protons (atomic number) but differing numbers of neutrons (mass numbers). Radioactive isotopes are commonly used to make DNA probes and metabolic tracers.

**J**

**Joining (J) segment.** A small DNA segment that links genes to yield a functional gene encoding an immunogobulin.

**K**

**Kanamycin.** An antibiotic of the aminoglycoside family that poisons translation by binding to the ribosomes.

**kanr.** Kanamycin resistance gene. (See Selectable marker.)

**Karyotype.** All of the chromosomes in a cell or an individual organism, visible through a microsope during cell division.

**L**

**Lag phase.** The initial growth phase, during which cell number remains relatively constant prior to rapid growth. See growth phase.

**Lawn.** A uniform and uninterrupted laver of bacterial growth, in which individual colonies cannot be observed.

**Legume.** A member of the pea family that possesses root nodules containing nitrogen-fixing bacteria.

**Library.** A collection of cells, usually bacteria or yeast, that have been transformed with recombinant vectors carrying DNA inserts from a single species. (See cDNA library, Expression library, Genomic library.)

**Ligase (DNA ligase).** An enzyme that catalyzes a condensation reaction that links two DNA molecules via the formation of a phosphodiester bond between the 3' hydroxyl and 5' phosphate of adjacent nucleotides.

**Ligate.** The process of joining two or more DNA fragments.

**Lineage.** A chart that traces the flow of genetic information from generation to generation.

**Linkage.** The frequency of coinheritance of a pair of genes and/or genetic markers, which provides a measure of their physical proximity to one another on a chromosome.

**Linkage map.** See Genetic linkage map.

**Linked genes/markers.** Genes and/or markers that are so closely associated on the chromosome that they are coinherited in 80% or more of cases.

**Linker.** A short, double-stranded oligonucleotide containing a restriction endonuclease recognition site, which is ligated to the ends of a DNA fragment.

**Liposomes.** Membrane-bound vesicles constructed in the laboratory to transport biological molecules.

**Locus (plural = loci).** A specific location or site on a chromosome.

**Log phase.** See Logarithmic phase.

**Logarithmic phase (log or exponential growth phase).** The steepest slope of the growth curve--the phase of vigorous growth during which cell number doubles every 20-30 minutes. (See Growth phase.)

**Lysis.** The destruction of the cell membrane.

**Lysogen.** A bacterial cell whose chromosome contains in- tegrated viral DNA.

**Lysogenic.** A type or phase of the virus life cycle during which the virus integrates into the host chromosome of the infected cell, often remaining essentially dormant for some period of time. See Lysogen.

**Lytic.** A phase of the virus life cycle during which the vi- rus replicates within the host cell, releasing a new generation of viruses when the infected cell lyses.

**M**

**Malignant.** Having the properties of cancerous growth.

**Mapping.** Determining the physical location of a gene or genetic marker on a chromosome. (See Continuous map, Genetic map, Physical map.)

**Megabase cloning.** The cloning of very large DNA fragments. (See Cloning.)

**Meiosis.** The reduction division process by which haploid gametes and spores are formed, consisting of a single duplication of the genetic material followed by two mitotic divisions.

**Messenger RNA (mRNA).** The class of RNA molecules that copies the genetic information from DNA, in the nucleus, and carries it to ribosomes, in the cytoplasm, where it is translated into protein. (See RNA.)

**Metabolism.** The biochemical processes that sustain a living cell or organism.

**Metallothionein.** A protective protein that binds heavy metals, such as cadmium and lead.

**Microbe.** A microorganism.

**Microbial mats (biofilms).** Layered groups or communities of microbial populations.

**Microinjection.** A means to introduce a solution of DNA, protein, or other soluble material into a cell using a fine microcapillary pipet.

**Mitosis.** The replication of a cell to form two daughter cells with identical sets of chromosomes.

**Molecular biology.** The study of the biochemical and mo- lecular interactions within living cells.

**Molecular cloning.** The biological amplification of a specific DNA sequence through mitotic division of a host cell into which it has been transformed or transfected. (See Cloning.)

**Molecular genetics.** The study of the flow and regulation of genetic information between DNA, RNA, and protein molecules.

**Monoclonal antibodies.** Immunoglobulin molecules of single- epitope specificity that are secreted by a clone of B cells.

**Monoculture.** The agricultural practice of cultivating crops consisting of genetically similar organisms.

**Monogenic.** Controlled by or associated with a single gene.

**Movable genetic element.** (See Transposon.)

**mRNA.** See Messenger RNA.

**Multi-locus probe.** A probe that hybridizes to a number of different sites in the genome of an organism. (See Probe.)

**Mutagen.** Any agent or process that can cause mutations. See Mutation.

**Mutation.** An alteration in DNA structure or sequence of a gene. (See Point mutation.)

**Mutualism.** See Symbiosis.

**Mycorrhizae.** Fungi that form symbiotic relationships with roots of more developed plants.

**N**

**National Institutions of Health (NIH).** A nonregulatory agency which has oversight of research activities that the agency funds.

**National Science Foundation (NSF).** A nonregulatory agency which has oversight of biotechnology research activities that the agency funds.

**Natural selection.** The differential survival and reproduc- tion of organisms with genetic characteristics that enable them to better utilize environmental resources.

**Nick translation.** A procedure for making a DNA probe in which a DNA fragment is treated with DNase to produce single-stranded nicks, followed by incorporation of radioactive nucleotides from the nicked sites by DNA polymerase I.

**Nicked circle (relaxed circle).** During extraction of plasmid DNA from the bacterial cell, one strand of the DNA becomes nicked. This relaxes the torsional strain needed to maintain supercoiling, producing the familiar form of plasmid. (See Plasmid.)

**NIH.** See National Institutes of Health.

**Nitrocellulose.** A membrane used to immobilize DNA, RNA, or protein, which can then be probed with a labeled sequence or antibody.

**Nitrogen fixation.** The conversion of atmospheric nitrogen to biologically usable nitrates.

**Nitrogenous bases.** The purines (adenine and guanine) and pyrimidines (thymine, cytosine, and uracil) that comprise DNA and RNA molecules.

**Nodule.** The enlargement or swelling on roots of nitrogen- fixing plants. The nodules contain symbiotic nitrogen- fixing bacteria. See Nitrogen fixation.

**Nontarget organism.** An organism which is affected by an interaction for which it was not the intended recipient.

**Northern blotting.** See Northern hybridization.

**Northern hybridization.** (Northern blotting). A procedure in which RNA fragments are transferred from an agarose gel to a nitrocellulose filter, where the RNA is then hybridized to a radioactive probe. (See Hybridization.)

**NSF.** See National Science Foundation.

**Nuclease.** A class of enzymes that degrades DNA and/or RNA molecules by cleaving the phosphodiester bonds that link adjacent nucleotides. In deoxyribonuclease (DNase), the substrate is DNA. In endonuclease, it cleaves at internal sites in the substrate molecule. Exonuclease progressively cleaves from the end of the substrate molecule. In ribonuclease (RNase), the substrate is RNA. In the S1 nuclease, the substrate is single-stranded DNA or RNA.

**Nucleic acids.** The two nucleic acids, deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), are made up of long chains of molecules called nucleotides. See DNA, RNA, Nucleotides.

**Nuclein.** The term used by Friedrich Miescher to describe the nuclear material he discovered in 1869, which today is known as DNA.

**Nucleoside.** A building block of DNA and RNA, consisting of a nitrogenous base linked to a five carbon sugar. (See Nucleoside analog.)

**Nucleoside analog.** A synthetic molecule that resembles a naturally occuring nucleoside, but that lacks a bond site needed to link it to an adjacent nucleotide. (See Nucleoside.)

**Nucleotide.** A building block of DNA and RNA, consisting of a nitrogenous base, a five-carbon sugar, and a phosphate group. Together, the nucleotides form codons, which when strung together form genes, which in turn link to form chromosomes. (See Chromosome, Codon, Complementary nucleotides, Dideoxynucleotide, DNA, Gene, Oligonucleotide, RNA.)

**Nucleus.** The membrane-bound region of a eukaryotic cell that contains the chromosomes.

**O**

**Occupational Safety and Health Act.** See Occupational Safety and Health Administration.

**Occupational Safety and Health Administration (OSHA).** One of the U.S. agencies responsible for regulation of biotechnology. The major law under which the agency has regulatory powers is the Occupational Safety and Health Act.

**Oligonucleotide.** A DNA polymer composed of only a few nucleotides. (See Nucleotide.)

**Oncogene.** A gene that contributes to cancer formation when mutated or inappropriately expressed. (See Cellular oncogene, Dominant oncogene, Immortalizing oncogene, Recessive oncogene.)

**Oncogenesis.** The progression of cytological, genetic, and cellular changes that culminate in a malignant tumor.

**Open pollination.** Pollination by wind, insects, or other natural mechanisms.

**Open reading frame.** A long DNA sequence that is unin- terrupted by a stop codon and encodes part or all of a protein. (See Reading frame.)

**Operator.** A prokaryotic regulatory element that interacts with a repressor to control the transcription of adjacent structural genes.

**Organelle.** A cell structure that carries out a specialized function in the life of a cell.

**Origin of replication.** The nucleotide sequence at which DNA synthesis is initiated.

**OSHA.** See Occupational Safety and Health Administration.

**Overlapping reading frames.** Start codons in different reading frames generate different polypeptides from the same DNA sequence. (See Reading frame.)

**Ovum.** A female gamete.

**P**

**Paleontology.** The study of the fossil record of past geo- logical periods and of the phylogenetic relationships between ancient and contemporary plant and animal species.

**Palindrome.** See Palindromic sequence.

**Palindromic sequence.** A DNA locus whose 5'-to-3' sequence is identical on each DNA strand. The sequence is the same when one strand is read left to right and the other strand is read right to left. Recognition sites of many restriction enzymes are palindromic. See DNA.

**pAMP.** Ampicillin-resistant plasmid developed for this laboratory course. (See Plasmid.)

**Parasitism.** The closee association of two or more dissimilar organisms where the association is harmful to at least one. See Commensalism, Parasitism, Symbiosis.

**Pathogen.** Organism which can cause disease in another organism.

**pBR322.** A derivation of ColE1, one of the first plasmid vectors widely used. (See Plasmid.)

**PCR.** See Polymerase chain reaction.

**Pedigree.** A diagram mapping the genetic history of a par- ticular family.

**Persistence.** Ability of an organism to remain in a particular setting for a period of time after it is introduced.

**Pesticide.** A substance that kills harmful organisms (for example, an insecticide or fungicide).

**Phage (particle).** See Bacteriophage.

**Phenotype.** The observable characteristics of an organism, the expression of gene alleles (genotype) as an observable physical or biochemical trait. See Genotype.

**Pheromone.** A hormone-like substance that is secreted into the environment.

**Phosphatase.** An enzyme that hydrolyzes esters of phosphoric acid, removing a phosphate group.

**Phosphodiester bond.** A bond in which a phosphate group joins adjacent carbons through ester linkages. A condensation reaction between adjacent nucleotides results in a phosphodiester bond between 3' and 5' carbons in DNA and RNA.

**Phospholipid.** A class of lipid molecules in which a phos- phate group is linked to glycerol and two fatty acyl groups. A chief component of biological membranes. (See Inositol phospholipid.)

**Phosphorylation.** The addition of a phosphate group to a compound.

**Physical map.** A map showing physical locations on a DNA molecule, such as restriction sites, and sequence-tagged sites. (See Mapping.)

**Plant Pest Act (PPA).** See U.S. Department of Agriculture.

**Plant Variety Act (PVA).** See U.S. Department of Agriculture.

**Plaque.** A clear spot on a lawn of bacteria or cultured cells where cells have been Iysed by viral infection.

**Plasmid (p).** A circular DNA molecule, capable of autonomous replication, which typically carries one or more genes encoding antibiotic resistance proteins. Plasmids can transfer genes between bacteria and are important tools of transformation for genetic engineers. (See Nicked circle, pAMP, Relaxed plasmid, Stringent plasmid, Supercoiled plasmid.)

**Pleiotrophy.** The effect of a particular gene on several different traits.

**Point mutation.** A change in a single base pair of a DNA sequence in a gene. (See Mutation.)

**Poly(A) polymerase.** Catalyzes the addition of adenine residues to the 3' end of pre-mRNAs to form the poly(A) tail. (See Polymerase.)

**Polyacrylamide gel electrophoresis.** Electrophoresis through a matrix composed of a synthetic polymer, used to separate proteins, small DNA, or RNA molecules of up to 1000 nucleotides. Used in DNA sequencing. (See Electrophoresis.)

**Polyclonal antibodies.** A mixture of immunoglobulin molecules secreted against a specific antigen, each recognizing a different epitope.

**Polygenic.** Controlled by or associated with more than one gene.

**Polylinker.** A short DNA sequence containing several re- striction enzyme recognition sites that is contained in cloning vectors.

**Polymer.** A molecule composed of repeated subunits.

**Polymerase (DNA).** Synthesizes a double-stranded DNA molecule using a primer and DNA as a template. (See Poly(A) polymerase, Polymerase chain reaction, RNA polymerase, Taq polymerase.)

**Polymorphisms.** Variant forms of a particular gene that occur simultaneously in a population.

**Polynucleotide.** A DNA polymer composed of multiple nucleotides. (See Nucleotide.)

**polymerase chain reaction (PCR).** A procedure that en- zymatically amplifies a DNA polymerase. (See Polymerase.)

**Polypeptide (protein).** A polymer composed of multiple amino acid units linked by peptide bonds.

**Polyploid.** A multiple of the haploid chromosome number that results from chromosome replication without nuclear division.

**Polysaccharide.** A polymer composed of multiple units of monosaccharide (simple sugar).

**Polyvalent vaccine.** A recombinant organism into which has been cloned antigenic determinants from a number of different disease-causing organisms. (See Vaccine.)

**Population.** A local group of organisms belonging to the same species and capable of interbreeding.

**PPA.** See U.S. Department of Agriculture.

**Prion.** See Proteinaceous infectious particle.

**Probe.** A sequence of DNA or RNA, labeled or marked with a radioactive isotope, used to detect the presence of complementary nucleotide sequences. See Nucleotide.

**Prokaryote.** A bacterial cell lacking a true nucleus; its DNA is usually in one long strand. See Eukaryote.

**Proto-oncogene.** See oncogene.

**Primary cell.** A cell or cell line taken directly from a living organism, which is not immortalized.

**Primer.** A short DNA or RNA fragment annealed to single-stranded DNA, from which DNA polymerase extends a new DNA strand to produce a duplex molecule.

**Probe.** A single-stranded DNA that has been radioactively labeled and is used to identify complementary sequences in genes or DNA fragments of interest. (See Multilocus probe.)

**Promoter.** A region of DNA extending 150-300 bp upstream from the transcription start site that contains binding sites for RNA polymerase and a number of proteins that regulate the rate of transcription of the adjacent gene. (See Constitutive promoter.)

**Pronucleus.** Either of the two haploid gamete nuclei just prior to their fusion in the fertilized ovum.

**Protease.** An enzyme that cleaves peptide bonds that link amino acids in protein molecules.

**Protein.** A polymer of amino acids linked via peptide bonds and which may be composed of two or more polypeptide chains. (See Polypeptide.)

**Proteinaceous infectious particle (prion).** A proposed pathogen composed only of protein with no detectable nucleic acid and which is responsible for Creutzfeldt-Jakob disease and kuru in humans and scrapie in sheep.

**Protein kinase.** An enzyme that adds phosphate groups to a protein molecule at serine, threonine, or tyrosine residues.

**Proteolytic.** The ability to break down protein molecules.

**Provirus.** See virus.

**Public Health Service Act.** See Food and Drug Administration.

**pUC.** A widely used expression plasmid containing a -galactosidase gene. (See Plasmid.)

**PVA.** The Plant Variety Act. See U.S. Department of Agriculture.

**R**

**Reading frame.** A series of triplet codons beginning from a specific nucleotide. Depending on where one begins, each DNA strand contains three different reading frames. (See Open reading frame, Overlapping reading frames.)

**Recessive(-acting) oncogene, (anti-oncogene).** A single copy of this gene is sufficient to suppress cell proliferation; the loss of both copies of the gene contributes to cancer formation. (See Oncogene.)

**Recessive gene.** Characterized as having a phenotype expressed only when both copies of the gene are mutated or missing.

**Recognition sequence (site).** A nucleotide sequence--composed typically of 4, 6, or 8 nucleotides--that is recognized by a restriction endonuclease. Type II enzyrnes cut (and their corresponding modification enzymes methylate) within or very near the recognition sequence.

**Recombinant.** A cell that results from recombination of genes.

**Recombinant DNA.** The process of cutting and recombining DNA fragments from different sources as a means to isolate genes or to alter their structure and function.

**Recombination frequency.** The frequency at which crossing over occurs between two chromosomal loci--the probability that two loci will become unlinked during meiosis.

**Regulatory gene.** A gene whose protein controls the activity of other genes or metabolic pathways.

**Relaxed circle plasmid.** See Plasmid.

**Relaxed plasmid.** A plasmid that replicates independently of the main bacterial chromosome and is present in 10-500 copies per cell. (See Plasmid.)

**Renature.** The reannealing (hydrogen bonding) of single- stranded DNA and/or RNA to form a duplex molecule.

**Replicon.** A chromosomal region containing the DNA sequences necessary to initiate DNA replication processes.

**Repressor.** A DNA-binding protein in prokaryotes that blocks gene transcription by binding to the operator.

**Restriction endonuclease (enzyme).** A class of endonucleases that cleaves DNA after recognizing a specific sequence, such as BamH1 (GGATCC), EcoRI (GAATTC), and HindIII (AAGCTT). Type I. Cuts nonspecifically a distance greater than 1000 bp from its recognition sequence and contains both restriction and methylation activities. Type II. Cuts at or near a short, and often symmetrical, recognition sequence. A separate enzyme methylates the same recognition sequence. Type III. Cuts 24-26 bp downstream from a short, asymmetrical recognition sequence. Requires ATP and contains both restriction and methylation activities.

**Restriction-fragment-length polymorphism (RFLP).** Differences in nucleotide sequence between alleles at a chromosomal locus result in restriction fragments of varying lengths detected by Southern analysis.

**Restriction map.** See Mapping.

**Retrovirus.** A member of a class of RNA viruses that utilizes the enzyme reverse transcriptase to reverse copy its genome into a DNA intermediate, which integrates into the hostcell chromosome. Many naturally occurring cancers of vertebrate animals are caused by retroviruses.

**Reverse genetics.** Using linkage analysis and polymorphic markers to isolate a disease gene in the absence of a known metabolic defect, then using the DNA sequence of the cloned gene to predict the amino acid sequence of its encoded protein.

**Reverse transcriptase (RNA-dependent DNA polymerase).** An enzyme isolated from retrovirus-infected cells that synthesizes a complementary (c)DNA strand from an RNA template.

**RFLP.** See Restriction-fragment-length polymorphism.

**Rhizobia.** Bacteria in a symbiotic relationship with leguminous plants that results in nitrogen fixation. See Nitrogen fixation.

**Rhizosphere.** The soils region on and around plant roots.

**Ribozyme.** See Catalytic RNA.

**Ribosomal RNA (rRNA).** The RNA component of the ribosome. (See RNA.)

**Ribosome.** Cellular organelle that is the site of protein synthesis during translation. See Organelle, Translation.

**Ribosome-binding site.** The region of an mRNA molecule that binds the ribosome to initiate translation.

**RNA (ribonucleic acid).** An organic acid composed of re- peating nucleotide units of adenine, guanine, cytosine, and uracil, whose ribose components are linked by phosphodiester bonds. (See Antisense RNA, Heterogeneous nuclear RNA, Messenger RNA, Ribosomal RNA, RNA polymerase, Small nuclear RNA, Transfer RNA.)

**RNA polymerase.** Transcribes RNA from a DNA template. (See Polymerase, RNA.)

**rRNA.** See Ribosomal RNA.

**S**

**Salmonella.** A genus of rod-shaped, gram-negative bacteria that are a common cause of food poisoning.

**Satellite RNA (viroids).** A small, self-splicing RNA molecule that accompanies several plant viruses, including tobacco ringspot virus.

**S&E.** See U.S. Department of Agriculture.

**Self-pollination.** Pollen of one plant is transferred to the female part of the same plant or another plant with the same genetic makeup.

**Selectable marker.** A gene whose expression allows one to identify cells that have been transforrned or transfected with a vector containing the marker gene. (See B-Lactamase, Kanr.)

**Semiconservative replication.** During DNA duplication, each strand of a parent DNA molecule is a template for the synthesis of its new complementary strand. Thus, one half of a preexisting DNA molecule is conserved during each round of replication.

**Sequence hypothesis.** Francis Crick's seminal concept that genetic information exists as a linear DNA code; DNA and protein sequence are colinear.

**Sequence-tagged site (STS).** A unique (single-copy) DNA sequence used as a mapping landmark on a chromosome.

**Sexual reproduction.** The process where two cells (gametes) fuse to form one hybrid, fertilized cell. See Asexual reproduction, Gamete, Hybrid.

**Signal transduction.** The biochemical events that conduct the signal of a hormone or growth factor from the cell exterior, through the cell membrane, and into the cytoplasm. This involves a number of molecules, including receptors, pro- teins, and messengers.

**Site-directed mutagenesis.** The process of introducing spe- cific base-pair mutations into a gene.

**Small nuclear RNA (snRNA).** Short RNA transcripts of 100-300 bp that associate with proteins to form small nuclear ribonucleoprotein particles (snRNPs), which participate in RNA processing. (See RNA.)

**snRNA.** See Small nuclear RNA.

**Somatic cell.** Any nongerm cell that composes the body of an organism and which possesses a set of multiploid chromosomes (diploid in most organisms). (See Gamete, Somatic cell gene therapy.)

**Somatic cell gene therapy.** The repair or replacement of a defective gene within somatic tissue. (See Somatic cell.)

**Somatotrophin.** See Human growth hormone.

**Southern blotting.** See Southern hybridization.

**Southern hybridization (Southern blotting).** A procedure in which DNA restriction fragments are transferred from an agarose gel to a nitrocellulose filter, where the denatured DNA is then hybridized to a radioactive probe (blotting). (See Hybridization.)

**Species.** A classification of related organisms that can freely interbreed.

**Spore.** A form taken by certain microbes that enables them to exist in a dormant stage. It is an asexual reproductive cell. See Asexual reproduction, Dormant.

**Stationary phase.** The plateau of the growth curve after log growth, during which cell number remains constant. New cells are produced at the same rate as older cells die. (See Growth phase.)

**Sticky end.** A protruding, single-stranded nucleotide se- quence produced when a restriction endonuclease cleaves off center in its recognition sequence.

**Stringency.** Reaction conditions--notably temperature, salt, and pH--that dictate the annealing of single-stranded DNA/DNA, DNA/RNA, and RNA/RNA hybrids. At high stringency, duplexes form only between strands with perfect one-to-one complementarity; lower stringency allows annealing between strands with some degree of mismatch between bases.

**Stringent plasmid.** A plasmid that only replicates along with the main bacterial chromosome and is present as a single copy, or at most several copies, per cell. (See plasmid.)

**STS.** See Sequence-tagged site.

**Stop codon.** See Termination codon.

**Structure-functionalism.** The scientific tradition that stresses the relationship between a physical structure and its function, for example, the related disciplines of anatomy and physiology.

**Subcloning.** The process of tranferring a cloned DNA fragment from one vector to another. (See Cloning.)

**Subunit vaccine.** A vaccine composed of a purified antigenic determinant that is separated from the virulent organism. (See Vaccine, Enzyme.)

**Supercoiled plasmid.** The predominant in vivo form of plasmid, in which the plasmid is coiled around histone-like proteins. Supporting proteins are stripped away during extraction from the bacterial cell, causing the plasmid molecule to supercoil around itself in vitro. (See Plasmid.)

**Supergene.** A group of neighboring genes on a chromosome that tend to be inherited together and sometimes are functionally related.

**Supernatant.** The soluble liquid &action of a sample after centrifugation or precipitation of insoluble solids.

**Symbiosis.** The close association of two or more dissimilar organisms where both receive an advantage from the association. See Commensalism, Parasitism.

**Synapsis.** The pairing of homologous chromosome pairs during prophase of the first meiotic division, when crossing over occurs.

**T**

**Taq polymerase.** A heat-stable DNA polymerase isolated from the bacterium Therrnus aquaticus, used in PCR. (See Polymerase.)

**TATA box.** An adenine- and thymine-rich promoter sequence located 25-30 bp upstream of a gene, which is the binding site of RNA polymerase.

**T-DNA (transfer DNA, tumor-DNA).** The transforming region of DNA in the Ti plasmid of Agrobacterium tumefaciens.

**Telomere.** The end of a chromosome.

**Template.** An RNA or single-stranded DNA molecule upon which a complementary nucleotide strand is synthesized.

**Termination codon.** Any of three mRNA sequences (UGA, UAG, UAA) that do not code for an amino acid and thus signal the end of protein synthesis. Also known as stop codon. (See Codon.)

**Terminator region.** A DNA sequence that signals the end of transcription.

**Tetracycline.** An antibiotic that interferes with protein synthesis in prokaryotes.

**Thymidine kinase (tk).** An enzyme that allows a cell to utilize an alternate metabolic pathway for incorporating thymidine into DNA. Used as a selectable marker to identify transfected eukaryotic cells.

**Ti (tumor-inducing) plasmid.** A giant plasmid of Agrobac- terium tumefaciens that is responsible for tumor formation in infected plants. Ti plasmids are used as vectors to introduce foreign DNA into plant cells.

**Toxic Substances Control Act (TSCA).** See Environmental Protection Agency.

**Trait.** See Phenotype.

**Transcapsidation.** The partial of full coating of the nucleic acid of one virus with a coat protein of a differing virus. See Coat protein.

**Transcription.** The process of creating a complementary RNA copy of DNA.

**Transducing phage.** See Transduction.

**Transduction.** The transfer of DNA sequences from one bacterium to another via lysogenic infection by a bacteriophage (transducing phage).

**Transfection.** The uptake and expression of a foreign DNA sequence by cultured eukaryotic cells.

**Transfer DNA.** See T-DNA.

**Transfer RNA (tRNA).** See tRNA.

**Transformant.** In prokaryotes, a cell that has been ge- netically altered through the uptake of foreign DNA. In higher eukaryotes, a cultured cell that has acquired a malignant phenotype. (See Transformation.)

**Transformation.** In prokaryotes, the natural or induced uptake and expression of a foreign DNA sequence--typically a recombinant plasmid in experimental systems. In higher eukaryotes, the conversion of cultured cells to a malignant phenotype--typically through infection by a tumor virus or transfection with an oncogene. (See Transformant, Transformation efficiency.)

**Transformation efficiency.** The number of bacterial cells that uptake and express plasmid DNA divided by the mass of plasmid used (in transformants/microgram). (See Transformation.)

**Transforming oncogene.** A gene that upon transfection converts a previously immortalized cell to the malignant phenotype. (See Oncogene.)

**Transgene.** See Transgenic.

**Transgenic.** An organism in which a foreign DNA gene (a transgene) is incorporated into its genome early in de- velopment. The transgene is present in both somatic and germ cells, is expressed in one or more tissues, and is inherited by offspring in a Mendelian fashion. See Transgenic animal, Transgenic plant.

**Transgenic animal.** Genetically enginnered animal or offspring of genetically engineered animals. The transgenic animal usually contains material from at lease one unrelated organism, such as from a virus, plant, or other animal. See Transgenic.

**Transgenic plant.** Genetically engineered plant or offspring of genetically engineered plants. The transgenic plant usually contains material from at least one unrelated organisms, such as from a virus, animal, or other plant. See Transgenic.

**Transition-state intermediate.** In a chemical reaction, an unstable and high-energy configuration assumed by reactants on the way to making products. Enzymes are thought to bind and stabilize the transition state, thus lowering the energy of activation needed to drive the reaction to completion.

**Translation.** The process of converting the genetic infor- mation of an mRNA on ribosomes into a polypeptide. Transfer RNA molecules carry the appropriate amino acids to the ribosome, where they are joined by peptide bonds.

**Translocation.** The movement or reciprocal exchange of large-chromosomal segments, typically between two different chromosomes.

**Transposable genetic element.** See Transposon.

**Transposition.** The movement of a DNA segment within the genome of an organism.

**Transposon (transposable, or movable genetic element).** A relatively small DNA segment that has the ability to move from one chromosomal position to another.

**tRNA (transfer RNA).** The class of small RNA molecules that transfer amino acids to the ribosome during protein synthesis. See Transfer RNA.

**Trypsin.** A proteolytic enzyme that hydrolyzes peptide bonds on the carboxyl side of the amino acids arginine and lysine.

**TSCA.** The Toxic Substances Control Act. See Environmental Protection Agency.

**Tumor DNA.** See T-DNA.

**Tumor-inducing plasmid.** See Ti plasmid.

**Tumor virus.** A virus capable of transforming a cell to a malignant phenotype. (See Virus.)

**U**

**Upstream.** The region extending in a 5' direction from a gene.

**USDA.** See The U.S. Department of Agriculture.

**U.S. Department of Agriculture.** The U.S. agency responsible for regulation of biotechnology products in plants and animals. The major laws under which the agency has regulatory powers include the Federal Plant Pest Act (PPA), the Federal Seed Act, and the Plant Variety Act (PVA). In addition, the Science and Education (S&E) division has nonregulatory oversight of research activities that the agency funds.

**V**

**Vaccine.** A preparation of dead or weakened pathogen, or of derived antigenic determinants, that is used to induce formation of antibodies or immunity against the pathogen. (See Polyvalent vaccine, Subunit vaccine.)

**Vaccinia.** The cowpox virus used to vaccinate against smallpox and, experimentally, as a carrier of genes for antigenic determinants cloned from other disease organisms.

**Variable surface glycoprotein (VSG).** One of a battery of antigenic determinants expressed by a microorganism to elude immune detection.

**Variation.** Differences in the frequency of genes and traits among individual organisms within a population.

**Vector.** An autonomously replicating DNA molecule into which foreign DNA fragments are inserted and then propagated in a host cell. Also living carriers of genetic material (such as pollen) from plant to plant, such as insects.

**Viral oncogene.** A viral gene that contributes to malig- nancies in vertebrate hosts. (See Oncogene.)

**Viroid.** A plant pathogen that consists of a naked RNA molecule of approximately 250-350 nucleotides, whose extensive base pairing results in a nearly correct double helix. (See Satellite RNA.)

**Virulence.** The degree of ability of an organism to cause disease.

**Virus.** An infectious particle composed of a protein capsule and a nucleic acid core, which is dependent on a host organism for replication. A double-stranded DNA copy of an RNA virus genome that is integrated into the host chromosome during lysogenic infection. (See Coat protein, DNA, Genome, Host, Nucleic acid, RNA, Tumor virus.)

**VSG.** See Variable surface glycoprotein.

**W**

**Weed.** An undesirable plant.

**Weediness.** Unwanted effects of a plant.

**Wild type.** An organism as found in nature; the organism before it is genetically engineered.

**X**

**X-linked disease.** A genetic disease caused by a mutation on the X chromosome. In X-linked recessive conditions, a normal female "carrier" passes on the mutated X chromosome to an affected son.

**X-ray crystallography.** The diffraction pattern of X-rays passing through a pure crystal of a substance.

**Z**

**Z-DNA.** A region of DNA that is "flipped" into a lefthanded helix, characterized by alternating purines and pyrimidines, and which may be the target of a DNA-binding protein.