

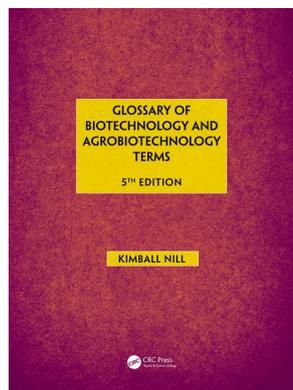
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## Glossary of Biotechnology and Agrobiotechnology Terms

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# C

# C

## C Terminus

See *Carboxyl terminus (of a protein molecule)*.

## C Value

The total amount of DNA in a haploid genome. See also *Deoxyribonucleic acid (DNA), Haploid, Genome*.

## C. elegans

See *Caenorhabditis elegans*.

## C3 Pathway

See *C3 Photosynthesis*.

## C3 Photosynthesis

Refers to the particular photosynthesis chemical system utilized by most green plants, in which an enzyme known as RuBisCO helps (along with sunlight of course) chemically combine carbon dioxide with a two-carbon molecule to initially yield a three-carbon molecule. Subsequent to that initial step, numerous other carbohydrate (sugar) molecules and other chemicals needed by the plant are synthesized from the initial three-carbon molecule.

Other plants utilize C4 photosynthesis, so called because it chemically combines carbon dioxide with a three-carbon molecule to initially yield the four-carbon molecule known as oxaloacetic acid. Subsequent to that initial step, numerous other carbohydrate (sugar) molecules and other chemicals are synthesized from the oxaloacetic acid.

C4 photosynthesis is much more efficient than C3 photosynthesis. For example, the C3 photosynthesis crop plant known as rice (i.e., domesticated form of *Oryza sativa* and/or *Oryza glaberrima*) produces approximately half the carbohydrate amount of the C4 photosynthesis crop plant maize (*Zea mays* L.). See also *Photosynthesis, Enzyme, Carbohydrates, Sugar molecules, Rice*.

## C4 Pathway

See *C4 Photosynthesis*.

## C4 Photosynthesis

Refers to the particular photosynthesis chemical system (pathway) utilized by some green plants, in which several enzymes plus the enzyme known as RuBisCO help (along with sunlight of course) to chemically combine carbon dioxide with a three-carbon molecule to initially yield the four-carbon molecule known as oxaloacetic acid. Subsequent to that initial step, numerous other carbohydrate (sugar) molecules and other chemicals needed by the plant are synthesized from the oxaloacetic acid.

Other plants utilize C3 photosynthesis, so called because it chemically combines carbon dioxide with a two-carbon molecule to initially yield a three-carbon molecule. C4 photosynthesis is much more efficient than C3 photosynthesis. For example, the C3 photosynthesis crop plant known as rice (i.e., domesticated form of *Oryza sativa* and/or *Oryza glaberrima*) produces approximately half the carbohydrate amount of the C4 photosynthesis crop plant maize (*Zea mays* L.).

Corn/maize (*Zea mays* L.) and sugarcane are 2 of the approximately 40 plant species that utilize C4 photosynthesis. See also *Photosynthesis, Enzyme, Carbohydrates, Sugar molecules, Corn, Rice, Hydrilla verticillata*.

## Caco-2

Developed during the late 1980s and early 1990s by Ronald Borchardt and Ismael Hidalgo, it refers to an immortal cell line (i.e., cells propagated over time in cell culture) of human colon adenocarcinoma cells that is utilized by research scientists. When Caco-2 cells are grown on suitable surfaces (in cell culture vessel), those cells differentiate and assume properties akin to intestinal mucosa cells.

Such cultured Caco-2 cells are used to assess *absorption* of pharmaceutical candidate (chemical) compounds (e.g., the likelihood and rate for a given candidate compound to be absorbed into the body through cell membranes from the gastrointestinal tract).

Enough is now known of Caco-2's absorption of each major category/type of chemical) for such absorption to often be predicted *in silico* (i.e., via computer modeling). See also *Cell, Differentiation, ADME Tests, Absorption, Plasma membrane, Pharmacokinetics, Pharmacogenomics, Cell culture, ADME, ADMET, In silico screening, Structure-activity models, ADME/Tox, Efflux pump*.

## Cadherins

A class of (cell surface) adhesion molecules that causes cells (e.g., in the lining of the intestine known as the epithelium) to *stick together* to form a continuous lining; plus cadherins sometimes function as cellular adhesion receptors.

For example, the (food poisoning) pathogenic bacteria *Listeria monocytogenes* is able to infect humans via its use of the E-cadherin receptor located on the surface of intestinal epithelium cells. That bacteria's *key* (a bacterial membrane surface protein known as inter-naulin) is *inserted* into the E-cadherin (*lock*), which opens up the otherwise closed-to-bacteria intestinal epithelium. The *L. monocytogenes* bacteria then leaves the intestine and infects the human body tissues. See also *Adhesion molecule, Cell, Receptors, Listeria monocytogenes, Epithelium*.

## Caenorhabditis elegans (C. elegans)

The name of a nematode (microscopic roundworm) that is commonly utilized by scientists in genetics experiments. Because of

this, a large base of knowledge about *C. elegans* genetics has been accumulated by the world's scientific community.

For example, of the nearly 300 *disease-causing genes* in the human genome, more than half of them have an analogous gene within the *C. elegans* genome. *C. elegans* was one of the first animals to have its entire genome sequenced by man.

Thus, one of the methodologies utilized by researchers to rapidly screen large numbers of chemical compounds for their potential use as pharmaceuticals is to

- Expose large numbers of *C. elegans* to the various chemical compounds that the researcher wants to investigate for potential pharmaceutical activity
- Pass those large numbers of previously exposed *C. elegans*, suspended in liquid such as water, through a small transparent chamber where a focused laser beam is shined upon the roundworm's side (for its full length, as the roundworm passes by)
- Utilize expression of fluorescent protein, autofluorescence, lectin (in the fluid) binding detected via laser reflectance, antibody (in the fluid) binding detected via laser reflectance, etc. as the basis for individual *C. elegans* to be sorted via tiny jets of air that blow into a container those *C. elegans* that show thus-visible sign(s) of having been changed by the particular chemical compound they were exposed to
- Evaluate in detail (e.g., via conventional gene expression analysis) the specific impact of that particular chemical compound on those *C. elegans* that had indicated an apparent change, so were sorted into the *likely target* receptacle

See also *Nematodes, Genetics, Gene, Genome, Gene expression, Gene expression markers, Expressed sequence tags (EST), Sequencing (of DNA molecules), High-throughput screening (HTS), High-throughput identification, Gene expression analysis, Target-ligand interaction screening, Target (of a therapeutic agent), Fluorescence, Lectins, Model organism.*

## Caffeine

A chemical [C<sub>8</sub>H<sub>10</sub>N<sub>4</sub>O<sub>2</sub>] that is naturally produced in some plants (e.g., coffee tree) to repel predatory insects. It also acts as a stimulant (when consumed by humans), so it is classified as a *phytochemical*. Caffeine was first isolated chemically and named in 1819 by Friedlieb Ferdinand Runge.

Research done by Seymour Diamond last 2000 showed that caffeine consumption causes interactions within the human body, with the synthetic chemical painkiller known as ibuprofen. Consuming both together was shown to be more effective in relieving pain than was consuming ibuprofen alone and brought pain relief faster than consumption of ibuprofen alone. See also *Phytochemicals, Coffee tree.*

## Calcium Channel Blockers

Refers to

- Drugs (e.g., verapamil, amlodipine, diltiazem, nifedipine) that are used to slow down calcium movement through cell membranes. This leads to dilation of the blood vessels and reduces the heart's workload. Blood vessels need

calcium to contract (causing flow constriction and hence an increase in blood pressure), so the drug-induced shortage of available calcium causes the body's blood vessels to remain dilated (which results in lower blood pressure).

- Drugs such as Prialt™/ziconotide (an *N-type calcium channel blocker*), or Neurontin™ and Lyrica™ (GABAergic calcium channel blockers) that act as powerful painkillers by slowing down calcium movement through certain cell membranes

See also *Cell, Ion channels, Membrane transport.*

## Calcium Oxalate

A crystalline salt that is normally deposited in the cells of some species of plants. In spinach, the presence of such oxalate inhibits absorption of the calcium (present in the spinach) by humans eating that spinach. In many animals, calcium oxalate is excreted in the urine, or retained by the animal's body in the form of urinary calculi. See also *Absorption, Oxalate, Cell.*

## Callipyge

(Means *beautiful buttocks* in the Greek language) An inherited trait in livestock (e.g., sheep) that results in thicker, meatier hindquarters. First identified as a genetic trait in 1983, this desirable trait results in a higher meat yield per animal. See also *Trait, Genotype, Phenotype, Wild type.*

## Callus

An undifferentiated cluster of plant cells that is a first step in

- Repair of a physical wound in some plants
- Regeneration of plants from excised sample (explant) placed into tissue culture medium
- Plant cell fermentation (in which calluses are propagated/kept alive in a water-based system containing needed amino acids, sugars, vitamins, trace elements, and other nutrients while they produce a desired substance such as paclitaxel)

See also *Cell, Somaclonal variation, Tissue culture, Culture medium, Plant cell fermentation, Amino acids, Vitamin, Paclitaxel.*

## Calorie

The amount of heat (energy) required to raise the temperature of 1 g of water from 14.5°C (58°F) to 15.5°C (60°F) at a constant pressure of one standard atmosphere. This unit measure of energy (i.e., one calorie) is also frequently utilized to express the amount of energy contained within certain foods or animal feeds. See also *Carbohydrates (saccharides), Fats, TME (N).*

## Calpain-10

A gene that increases the likelihood for development of diabetes disease, in humans whose DNA carries that gene (i.e., approximately 80% of humans carry that gene). See also *Diabetes, Insulin, Insulin-dependent diabetes mellitus (IDDM), Gene, Deoxyribonucleic acid (DNA).*

**CAM**

Acronym for crassulacean acid metabolism. See also *Crassulacean acid metabolism (CAM)*.

**CAM**

Acronym for cell adhesion molecule. See *Adhesion molecule*.

**Campesterol**

A phytosterol that is produced within the seeds of the soybean plant (*Glycine max* L.), among others. Evidence shows that human consumption of campesterol helps to reduce total serum (blood) cholesterol and low-density lipoprotein levels and thereby lowers the risk of coronary heart disease.

Evidence indicates that certain phytosterols (including campesterol) interfere with the absorption of cholesterol by the intestines and decrease the body's recovery and reuse of cholesterol-containing bile salts, which causes more (net) cholesterol to be excreted from the body. See also *Phytosterols, Phytochemicals, Sterols, Soybean plant, Cholesterol, Stigmasterol, Beta-sitosterol (B-Sitosterol), Coronary heart disease (CHD)*.

**Campesterol**

See *Campesterol*.

**Camptsterol**

See *Campesterol*.

**Camptothecins**

See *Rubitecan*.

**CaMV**

See *Cauliflower mosaic virus 35S promoter (CaMV 35S)*.

**CaMV 35S**

See *Cauliflower mosaic virus 35S promoter (CaMV 35S)*.

**Canavanine**

An uncommon amino acid. It is used in biology as an arginine (another amino acid) analogue. It is a potent growth inhibitor of many organisms. See *Amino acid, Biomimetic materials*.

**Cancer**

The name given to a group of diseases that are characterized by uncontrolled cellular growth (e.g., formation of tumor) without any differentiation of those cells (i.e., into specialized and different tissues).

Causes include consumption of carcinogens (e.g., certain mycotoxins), mutagens (e.g., certain radiation), some viruses (e.g., approximately 70% of human cervical cancers and 30% of oropharyngeal cancers are caused by the human papilloma virus), etc. During 2010, Stuart Gordon discovered that people infected with

hepatitis C were twice as likely to develop kidney cancer, as non-infected people.

During 1930, Otto Warburg discovered that most cancer cells utilize glycolysis to generate energy via oxidation of sugar molecules, instead of utilizing the cell mitochondria as normal cells do, for energy generation. That utilization of glycolysis enables cancer cells to better survive hypoxia (shortage of oxygen due to lack of good blood supply to a growing tumor) and to better avoid apoptosis (i.e., *programmed cell death*, initiated by mitochondria in cells whose DNA is damaged). See also *Carcinogen, Oncogenes, Tumor-suppressor genes, ras gene, Tumor, Virus, Telomeres, Retinoids, Mutagen, Cell, Telomerase, Neoplastic growth, Chemotherapy, Differentiation, Oropharyngeal cancer, Oral cancer, Mycotoxins, RNase 1 gene, Regulatory T cells, Phosphorylation, Oncolytics, Chronic inflammation, Glycolysis, Hypoxia, Sugar molecules, Mitochondria, Apoptosis, miRNA gene, Receptor binding mapping*.

**Cancer Epigenetics**

See *Epigenetic, Micro-RNAs*.

**Cancer Immunotherapy**

Refers to cancer treatments that target the body's immune system rather than tumors directly. When effective, these treatments induce the body's T cells and other immune system cells to combat the cancer/tumors. See also *Tumor, Cancer, Cellular immune response, Immunogen, Checkpoint blockade*.

**Cancer Stem Cells**

See *Apoptosis*.

**CANDA**

Computer-assisted new drug application. An application to the U.S. Food and Drug Administration (FDA) seeking approval of a drug that has undergone Phase 2 and Phase 3 clinical trials. A CANDA is submitted in the form of computer-readable (e.g., clinical) data that provides the FDA with a sophisticated database that allows the FDA reviewers to evaluate (e.g., statistically) the data themselves, directly. See also *NDA (to FDA), NDA (to Koseisho), Food and Drug Administration (FDA), MAA Marketing authorization application, Phase I clinical testing*.

**Canola**

Historically, this term has referred to *Brassica napus* or *Brassica campestris/rapa* strains of the rapeseed plant (oilseed rape), which were developed by plant breeders after the 1960s. This was because oil produced from rapeseed grown prior to 1971 contained 30%–60% erucic acid.

By 1974, canola varieties producing oil containing less than 5% erucic acid constituted virtually all of that year's Canadian rapeseed crop, and Canadian breeders continued to develop new canola varieties with ever-lower erucic acid content (e.g., oil from *double-zero* canola varieties contains less than 0.1% erucic acid).

In 1982, Canada filed with the U.S. Food and Drug Administration (FDA) to have low-erucic-acid rapeseed (LEAR) oil affirmed to be Generally Recognized As Safe, which the FDA did. LEAR was one of the first foodstuffs to be determined to be *substantially equivalent* under the OECD-defined criteria for *substantial equivalence*



because LEAR was shown (in OECD petition) to be very similar to, and composed of the same basic components as, traditional rapeseed oil (and other commonly consumed vegetable oils) except for a lower level of erucic acid (the component of earlier concern earlier).

In 2002, a *Brassica juncea* canola variety was introduced for the first time ever in Canada. Genomic differences among the three species sometimes result in certain diseases causing more damage in one canola species than the other. For example, the fungal disease *Alternaria* black spot tends to cause more damage in *juncea* or *rapa* canola varieties than in *napus* canola varieties. For example, fungal *Albugo candida* staghead disease tends to cause more damage in *rapa* canola varieties than in *napus* or *juncea* canola varieties.

Because it is a *Brassica* plant, canola also produces sulfur-based gases (a natural defense against certain fungi, nematodes, and insect pests). For example, Australian CSIRO scientists discovered in 1994 that sulfur-based isothiocyanates emitted by *Brassica* actively combat Wheat Take-All Disease (a fungal disease that attacks the roots of the wheat plant). Those isothiocyanates also combat parasitic soybean cyst nematodes (*Heterodera glycines*), thereby benefiting soybean crop planted in rotation after *Brassica* species such as canola or oilseed rape. See also *Strain, Fats, Laurate, Fatty acid, Oleic acid, Gras list, Organization for Economic Cooperation and Development (OECD), Glucosinolates, Brassica, High-stearate canola, Nematodes, Soybean cyst nematodes (SCN), Fungus, Wheat, Wheat take-all disease, Crop rotation.*

## CAP

Catabolite gene-activator protein, also known as catabolite regulator protein (CRP) or cyclic AMP receptor protein. The protein mediates the action of cyclic AMP (cAMP) on transcription in that cAMP and CAP must first combine. The cAMP–CAP complex then binds to the promoter regions of *Escherichia coli* and stimulates transcription of its operon. Since a cell component increases rather than inhibits transcription, this type of regulation of gene expression is called “positive transcriptional control.” See also *Escherichia coliform (E. coli), Catabolite repression, Transcription, Operon, Transcription activators.*

## Capillary Electrophoresis

A research technology/methodology that is utilized to electrophoretically separate ions (e.g., DNA/RNA/nucleic acids, protein molecules). That separation occurs inside a tiny capillary tube, when a powerful electrical field is applied across the (length of) capillary tube, because the ions (in solution inside capillary tube) move at different speeds through the tube depending on their charges and their molecular size/weight. Optical detection systems are typically utilized to determine each of the ions (each molecule) as they emerge from the capillary tube.

Capillary electrophoresis is utilized to perform DNA sequencing, biowarfare (pathogen) detection, heterozygote detection, mutation analysis (e.g., in site-directed mutagenesis efforts), single-nucleotide polymorphism analysis, gene expression analysis, amplified fragment length polymorphism analysis/“fingerprinting,” quantitation of PCR (products), quantitation of RT-PCR (products), the identity of glycan molecular structures (which can be determined with the assistance of glycoinformatics based on their electrophoretic migration-time-based glucose unit [GU] values), etc. See also *Electrophoresis, Ion, Protein, Isoelectric focusing (IEF), Molecular weight, Nucleic acids, Deoxyribonucleic acid (DNA), Protein, Ribonucleic acid (RNA), Sequence (of a DNA molecule), Gene, Sequencing (of DNA molecules), Pathogen, Heterozygote, Mutation,*

*Site-directed mutagenesis (SDM), Single-nucleotide polymorphisms (SNPs), Amplified fragment length polymorphism, Gene expression analysis, PCR, RT-PCR, Isotachopheresis, Glycoinformatics, Structural biology, Glucose unit (GU) values.*

## Capillary Isotachopheresis

See *Isotachopheresis.*

## Capillary Isotachopheresis

See *Isotachopheresis.*

## Capillary Zone Electrophoresis

See *Capillary electrophoresis.*

## Capsid

The external protein coat of a virus particle that surrounds the nucleic acid. The individual proteins that make up the capsid are called “capsomers” or protein subunits. It has been discovered that resistance to certain viral diseases may be imparted to some plants by inserting the gene for production of the capsid protein coat into the plants (thereby preventing the virus from uncoating, which it must first do in order to infect the plants). See also *Tobacco mosaic virus (TMV), Virus, Protein.*

## Capsule

An envelope surrounding many types of microorganisms. The capsule is usually composed of polysaccharides, polypeptides, or polysaccharide–protein complexes. These materials are arranged in a compact manner around the cell surface. Capsules are not absolutely essential cellular components. See also *Microorganism, Polysaccharides, Polypeptide (protein), Protein, Cell, Gram-negative (G–), Mannanoglycosaccharides (MOS), Gram-positive (G+).*

## Capture Agent

Also known as a *capture molecule.* See *Capture molecule.*

## Capture Molecule

Also known as a *capture agent.* Refers to molecules such as ligands, receptors, aptamers, DNA segments, enzymes, antigens, antibodies, etc. that bind to specific molecules sought by a scientist (e.g., within a sample being analyzed via microarray testing). See also *Microarray (testing), Protein microarrays, Deoxyribonucleic acid (DNA), Hybridization (molecular genetics), DNA chip, Biochip, Magnetic particles, Ligand (in biochemistry), Receptors, Aptamers, Enzyme, Antigen, Antibody, Nanosheets.*

## CARB

See *Center for Advanced Research in Biotechnology (CARB).*

## Carbetimer

An antineoplastic (i.e., anticancer) low-molecular-weight polymer that acts against several types of cancer tumors, perhaps via

stimulation of the patient's immune system. It has minimal toxicity. See also *Polymer, Cancer*.

## Carbohydrate Engineering

The selective, deliberate alteration/creation of carbohydrates (and the oligosaccharide side chains of glycoprotein molecules) by man. See also *Gluconeogenesis, Glycobiology, Glycoform, Glycolipid, Glycolysis, Glycoprotein, Glycosidases, Restriction endoglycosidases, Glycoside, Glycosylation, Carbohydrate microarrays*.

## Carbohydrate Microarrays

Refers to a piece of glass, plastic, or silicon onto which has been placed a large number of specifically known sugar molecules (also known as oligosaccharides, polysaccharides, carbohydrates, or glycans) in specific locations. These microarrays can then be utilized to test a single biological sample for a variety of carbohydrate-specific attributes or effects.

The sugar molecules can be bound to the chip (glass, plastic, or silicon) via use of *thiol molecular groups, use of biotinylation* (to subsequently adhere the biotinylated sugar molecules onto streptavidin-coated chip surface), *conversion of the sugar molecules to glycolipids* (to subsequently adhere those glycolipids via hydrophobic adsorption onto the chip surface), other glycoconjugates (e.g., glycosaminoglycans), etc.

For example, during 2002, Denong Wang attached numerous pathogen-applicable sugar molecules onto chips (thereby creating a carbohydrate microarray) and then utilized those microarrays to evaluate the *specificity* of various antibodies and other immune system proteins in binding to those *polysaccharides typically attached to surfaces of pathogens*. See also *Microarray (testing), Oligosaccharides, Biochips, High-throughput screening (HTS), Target (of a therapeutic agent), Assay, Bioassay, Thiol group, Biotinylation, Streptavidin, Glycolipid, Glycobiology, Pathogen, Antibody, Combining site, Glycoprotein, Glycoform, Glycoconjugates*.

## Carbohydrates (Saccharides)

A large class of carbon–hydrogen–oxygen compounds. Monosaccharides are called “simple sugars,” of which the most abundant is D-glucose. It is both the major fuel for most organisms and constitutes the basic building block of the most abundant polysaccharides, such as starch and cellulose.

While starch is a fuel source, cellulose is the primary structural material of plants. Carbohydrates are produced by photosynthesis in plants. Most, but not all, carbohydrates are represented chemically by the formula  $C_x(H_2O)_n$ , where  $n$  is 3 or higher. On the basis of their chemical structures, carbohydrates are classified as polyhydroxy aldehydes, polyhydroxy ketones, and their derivatives.

The term *carbohydrates* was originally utilized to apply to any compounds (i.e., saccharides) whose molecular formula *could* be written in a form implying an equal number of moles of carbon and water. See also *Glucose (GLc), Glycogen, Monosaccharides, Oligosaccharides, Polysaccharides, Sialic acid, C4 photosynthesis, Mole*.

## Carbon Nanohorns

Refers to tiny tubes composed of carbon *that are closed off on one end via a cone-shaped cap*, whose diameter is measured in nanometers.

Groups of carbon nanohorns self-assemble into spherical structures with the capped (i.e., *horn*) ends pointing outward in all directions. These spherical nanohorn structures have a diameter of less than 100 nm, so are able to penetrate the plasma membrane (i.e., *outer skin*) of cells, but not the nucleus of cells.

When certain natural polysaccharides or gum arabic is applied to the surfaces of carbon nanohorns, these nanohorn structures can subsequently be utilized to carry certain pharmaceutical compounds into cells. This can be a means to carry specific pharmaceuticals into cells, which would otherwise not penetrate the plasma membrane of the (diseased) cells. See also *Nanometers (nm), Nanoscience, Nanotechnology, Self-assembly (of large molecular structure), Cell, Nucleus, Plasma membrane, Polysaccharides*.

## Carbon Nanotubes

Refers to any tiny tube composed of carbon, whose diameter is measured in nanometers (nm). There are several potential applications for the utilization of carbon nanotubes (CNTs) within fields of nanobiotechnology.

For example, during 2003, Bruce J. Hinds and coworkers were able to incorporate numerous CNTs into a polymer membrane (film) in a manner such that the CNTs served as *pores* through which molecules possessing 1–10 nm *diameters* could pass from one side of the membrane to the other. Such *nanotube membranes* hold significant potential utility as *molecular sieves* (e.g., to screen certain biochemicals out of solution/mixture), as the contact surface for certain biosensors (e.g., allowing-in only the molecules *sought to be sensed*).

During 2009, Stuart Lindsay and colleagues utilized single-walled carbon nanotubes (SWNTs) to construct a *nanopore sequencer*.

During 2012, Marshall, Brown, and Jimmy Xu synthesized carbon nanotubes that have a diameter of approximately 40 nm (i.e., large enough to carry anticancer drug molecules suspended in a temperature-sensitive hydrogel). After injecting these carbon nanotubes and waiting for them to be taken up by tumor cells, an alternating magnetic field was applied (external to the body), which induced an alternating electric current within the nanotubes. The nanotubes' electrical resistance to that current generated heat that liquefied the hydrogel, thereby releasing the drugs into the tumor cells.

During 2004, Hongjie Dai and Paul A. Wender utilized single-walled carbon nanotubes to *ferry-specific proteins* (e.g., streptavidin) across the plasma membrane of certain cells, where the protein was able to then act upon the cell's interior. Dai and Wender showed that those specific proteins (bound to biotin-coated carbon nanotubes) entered the cells via endocytosis.

Certain carbon nanotubes can form into bundles that rotate (spin) rapidly in the presence of a rotating magnetic field. Via precise manipulation of that magnetic field, these *nanodrills* could be utilized to drill into specific cells (e.g., cancer cells) inside the body to deliver drugs into those cancer cells or to kill them outright.

Some carbon nanotubes can also act as an *antenna* to receive electromagnetic radiation possessing wavelengths of several hundred nanometers length (i.e., visible light). That visible light's energy is converted by the carbon nanotubes into either electricity or thermal energy (i.e., to drive a chemical reaction in adjacent substrate). Thus, these carbon nanotubes may be utilized in the future to construct light-sensing biosensors.

Some single-walled carbon nanotubes are fluorophores. See also *Nanoscience, Nanobiotechnology, Nanometers (nm), Nanotechnology, Self-assembly (of a large molecular structure), Single-stranded DNA, Polymer, Biosensors (chemical), Biosensors (electronic), Nanofibers, Protein, Streptavidin, Cell, Plasma*

*membrane, Biotin, Endocytosis, Substrate (chemical), Activation energy, Fluorophores, Single-walled carbon nanotubes, Nanopore sequencing, Nanobionics, Nanodrills, Tumor, Cancer, Modulatory nanotechnologies.*

### Carboxyl Terminus (of a Protein Molecule)

Refers to the carboxyl group [–COOH] that is attached to one end of some protein molecules, or one end of some amino acid molecules. See also *Protein, Amino acid*.

### Carcinogen

A cancer-causing agent. See also *Mutagen, Proto-oncogenes, Aflatoxins, Antioxidants*.

### Carnitine

A *vitamin-like* nutrient that occurs naturally in the cells within animals and that is needed for the body to convert fatty acids to energy (which can then be used by the body's cells). Carnitine is essential to facilitate the transport of acyl-CoA enzyme (attached to a fatty acid molecule) into the cell's mitochondria, where the beta-oxidation of fatty acids occurs (thereby providing energy to the cell).

Before fatty acids can enter the mitochondria, they must be *activated* by a chemical reaction (which occurs on the outer mitochondrial membrane), in which acyl-CoA is attached to the fatty acid molecule via a chemical reaction that is driven by adenosine triphosphate and is catalyzed by acyl-CoA synthetase. Adenosine monophosphate is a by-product of that chemical reaction. See also *Fatty acids, Metabolism, Acyl-CoA, Enzyme, Acetyl carnitine, Acetylcarnitine transferase, Mitochondria, Plasma membrane, Activation energy, Adenosine triphosphate (ATP), Synthase, Adenosine monophosphate (AMP)*.

### Carotenoids

A general term for a group of plant-produced and microorganism-produced pigments ranging in color from yellow to red and brown that act as protective antioxidants in photosynthetic plants and in animals that consume carotenoids.

Approximately 600 carotenoids have been discovered and studied by man. The carotenes and the xanthophylls, orange to yellow in color, are the most common. Carotenoids are responsible for the coloration of certain plants (e.g., the carrot) and of some animals (e.g., the lobster). The carotenoid pigments are transferred to animals as an element in their foods. Carotenoids are composed of isoprene units (usually eight) that may be modified by the addition of other chemical groups on the molecule. The carotenes are of importance to higher animals because they are utilized in the formation of vitamin A.

Carotenoids act as antioxidants (*quencher*s of free radicals), so consumption of carotenoids apparently thereby reduces the risk of some cancers, coronary heart disease, eyesight loss, and cataracts. See also *Vitamin, Beta carotene, Cancer, Coronary heart disease (CHD), Astaxanthin, Lycopene, Antioxidants, Free radical, Oxidative stress, Insulin, Lutein, Zeaxanthin, Golden rice, Photosynthesis, Microorganism*.

### Cartilage-Inducing Factors A and B

Compounds produced by the body that also have immunosuppressive activity. See also *Immunosuppressive*.

### Cas Proteins

Abbreviation for *CRISPR-associated protein nuclease*. It is a family of RNA-guided bacterial nucleases (i.e., DNA-cutting enzymes) that targets a particular DNA sequence (e.g., of a specific virus that had earlier invaded a bacterium) for destruction, thereby protecting the bacterium from later reinvasion by that virus. See *Bacteria, CRISPR, CRISPR/CAS9 gene-editing systems, Deoxyribonucleic acid (DNA), Ribonucleic acid (RNA), Enzyme, Nuclease, Virus, Site-directed nucleases*.

### Cas1

See *CRISPR*.

### Cas1–Cas2 Complex

See *CRISPR*.

### Cas2

See *CRISPR*.

### Cas9

Abbreviation for *CRISPR-associated protein nuclease*. It is a family of RNA-guided bacterial nucleases (i.e., DNA-cutting enzymes) that targets a particular DNA sequence (e.g., of a specific virus that had earlier invaded a bacterium) for destruction, thereby protecting the bacterium from later reinvasion by that virus. See *Bacteria, CRISPR/CAS9 gene-editing systems, Deoxyribonucleic acid (DNA), Ribonucleic acid (RNA), Enzyme, Nuclease, Site-directed nucleases, Virus*.

### Cascade

A sequential series of events (e.g., gene expressions, chemical reactions, immune responses), which is initiated (i.e., *set off*) by a specific first event (e.g., a signaling molecule *docking* at a receptor molecule, an antibody–antigen complex forming in the body, thrombin cleaving fibrinogen). See also *Signaling molecule, Signal transduction, Receptors, Protein signaling, Systemic acquired resistance (SAR), Harpin, Complement (component of immune system), Complement cascade, Thrombin, Fibrin, Gene expression cascade, R genes, Transactivating protein, Viral transactivating protein, Kinases, Mitogen-activated protein kinase cascade*.

### Casimir Force

A small naturally occurring attractive force that acts between two (uncharged) small objects (e.g., nanoparticles) that are near each other.

In certain instances (e.g., gold nanoparticles located very close to a small silicon plate), the shining of appropriate wavelength light onto the silicon plate increases the number of electrons present at the surface of the silicon, which thereby increases the Casimir force acting on the gold nanoparticle. This ability to remotely control the Casimir force impacting on nanometer-scale objects (e.g., tiny machines) points to the future ability to remotely power/control *nanobots* (e.g., micromachines designed to do specific tasks within the body's bloodstream, cells, etc.). See also *Nanometers (nm), Nanoparticles, Nanobots, Nanoscience, Self-assembling*.

*molecular machines, Nanotechnology, Nanoelectromechanical systems (NEMS).*

## Caspases

Refers to a *family* of cysteine proteases, which are coded for by certain genes (e.g. the **ced-3** gene) during cell apoptosis.

As a result of apoptosis causing synthesis of several caspases, the (dying) cells cleave/destroy a variety of cellular proteins (i.e., the cell undergoes *self-digestion*). See also *Enzyme, Protease, Cell, Gene, Apoptosis, Protein, PARP*.

## Cassette

A *package* of genetic material (containing more than one gene) that is inserted into the genome of a cell via gene splicing techniques. May include promoter(s), leader sequence, termination codon, etc. See also *Gene splicing, Leader sequence, Promoter, Genetic code, Termination codon (sequence), Genetic engineering, Transgene, Genome*.

## Catabolism

Energy-yielding pathway. The phase of metabolism involved in the energy-yielding breakdown of nutrient (food) molecules. See also *Dissimilation, Metabolism, Pathway, Sterols*.

## Catabolite Activator Protein

See CAP.

## Catabolite Repression

Common in bacteria. The decreased expression of catabolic enzymes as brought about by a catabolite such as glucose. For example, glucose is the preferred fuel source for certain bacteria, and when it is present in the culture medium, it represses the formation of enzymes that are required for the utilization of other fuel sugars such as  $\beta$ -galactosidase. Since glucose or other catabolites (other molecules derived from glucose) cause the repression, it is known as catabolite repression. See also *CAP, Operon, Glucose (GLc), Adenosine monophosphate (AMP), Pathway feedback mechanisms*.

## Catalase

An enzyme that catalyzes the very rapid decomposition of hydrogen peroxide to water and oxygen. Catalase is in the group of enzymes known as metalloenzymes because it requires the presence of a metal in order to be catalytically active. The metal (known as a cofactor) is, in the case of catalase, iron, which is found in both plants and animals.

For example, Karin U. Schallreuter showed that during the early decades of a human's life, the production of the applicable catalase within human hair prevents hydrogen peroxide (also produced within human hair) from bleaching that hair. Later in life, the catalase production within hair declines, and the hair of older humans gets bleached white/gray by the hydrogen peroxide. See also *Hydrolysis, Human superoxide dismutase (hSOD), PEG-SOD (polyethylene glycol superoxide dismutase)*.

## Catalysis

Coined by Jons J. Berzelius in 1838, this term refers to the act of increasing the rate of a given chemical reaction via use of a catalyst.

Almost all chemical reactions in biological systems (e.g., within an organism) are catalyzed by molecules known as enzymes. Enzymes typically increase the rate of a given biological/chemical reaction by at least a millionfold. See also *Catalyst, Catalytic site, Enzyme, Metalloenzyme*.

## Catalyst

From the Greek word “katalyein,” which means “to dissolve.” Any substance (entity), either of protein or of nonproteinaceous nature, that increases the rate of a chemical reaction, without being consumed itself in the reaction. In biosciences, the term “enzyme” is used for a proteinaceous catalyst. Enzymes catalyze biological reactions. See also *Enzyme, Catalytic site, Active site, Catalytic antibody, Semisynthetic catalytic antibody, Metalloenzyme*.

## Catalytic Antibody

Discovered by Richard A. Lerner and Peter G. Shultz during the 1980s, these are antibodies produced by an organism's body in order to help catalyze certain chemical reactions (e.g., needed for certain body functions).

Scientists have subsequently been able to cause organisms to produce an antibody in response to a carefully selected antigen (e.g., target molecule in bloodstream, or molecule involved in chemical reaction of interest), which itself catalyzes the *splitting* of a molecule in the bloodstream (e.g., heroin into two harmless small molecules) or mimics

- Restriction endonucleases that cleave (cut) proteins or DNA molecules precisely at specific locations on those molecules
- Restriction endoglycosidases that are capable of cleaving oligosaccharides or polysaccharide molecules precisely at specific locations on those molecules
- Transition state chemical complex in the chemical reaction that is to be catalyzed—resultant antibody acts both as an antibody (to the selected transition-state-complex antigen) and as a catalyst (for the chemical reaction possessing that selected transition state chemical complex)

This catalyst (enzyme) thus possesses the remarkable specificity of an antibody (i.e., specific only to the desired transition-state reactant) that holds the potential to yield chemical reaction products of greater purity than those achieved via current (less specific) catalysts.

Because the immune system will (in theory) produce an antibody to virtually every molecule of sufficient size to be detected by the immune system (i.e., 6–34 Å), it should be possible to raise catalytic antibodies for a large number of industrial chemical reactions that are currently catalyzed via conventional (less specific) catalysts. Commercial quantities of such antibodies would be produced via monoclonal antibody techniques (e.g., in bioreactors/fermentation vats). See also *Oligosaccharides, Catalyst, Antibody, Organism, Restriction endonucleases, Restriction endoglycosidases, Cell, Monoclonal antibodies (MAb), Antigen, Transition state, Protein, Activation energy, Semisynthetic catalytic antibody, Angstrom (Å), Abzymes*.

## Catalytic Domain

See *Domain (of a protein)*.



## Catalytic RNA

Discovered by Thomas R. Cech and Sidney Altman in 1983, this refers to an RNA (ribonucleic acid) molecule that acts to cleave (*cut*) any other RNA. See also *Ribozymes*, *Ribonucleic acid (RNA)*.

## Catalytic Site

The site (geometric area) on an enzyme molecule (or other catalyst) that is actually involved in the catalytic process. The catalytic site usually consists of a small portion of the total area of the enzyme. See also *Catalyst*, *Enzyme*, *Active site*, *Catalytic antibody*.

## Catechins

Refers to a *family* of polyphenol chemical compounds (phytochemicals) that are naturally produced in most teas, red wines, apples, grapes, chocolates, etc.

When consumed by humans, catechins have been shown to have beneficial antioxidant, anti-inflammatory, and antithrombotic effects in the human body. See also *Polyphenols*, *Phytochemicals*, *Antioxidants*, *Thrombosis*.

## Catecholamines

Hormones (such as adrenalin, dopamine) that are amino derivatives of a base structure known as catechol. Some catecholamines (e.g., endorphins) are released into the bloodstream by exercise and act as natural *tranquilizers*. See also *Endorphins*, *Dopamine*, *Hormone*.

## Cation

See *Ion*, *Chelation*, *Chelating agent*.

## Cationic Lipids

Refers to lipid molecules that possess a positive charge on one end. See also *Lipids*, *Cation*.

## Cauliflower Mosaic Virus 35S Promoter (CaMV 35S)

A promoter (sequence of DNA) that is often utilized in genetic engineering to control expression of (inserted) gene, that is, synthesis of desired protein in a plant. See also *Virus*, *Promoter*, *Deoxyribonucleic acid (DNA)*, *Gene*, *Genetic engineering*, *Protein*.

## Caveolae

Discovered during the 1950s by Eichi Yamada and George Palade. Named by Yamada, who felt they looked like small caves (Latin *caveola*, meaning “small caves”). See *Plasma membrane*.

## CBA

Acronym for *cell-based assay*. See *Cell-based assays*.

## CBD

See *Convention on Biological Diversity (CBD)*.

## CBF Proteins

A *family* of cold (temperature)-regulated transcriptional activators (transcription factors). See *CBF1*.

## CBF/DREB1 Pathway

See *CBF proteins*, *DREB proteins*, *Pathway*.

## CBF1

A transcription factor (i.e., special protein that acts upon genes) that is synthesized (i.e., manufactured) within certain plants (e.g., *Arabidopsis thaliana*) when that plant is exposed to cold temperatures. CBF1 then interacts with certain portions of the plant's DNA (i.e., COR genes, regulatory sequences) to thus “switch on” the process of cold hardening (via proteins coded for by that plant's COR genes). See also *Transcription factors*, *Protein*, *Gene*, *Synthesizing (of proteins)*, *Arabidopsis thaliana*, *Genetic code*, *Coding sequence*, *Regulatory sequence*, *Deoxyribonucleic acid (DNA)*, *Cold hardening*, *Acclimatization*, *COR genes*.

## C-C Chemokine Receptor Type 5

See *CCR5 protein*.

## CCC DNA

A covalently linked circular DNA molecule, such as a plasmid. See also *Deoxyribonucleic acid (DNA)*, *Plasmid*.

## CCD

See *Charge-coupled device*.

## CCR5 Protein

Also referred to as C-C chemokine receptor type 5, it is a G-protein-coupled receptor (embedded in surface membrane of cell) to facilitate entry of certain chemokines into cell. The CCR5 protein is expressed in the plasma membrane of macrophages, T cells, and dendritic cells. See also *Protein*, *Receptors*, *G-protein-coupled receptors*, *Plasma membrane*, *Chemokines*.

## CCR5-Delta 32

A deletion mutation within the human CCR5 gene that confers resistance to certain pathogenic viruses such as bubonic plague (*Yersinia pestis*) and HIV/AIDS. The delta-32 mutation causes the cell surface receptor coded for by the CCR5 gene to be “turned off,” thereby preventing entry into cell of the bubonic plague or HIV/AIDS virus. See also *CCR5 protein*, *Cell*, *Deletions*, *Mutation*, *Gene*, *Pathogenic*, *Virus*, *Receptors*, *Plasma membrane*, *Human immunodeficiency virus type 1*, *Human immunodeficiency virus type 2*, *Acquired immune deficiency syndrome (AIDS)*, *Coding sequence*.

## CD19

See *Blinatumomab*.

## CD20 Protein

A cell-membrane-spanning glycosylated phosphoprotein expressed on the surface of all human B cells. It is coded for by the human MS4A1 gene and plays a role in the development and differentiation of B cells into plasma cells. See also *Protein*, *Cell*, *Plasma membrane*, *Transmembrane proteins*, *B cells*, *Plasma cell*, *Glycosylation*.

(to glycosylate), *Posttranslational modification of protein, Gene, Coding sequence, Differentiation, Humanized antibody.*

### CD3

See *Blinatumomab.*

### CD4 EPSP Synthase

See *EPSP synthase, CP4 EPSPS.*

### CD4 EPSPS

See *EPSP synthase, CP4 EPSPS.*

### CD4 Protein

An adhesion molecule (protein) imbedded in the outer wall (envelope) of human immune system and brain cells that functions as the receptor (door to entry into the cell) for the HIV (AIDS) virus. The gp120 envelope glycoprotein of the HIV (i.e., AIDS virus) directly interacts with the CD4 protein on the surface of helper T cells to enable the virus to invade the helper T cells. See also *T cell receptors, Adhesion molecule, GP120 protein, Soluble CD4.*

### CD44 Protein

One of the adhesion molecules (embedded in the surface of the linings of blood vessels) that assists the neutrophils on their journey from the bloodstream through the walls of blood vessels (e.g., to combat pathogens into adjacent tissues). Tumor cells also exploit CD44 molecules in order to metastasize (spread throughout the body's tissue from a single beginning tumor) via a similar (tumor cell) through-blood vessel-wall adhesion molecule mechanism. See also *Adhesion molecule, CD4 protein, Protein, Neutrophils, Pathogen, Tumor, Cancer, Soluble CD4.*

### CD4-PE40

A pharmaceutical discovered in 1988 by Ira Pastan and Bernard Moss that has indicated potential to combat acquired immune deficiency syndrome (AIDS). CD4-PE40 is a conjugated protein (fusion protein) consisting of a CD4 protein (molecule) attached to *Pseudomonas* exotoxin (a substance produced by *Pseudomonas* bacteria that is toxic to certain living cells). The gp 120 glycoprotein on the surface of the HIV (i.e., AIDS) virus attaches preferentially to the CD4 portion of this immunoconjugate, and the virus is inactivated by the *Pseudomonas* exotoxin portion of this immunoconjugate. See also *Protein, CD4 protein, Fusion protein, GP120 protein, Soluble CD4, Immunotoxin, Conjugated protein, Acquired immune deficiency syndrome (AIDS), Human immunodeficiency virus type 1 (HIV-1), Human immunodeficiency virus type 2 (HIV-2), Ricin, Abrin.*

### CD8<sup>+</sup> T Cells

One class of T cells (i.e., part of the immune system) that is triggered by an infection (or a vaccination) to differentiate into two different populations of cells. One population (i.e., effector T cells) attacks the pathogen to clear it from the body. Effector T cells have a short lifespan.

The second population (i.e., memory T cells) constitute a long-lived reservoir of cells that *remember* that pathogen's specific antigenic determinant and mediate the immune system's response to any future infection by the same pathogen (faster/more effective response). That future memory, T-cell-mediated response is known as the *adaptive immune response.*

Memory T cells also contain elevated levels of a protein known as the Signal Transducer and Activator of Transcription #4 (STAT4), which makes them much more responsive to cytokines. Thus, these STAT4-containing CD8<sup>+</sup> T cells are also part of the future cytokine-mediated *innate immune response.* See also *Cell, T cells, Effector T cells, Memory T cells, Differentiation, Pathogen, Antigenic determinant, Cellular immune response, Innate immune system, Innate immune response, Signal transducers and activators of transcription (STATs).*

### CD95 Protein

Also called "APO-1/Fas," it is a transmembrane protein (embedded within the surface membrane of the cell) that transmits apoptosis ("programmed" cell death) "signal" into cells. Transduction of that apoptosis signal occurs when certain ligands or antigens (i.e., the APO-1/Fas antigen) bind to the extracellular (i.e., portion outside of cell membrane) part (i.e., receptor) of the CD95 protein. See also *Apoptosis, Protein, Cell, Signal transduction, Signaling, Nuclear receptors, Antigen, Receptors, Fusarium.*

### cDNA

See *Complementary DNA (cDNA).*

### C-DNA

Also known as copy DNA. A helical form of DNA. It occurs when DNA fibers are maintained in 66% relative humidity in the presence of lithium ions. It has fewer base pairs per turn than B-DNA. See also *B-DNA, Deoxyribonucleic acid (DNA), Base pair (bp), Complementary DNA (cDNA).*

### cDNA Array

See *Microarray (testing).*

### cDNA Clone

A DNA molecule synthesized (*made*) from an mRNA sequence via sequential use of reverse transcriptase (acting on mRNA) and DNA polymerase.

A collection of such cloned molecules that represents all the genetic information expressed by a given cell or by a given tissue type is referred to as a "cDNA library." See also *Deoxyribonucleic acid (DNA), Messenger RNA (mRNA), Complementary DNA (cDNA), Sequence (of a DNA molecule), Reverse transcriptase, DNA polymerase, Clone (a molecule), Cell, Genetic code.*

### cDNA Library

See *cDNA clone.*

### cDNA Microarray

See *Microarray (testing), Complementary DNA (cDNA).*

**CDR**

Acronym for *complementarity-determining regions*, or acronym for *commonly deleted region*. See the links. See also *Deoxyribonucleic acid (DNA)*, *Complementarity (molecular genetics)*, *Deletions*.

**CDx**

Abbreviation for companion diagnostic. See *Companion diagnostic*.

**CE**

Acronym for capillary electrophoresis. See *Capillary electrophoresis*.

**Cecrophins**

(Lytic proteins) Proteins produced by certain white blood cells (called cytotoxic T lymphocytes [CTL] or killer T cells). The proteins allow lysis (i.e., bursting) of infected cells. Cecrophins are amphipathic (i.e., contain both a hydrophobic region and a hydrophilic region) and work by “worming” the hydrophobic portion into the cell membrane (so the hydrophobic portion of the cecrophin molecule is out of the water). This creates a transmembrane pore (i.e., a hole in the membrane) that is lined with the cecrophin’s hydrophilic portion. Membranes function simply to separate various components. This separation is required for life to exist. When holes are introduced into cell membranes, water rushes into the targeted cell due to differences in osmotic pressure and the cell ruptures (explodes). T cecrophins are only able to lyse (i.e., burst) infected cells because only “sick” cells have a weakened cytoskeleton (located just inside the cell membrane), which cannot prevent the contents of the cell from spilling out through the pores (created by cecrophins). See also *Helper T cells (T4 cells)*, *Pathogen*, *Complement*, *Hydrophobic*, *Hydrophilic*, *Complement cascade*, *Lyse*, *Lysis*.

**Cecropin A**

See *Cecropin A peptide*.

**Cecropin A Peptide**

See *Cecrophins*, *Peptide*.

**C-Extein**

See *Intein*.

**Celiac Disease**

From the Greek word *koelia* (abdomen), it is a genetic-susceptibility-resultant disease of the small intestine. People possessing the relevant genes (especially common in Italians and people descended from Italians) are unable to tolerate gluten (a component of cereal grains) or gluten-similar proteins (secalin and hordein) in rye and barley. Consumption of gluten (e.g., in wheat-containing products) causes villi (small fingerlike projections on the surface of the inner wall of the small intestine) to become chronically inflamed. An enzyme named tissue transglutaminase is released by the damaged cells (enterocytes). In genetically susceptible individuals, the B cells of the immune system make and release antibodies against the tissue transglutaminase. When those antibodies encounter molecules of tissue transglutaminase on the surfaces of villi, they can cause

degeneration of villi in the small intestine and thereby result in a reduction in the body’s subsequent ability to absorb nutrients from foods. In severe cases, this may result in malnutrition occurring while an otherwise adequate diet is later consumed.

Tissue transglutaminase can also modify undigested gluten (peptides) present in the small intestine, thereby enabling the gluten to tightly bind to certain histocompatibility leukocyte antigens (HLA-DQ2 and HLA-DQ8). When that occurs, applicable T cells are activated to release into the bloodstream cytokines and chemokines. See also *Gluten*, *Heredity*, *Genetics*, *Enterocytes*, *Peptide*, *Antigen*, *Antibody*.

**Cell**

From the Latin word “cella,” which means “small room.” Discovered by Robert Hooke in 1665, the cell is the fundamental self-containing unit of life. The living tissue of every multicelled organism is composed of these fundamental living units. Certain organisms may consist of only one cell, such as yeast or protein bacteria, protozoa, some algae, and gametes (the reproductive stages) of higher organisms. Larger organisms are subdivided into organs that are relatively autonomous but cooperate in the functioning of that plant or animal. Unicellular (i.e., single-cell) organisms perform all life functions within the one cell.

In a higher organism (i.e., a multicellular organism), entire populations of cells (i.e., an organ) may be designated a particular specialized task (e.g., the heart to facilitate circulation). The cells of muscle tissue are specialized for movement and those of bone and connective tissue, for structural support.

The surface of some cells bear extensions (e.g., extended “arms”). For example, such extensions from the bone cells known as osteocytes are called “dendrites.”

While most cells are too small to be seen with the unaided eye, the egg yolk of birds is a single cell, so the egg yolk of an ostrich is the world’s largest cell. See also *Plasma membrane*, *Gamete*, *Germ cell*, *Microbiology*, *Oocytes*, *Dendrites (in bone)*.

**Cell Adhesion Molecule**

See *Adhesion molecule*.

**Cell Adhesion Proteins**

From the Latin *adhaerere* meaning “to stick to.” The term “cell adhesion protein” refers to a glycoprotein molecular “chain” that protrudes from the surface membrane of certain cells and causes cells (possessing “matching” adhesion proteins) to adhere to each other. For example, in 1952 Aaron Moscona observed that (harvesting enzyme-separated) chicken embryo cells did not remain separated but instead coalesced again into an (embryo) aggregate. In 1955, Philip Townes and Johannes Holtfreter showed that “like” amphibian (e.g., frog) neuron cells will rejoin together after being physically separated (e.g., with a knife blade); but “unlike” cells remain segregated (apart).

Cell adhesion proteins *per se* were formally discovered by Gerald M. Edelman during the 1970s.

Adhesion proteins also play a crucial role in guiding monocytes to sources of infection (e.g., pathogens) because adhesion molecules in the walls of blood vessels (after activation caused by pathogen invasion of adjacent tissue) adhere to like adhesion molecules in the membranes of monocytes in the blood. The monocytes pass through the blood vessel walls, become macrophages, and fight the pathogen

infection (e.g., triggering tissue inflammation). When certain cell adhesion proteins are absent from tissues (where they are normally present), it can lead to cancers of the endometrium, bladder, prostate, skin, breast, pancreas, colon, etc.

See also *Monocytes, Macrophage, Polypeptide (protein), Cell, Pathogen, CD4 protein, CD44 protein, GPI20 protein, Vaginosis, Harvesting enzymes, Harvesting, Signal transduction, Selectins, Lectins, Glycoproteins, Sugar molecules, Leukocytes, Lymphocytes, Neutrophils, Endothelium, Endothelial cells, P-selectin, ELAM-1, Integrins, Cytokines, Cancer, Chronic inflammation.*

## Cell Culture

The *in vitro* (i.e., outside of body, in a test tube or vat) propagation of cells isolated from living organisms. See also *Mammalian cell culture, Insect cell culture, Dissociating enzymes, Harvesting enzymes, Vero, MDCK, Plant cell culture.*

## Cell Cytometry

See *Cell, Cell sorting, Fluorescence activated cell sorter (FACs), Magnetic particles.*

## Cell Differentiation

The process whereby descendants of a common parental cell achieve and maintain specialization of structure and function. In humans, for instance, all the different types of cells (e.g., muscle cells, bone cells) differentiate from the zygote (itself formed by union of the simple sperm and egg). In humans, the various blood cell types (e.g., red blood cells, white blood cells) differentiate from stem cells in the bone marrow. Cell differentiation is caused/triggered/assisted by micro-RNAs, colony-stimulating factors, growth factors, and certain other proteins (e.g., hedgehog proteins, mediator, cohesin). See also *Stem cells, Stem cell one, Differentiation, Protein, Hedgehog signaling pathway, Hedgehog proteins, Erythrocytes, Leukocytes, Colony-stimulating factors, Growth factors, Mitogen-activated protein kinase cascade, Micro-RNAs, Tetraspanin proteins, Mediator, Cohesin.*

## Cell Fusion

The combining of cell contents of two or more cells to become a single cell. Fertilization is such a process (fusing of gametes' cells). See also *Gamete, Cell.*

## Cell Motility

Refers to *cell movement* (e.g., during an organism's early development, during repair of some tissues, during cancer metastasis).

For example, during some stages of a human baby's development in the womb, entire "sheets" of cells will suddenly move significant distances to a new location on the baby's body.

For example, when blood vessels get injured, the harmed cells release a signal. That signal causes some of the endothelial smooth muscle cells to "transform" from *contractile* phenotype (i.e., normal state, in which they help to control blood pressure) to *synthetic* phenotype (i.e., which can move). The cells in synthetic state move to the site of the injury, where they repair it via growing/dividing, and then they return to the contractile state.

During metastasis, transforming growth factor-beta (TGF-beta) exuded by a cancerous tumor causes epithelial cells to "transform" to a mesenchymal phenotype (thereby enabling subsequent cell motility).

The molecule *n-cofilin* plays a critical role in the body's regulation of cell motility (e.g., helps to break down actin fibers, resulting in cells moving during development). See also *Cell, Pathway, Signaling, Hedgehog signaling pathway, Embryology, Endothelium, Cancer, Metastasis, Transforming growth factor-beta (TGF-beta), Phenotype, Cholesterol, Actin.*

## Cell Recognition

See *Adhesion molecule, Signal transduction, Receptors.*

## Cell Signaling

See *Signaling.*

## Cell Sorting

A process utilized (e.g., by researchers) to sort/separate different cells (e.g., pathogens, cancerous vs. normal cells, sperm that are bearing chromosomes for male vs. female).

Some automated means of cell sorting include *biochips* (utilizing controlled electrical fields to collect specific cell types onto electrodes in the biochip), fluorescence-activated cell sorter machines using a laser to light up cell surface proteins, magnetic particles (e.g., attached to antibodies that themselves attach to cell surface proteins), level(s) of RNA resultant from gene expression in the cell, etc. See also *Cell, Pathogen, Cancer, Chromosome, Biochip, BioMEMS, Fluorescence activated cell sorter (FACs), Magnetic particles, Gene expression.*

## Cell State

See *Mediator, Cohesin.*

## Cell-Based Assays

Refers to assays in which whole cells (generally living) are probed. See also *Assay, Bioassay cell, Multiplexed (assay), High-content screening, Flow cytometry, Whole-cell patch-clamp recording, Molecular beacon.*

## Cell-Differentiation Proteins

The various growth factors and other proteins that cause/assist in cell differentiation. See also *Cell differentiation, Mediator, Cohesin, Hedgehog proteins.*

## Cell-Free Gene Expression System

Refers to a (science researcher's) system of carefully prepared compounds/vessels for the *expression of a given gene* in crude cell extract, without the use of any cells.

For example, a given gene can be transcribed in a research vessel (test tube) via addition of the proper RNA polymerase. The resultant RNA is then translated via the proper lysate (e.g., extracted from rabbit reticulocytes or from wheat germ). See also *Cell, Gene, Express, Transcription, Translation.*

## Cell-Free Translation System

See *Cell-free gene expression system.*

## Cell-Free Fermentation

Discovered by Eduard Buchner in 1896, this refers to a (science researcher's) system of carefully prepared compounds/vessels for the *fermentation of a particular substrate* (e.g., glucose) without the use of any cells. See also *Fermentation, Cell, Substrate (chemical), Glucose (GLC)*.

## Cell-Mediated Immunity

See *Cellular immune response*.

## Cell-Penetrating Peptide

See *Peptide-oligonucleotide conjugates*.

## Cellular Adhesion Molecule

See *Adhesion molecule*.

## Cellular Adhesion Receptors

See *Cell, Adhesion molecule, Receptors, Integrins, Selectins, Cadherins*.

## Cellular Affinity

Tendency of cells to adhere specifically to cells of the same type. This property is lost in some cancer cells. See also *Cell, Adhesion molecule, Cell differentiation*.

## Cellular Immune Response

Also called “cell-mediated immunity.” The immune response that is carried out by specialized cells, in contrast to the response carried out by soluble antibodies. The specialized cells that make up this group include cytotoxic T lymphocytes, helper T lymphocytes, macrophages, and monocytes. This system works in concert with the humoral immune response. See also *Humoral immunity, T cells, CD8<sup>+</sup> T cells, T cell receptors, Phagocyte, Helper T cells (T4 cells), Cytokines, Macrophage*.

## Cellular Oncogenes

See *Proto-oncogenes*.

## Cellular Pathway Mapping

Refers to the process of determining each of the pathways and pathway feedback mechanisms within a given cell's vital processes.

Cellular pathway mapping can be utilized to identify targets of therapeutic agents, identify cross talk between some of the cell's pathways, and identify “branched” pathways that—when perturbed by a potential therapeutical agent (e.g., pharmaceutical)—could result in toxic side effects. See also *Pathway, Cell, Pathway feedback mechanism, Target (of a therapeutic agent), Validation (of target), Toxicogenomics, Metabolite profiling, High-content screening, RNA interference (RNAi), Metabonomics*.

## Cellulase

An enzyme that digests cellulose to simple sugars such as glucose. Commercial cellulases (e.g., for biofuel production) have been

extracted from some fungi and from archaea. See also *Enzyme, Cellulose, Digestion (within chemical production plants), Fungus, Archaea*.

## Cellulose

A polymer of glucose units found in all plant matter; it comprises 40%–55% of the cell wall in plant cells. Because of its presence in all plant cells, cellulose is the most abundant biological compound on earth.

Cellulose is also synthesized (made) by some single-celled organisms such as cyanobacteria. See also *Carbohydrates, Glucose (GLC), Cell, Van der Waals forces, Cortical microtubules*.

## CenH3 Gene

See *CENH3 protein, Doubled-haploid breeding program*.

## CenH3 Protein

One of the histone proteins (i.e., around which are “wound” the cell's DNA to make chromosomes). CENH3 is found only within the centromere (i.e., the part of the chromosome that controls how it is passed to the next generation). See also *Chromosomes, Histones, Protein, Meiosis, Mitosis, Deoxyribonucleic acid (DNA), Centromere, Doubled-haploid breeding program*.

## Center for Advanced Research in Biotechnology (CARB)

A protein engineering research consortium that was established in Rockville, Maryland, during 1989 by the U.S. Government, the University of Maryland, and the local government. See also *Protein engineering*.

## Central Dogma (New)

Coined by Shankar Subramaniam during 1999, it is a restatement of the (old) former “central dogma” to include the fact that an organism's environment/activity also impacts *when* and *how* and *how much* some of its genes are expressed (e.g., to cause certain proteins to be “manufactured”). Environmental factors impacting gene expression include temperature, sunlight, humidity, consumption of some vitamins, industrial chemicals, the presence of certain bacteria, the presence of signal transducers and activators of transcription (STATs), etc.

In addition, epigenetics cause organisms to preferentially express certain alleles (e.g., those inherited from the mother or from the father). For example, in mice, more maternal-origin alleles are expressed within the developing brain, and more paternal-origin alleles are expressed within the adult mouse brain than would occur from a simple random 50/50 contribution of parental alleles to the offspring's DNA.

For example, the eggs of the saltwater crocodile (*Crocodylus porosus*) yield a larger fraction of male offspring when those eggs are incubated in the nest (made of rotting vegetation) at temperatures above 90°F (32°C) than when those eggs are incubated at temperatures below 90°F (32°C).

Recent research indicates that *physical exercise* changes the expression levels of some genes (within human skeletal muscles) involved in the body's metabolism of carbohydrates.

That (central dogma) restatement also expressly includes the fact that *more than one protein* can result from each gene in an

organism's genome (e.g., due to interactions *between* genes, interactions between genes and their protein products [e.g., STATs], interactions between genes and histones, and interactions between genes and some environmental factors). Mechanistically, this results in (different) proteins via the following:

- Alternative splicing of the mRNA transcript. For example, the COX-3 enzyme is produced in the human body when *intron 1* is retained in the mRNA transcript during transcription of the COX-1 gene. For example, a single intronic base substitution that is present within the IKAP gene (the allele responsible for the human disease known as *familial dysautonomia*) affects the splicing of the IKAP transcript (i.e., the mRNA segment that determines which protein is subsequently *manufactured* by relevant cells).
- Varying translation start or stop site (on the gene).
- Frameshifting (i.e., different set of triplet codons in the mRNA is translated).
- Contiguous genes.
- Recombination of some gene segments.

See also *Central dogma (OLD)*, *Organism*, *Molecular genetics*, *Complementary DNA (c-DNA)*, *Gene*, *Allele*, *Protein*, *Enzyme*, *Replication (of virus)*, *Gene*, *Transcription*, *Translation*, *Deoxyribonucleic acid (DNA)*, *Genome*, *Ribonucleic acid (RNA)*, *Messenger RNA (mRNA)*, *Transcription factors*, *Ribosomes*, *Signal transduction*, *Signal transducers and activators of transcription (STATs)*, *Photoperiod*, *Gene expression*, *Alternative splicing*, *Gene splicing*, *Splicing*, *Splice variants*, *Frameshift*, *Codon*, *Intron*, *Pharmacogenetics*, *Cyclooxygenase*, *Metabolism*, *Carbohydrates*, *Transcriptome*, *Activator (of gene)*, *Contiguous genes*, *Epigenetic*, *Vitamin*, *Histones*, *Epigenetic*.

### Central Dogma (Old)

The historical organizing principle of molecular genetics; it states that genetic information flows from DNA to RNA to protein, or stated in another way, DNA makes RNA, which makes protein. This principle was first stated by Watson and Crick. It is, however, not rigorously accurate as illustrated by the following facts:

- DNA (i.e., genes) “information flow” is influenced (e.g., timing, amounts) by some environmental factors (e.g., temperature, humidity).
- The enzyme reverse transcriptase produces (“makes”) DNA using an RNA template.
- Prions do not contain any DNA.

See also *Molecular genetics*, *Complementary DNA (c-DNA)*, *Protein*, *Enzyme*, *Replication (of virus)*, *Transcription*, *Translation*, *Deoxyribonucleic acid (DNA)*, *Ribonucleic acid (RNA)*, *Messenger RNA (mRNA)*, *Prion*, *Template*, *Central dogma (new)*, *Reverse transcriptases*, *RT-PCR*, *Activator (of gene)*.

### Centrifuge

A machine that is used to separate heavier from lighter molecules and cellular components and structures. See also *Ultracentrifuge*.

### Centriole

An organelle within cells that helps organize the cell's microtubules (e.g., to move certain protein molecules around the cell's interior,

from where they were manufactured to where they are needed by the cell). See also *Microtubules*, *Cell*, *Protein vesicular transport (of a protein)*.

### Centromere

A constricted region of a chromosome that includes the site of attachment to the mitotic or meiotic spindle. Due to that role, the centromere is a crucial segment of DNA for ensuring that the right numbers of chromosomes are delivered to the correct location within each “daughter cell” during cell division. See also *Deoxyribonucleic acid (DNA)*, *Chromosomes*, *Meiosis*, *Chromatin*, *Mitosis*, *Karyotype*, *Karyotyper*.

### Centrosome

Refers to the *pair of centromeres* in a cell that (during interphase) organize microtubules within the cell (e.g., to pull apart the paired chromosomes, prior to separation of the “parent” cell into two daughter cells). Centrosomes also form the base of cilium—a tail-like protrusion on the surface of certain cells (e.g., epithelial cells that line the inner surface of the trachea/bronchial tubes) that “sweep” debris (e.g., bacteria) out to where it can be expelled via coughing, etc. See also *Cell*, *Centriole*, *Meiosis*, *Microtubules*, *Cilia*.

### Cerebrose

See *Galactose (gal)*.

### Cessation Cassette

A three-gene cassette (genetic sequence construct) that, *when inserted into a plant* and when activated via tetracycline antibiotic, prevents the seeds produced by that plant from germinating. That is because the *cessation cassette* stops those resultant seeds from synthesizing a specific protein needed for seed germination. See also *Cassette*, *Gene*, *Genetic engineering*, *Protein*, *Synthesizing (of proteins)*, *Sequence (of a DNA molecule)*, *antibiotic*.

### Cetuximab

A monoclonal antibody approved by the U.S. Food and Drug Administration as the pharmaceutical Erbitux™ to treat colon cancer and head and neck cancers. By attaching itself to epidermal growth factor receptors (EGF receptors) on the surface of those cancer cells, it thereby interferes with inappropriate (malignant) signaling and thus slows or even stops growth of those cancerous cells. See also *Monoclonal antibodies (MAb)*, *Food and Drug Administration (FDA)*, *Cancer*, *Cell*, *Receptor*, *Epidermal growth factor (EGF)*, *EGF receptor*, *Signaling*.

### CFH Protein

Abbreviation for complement factor H protein. See *Complement factor H gene*.

### CFP

Acronym for cyan fluorescent protein. See *Visible fluorescent proteins*.

**CFTR**

See *Cystic fibrosis transmembrane regulator protein (CFTR)*.

**CGE**

Acronym for control of gene expression. See *Genetic use restriction technologies*.

**CGIAR**

See *Consultative Group on International Agricultural Research (CGIAR)*.

**cGMP**

Current Good Manufacturing Practices. The set of current, up-to-date methodologies, practices, and procedures mandated by the Food and Drug Administration (FDA) that are to be followed in the testing and manufacture of pharmaceuticals. The set of rules and regulations promulgated and enforced by the FDA to ensure the manufacture of safe clinical supplies. The cGMP guidelines are more fine-tuned and up to date (technologically speaking) than the more general GMP. See also *Phase I clinical testing, IND, Good manufacturing practices (GMP)*.

**Chaconine**

A neurotoxin that is naturally present at low levels within potatoes. As a result of that, chaconine is present at detectable levels in the bloodstream of humans that consume potatoes.

When consumed by humans, chaconine acts as a plasma cholinesterase inhibitor. See also *Toxin, Solanine, Plasma, Cholinesterase, Inhibition*.

**Chakrabarty Decision**

*Diamond vs. Chakrabarty*, U.S. Department of Commerce, 1980, a landmark case in which the U.S. Supreme Court held that the inventor of a “new” microorganism (*Burkholderia cepacia* bacteria) whose invention otherwise met the legal requirements for obtaining a patent could not be denied a patent solely because the invention was alive. It essentially allowed the patenting of life forms.

The scientist Ananda Chakrabarty had modified the genes of *Burkholderia cepacia*, making it better able to break down petroleum and digest it. See also *U.S. Patent and Trademark Office (USPTO), Microorganism, Bacteria*.

**Chalcone Isomerase**

An enzyme present within some plants (e.g., tomato) that can catalyze/increase production of certain flavonols (e.g., naringenin chalcone, quercetin glycosides), which act as antioxidants in the human body when they are consumed by humans.

Because oxidation of certain lipids (e.g., low-density lipoproteins) in the bloodstream is the initial step in atherosclerosis disease, consumption of large amounts of such flavonols may help to prevent atherosclerosis (and some other diseases caused by oxidative stress). See also *Flavonols, Oxidation, Lipids, Oxidative stress, Antioxidants, Atherosclerosis, Quercetin*.

**Channel Blockers**

See *Calcium channel blockers*.

**Chaotrope**

See *Chaotropic agent*.

**Chaotropic Agent**

From the Greek meaning “disorder maker,” it is a substance that yields ions (in water solution) that can increase unfolding/denaturation of protein molecules in solution, dissolve biological membranes/proteins, and/or denature nucleic acids. One example of a chaotropic agent is guanidium isothiocyanate. See also *Ion, Plasma membrane, Protein, Protein folding, Denaturation, Denatured DNA, Nucleic acids*.

**Chaperone Molecules**

See *Chaperones*.

**Chaperone Proteins**

See *Chaperones*.

**Chaperones**

Protein molecules inside living cells of organisms that assist with

- Correct protein folding as the protein molecule emerges from the cell’s ribosomes
- Correct RNA molecule folding

Also, they help to convey those protein(s) and RNA(s) to their ultimate destination(s) in the organism.

Later, when cellular protein molecules begin to “unfold” due to age, heat, viruses, or exposure to certain chemicals or ultraviolet light, chaperones often cause those unfolded protein molecules to return to their correct (initial) conformation.

Examples of such chaperone molecules include heat-shock proteins (e.g., heat-shock protein 70, heat-shock protein 40), certain cold-shock proteins, GroEL protein, and GroES protein. See also *Leader sequence (protein molecule), Protein folding, Heat shock proteins, Protein, Ribosomes, Cell, Conformation, Virus, Congo red, Cold-shock protein, Ribonucleic acid (RNA)*.

**Chaperonins**

Protein molecules inside living cells that facilitate proper folding of the (new) protein molecules that are synthesized (i.e., *manufactured*) in the cell’s ribosomes. Chaperonins also facilitate proper folding of some (old) proteins that have been stress-denatured (e.g., they lost their proper folded structure as a result of stress or aging of the cell). Chaperonins accomplish this by encapsulating the applicable protein molecules inside a protective chamber that is formed from two rings of molecular complexes stacked back to back. See also *Protein, Co-chaperonin, Chaperones, Molecular chaperones, Protein folding, Ribosomes, Cell, Conformation*.

## Characterization Assay

See *Assay, High-throughput screening (HTS), Bioassay, Biochips*.

## Charge-Coupled Device

A matrix of photosensitive electronic circuits, which functions akin to a camera in the recording of an image (*photograph*) electronically. See also *Dynamic light scattering*.

## CHARM

Acronym for comprehensive high-throughput arrays for relative methylation. This particular microarray technology allows scientists to analyze the whole genome of an organism at once. See also *Microarray (testing), Cell array, Multiplexed (assay), Gene expression analysis, Genome, Genomics, Organism, DNA methylation, Methylated, Whole-genome association, Whole-genome shotgun sequencing*.

## Chassis

See *Synthetic biology*.

## CHD

Acronym for coronary heart disease. See *Coronary heart disease (CHD), Atherosclerosis, Low-density lipoproteins (LDLs), Carotenoids*.

## Checkpoint Blockade

Refers to how certain cancer tumors avoid being destroyed by the human immune system by synthesizing and secreting certain protein molecules that bind to receptors located on the surface of applicable immune system cells, thereby “blockading” those immune system cells. See also *Tumor, Cancer, Cancer immunotherapy, Protein, Receptors, Synthesizing (of proteins)*.

## Chelating Agent

A molecule capable of “binding” metal atoms. The word “chelated” is Greek for *claw/binding together*. The chelating agent/metal complex is held together by coordination bonds that have a strong polar character. One example of a common chelating agent is ethylenediamine tetraacetate (EDTA), which tightly and reversibly binds  $Mg^{2+}$  and other divalent cations (positively charged ions). If a chelate is allowed to bind to metal ions required for enzyme activity, the enzyme will be inactivated (inhibited). Cobalamin (vitamin  $B_{12}$ ), EDTA, and the iron–porphyrin complex of heme (which provides the red color of blood) are other examples of chelates. See also *EDTA, Phytate, Low-phytate soybeans, Low-phytyate corn, Chelation, Heme, Transferrin*.

## Chelation

From the Greek for *claw/binding together*. The binding of metal cations (metal atoms or molecules possessing a positive electrical charge) by atoms possessing unshared electrons (thus the electrons can be “donated” to a bond with a cation). The binding of the metal (cation) to the (electron excess) chelator atom (ligand) results in

formation of a chelator/metal cation complex. The intra-atom bonds thus formed are given the name of coordination bonds.

The properties of the chelator/metal cation complex frequently differ markedly from the “parent” cation. Both carboxylate and amino (molecular) groups readily bind metal cations. One of the most widely used chelators is ethylenediamine tetraacetate (EDTA). It has a strong affinity for metal cations possessing two (bi) or more positive (electrical) charges. Each EDTA molecule binds one metal cation. The EDTA molecule can be visualized as a “hand” (having only four fingers) that grasps the metal cation. Some enzymes (which require metal cations for their activity) are inactivated by EDTA (and other chelators) in that the chelators preferentially remove the metal from the enzyme. See also *Ion, EDTA, Ligand (in biochemistry), Carbohydrates, Enzyme, Heme, Chelating agent, Transferrin, Phytate, Low-phytate corn, Low-phytate soybeans*.

## Chemical Genetics

Coined by Rebecca Ward and Tim Mitchison, this term refers to the creation and use of synthetic chemicals that act to either change the sequence (of amino acids), change the conformation, block, or enhance the activity of a protein (or gene that codes for protein). This enables scientists to then determine the specific function(s) of specific protein molecules.

For example, during 2002, Henning D. Mootz and Tom W. Muir devised a methodology to use a dimerizer ligand to initiate protein splicing. When carefully devised (e.g., the dimerizer ligands are each bound to one-half of an *intein*), which are themselves bound to *exteins*, the intein is thereby “popped out” of the center (of the protein molecule), and the two exteins (i.e., the two “end sequences” of protein molecule after intein is removed) are spliced together in a manner that is controlled (to yield desired *new net protein* molecule). See also *Genomics, Functional genomics, Protein, Gene, Genetic code, Zinc finger proteins, Combinatorial chemistry, Conformation, Genomic sciences, Gene function analysis, Sequence (of a protein molecule), Ligand (in biochemistry), Intein, Extein*.

## Chemiluminescence

See *Luminescent assays, Chemiluminescent immunoassay (CLIA)*.

## Chemiluminescent Immunoassay (CLIA)

An immunoassay (i.e., an antibody-based bioassay) that utilizes a signal that is generated by light-releasing chemical reactions (e.g., triggered by the binding of antibody to analyte). See also *Immunoassay, Antibody, Luminescent assays*.

## Chemoautotroph

A microorganism that obtains its energy from reactions between it and inorganic (chemical) compounds. For example, certain *Archaea* microorganisms derive energy from chemicals present on the ocean floor where they live (e.g., in/near volcanoes, lava vents). See also *Autotroph, Archaea*.

## Chemokines

Refers to a category of small cytokines (approx. 8–10 kDa in mass) that are able to cause nearby cells to undergo chemotaxis (i.e., those cells move toward or away from the source of the chemokines).

That directed cell migration is an important part of an organism's growth/development. Because of that, the word "chemokines" is created from the phrase *chemotactic cytokines*. See also *Cytokines*, *CCR5 protein*, *Cell*, *Chemotaxis*, *Kilodalton (kDa)*.

### Chemometrics

An empirical methodology utilized to (inexpensively) infer a chemical quantity/value from (indirect) measurement(s) of other physical/chemical values (which can be obtained inexpensively).

The term "chemometrics" was coined in 1975 by Bruce Kowalski. One example of the use of chemometrics is to infer the "true metabolizable energy" (TME [N]) of high-oil corn from that corn's protein and oil (fat) content. See also *High-oil corn*, *TME (N)*, *Protein*, *Fats*.

### Chemopharmacology

Therapy (to cure disease) by chemically synthesized drugs. See also *Pharmacology*, *Cisplatin*.

### Chemotaxis

Sensing of, and movement toward or away from, a specific chemical agent by living, freely moving cells (e.g., bacteria, macrophages, neutrophils).

For example, the *Clostridium botulinum* bacteria can sense and move away from nitric oxide (which can kill *Clostridium botulinum*). See also *Cell*, *Bacteria*, *Macrophage*, *Neutrophils*, *Actin*, *Nodulation*, *Nitric oxide*, *Chemokines*.

### Chemotherapy

When this term was first coined by Paul Ehrlich in 1905, it was defined as any therapy (to cure diseases) via chemically synthesized drugs.

Over time, the term "chemotherapy" has increasingly been utilized to refer to only application of such therapy to treat cancers.

Note that autophagosomes sometimes gather up and carry certain pharmaceuticals (e.g., chemotherapy agents introduced into cancer cells) to lysosomes within the cell, where those pharmaceuticals are broken down and/or excreted (e.g., by efflux pumps).

See also *Chemopharmacology*, *Cancer*, *Cisplatin*, *Taxol*, *Paclitaxel*, *Toxicogenomics*, *Autophagy*, *Lysosome*, *Efflux pump*.

### Chimera

An organism consisting of tissues or parts of a diverse genetic constitution. An example of a chimera would be a centaur, the half-man, half-goat figure in Greek mythology.

The word "chimera" is from the mythological creature by that name that possessed the head of a lion, the body of a goat, and the tail of a serpent. The word "chimera" is very general and may be applied to any number of entities. For example, chimeric antibodies may be produced by cell cultures in which the variable, antigen-binding regions are of murine (mouse) origin while the rest of the molecule is of human origin. It is hoped that this combination will lead to an antibody that, when injected into patients, would not elicit *rejection* and not give rise to a lesser immune response by the host against disease(s) the antibody is *aimed* at. See also *Deoxyribonucleic acid (DNA)*, *Genetic engineering*, *Chimeric DNA*, *Chimeric proteins*, *Chimeric antibody*, *Chimeroplasty*, *Organism*, *Antibody*, *Engineered antibodies*.

### Chimeroplasty

A method utilized by man to introduce a gene (from the same or another species) into the DNA of a living organism or cell, via *gene repair* mechanism. Scientists add the desired DNA (gene) to a cell, along with RNA, in a paired-group known as a chimeroplast. The chimeroplast attaches itself to the cell's DNA at the site of the specific gene (to be changed) and *repairs* it utilizing its (new) chimeroplast DNA as a *template*. See also *Gene repair (done by man)*, *Gene*, *Species*, *Deoxyribonucleic acid (DNA)*, *DNA repair*, *Organism*, *Cell*, *Chimera*, *Template*, *Ribonucleic acid (RNA)*, *Oligonucleotide-mediated mutagenesis*.

### Chimeric Antibody

A (genetically engineered) antibody that combines characteristics of antibodies from two different sources. For example, the complementarity-determining (i.e., antigen-binding) portion of an animal antibody (e.g., raised against a specific antigen) with human monoclonal antibody.

The pharmaceutical rituximab (Rituxan™) is a chimeric antibody utilized to treat non-Hodgkin's lymphoma. Its complementarity-determining portion binds to CD20, a receptor found on the surface of B cells in humans who have non-Hodgkin's lymphoma (a cancer of the bone marrow/spleen/lymph nodes). That binding to CD20 induces death of those B cells via apoptosis or humoral immune response. Because bone marrow stem cells (progenitors to B cells) do not have CD20 receptors, rituximab does not bind to them, so after the treatment has ended, those stem cells will again make (noncancerous) B cells.

The pharmaceutical cetuximab (Erbix™) is a chimeric antibody used to treat certain metastatic colorectal cancers and head and neck cancer. Its complementarity-determining portion binds to an EGF receptor, a receptor found in abundance on the surface of those tumors' cells. That binding to EGF receptors induces tumor cell death via apoptosis or humoral immune response. See also *Antibody*, *Antigen*, *Avidity*, *Monoclonal antibodies (MAB)*, *Chimera*, *Chimeric proteins*, *Genetic engineering*, *Humanized antibody*, *Cancer*, *Humoral immune response*, *EGF receptor*, *Anti-epidermal growth factor receptor monoclonal antibodies*, *Tumor*, *Rituximab*.

### Chimeric DNA

(Recombinant) DNA containing spliced genes from two different species.

Transcription/translation of chimeric DNA results in synthesis (by ribosome) of a *chimeric protein* (also known as a fusion protein). See also *Deoxyribonucleic acid (DNA)*, *Gene*, *Transcription*, *Translation*, *Ribosome*, *Protein*, *Chimeric proteins*, *Gene splicing*, *Species*, *Recombinant DNA (rDNA)*, *Genetic engineering*, *Gene fusion*.

### Chimeric Molecule

A molecule consisting of diverse constituents (e.g., a peptide and an oligonucleotide). See also *Chimera*, *Chimeric antibody*, *Chimeric DNA*, *Chimeric proteins*, *Peptide-oligonucleotide conjugates*.

### Chimeric Oligonucleotide-Dependent Mismatch Repair

See *Oligonucleotide-mediated mutagenesis*, *Genome editing*.

## Chimeric Proteins

Fused proteins from different species that are produced from the chimeric DNA template. See also *Chimera*, *Chimeric DNA*, *Deoxyribonucleic acid (DNA)*, *Antibody*, *Engineered antibodies*, *Chimeric antibody*, *Gene fusion*, *Peptide-oligonucleotide conjugates*.

## Chinese Hamster Ovary Cells

See *Cho cells*.

## CHIP

Acronym for “chemical inkjet printer.” Such CHIPS are sometimes utilized to manufacture certain microarrays by depositing precise amounts of chemicals (e.g., DNA segments) onto microarray surface (e.g., slide) at specific location(s). See also *Microarray (testing)*, *Deoxyribonucleic acid (DNA)*, *DNA chip*, *Probe*, *Hybridization (molecular biology)*, *Hybridization surfaces*, *Biochips*, *High-throughput screening (HTS)*.

## ChIP

Acronym for “Chromatin ImmunoPrecipitation method” (test). It is a test methodology utilized to determine which protein molecules (e.g., transcription factors) bind to specific DNA segments (e.g., regulatory sequence).

The test device (biochip) is created by attaching DNA segments of known sequence to a substrate and then determining which protein molecules (e.g., from a solution passed over the substrate) attach themselves to which DNA segment. See also *Protein*, *Deoxyribonucleic acid (DNA)*, *Transcription factors*, *Sequence (of a DNA molecule)*, *Chromatin*, *Chromatin immunoprecipitation*, *Substrate (structural)*, *Biochips*, *cis-acting protein*, *trans-acting protein*, *Surface plasmon resonance (SPR)*, *Proteomics*, *Genomics*.

## Chiral Compound

A chemical compound that contains an asymmetrical center and is capable of occurring in two nonsuperimposable mirror images. This phenomenon was first described by Louis Pasteur. “Chiral” is a word derived from the Greek *cheir* (meaning “hand”).

For example, human hands may be used to illustrate chirality in that when the left and right hand are held one on top of the other, one thumb sticks out on one side while the other thumb sticks out on the other side. The point is that the same number and type of fingers and thumbs exist in both hands, but their arrangement in space may be different. So it is with the arrangement of a given molecule’s (e.g., a drug’s) atoms in 3D space. The two are designated as “R” for right-handed and “S” for left-handed (S is from the Latin “sinistro”).

Approximately 40% of drugs on the market today consist of chiral compounds. In many chiral drugs, only one type of the molecule is beneficially biologically active (i.e., acts beneficially to control disease, reduce pain, etc.), while the other type of the drug molecule is either inactive or else causes undesired impacts (called “side effects” of the drug mixture). For example, one enantiomer of the drug thalidomide is a potent angiogenesis inhibitor (e.g., halts multiple myeloma and leprosy), but the other enantiomer causes birth defects in babies of pregnant women taking it. See also *Stereoisomers*, *Angiogenesis*, *Optical activity*, *Enantiomers*, *cis/trans isomerism*.

## Chitin

A water-insoluble polysaccharide polymer composed of *N*-acetyl-D-glucosamine molecular units, which is a major constituent of the cell walls of fungi and also forms the exoskeletons and some other parts of arthropods (insects) and crustacea. Shellac is produced from chitin.

Because the lining of the midgut (*stomach*) of certain insect pests is composed at least partially of chitin, genetically engineering a crop plant to produce within its applicable tissues some chitinase (an enzyme that degrades chitin) or the lectin known as HFR-3 (which tightly latches-onto chitin molecules) can help such crop plants to resist being attacked by that particular insect pest. See also *Polysaccharides*, *Polymer*, *Chitinase*, *Fungus*, *Cell*, *Lectins*, *PAMPs*, *Genetic engineering*.

## Chitinase

An enzyme that degrades (breaks down) chitin. It is one of the pathogenesis-related proteins produced by certain plants as a disease-fighting response to entry into plant of pathogenic (i.e., disease-causing) fungi.

Because the lining of the midgut (“stomach”) of certain insect pests is composed at least partially of chitin, genetically engineering a crop plant to produce within its applicable tissues some chitinase can help such crop plants to resist being attacked by that particular insect pest.

It (chitinase) is also sometimes produced by certain fungi and actinomycetes that destroy the eggs (i.e., chitin-containing shells) of harmful roundworms. See also *Chitin*, *Enzyme*, *Stress proteins*, *Pathogenesis related proteins*, *Fungus*, *Aflatoxin*, *Genetic engineering*.

## Chloroplast Transit Peptide (CTP)

A transit peptide that, when fused to a protein, acts to transport that protein into chloroplast(s) in a plant. Once (both are) inside the chloroplast, the transit peptide is cleaved off the protein and that protein is then free (to do the task it was designed for). For example, the CP4 EPSPS enzyme in genetically engineered glyphosate-resistant soybean [*Glycine max* (L.) *Merrill*] plant is transported into the soybean plant’s chloroplasts by the CTP known as “N-terminal petunia chloroplast transit peptide.” After (both) reaching the chloroplast, the CTP is cleaved and degraded, so the CP4 EPSPS is then free to do its task (i.e., confer resistance to glyphosate). See also *Peptide*, *Chloroplasts*, *Gated transport*, *Vesicular transport*, *Transit peptide*, *Fusion protein*, *Protein*, *Soybean plant*, *CP4 EPSPS*, *EPSP synthase*, *Herbicide-tolerant crop*.

## Chloroplasts

Specialized chlorophyll-containing photosynthetic organelles (plastids) in eucaryotic cells (i.e., the sites where photosynthesis takes place in plants).

Because there are approximately 100 chloroplasts within each plant cell, and each chloroplast contains approximately 100 copies of the plant’s DNA, it is theoretically possible to have 10,000 copies (e.g., of a gene inserted via genetic engineering) coding for a given protein. See also *Eucaryote*, *Organelles*, *Cell*, *Photosynthesis*, *Chloroplast transit peptide (CTP)*, *Transit peptide*, *Deoxyribonucleic acid (DNA)*, *Gene*, *Genetic engineering*, *Coding sequence*, *Protein*.

## CHO Cells

Abbreviation for “Chinese hamster ovary cells.” This refers to cell line(s) propagated/grown in cell culture (e.g., in petri dishes) that were originally removed from a Chinese hamster. Such cell culturing of CHO cells has been done by scientists since the 1960s to study genetics, gene expression, nutrition, etc.

Some pharmaceutical proteins (e.g., etanercept) and some enzymes (e.g., PARP) are produced by CHO cells via large-scale cell culture (e.g., fermentation vats, which have internal substrates for the CHO cells). See also *Cell*, *Cell culture*, *Mammalian cell culture*, *Gene*, *Gene expression*, *Fusion protein*, *Etanercept*, *Substrate (structural)*, *PARP*.

## Cholera Toxin

The toxin that is produced by the *Vibrio cholerae* (Latin America) bacteria, a source of food/water-borne gastrointestinal disease.

The cholera toxin has a strong affinity for certain receptors that are present on the surface of gastrointestinal cells. See also *Toxin*, *Enterotoxin*, *Conjugate*, *Immunoconjugate*, *Receptors*, *G-proteins*.

## Cholesterol

From the Greek word *chole* (bile), it is a sterol (sterol–lipid) that is an essential material for the creation of cell membranes, cell differentiation, and cell proliferation and is a *building block* for certain hormones (progesterone, estrogens, etc.), sterols, and acids used by the body. For example, the bile acids are made in the liver from cholesterol.

Cholesterol is also vital for normal embryonic development (e.g., of humans in the uterus) because it comprises a crucial portion of the *hedgehog proteins* that direct tissue differentiation (of the mammal embryo into various organs, limbs, etc.).

In addition to getting some via dietary intake, cholesterol is synthesized by the human body using the enzyme HMG-CoA reductase. However, deposition of (excess) oxidized cholesterol on the interior walls of blood vessels (in the form of plaque) can result in atherosclerosis and/or coronary heart disease, two often fatal diseases. See also *High-density lipoproteins (HDLPS)*, *Low-density lipoproteins (LDLPs)*, *Cell*, *Sterols*, *Phytosterols*, *Hormone*, *Sitostanol*, *Fructose oligosaccharides*, *Enzyme*, *Cholesterol oxidase*, *Coronary heart disease (CHD)*, *High-oleic oil soybeans*, *Steroid*, *Lipids*, *Hedgehog*, *Differentiation proteins*, *Campesterol*, *Stigmasterol*, *Sitosterol*, *Sitostanol*, *Resveratrol*, *Bile acids*, *Atherosclerosis*, *Plaque*, *CYP46*, *APOE4*, *Alzheimer's disease*.

## Cholesterol Oxidase

An enzyme that catalyzes the breakdown of cholesterol molecules (causing oxygen consumption in the breakdown process). Because cholesterol molecules are essential for creation and maintenance of cell membranes and some hormones, an excess of cholesterol oxidase can be harmful (e.g., to certain insects).

When the gene (which codes) for cholesterol oxidase is inserted into the genome of the corn (maize) plant, it can enable that plant to resist many of the worm pests (e.g., corn earworm, European corn borer, corn rootworm, black cutworm, armyworm) that attack corn (maize) in the field.

When the gene (which codes) for cholesterol oxidase is inserted into the cotton plant, it can enable that plant to resist weevils and other sucking insects that attack cotton plants in the field. See also

*Enzyme*, *Gene*, *Genetic engineering*, *Genome*, *Corn*, *Cholesterol*, *Helicoverpa zea (H. zea)*, *Corn rootworm*.

## Choline

Formerly known as vitamin B<sub>4</sub>, choline is an essential nutrient that takes part in many of the metabolism processes in the human body. Naturally present in egg yolks, organ meats, dairy products, soybean lecithin, spinach, and nuts, choline

- Is a major component of cell membranes
- Is required by the body to make phospholipids
- Promotes fat metabolism in the liver
- Is used by the liver to make certain choline-based compounds (necessary for the transport of fat from the liver to the rest of the body)
- Is used for the synthesis of high-density lipoproteins (i.e., HDLP, also known as “good” cholesterol) by the liver

It is also utilized by the body in order to synthesize (i.e., *manufacture*) acetylcholine, an important neurotransmitter (substance that transmits nerve impulses).

Because significant choline deficiency can cause liver carcinogenesis, cirrhosis, coronary heart disease, and hypertension and can impair cell signaling, the U.S. government has defined choline to be an essential nutrient and has formally established an *adequate intake* level per day for choline (550 mg/day for men and 425 mg/day for women, per NAS, 1998). In 1998, the U.S. Food and Drug Administration authorized a formal *nutrient content claim (on labels)* for food products and dietary supplements containing appropriate amounts of choline (e.g., those containing soybean lecithin).

One active metabolite of choline is the platelet-activating factor, which is involved in the body's hormonal and reproductive functions. Choline is so important in proper infant development/growth that it is included in manufactured infant formula at the rate of at least 7 mg/100 kcal. See also *Lecithin*, *Metabolism*, *Metabolite*, *High-density lipoproteins (HDLPS)*, *Essential nutrients*, *Cell*, *Plasma membrane*, *Phospholipids*, *Hormone*, *Soybean oil*, *Vitamin*, *Acetylcholine*, *Cholinesterase*, *Neurotransmitter*, *Fats*, *Cancer*, *Coronary heart disease (CHD)*, *Signaling*, *Homocysteine*.

## Cholinesterase

An enzyme that catalyzes the chemical reaction in which the neurotransmitter (i.e., substance that transmits nerve impulses) molecule *acetylcholine* is synthesized (i.e., *manufactured*) from Ac-CoA and choline. See also *Enzyme*, *Neurotransmitter*, *Ac-CoA*, *Choline*, *Lecithin*, *Alzheimer's disease*, *Solanine*, *Chaconine*.

## Chromatids

Copies of a chromosome produced by replication within a living eucaryotic cell during the prophase (i.e., the first stage of mitosis). They are compact cylinders consisting of DNA coiled around flexible rods of histone protein. See also *Chromatin*, *Eucaryote*, *Mitosis*, *Chromosomes*, *Replication (of virus)*, *Histones*, *Protein*.

## Chromatin

From the Greek word *chroma* meaning color. Named by Walter Flemming in 1882, due to the fact that chromatin's band-like structures stained darkly, chromatin is the complex of DNA and (histone) protein of which the chromosomes are composed. Consisting

of fibrous swirls of unraveled DNA molecules in the nucleus of the interphase (i.e., the prolonged period of cell growth between cell division phases) eucaryote cell, chromatin DNA gradually coils itself around flexible rods of histone protein during the prophase (i.e., the first stage of mitosis), forming two parallel compact cylinders (called “chromatids”) connected by a knot-like structure (called a “centromere”) at their middles. In appearance, they are sort of like two rolls of carpeting standing side by side that are tied together with rope at their middles.

These (recently replicated) cylinders (that are joined at their middles) are homologous chromosomes (i.e., the genes of the two chromosomes are linked in the same linear order within the DNA strands of both chromosomes). While they are still joined at their middles, these paired chromosomes appear X-shaped when photographed by a karyotyper to produce a karyotype.

Chromatin is usually not visible during the interphase of a cell but can be made more visible during all phases by reaction with basic stains (dyes) specific for DNA.

*Chromatin modification* is a term that refers to any (epigenetic) change in a cell's chromatin that impacts how (or if) a given gene is expressed. See also *Cell, Basophilic, Deoxyribonucleic acid (DNA), Protein, Histones, Chromatids, Chromosomes, Mitosis, Replication (of virus), Centromere, Karyotype, Eucaryote, Karyotyper, Epigenetic, Express, Chromatin remodeling, Chromatin remodeling elements, Short interfering RNA (siRNA), Differentiation pathways.*

### Chromatin Immunoprecipitation

Refers to the use in genomics/proteomics of antibodies created to adhere to a given DNA-binding protein (e.g., transcription factor, DNA repair proteins) to find sites where a particular DNA-binding protein will bind to the DNA.

The researcher treats applicable cells with a chemical such as formaldehyde, which causes cross-linking of a cell's DNA and relevant protein-binding molecules. The cells are then broken open, their chromatin is separated out, and the DNA molecule within that chromatin is cut into small fragments. A selected antibody (against one selected DNA-binding protein) is added to the mixture in order to precipitate that protein *along with the DNA (fragment) it is bound to*. Following a chemical reaction that breaks the protein–DNA cross-links, the now-liberated DNA fragments are analyzed to determine precisely the locations on an organism's DNA where each DNA-binding protein attaches. This thereby reveals all DNA points (e.g., genes, promoters) impacted by that DNA-binding protein. See also *Deoxyribonucleic acid (DNA), Gene, Antibody, Organism, Protein, Transcription factors, Promoter, Sequence (of a DNA molecule), Genomics, Proteomics, Chromatin, Histone, Cell, Organism, DNA repair, Gene repair (natural), Sliding clamps.*

### Chromatin Immunoprecipitation Method

See *Chromatin immunoprecipitation.*

### Chromatin Modification

See *Chromatin, DNA methylation.*

### Chromatin Remodeling

Refers to the reshaping (at molecular scale) of chromatin (i.e., organism's complex of DNA and histone protein) that *alters which specific genes in that organism's DNA subsequently get expressed.*

Can be caused by short interfering RNA, certain transcription activators, acetylation of histone, methylation of histone, sumoylation of histone, etc. See also *Chromatin, Deoxyribonucleic acid (DNA), Gene, Gene expression, Epigenetic, Epigenetic marks, Gene silencing, Gene splicing, Short interfering RNA (siRNA), Silencing, Transcription activators, Histones, Methylated, Repression (of gene transcription or translation), Small ubiquitin-related modifier, Differentiation pathways, Apoptosis.*

### Chromatin Remodeling Elements

See *Chromatin remodeling, Transcription activators, Short interfering RNA (siRNA).*

### Chromatography

Coined by Mikhail S. Tswett in 1906, this word refers to a process by which complex mixtures of different molecules may be separated from each other. This is accomplished by subjecting the mixture to many repeated partitionings between a flowing phase and a stationary phase. Chromatography constitutes one of, if not, *the* most fundamental separation techniques used in the biochemistry/biotechnology arena to date. See also *Polyacrylamide gel electrophoresis (PAGE), Substrate (in chromatography), Affinity chromatography, Monolithic chromatography substrates, Biotechnology, Agarose, Gel filtration.*

### Chromosomal Packing Unit

See *Nucleosome.*

### Chromosomal Translocation

See *Jumping genes.*

### Chromosome Map

See *Linkage map.*

### Chromosome Painting

See *Fluorescence in situ hybridization (FISH).*

### Chromosome Walking

A methodology for determining the location of, and sequencing of, *a given gene* (within an organism's DNA) by sequencing (specific DNA sequences that overlap and span collectively) that gene's location within the organism's DNA. See also *Gene, Deoxyribonucleic acid (DNA), Sequence (of a DNA molecule), Organism, Chromosomes.*

### Chromosomes

Discrete units of the genome carrying many genes, consisting of (histone) proteins and a very long molecule of DNA. Found in the nucleus of every plant and animal cell. See also *Genome, Gene, Genetic code, Chromatin, Chromatids, Karyotype, Karyotyper, “Designer” chromosome, Philadelphia chromosome.*

### Chronic Heart Disease

See *Coronary heart disease (CHD).*

## Chronic Inflammation

Refers to inflammation (i.e., the body's natural response to infection or injury) that does not stop after the initial cause (infection/injury) has disappeared. Chronic inflammation is present in some diseases such as coronary heart disease, gastric ulcers, diabetes, Crohn's disease, periodontitis (periodontal disease), and chronic kidney disease and results when certain immune cells (e.g., neutrophils, macrophages) release reactive chemicals such as hypochlorous acid (HOCl), reactive oxygen species, CO<sub>3</sub>, NO<sub>2</sub>, HOBr, and N<sub>2</sub>O<sub>3</sub>. Although those reactive chemicals are intended to kill invading pathogens during an infection, their *chronic* release by neutrophils/macrophages (e.g., after an infection is over, or as a result of plaque deposition on walls of blood vessels) can harm body tissues by causing inflamed blood vessel linings, swollen joints, and damaged DNA (potentially leading to certain cancers such as breast cancer).

In people who have an applicable cancer, their body often overproduces interleukin-6 (IL-6) (i.e., a cytokine that normally stimulates several different types of immune system cells in response to infections or injuries) because those cancerous cells cause decreased presence of the protein known as SOCS3. SOCS3 is present in normal cells, where it functions as an *off-switch* in a feedback loop involving the IL-6, thereby normally halting that inflammation promoter after IL-6's work (e.g., combatting the infection) is completed. However, in the case of late-stage/metastatic triple-negative breast cancer, IL-6 levels are 40 times higher than normal (thereby adding to the chronic inflammation aspect of the cancer).

Consumption of adequate amounts of certain anti-inflammatory nutrients such as linolenic acid helps dampen inflammatory reactions within the human body via blocking the formation of certain compounds that promote inflammation such as omega-6 (*n*-6)-derived eicosanoids, cytokines, platelet-activating factor, and C-reactive protein.

Consumption of resveratrol helps dampen inflammatory reactions within the human body via the resveratrol molecule acting as such an agonist-binding partner with the estrogen receptor (without stimulating estrogenic cell proliferation) to beneficially control the body's inflammation response. See also *Diabetes, Crohn's disease, Neutrophils, Macrophage, Reactive oxygen species, Protein, Cell adhesion proteins, Cancer, Interleukin-6 (IL-6), Beta-conglycinin, Tight junction proteins, N-3 fatty acids, Resveratrol, Curcumin, Atherosclerosis, Plaque, Coronary heart disease (CHD), Nanoparticles, C-reactive protein (CRP), Agonists*.

## Chymosin

Also known as rennin. It is an enzyme used to make cheeses (from milk). Chymosin occurs naturally in the stomachs of calves and is one of the oldest commercially used enzymes. Chymosin (rennin) is chemically similar to renin, an enzyme that plays an important role in regulating blood pressure in humans. See also *Renin*.

## Cilia

Protein-based structures that occur in certain cells of both the plant and animal world. Cilia are very tiny hair-like structures and occur in large numbers on the outside of certain cells. In higher organisms such as man, they usually function to move extracellular material along the cell surface. An example is the *sweeping out of foreign matter* action of cilia in the bronchial tubes in which very small particles are moved into the throat to be expelled or swallowed.

In man, the cilia on cartilage cells swiftly increase in length by 50% when exposed to the inflammatory protein (cytokine) known as interleukin-1 (IL-1). Thus, these cartilage cells' primary cilia are linked to the inflammatory response.

Some lower organisms use their cilia for locomotion (swimming). Cilia are used in the swimming motion of bacteria toward sources of nutrients in a process called "chemotaxis." Cilia are shorter and occur in larger numbers per cell than flagella. Singular: cilium. See also *Chemotaxis, Microtubules, Centrosomes, Flagella, Dynein, Interleukin-1 (IL-1), Inflammatory response*.

## Ciliary Neurotrophic Factor (CNTF)

A human protein that has been shown to help the survival of those cells in the nervous system that act to convey sensation and control the function of muscles and organs. CNTF was approved by the U.S. FDA to treat amyotrophic lateral sclerosis (also known as Lou Gehrig's disease) in 1992. Amyotrophic lateral sclerosis causes the victim's muscles to degenerate severely, and it affects approximately 30,000 people per year in the United States. CNTF *might* prove useful for treating Alzheimer's Disease and/or other human neurological diseases.

Research published in 2006 reported that CNTF also activates an enzyme within muscles that increases the metabolism of fats and sugars. See also *Protein, Cell, Nerve growth factor (NGF), Food and Drug Administration (FDA), Enzyme, Fats, Sugar molecules, Metabolism*.

## cis/trans Isomerism

A type of geometrical isomerism found in alkenic systems in which it is possible for each of the doubly bonded carbons to carry two different atoms or groups. Two similar atoms or groups may be on the same side (i.e., *cis*) or on opposite sides (i.e., *trans*) of a plane bisecting the alkenic carbons and perpendicular to the plane of the alkenic systems. See also *Isomer, Chiral compound, Trans fatty acids*.

## cis/trans Test

Assays (determines) the effect of relative configuration on the expression of two (gene) mutations. In a double heterozygote, two mutations in the same gene show mutant phenotype in the *trans* configuration and wild (phenotype) in the *cis* configuration. The phenotypic distinction is referred to as the position effect.

See *Gene, Phenotype, cis-acting protein, Position effect, Heterozygote, Mutation*.

## cis-Acting Protein

A *cis*-acting protein has the exceptional property of acting only on the molecule of DNA from which it was expressed. See also *trans-acting protein, Deoxyribonucleic acid (DNA)*.

## Cisgenesis

Refers to the genetic modification of an organism via insertion of a gene(s) from a sexually compatible (i.e., crossable) organism that is the same species or a closely related species. The inserted gene would include its (native) introns, promoter, and terminator in their normal SENSE orientation. See also *Gene, Intron, Promoter, Terminator, Sense, Intragenesis*.

## Cisplatin

First synthesized by Michel Peyrone during 1845, it is a platinum-containing drug that is used in chemotherapy regimens against certain types of cancer tumors (e.g., testicular cancer, ovarian cancer, bladder cancer, lung cancer).

Cisplatin works against (tumor) cells by binding to the cell's DNA and generating intrastrand cross-links (between the two strands of the DNA molecule). These intrastrand cross-links prevent replication and cause cell death. See also *Chemopharmacology, Chemotherapy, Cancer, Deoxyribonucleic acid (DNA), Replication fork, Replication (of DNA)*.

## Cistron

Synonymous with *gene*, it refers to a specific DNA sequence that codes for the synthesis (by ribosome) of a single protein (polypeptide molecular chain). See also *Gene, Deoxyribonucleic acid (DNA), Protein, Ribosome*.

## Citrate Synthase

The enzyme that is utilized (e.g., by plants) to synthesize (i.e., create) citric acid. See also *Enzyme, Citric acid*.

## Citrate Synthase (CSb) Gene

A bacterial gene that is utilized by certain bacteria (e.g., *Pseudomonas*) to code for (i.e., cause to be produced by bacterium possessing that gene) the enzyme known as citrate synthase. That enzyme is utilized to synthesize (i.e., create) citric acid.

In 1996, Luis Herrera-Estrella discovered that inserting the CSb gene from *Pseudomonas aeruginosa* into certain plants caused those plants to produce up to 10 times more citrate in their roots and to release up to 4 times more citric acid from those roots into the surrounding soil (thus decreasing aluminum toxicity via chemically "binding" aluminum ions that are present in some soils). Such soil aluminum, which slows plant growth and decreases crop yields, is present to a certain degree in approximately one-third of the Earth's arable land (e.g., in the country of Colombia, it affects 70% of the arable land). See also *Gene, Enzyme, Express, Citrate synthase, Ion, Citric acid*.

## Citrate Synthase Gene

A gene that codes for (i.e., causes to be produced by an organism possessing that gene) the enzyme known as "citrate synthase." See also *Gene, Enzyme, Express, Citrate synthase, Citric acid*.

## Citric Acid

A tricarboxylic acid occurring naturally in plants, especially citrus fruits. It is used as a flavoring agent, as an antioxidant in foods, as an animal feed ingredient, and as a sequestering agent. The commercially produced form of citric acid melts at 153°C (307°F). Citric acid is found in all cells, its central role is in the metabolic process.

Some plants naturally release citric acid from their roots into the surrounding soil in order for that citric acid to chemically *bind* aluminum ions that are present in some soils. Such aluminum, which slows plant growth and decreases crop yields, is present to a certain degree (which causes at least some crop yield reduction)

in approximately one-third of the world's arable land. For example, 70% of the agricultural land in the country of Colombia possesses harmful amounts/conditions of aluminum to damage crops.

Corn (maize) yields are reduced up to 80% by such aluminum in soils. Soybeans, cotton, and field bean yields are also reduced. See also *Metabolism, Acid, Cell, Citrate synthase, Citrate synthase gene, Citrate synthase (Csb) gene, Citric acid cycle, Metabolite, Cell, Ion, Soybean plant, Corn, Probiotics*.

## Citric Acid Cycle

Also known as the tricarboxylic acid cycle (TCA cycle because the citric acid molecule contains three [tri] carboxyl [acid] groups). Also known as the Krebs cycle after Hans A. Krebs, who first postulated the existence of the cycle in 1937 under its original name of "citric acid cycle." A cyclic sequence of chemical reactions that occurs in almost all aerobic (air requiring) organisms. A system of enzymatic reactions in which acetyl residues are oxidized to carbon dioxide and hydrogen atoms and in which formation of citrate is the first step. See also *Citric acid, Citrate synthase, Citrate synthase gene, Citrate synthase (Csb) gene, Acid, Aerobic, Metabolism, Enzyme, Oxidation*.

## Citrinin

A mycotoxin initially isolated in 1931 from a culture of *Penicillium citrinum*. It has since been found to be produced by a number of other fungal species that are found or used in the production of human foods, such as grain, cheese, sake, and certain red pigments. Those fungal species include *Aspergillus niveus, Aspergillus ochraceus, Aspergillus oryzae, Aspergillus terreus, Monascus ruber, Monascus purpureus*, and *Penicillium camemberti*. See also *Mycotoxins*.

## c-kit Genetic Marker

See *Genetic marker, Fluorescence in situ hybridization (FISH)*.

## CKR-5 Proteins

See *Human immunodeficiency virus type 1 (HIV-1), Human immunodeficiency virus type 2 (HIV-2), Receptors, Protein*.

## CLA

Abbreviation for conjugated linoleic acid. See *Conjugated linoleic acid (CLA)*.

## Clades

The taxonomic subgroups within cladistics. See also *Cladistics*.

## Cladistics

Initially popularized by Willi Hennig's 1950 book entitled *Phylogenetic Systematics*, cladistics is a system of taxonomic classification of organisms (and/or their specimens) that is based upon (determined) similar lines of selected shared traits. See also *Clades, Type specimen, Genetics, Biology, Species, Systematics, American type culture collection (ATCC), Trait*.

## Clathrin

A protein that forms itself into a lattice-like structure on the surface of the cell membrane forming a vesicle within a cell during the process of endocytosis. See *Endocytosis*.

## Clathrin-Dependent Endocytosis

See *Endocytosis*.

## Cleistogamous

Refers to *self-pollinating* plants. See also *Monoecious*.

## CLIA

Acronym for **chemiluminescent immunoassay**. See *Chemiluminescent assay (CLIA)*.

## Click Chemistry

Invented by K. Barry Sharpless, it is a category of chemistry (e.g., a *family* of related chemical reactions) that utilizes heteroatom links to hook together specific molecular units (modules) into longer molecular structures, in a modular manner.

Click chemistry can be utilized to attach fluorescent labels (i.e., molecular units that fluoresce when illuminated by light of applicable wavelength) to the surface of living cells. That facilitates subsequent imaging of those cells by scientists who are investigating functions of cells.

Click chemistry can be utilized to make certain small molecule *modules* capable of passing through the blood-brain barrier (BBB) that Matthew Disney and colleagues developed in 2014 to bind to adjacent portions of the RNA defect known as a “tetranucleotide repeat” in which a series of four nucleotides is repeated more times than normal within an individual’s genetic code. When that tetranucleotide repeat causes applicable RNA splicing abnormalities, it results in the progressive muscle-weakening disease known as myotonic dystrophy type 2. However, via this use of click chemistry, the Disney-created small molecule modules are able to pass through the BBB, bind to the defective RNA, and thereby reverse the effect of the disease.

Click chemistry can be utilized to attach a targeting molecule (e.g., folic acid) onto a nanoparticle (e.g., nanocapsules, nanoshells) that has been filled with an applicable pharmaceutical (e.g., tumor necrosis factor). Because many cancerous tumors consume very large amounts of folic acid during their rapid growth, folic acid can be utilized as a *targeting molecule* (e.g., attached to the surface of such therapeutic nanoparticles) to deliver the tumor necrosis factor (TNF) directly to the tumor. The TNF can then act to disrupt formation of the new vasculature (blood vessels) needed by the tumor for blood supply. See also *Fluorescence*, *Fluorescence mapping*, *Label (fluorescent)*, *Target (of a therapeutic agent)*, *Blood-brain barrier (BBB)*, *Ribonucleic acid (RNA)*, *RNA splicing*, *Folic acid*, *Cancer*, *Nanoparticles*, *Nanocapsules*, *Tumor necrosis factor (TNF)*.

## Clinical Trial

One of the final stages in the collection of data (for drug approval prior to commercialization) in which the new drug is tested in human subjects. Used to collect data on effectiveness, safety, and

required dosage. See also *Phase I clinical testing*, *Food and Drug Administration (FDA)*, *Koseisho*, *Bundesgesundheitsamt (BGA)*, *Committee on Safety in Medicines*, *Committee for Proprietary Medicinal Products (CPMP)*.

## CLL

Acronym for chronic lymphocytic leukemia. See *Rituximab*, *Ibrutinib*.

## Clone (a Molecule)

To create copies of a given molecule via various methods. See also *Polymerase chain reaction (PCR)*, *Monoclonal antibodies (MAb)*, *Cloning*, *Antibody*, *cDNA clone*.

## Clone (an Organism)

A group of individual organisms (or cells) produced from one individual cell through asexual processes that do not involve the interchange or combination of genetic material. As a result, members of a clone have identical genetic compositions.

For example, many plants reproduce asexually (i.e., without sex) via a process known as apomixis.

For example, man has reproduced numerous trees via grafting of a branch from a valuable tree into a less-valuable tree (which subsequently provides nutrients, etc. to that ingrafted branch so it can continue to grow, flower, and reproduce). Via such grafting, every navel (seedless) orange tree on Earth is an exact genetic copy of one bud mutation that occurred in 1820 on a sour orange tree in Bahia, Brazil.

Protozoa, bacteria, and some animals (e.g., the anemone *Anthopleura elegantissima*) can reproduce asexually (i.e., without sex) by a process called “binary fission.” In binary fission a single-celled organism undergoes cell division. The result is two cells with identical genetic composition. When these two identical cells undergo division, the result is four cells with identical genetic composition. These identical offspring are all members of a clone. The word “clone” may be used either as a noun or a verb.

Scientists have cloned some adult mammals via nuclear transfer. In that process, the nucleus of an oocyte is removed and replaced with a nucleus taken out of another conventional somatic (adult’s body) cell. That oocyte can then grow up to become a clone of the (adult) animal. See also *Organism*, *Apomixis*, *Bacteria*, *Cell*, *Oocytes*, *Somatic cells*, *Mutation*, *Nuclear transfer*, *Reprogramming*.

## Clostridium

A genus of bacteria. Most are obligate anaerobes, and form endospores. See also *Anaerobe*, *Endospore*.

## CMC

See *Critical micelle concentration*.

## CML

Abbreviation for *chronic myelogenous leukemia* (also known as *chronic myeloid leukemia*, or *chronic myelocytic leukemia*). See *Gleevec™*.

**CMV**

See *Cytomegalovirus (CMV)*.

**CNHs**

Acronym for *carbon nanohorns*. See *Carbon nanohorns*.

**CNP**

Acronym for *copy number polymorphisms*. See *Copy number polymorphisms*.

**CNTF**

See *Ciliary neurotrophic factor (CNTF)*.

**CNTs**

Acronym for *carbon nanotubes*. See *Carbon nanotubes*.

**CNV**

Acronym for *copy number variant* or *copy number variation*. See *Copy number variant*, *Copy number variation*.

**CoA**

See *Coenzyme A*.

**Co-Chaperonin**

A protein molecule inside living cells that *works together* with applicable chaperonin(s) to help ensure proper folding of the (new) protein molecules that are synthesized (*manufactured*) in the cell's ribosomes. See *Chaperonins*, *Protein*, *Protein folding*, *Cell*, *Ribosomes*, *Conformation*.

**Coccus**

A spherical-shaped bacterium. See also *Bacillus*.

**Cocloning (of Molecules)**

The additional (accidental) cloning (i.e., copying) of extramolecular fragments, other than the desired one, that sometimes occurs when a scientist is attempting to clone a molecule. See also *Clone (a molecule)*, *Polymerase chain reaction (PCR)*, *Q-beta replicase technique*.

**Codex Alimentarius**

See *Codex alimentarius commission*.

**Codex Alimentarius Commission**

An international regulatory body that is part of the United Nations' Food and Agriculture Organization (FAO), it is one of the three international SPS (sanitary and phytosanitary) standard-setting organizations that is recognized by the World Trade Organization.

It was created in 1962 by the UN's FAO and the World Health Organization (WHO). It has 165 member nations.

In the Latin language, *Codex Alimentarius* means "food law" or "food code." The Codex Alimentarius Commission is responsible for execution of the Joint FAO/WHO Food Standards Program. The Codex Alimentarius standards are a set of international food mandates that have been adopted by the commission. The commission is composed of delegates from member country governmental agencies. The Codex Secretariat is headquartered in Rome, Italy.

The commission periodically determines and then publishes a list of food ingredients and maximum allowable levels that it deems safe for human consumption (known as the *Codex Alimentarius*). See also *Maximum residue level (MRL)*, *SPS*, *International Plant Protection Convention (IPPC)*, *International Office of Epizootics (OIE)*, *World Trade Organization (WTO)*.

**Coding Region**

See *Coding sequence*.

**Coding Sequence**

The region within a DNA molecule (i.e., between the start and stop codons) that encodes the amino acid sequence of a protein, or for a specific microRNA. See also *Genetic code*, *Informational molecules*, *Gene*, *Messenger RNA (mRNA)*, *Base (nucleotide)*, *Control sequences*, *Codon*, *MicroRNAs*.

**Codon**

A triplet of nucleotides (three nucleic acid units [residues] in a row) within either DNA or messenger RNA that codes for an amino acid (triplet code) or a termination signal. See also *Genetic code*, *Deoxyribonucleic acid (DNA)*, *Termination codon (sequence)*, *Amino acid*, *Nucleotide*, *Informational molecules*, *Messenger RNA (mRNA)*, *Leader sequence (mRNA)*.

**Coenzyme**

A nonproteinaceous organic molecule required for the action of certain enzymes. The coenzyme contains as part of its structure one of the vitamins. This is why vitamins are so critically important to living organisms. Sometimes the same coenzyme is required by different enzymes that are involved in the catalysis of different reactions. By analogy, a coenzyme is like a part of a car, such as a tire, that can be identified in and of itself and that can, furthermore, be removed from the car. The car (enzyme), however, must of necessity have the tire in order to carry out its prescribed function. Coenzymes have been classified into two large groups: fat soluble and water soluble. Examples of a few water-soluble vitamins are: thiamin, biotin, folic acid, vitamin C, and vitamin B<sub>12</sub>. Examples of fat-soluble vitamins are: vitamins A, D, E, and K. See also *Enzyme*, *Catalyst*, *Holoenzyme*, *Vitamin*, *Polypeptide (protein)*, *Biotin*.

**Coenzyme A**

A water-soluble vitamin known as pantothenic acid. A coenzyme in all living cells. It is required by certain condensing enzymes and functions in acyl-group transfer and in fatty acid metabolism. Abbreviated CoA. See also *Enzyme*, *Fats*, *Fatty acid*.

## Coenzyme Q10

A name sometimes utilized for ubiquinone, as dietary ingredient. See also *Ubiquinone*.

## Cofactor

A nonprotein component required by some enzymes for activity. The cofactor may be a metal ion or an organic molecule called a “coenzyme.” The term “cofactor” is a general term. Cofactors are generally heat stable. See also *Coenzyme*, *Holoenzyme*, *Molecular weight*.

## Cofactor Recycle

The regeneration of a spent cofactor by an auxiliary reaction such that it may be reused many times over by a cofactor-requiring enzyme during a reaction. See also *Cofactor*, *Holoenzyme*, *Enzyme*.

## Coffee Berry Borer

Refers to the pest insect *Hypothenemus hampei*, which attacks berries of the coffee tree (Coffee Arabica, *Coffea canephora*). See also *Amylase inhibitors*, *Coffee tree*.

## Coffee Tree

Refers to the specific plants:

- *Coffea canephora*, whose berries are utilized to make approximately 30% of the world's coffee production
- *Coffea arabica*, whose berries are utilized to make the majority of the world's coffee, and which make a resultant coffee possessing a less acidic taste and lower caffeine than *Coffea canephora*

See also *Coffee berry borer*, *Caffeine*.

## Cohesin

Refers to a protein molecule that, together with another protein known as *mediator*, forms a protein complex (structure) that helps a cell's DNA form into the specific loop that is necessary for the applicable gene(s) in the DNA to be activated that control that particular cell's state (e.g., the tissue it has differentiated into, if the cell is no longer in its embryonic state).

Additionally, Cohesin also helps to hold chromosomes together. See also *Protein*, *Cell*, *Deoxyribonucleic acid (DNA)*, *Cohesin*, *Loop*, *Gene*, *Activator (of gene)*, *Expressivity*, *Cell differentiation*, *Embryonic stem cells*, *Pluripotent stem cells*, *Differentiation*, *Chromosomes*.

## Cohesive Ends

See *Sticky ends*.

## Cohesive Termini

See *Sticky ends*.

## Colchicine

Discovered in 1937, it is a chemical (alkaloid) that can be extracted from certain members of the lily family of plants

(e.g., *Colchicum autumnale*, autumn crocus, or meadow saffron). It has sometimes been used as an anti-inflammatory, to try to treat gout in humans.

Colchicine has also been used by some plant breeders to induce mutations in crop plants (e.g., by soaking seeds in it) in order to create crop plant varieties with new traits. That happens because colchicine prevents chromosomes from separating during the anaphase of mitosis, thereby causing the cell to become tetraploid (i.e., four copies of each chromosome). Such induced polyploidy (i.e., extra copies of chromosomes in the cells of breeding “parents”) can be utilized in crop-breeding programs to speed up the rate at which new crop varieties are produced/commercialized. See also *Alkaloids*, *Mutation breeding*, *Traditional breeding methods*, *Trait*, *Chromosomes*, *Induced polyploidy*, *Mitosis*, *Tetraploid*.

## Cold Acclimation

See *Cold hardening*.

## Cold Acclimatization

See *Cold hardening*.

## Cold Hardening

A process of acclimatization in which certain organisms produce specific proteins that protect them from freezing to death during the winter. Among other organisms, the common housefly, the *Arabidopsis thaliana* plant, the fruit fly *Drosophila*, and *no-see-ems* (i.e., *Culicoides variipennis*) can produce these proteins (e.g., during the gradually decreasing temperatures of a typical autumn season in North America). The amount of such proteins produced within their bodies is proportional to the severity and duration of the cold experienced.

For example, prior to cold hardening, *Culicoides variipennis* insects usually die after exposure for 2 h to a temperature of 14°F (−10°C). If those insects are first exposed for 1 h to a temperature of 41°F (5°C), approximately 98% of these insects can then survive exposure for 3 days to a temperature of 14°F (−10°C).

In certain plants, such exposure to cold causes oxidative stress. That oxidative stress then can initiate the activation of the mitogen-activated protein kinase cascade, resulting in production of several *stress responsive proteins* (e.g., heat-shock proteins). Those *stress proteins* help protect such plants from cold temperatures. See also *Acclimatization*, *Protein*, *Low-tillage crop production*, *No-tillage crop production*, *Drosophila*, *Arabidopsis thaliana*, *CBF1*, *Transcription factors*, *Linoleic acid*, *Mitogen-activated protein kinase cascade*, *Oxidative stress*, *Stress proteins*.

## Cold-Shock Protein B

Refers to a cold-shock protein (naturally produced in the bacterium *Bacillus subtilis*) that, when inserted into the DNA of a corn (*Zea mays* L.) plant, confers resistance to drought and other environmental stresses. See also *Cold-shock protein*, *Protein*, *Deoxyribonucleic acid (DNA)*, *Corn*.

## Cold Tolerance

See *Cold hardening*.

## Cold-Shock Protein

Refers to particular chaperone protein molecules that are expressed by cells in an organism exposed to low-environmental temperatures, to protect living cells (from freeze damage).

For example, at low temperatures, *Escherichia coli* bacteria sometimes express CspA, a cold-shock protein that protects those *E. coli* bacteria from (some) freeze damage.

For example, at low temperatures, *Bacillus subtilis* bacteria sometimes express CspB, a cold-shock protein that protects those *B. subtilis* bacteria from (some) freeze damage. See also *Cold hardening, Chaperones, Protein, Organism, Bacteria, cspB gene, Bacillus subtilis (B. subtilis), Cold shock protein B.*

## Colicins

Proteins produced by *Escherichia coli* (*E. coli*) that are toxic (primarily) to other closely related strains of bacteria. The particular *E. coli* that produce a given colicin are generally unaffected by the colicin that they produce. See also *Bacteriocins, Bacteriology, Strain, Bacteria, Protein, Toxin, Escherichia coliform (E. coli).*

## Colinearity

See *Co-linearity.*

## Collagen

The major structural protein in connective and bone tissue. It is instrumental in wound healing (stimulated by fibroblast growth factor, platelet-derived growth factor, and insulin-like growth factor-1). See also *Protein, Fibroblast growth factor (FGF), Platelet-derived growth factor (PDGF), Insulin-like growth factor-1 (IGF-1), Inhibition.*

## Collagenase

An enzyme that catalyzes the cleavage of collagen. One example of this is when bacteria in the mouth cause production of collagenase that then cleaves (i.e., breaks down) the collagen that holds teeth in place. Some cancers use collagenase to break down connective tissues in the body they inhabit, to enable the cancers to form the (new) blood vessels that nourish those cancers and help those cancers to spread through the body. Collagenase may also be responsible indirectly for certain autoimmune diseases such as arthritis, via breaking down the protective proteoglycan coat that covers cartilage in the body. See also *Stromelysin (MMP-3), Proteolytic enzymes, Enzyme, Collagen, Cancer, Autoimmune disease.*

## Collective Swimming

See *Bacillus subtilis (B. subtilis).*

## Co-Linearity

Refers to when the DNA segment(s) that are common to two different organisms (e.g., rice and maize/corn) are present in the same linear order within their respective DNA molecules (i.e., when one overlooks other *inserted/deleted segments*, sometimes called “indels” or “in/dels”). See also *Deoxyribonucleic acid (DNA), Sequence (of a DNA molecule), Organism, Corn, Gene.*

## Colony

A growth of a group of microorganisms derived from one original organism. After a sufficient growth period, the growth is visible to the eye without magnification. See also *Microorganism.*

## Colony Hybridization

A technique using *in situ* hybridization to identify bacterial colonies carrying inserted DNA that is homologous with some particular sequence (probe). See also *DNA probe, Homology, In situ, Regulatory sequence.*

## Colony-Stimulating Factors (CSFs)

Specific glycoprotein growth factors required for the proliferation and differentiation of hematopoietic progenitor cells. Different CSFs stimulate the growth of different cells. See also *Macrophage colony-stimulating factor (M-CSF), Granulocyte colony-stimulating factor (G-CSF), Granulocyte-macrophage colony-stimulating factor (GM-CSF), Epidermal growth factor (EGF), Fibroblast growth factor (FGF), Hematologic growth factors (HGF), Insulin-like growth factor-1 (IGF-1), Megakaryocyte stimulating factor (MSF), Nerve growth factor (NGF), Platelet-derived growth factor (PDGF), Transforming growth factor-alpha (TGF-alpha), Transforming growth factor-beta (TGF-beta).*

## Combinatorial Biology

A term used to describe the set of DNA technologies that are utilized to generate a large number of samples of new chemicals (metabolites) via creation of nonnatural metabolic pathways. This collection of samples thus generated is called a “library,” and the samples are then tested for potential use (e.g., for therapeutic effect, in the case of pharmaceutical). These technologies enable greater efficiency in a pharmaceutical researcher’s screening process for drug discovery. See also *Combinatorial chemistry, Target, Molecular diversity, Metabolism, Intermediary metabolism, Metabolite, Receptors.*

## Combinatorial Chemistry

A term used to describe the set of technologies that are utilized to generate a large number of samples of (new) chemicals, which are then tested (screened) for potential use (e.g., for therapeutic effect, in the case of a pharmaceutical). These large numbers of chemical samples, thus generated, are called a “library” and are screened (e.g., for therapeutic effect) via a variety of laboratory, biosensor, computational, receptor, or animal tests.

Combinatorial chemistry was made feasible by the fact that, during the 1980s, H. Mario Geysen developed a methodology to synthesize arrays of peptides on pin-shaped solid supports. In addition, Richard A. Houghten developed a technique for the creation of peptide libraries in small mesh “bags” by solid-phase parallel synthesis, thereby enabling automation of the process (in the early 1990s).

For a library that is used for new drug (candidate) screening, high diversity in molecular structure among the chemicals in the library is desired, to increase the efficiency of the screening process. One method used to measure diversity of the molecular structure among samples in a library is called “molecular fingerprinting.” If two samples are identical in molecular structure, the “fingerprint” coefficient is 1.0. If two samples are totally dissimilar in molecular structure, the coefficient is 0. The diversity of a library is measured by

comparing each sample's molecular structure to that of all the others in the library. See also *Combinatorial biology*, *Target*, *Molecular diversity*, *Receptors*, *Biosensors (electronic)*, *Peptide*, *Synthesizing (of proteins)*, *Biochips*, *High-throughput screening*, *Target–ligand interaction screening*.

## Combinatorics

See *Combinatorial chemistry*.

## Combining Site

The site on an antibody molecule that locks (binds) onto an epitope (hapten). See also *Antibody*, *Epitope*, *Engineered antibodies*, *Nanobodies*, *Hapten*, *Catalytic antibody*.

## Commensal

A term that literally means *eating at the same table*; it is often used to refer to organisms such as

- The house mouse (*Mus musculus*), etc. that tends to thrive alongside/among humans
- The *Bacteroides thetaiotaomicron* bacteria that live within the human gastrointestinal tract and induce appropriate glycosylation (fucosylation) of intestinal epithelial cells
- Certain strains of the bacteria *Pseudomonas fluorescens* that thrive living on the surfaces of plants and can even help protect those plants against pathogens via the production of antibiotics, etc.

The commensal aspect tends to be species specific. For example, numerous strains of *Salmonella* bacteria can live within the intestine of an adult cow without harming that cow, but would be pathogenic (i.e., disease-causing) in a human's intestine.

Another example is that the *E. coli* 0157:H7 strain of *Escherichia coliform* bacteria can live within the digestive system of an adult cow without harming that cow, but would be pathogenic (i.e., disease-causing) in a human's digestive system. However, hundreds of other strains of *Escherichia coliform* bacteria live within the digestive system of humans, without causing harm to the human body (i.e., those hundreds of strains of *Escherichia coliform* bacteria are commensal).

In some people, commensal intestinal bacteria can lead to an autoimmune disease. For example, certain individual humans possessing specific alleles of the *NOD2/CARD15* gene have been shown to be likely to mount an inappropriate immune system response against their own bowel tissues, which are in intimate contact with commensal intestinal bacteria. That can result in such autoimmune diseases as Crohn's disease or ulcerative colitis. See also *Organism*, *Microorganism*, *Bacteria*, *Glycosylation (to glycosylate)*, *Pseudomonas fluorescens*, *Salmonella typhimurium*, *Salmonella enteritidis*, *Pathogen*, *Pathogenic*, *Strain*, *Escherichia coliform (E. coli)*, *Escherichia coliform 0157:H7*, *Autoimmune disease*, *Gene*, *Allele*, *Immune response*, *Antibiotic*, *Helicobacter pylori*.

## Commission E Monographs

Documents published by the government of Germany, which detail the proven safety and efficacy of certain phytochemical-containing herbs (approved by the German government).

For example, consumption of *Saint John's wort* (a plant native to Europe) is approved in Germany for treatment of depressive mood disorders, anxiety, and nervous unrest. See also *Phytochemicals*, *Saint John's wort*.

## Commission of Biomolecular Engineering

An agency of the French government, established to oversee and regulate all genetic engineering activities in the country of France. See also *Genetic engineering*, *IOGTR*, *Recombinant DNA Advisory Committee (RAC)*, *ZKBS (Central Committee on Biological Safety)*, *Indian Department of Biotechnology*, *Gene technology regulator (GTR)*, *Gene Technology Office*.

## Committee for Proprietary Medicinal Products (CPMP)

The European Union's (EU's) scientific advisory organization dealing with new human pharmaceuticals approval. Its recommendations (e.g., to either approve or not approve a new product) are usually adapted by the European Medicines Evaluation Agency (EMA), to which the CPMP reports.

Within 60 days of a CPMP "approval for recommendation" being adopted by the EMA, each of the EU's member countries must advise the EMA of its progress toward a regulatory decision on that pharmaceutical's submission for approvals. See also *Food and Drug Administration (FDA)*, *Koseisho*, *European Medicines Evaluation Agency (EMA)*, *Committee on Safety in Medicines*, *Bundesgesundheitsamt (BGA)*.

## Committee for Veterinary Medicinal Products (CVMP)

The European Union's scientific advisory organization dealing with approvals of new medicinal products intended for use in animals. Its recommendations (e.g., to either approve, or not approve a new product) are usually adopted by the European Medicines Evaluation Agency. See also *Committee for Proprietary Medicinal Products (CPMP)*, *Food and Drug Administration (FDA)*, *Koseisho*, *Committee on Safety in Medicines*, *Medicines Control Agency (MCA)*, *EMA*, *Bundesgesundheitsamt (BGA)*.

## Committee on Safety in Medicines

The British Government agency that must approve new pharmaceutical products for sale within the United Kingdom. In concert with the Medicines Control Agency, it regulates all pharmaceutical products in the United Kingdom. It is the equivalent of the U.S. Food and Drug Administration. See also *Food and Drug Administration (FDA)*, *Medicines Control Agency (MCA)*, *Committee for Proprietary Medicinal Products (CPMP)*, *Koseisho*, *NDA (to koseisho)*, *IND*, *Bundesgesundheitsamt (BGA)*, *EMA*.

## Community Plant Variety Office

An agency of the European Union that was established by Council Regulation 2100/94 and is located in Angers, France. It applies the Union for Protection of New Varieties of Plants rules across all countries of the European Union when a plant breeder registers a new plant variety at the Community Plant Variety Office. Thus, it confers/protects the plant breeder's rights across the entire European Union in a manner analogous to the way the European Patent Office confers patent rights (for patented inventions) across the entire European Union. See also *Union for Protection of New*

*Varieties of Plants (UPOV), Plant breeder's rights (PBR), European Patent Office (EPO), Plant Variety Protection Act (PVP).*

### Companion Diagnostic

Abbreviated **CDx**, this term refers to diagnostic tests that determine in advance the likelihood that a particular pharmaceutical will benefit a given patient, based on that patient's gene(s) or biomarker(s) applicable to a specific disease or condition.

For example, the U.S. Food and Drug Administration (FDA) has approved as a companion diagnostic the BioMerieux THxID-BRAF test, a polymerase chain reaction test that can pinpoint the particular melanoma (skin cancer) patients whose tumors are driven by specific mutations (V600E and V600K) in the BRAF gene. Those melanoma tumors thus identified by that BioMerieux companion diagnostic are susceptible to treatment by Tafenlar (dabrafenib) and Mekinist (trametinib), two GlaxoSmithKline melanoma drugs.

For example, the U.S. FDA has approved as a companion diagnostic the Myriad Genetics, Inc. BRACAnalysis test, to be used in conjunction with the AstraZeneca's drug Lynparza (olaparib). Lynparza is the first FDA-approved poly ADP-ribose polymerase (PARP) inhibitor for patients with germline mutations in BRCA1/2 advanced ovarian cancer who have had three or more lines of chemotherapy. See also *Gene, HER-2 gene, Biomarkers, Food and Drug Administration (FDA), Polymerase chain reaction (PCR), Tumor, Mutation, Cancer, PARP inhibitors, Chemotherapy.*

### Comparative Analysis

See *Homologous (chromosomes or genes).*

### Competence Factor

See *Platelet-derived growth factor (PDGF).*

### Complement (Component of Innate Immune System)

A group of more than 15 soluble proteins found in blood serum that interacts in a sequential fashion, in which a precursor molecule is converted into an active enzyme. Each enzyme uses the next molecule in the system as a substrate and converts it into its active (enzyme) form. This cascade of events and reactions leads ultimately to the formation of an attack complex that forms a transmembrane channel in the cell membrane (e.g., of a pathogen). It is the presence of the channel that leads to lysis (rupturing) of the cell. See also *Innate immune system, Innate immune response, Plasma membrane, Cell, Pathogen, Cascade, Complement cascade, Complement factor H gene, Cecrophins, Humoral immunity, Lyse, Lysis.*

### Complement Cascade

The precisely regulated, sequential interaction of proteins (in the blood) that is triggered by a complex of antibody and antigen to cause lysis of infected cells. The triggering of lysis by multivalent antibody-antigen complexes is mediated by the classical pathway, beginning with the activation of C1, the first component (protein) of the pathway. This activation step, in which C1 undergoes conversion from a zymogen to an active protease, results in sequential cleavage of the C4, C2, C3, and C5 components (proteins). C5b, a fragment of C5, and then joins C6, C7, and C8 to penetrate the (cell) membrane bearing the antigen. Finally, the binding of some 16 molecules of C9 to this *bridgehead* produces large pores in the

(cell) membrane, which cause the lysis and destruction of the target cell. See also *Antibody, Antigen, Lysis, Cell, Plasma membrane, Complement, Complement factor H gene, Zymogens, Cecrophins, Cascade, Pathway.*

### Complement Factor H Gene

A gene that codes for the production of complement factor H, a protein also known as "CFH protein" that helps regulate the complement cascade of the human immune system. For example, CFH protein can bind (inflammation) initiation factors such as C-reactive protein and can inactivate certain components of the complement cascade.

Certain variants (alleles) of this gene in humans increase the probability of that person developing age-related macular degeneration disease. See also *Gene, Protein, Coding sequence, Allele, Complement, Complement cascade, Initiation factors, C-reactive protein (CRP), Age-related macular degeneration (AMD).*

### Complementary (Molecular Genetics)

Refers to strands of DNA that will hybridize (*bind*) to each other, due to one-for-one matchup of each strand's sequence of nucleotides. Any sequence (within the two strands) that does *not* match up one for one will not hybridize to the respective sequence (in adjacent strand). See also *Molecular genetics, Hybridization (molecular genetics), Deoxyribonucleic acid (DNA), Double helix, Nucleotide, Microarray (testing), Biomotors, Southern blot analysis.*

### Complementary DNA (cDNA)

A single-stranded DNA that is complementary to a strand of mRNA. The DNA is synthesized *in vitro* by an enzyme known as reverse transcriptase. Then, a second DNA strand is synthesized via the enzyme known as *DNA polymerase*.

Complementary DNA is often utilized in hybridization studies and in microarrays (e.g., to detect/identify genes) because cDNAs usually do not contain *regulatory sequences* of DNA, since the cDNA was copied from mRNA. Because cDNA is a DNA copy of mRNA (messenger RNA), it is an exception to the (old) central dogma. See also *Deoxyribonucleic acid (DNA), Messenger RNA (mRNA), Central dogma (old), Enzyme, DNA polymerase, Hybridization (molecular genetics), Microarray (testing), Gene expression analysis, Regulatory sequence, Reverse transcriptases.*

### Compound Q

See *Trichosanthin.*

### Computational Biology

See *Bioinformatics, In silico biology, Rational drug design, Docking (in computational biology).*

### Computer-Assisted New Drug Application

(also called "computer-assisted NDA") See *CANDA.*

### Computer-Assisted Drug Design (CADD)

See *Rational drug design, Pharmacophore searching.*



## Configuration

The 3D arrangement in space of substituent groups in stereoisomers.

## Confocal Microscopy

Invented by Marvin Minsky in 1957, this refers to the use of a special microscope that is utilized to scan (e.g., in tissue) a 2D plane at varying depths. Today, this is typically done using the following:

- Laser beams that rapidly raster scan the sample via galvomirrors. The resultant images can then be put together via a process known as volume rendering, in order to yield a 3D overall image.
- Light that has been passed through a pattern of tiny slits or pinholes in a specially designed (and often rotating) disk, resulting in that light being confined to (and illuminating) the desired 2D sample plane.

Today, using visible fluorescent proteins to “label” some protein molecules of interest, it is possible to watch the movement/interactions of labeled proteins inside living cells via confocal microscopy.

Some confocal microscopes utilize fluorescence resonance energy transfer to achieve better resolution and/or 4D images. See also *Volume rendering, Multiplex assay, Fluorescence, Protein, Label (fluorescent), Visible fluorescent proteins, Green fluorescent protein, Fluorescence resonance energy transfer (FRET)*.

## Conformation

The 3D arrangement of substituent groups in a protein or other molecular structure (e.g., aptamer molecule) that is free to assume different positions. The geometric form or shape of a protein in 3D space. See also PROTEIN.

Some protein molecules (e.g., receptors) change their conformation when applicable ligands bind to those protein molecules. See also *Native conformation, Tertiary structure, Aptamers, Effector, Protein, Protein folding, Proteomics, Unfoldases, Transcriptome, Disulfide bond, Structure-activity models, Raman optical activity spectroscopy, Receptors, Ligand (in biochemistry), Target–ligand interaction screening, Nuclear proteins*.

## Congo Red

A chemical dye that adheres to  $\beta$ -amyloid protein (which can lead to Alzheimer’s disease when clumped together inside neurons). At high concentrations, Congo red can inhibit such clumping.

Research indicates that when molecules of Congo red are chemically linked to relevant ligands for FKBP (a large cellular *chaperone protein*), that linked-together chemical entity *recruits* an FKBP protein molecule to insert itself between  $\beta$ -amyloid proteins, which could prevent clumping. See also *Alzheimer’s disease, Protein, Cell, Neuron, Ligand (in biochemistry), Chaperones*.

## Conjugate

A molecule created by fusing together (e.g., via recombination or chemically) two unlike (different) molecules. The purpose of this is to create a molecule in which one of the original molecules has one function, for example, a toxic, cell-killing function, while the other original molecule has another function, such as targeting the toxin to a specific site in the body, which might be cancerous cells.

For example, molecules of interleukin-2 (IL-2) have been fused with molecules of diphtheria toxin to create a conjugate that does the following:

- It enters leukemia and lymphoma cells. Because these two types of cancer cells possess IL-2 receptors on their surfaces, the IL-2 (targeting function) binds to that receptor and is internalized by the cell.
- The diphtheria toxin (killing function) then shuts down protein synthesis within the cancer cells.
- It then kills the cancerous cells.

This type of approach is widespread and there are many different types of this category of conjugate.

Another type of conjugate consists of enzymes used in the treatment of certain molecular diseases attached covalently to polyethylene glycol (PEG). In this case, the PEG greatly diminishes both the immunogenicity (the tendency to induce the body’s immune reaction) and the antigenicity (the ability to react with preformed antibodies).

Another type of conjugate consists of various molecules (e.g., fluorophores, toxins) or nanoparticles (e.g., quantum dots) attached to antibodies. Such conjugated antibodies may be utilized as vectors to carry either small molecules of destructive toxins or imaging proteins (e.g., green fluorescent protein) or imaging particles (e.g., quantum dots) to specific sites (cells) within the body. Antibodies may be coupled to enzymes, toxins, and/or ribosome-inhibiting proteins, as well as radioisotopes. These conjugates are known collectively as immunoconjugates. See also *Immunoconjugate, Conjugated protein, “Magic bullet,” Fusion protein, Molecular bridge, Recombination, Toxin, Interleukin-2 (IL-2), Ricin, Abrin, Receptors, Ribosomes, Messenger RNA (mRNA), Diphtheria toxin, Antibody, Fluorophore, Green fluorescent protein, Quantum dot, Enzyme, Nanoparticles, Chimeric molecules, Peptide-oligonucleotide conjugates*.

## Conjugated Linoleic Acid (CLA)

Also known as *alpha-rumenic acid* or *9-cis, 11-trans C 18:1*, it is a naturally occurring *n*-6 polyunsaturated fatty acid (PUFA) discovered in 1979 by Michael W. Pariza whose consumption by humans has been linked to

- Reduction in risk for atherosclerosis
- Reduction in blood triglyceride levels
- Reduction in blood pressure
- Reduction in body fat (adipose tissue) in obese humans
- Increase in lean body mass
- Reduction in risk for breast cancer, skin cancer, and some other types of cancer

CLA inhibits angiogenesis (i.e., formation of new blood vessels, such as the ones needed for tumors to be able to grow), and CLA exhibits powerful antioxidant properties (i.e., it “quenches” free radicals). Chemically, CLA consists of two linoleic acid molecules linked together by a chemical bond, so it is a dimer.

Foods that are naturally highest in CLA content include beef, lamb, full-fat milk, butter, cheese, some creams, and full-fat yogurt. However, that natural level (3–7 mg/g of fat) is too small to exert much beneficial impact. Feeding of soybean oil (in feed rations) to livestock has been proven to increase CLA content in the resultant meat. In 1998, T.R. Dhiman showed that feeding of soybean oil

(i.e., whole) to dairy cattle did also increase the content of CLA in their milk.

Research conducted during the 1990s indicated that consumption of CLA (e.g., by humans, swine, rats) causes the bodies of those animals to change the way they utilize and store energy. Thus, the body requires less food to perform at the same level. The body also tends to produce less body fat (adipose tissue) and more lean protein (e.g., muscle) tissue. See also *Polyunsaturated fatty acids (PUFA), Fats, Linoleic acid, Atherosclerosis, Oxidative stress, Antioxidants, Soybean oil, Adipose, Adipokines, Cancer, Volicitin, Oligomer, Tumor, Angiogenesis*.

### Conjugated Protein

A protein containing a metal or an organic prosthetic group (e.g., heme group, carbohydrate, lipid group), or both. For example, a glycoprotein is a conjugated protein bearing at least one oligosaccharide group. See also *Prosthetic group, Glycoprotein, Protein, Oligosaccharides, Conjugate, CD4-PE40*.

### Conjugation

A process akin to sexual reproduction occurring in bacteria, mating in bacteria. A process that involves cell-to-cell contact and the one-way transfer of DNA from the donor to the recipient. In contrast to some other DNA-transfer processes of bacteria, conjugation may involve the transfer of large portions of the genome. The discovery caused considerable controversy at the time. See also *Transformation, Bacteria, Transduction (gene), Transduction (signal), Deoxyribonucleic acid (DNA), Genome, Sexual conjugation*.

### Consensus Sequence

The nucleotide sequence (within a DNA molecule) that gives the *most common* nucleotide at each position (along that sequence of that DNA molecule), for those instances (in certain organisms) where a (usually small) number of variations in nucleotide sequences can occur (e.g., for a given nucleotide sequence such as a promoter sequence). See also *Nucleotide, Deoxyribonucleic acid (DNA), Sequence (of a DNA molecule), Genetic code, Gene, Promoter, Pharmacogenomics*.

### Conservation Tillage

Refers to crop production (farming) techniques/practices such as *low-tillage crop production, no-tillage crop production*, etc. that avoid or minimize the disturbance of topsoil. The field's topsoil is protected from soil erosion by the decomposing leftover crop residue on the field surface resulting from low or no tillage. Via shading of the field's topsoil and via reducing field surface wind speed to near zero, the leftover crop residue also minimizes evaporation of moisture from the field's soil. See also *Low-tillage crop production, No-tillage crop production, Drought tolerance, Glomalin*.

### Conserved

A term used to describe the following:

- The number of genes that are present within the DNA of more than one species. For example, approximately 25% of the genes found within the human genome (DNA) are also found within the DNA of plants.

- A particular domain (region) of a molecule on the surface of a rapidly mutating microorganism (e.g., the influenza virus, the AIDS virus) that remains the same in all, or most, variations of that microorganism. If that *conserved* region is suitable to act as an antigen (haptent, epitope), it may be possible to create a successful vaccine against that microorganism that would otherwise be unsuccessful due to the fact that the rapid mutation would cause it (e.g., the AIDS virus) to appear to be *different* than the one (antigen) the vaccine was designed against.

See also *Domain (of a protein), GPI20 protein, Superantigens, Mutation, Acquired immune deficiency syndrome (AIDS), Antigen, Haptent, Epitope, Virus, Gene, Deoxyribonucleic acid (DNA), HIV-1 and HIV-2*.

### Consortia

Microorganisms that interact with each other (or at least *coexist peacefully*) when growing together. An example of such interaction/coexistence would be *bioleaching*. See also *Bioleaching, Biorecovery, Biodesulfurization, Biosorbents*.

### Constant Region

See *Antibody*.

### Constitutive Enzymes

Enzymes that are part of the basic, permanent enzymatic machinery of the cell. They are formed at a constant rate and in constant amounts regardless of the metabolic state of the organism. For example, enzymes that function in the production of cell-usable energy (such as ATP) might be good candidates. And this, in fact, is the case with the enzymes of the glycolytic sequence, which is the most ancient energy-yielding catabolic pathway. See also *Enzyme, Metabolism, Cell, Pathway*.

### Constitutive Genes

Expressed as a function of the interaction of RNA polymerase with the promoter, without additional regulation. They are sometimes also called "household genes" in the context of describing functions expressed in all cells at a low level. See also *Gene, RNA Polymerase, Promoter*.

### Constitutive Heterochromatin

The inert state of permanently nonexpressed sequences, usually satellite DNA. See also *Express, Coding sequence, Deoxyribonucleic acid (DNA), Chromatin*.

### Constitutive Mutations

Mutations (changes in DNA) that cause genes that are nonconstitutive (have controlled protein expression) to become constitutive (in which state the protein is expressed all of the time). See also *Constitutive genes, Mutation, Regulatory sequence, Protein*.

## Constitutive Promoter

Refers to a promoter that is (present/acts at) high level in all cells of an organism. See also *Promoter, Cell, Organism*.

## Construct

See *Cassette, Transgene*.

## Consultative Group on International Agricultural Research (CGIAR)

An organization that is cosponsored by the Rome-based United Nations Food and Agriculture Organization (FAO), the United Nations Development Programme, and the World Bank. The CGIAR is an association of 58 public and private donors that jointly support 16 international agricultural research centers that are located primarily in developing countries. Twelve of the research centers have collectively assembled 500,000 different preserved samples (i.e., germplasm) of major food, forage, and forest plant species into a gene bank. This, the world's largest internationally held collection of genetic resources, was legally placed under the auspices of the FAO in 1994 in order "to hold the collection in trust for the international community." Since 1970, CGIAR's collection has supported research efforts to develop better varieties of staple foods consumed primarily in developing countries of the world. See also *American type culture collection (ATCC), Type specimen, Germplasm*.

## Contaminant

By definition, it is any unwanted or undesired organism, compound, or molecule present in a controlled environment. Unwanted presence of an entity in an otherwise clean or pure environment. See also *Organism*.

## Contiguous Genes

A *group* of genes that are situated together on an organism's chromosome and that often function *together as a unit* to express a trait in that organism. See also *Linkage, Organism, Gene, Chromosome, Trait*.

## Con-Till

An abbreviation that refers to *conservation tillage* farming practices. See also *Conservation tillage, Low-tillage crop production, No-tillage crop production, Glomalin*.

## Continuous Perfusion

A type of cell culture in which the cells (either mammalian or otherwise) are immobilized in a part of the system, and nutrients/oxygen are allowed to flow through the stationary cells, thus effecting nutrient/waste exchange. Ideally the system incorporates features that retard the activity of proteolytic enzymes and reduce the need for anti-infective agents (e.g., antibiotics) and fetal bovine serum, which are required by most other cell culture systems. Continuous perfusion is used because, among other things, it eliminates the need to separate the cells from the culture medium when fresh medium is exchanged for old. See also *Mammalian cell culture, Enzyme, Proteolytic enzymes*.

## Control Sequences

Those sequences of DNA that are adjacent to a gene (in genome) and "turn on" and/or "turn off" that gene. See also *Sequence (of a DNA molecule), Gene, Genome, Promoter, Termination codon (terminator sequence), Base (nucleotide), Coding sequence*.

## Convention on Biological Diversity (CBD)

The international treaty governing the conservation and use of biological resources around the world, which was signed by more than 150 countries at the 1992 United Nations Conference on Environment and Development.

Article 19.4 of the CBD called for the establishment of a *protocol on biosafety* to govern the transnational-boundary movement of non-indigenous living organisms. See also *MEA, Consultative Group on International Agricultural Research (CGIAR), International Plant Protection Convention (IPPC), Biodiversity, Introduction*.

## Convergent Improvement

See *Transgressive segregation*.

## Coordinated Framework for Regulation of Biotechnology

The regulatory *framework* via which the United States evaluates/approves new products derived via biotechnology. The Coordinated Framework assigns specific regulatory tasks to each of the U.S. government's applicable agencies (see the following).

For example, the U.S. Environmental Protection Agency is assigned to evaluate/regulate all genetically modified pest-protected new plants, in terms of their impact on pests. The U.S. Food and Drug Administration is assigned to evaluate/regulate all new food crops derived via biotechnology, in terms of their potential food safety impact (e.g., allergenicity, toxicity). The U.S. Department of Agriculture is assigned to evaluate/regulate all new plants derived via biotechnology, in terms of field (i.e., outdoor) testing, in terms of potential environmental impacts such as weediness. See also *Biotechnology, Food and Drug Administration (FDA), Genetically modified pest-protected (GMPP) plants, Allergies (foodborne), APHIS*.

## Coordination Chemistry

See *Chelation*.

## Copy DNA (C-DNA)

See *C-DNA*.

## Copy Number (Plasmid or Plastid)

The number of molecules (copies) of an individual plasmid or plastid that is typically present in a single (e.g., bacterial for *plasmid*, plant for *plastid*) cell. Each plasmid has a characteristic copy number value ranging from 1 to 50 or more. Higher copy numbers result in a higher yield of the protein encoded for by the plasmid gene in each cell. See also *Plasmid, Plastid, Protein, Gene, Extranuclear genes, Genetic code, Multi-copy plasmids*.

## Copy Number (Protein Molecules)

The number of protein molecules coded for/produced by a specified gene within the DNA of an organism, as a result of *copy number variation*. Higher copy numbers (of that gene, within the DNA) result in more protein molecules being synthesized. See also *Protein, Deoxyribonucleic acid (DNA), Gene, Organism, Copy number variation, Multi-allelic copy number variation loci*.

## Copy Number Polymorphisms

Abbreviated CNP, it refers to the genotypic variations (e.g., among a population of organisms of the same species) resulting from the loss, gain, or duplication of specific segments (sequences) of their DNA. See also *Copy number variant, Polymorphism (genetic), Genotype, Organism, Species, Deoxyribonucleic acid (DNA), Sequence (of a DNA molecule), Multi-allelic copy number variation loci*.

## Copy Number Variant

Abbreviated CNV, it refers to different members of the same species possessing differing copy number variations—that is, fragments of the organism's DNA that are either missing or existing in extra copies (e.g., fewer or more copies of a given gene)—within their genome. CNVs can perturb (affect the function of) many genes within a genome simultaneously. See also *Copy number variation, Copy number polymorphisms, Species, Deoxyribonucleic acid (DNA), Genome, Multi-allelic copy number variation loci*.

## Copy Number Variation

Refers to differing numbers of a specific protein molecule produced from the gene that codes for that protein. This copy number variation (CNV) is typically caused by *extra* copies of that gene inserted in an organism's DNA or *deleted* copies of the gene (although it is sometimes due to another source such as *deleterious mutations* within a gene or within the regulatory sequence for that gene, which prevent proper function of that gene) and may be a cause of

- Response of the body to certain pharmaceuticals (e.g., pharmacogenetics/pharmacogenomics)
- Rate of cancer progression/metastasis
- Susceptibility to certain genetic diseases

For example, the heritable disorder known as “congenital generalized hypertrichosis terminalis” results when large fractions of DNA are absent (due to mutations) from four specific human genes.

For example, some research is indicative that copy number variation in the gene(s) that code for one or another subunit of the *myelin protein structure (which is composed of multiple of such subunits)* may cause or contribute to the human disease known as “multiple sclerosis.”

For example, a 2012 research by David E. Cook et al. showed that overexpression (10X higher copy variant) of a set of three specific soybean genes together at locus *Rhg1* conferred enhanced resistance to soybean cyst nematode (*Heterodera glycines* or SCN, a parasitic roundworm that attacks soybean plants).

Copy number variation is even found in DNA of monozygotic (*identical*) twins. It typically results when both strands of the applicable DNA molecule break, and the DNA repair process inserts extra copies of a gene or leaves out some genes.

People in some human cultures that consume a lot of starch-containing foods tend to have a higher copy number for the enzyme amylase (which helps digestion of starch) in their saliva.

Copy number variations occur in less than 10% of human genes. See also *Protein, Deoxyribonucleic acid (DNA), Gene, Organism, Multiple sclerosis, aCGH, Mutation, Multi-allelic copy number variation loci, DNA repair, Pharmacogenetics, Pharmacogenomics, Cancer, Metastasis, Amylase, Aneuploidism, Regulatory sequence, Soybean cyst nematodes (SCN)*.

## CoQ10

See *Coenzyme Q10*.

## COR Genes

Refer to a category of plant genes that, when activated, express proteins that protect plant cells from membrane damage and other cold (temperature)-induced damage. See *CBF1*.

## Core Histones

See *Histones, Epigenetic marks*.

## Corepressor

A small molecule that combines with the repressor to trigger repression (the shutting down) of transcription. See also *Transcription*.

## Corn

The domesticated plant *Zea mays* L. also known as maize. A green, leafy (grain) plant that is one of the world's largest providers of edible starch and fructose (sugar) for mankind's use. This summer annual plant varies in height from 2 ft (0.5 m) to more than 20 ft (6 m) tall. The seeds (kernels) are borne in cobs, ranging in size from 2 ft long to smaller than a man's thumb.

Due to genetic variation (i.e., of different hybrids/varieties), the fraction of kernel that consists of recoverable starch varies between 42% and 73% for different corn varieties.

Due to genetic variation (i.e., of different hybrids/varieties), the fraction of kernel that consists of protein varies between 8% and 10%, but that protein content can be increased by 10% via insertion into corn plant of the *glutamate hydrogenase gene*.

Due to genetic variation (i.e., of different hybrids/varieties), the fraction of kernel that consists of oil varies between 3.5% and 8.5% for different corn varieties.

Grown widely in the world's temperate zones, corn is grown as far north as latitude 58° in Canada and Russia and as far south as latitude 40° in the Southern Hemisphere.

During the 1980s, scientists were able to insert genes from the *Bacillus thuringiensis* bacteria into the corn plant, to make that plant resistant to certain insects. During the 1990s, scientists were able to insert genes into the corn plant, to make it tolerant to certain herbicides and to cause the corn plant to produce monoclonal antibodies.

Some of the major economic pests of corn include the European corn borer (*Ostrinia nubilalis*), corn earworm/soybean podworm (*Helicoverpa zea*), corn rootworm (*Diabrotica virgifera virgifera*), and beet armyworm (*Pseudaletia unipuncta*). See also *Hybridization (plant genetics), Bacillus thuringiensis (B.t.), Protein, Stress proteins, Maysin, Cry proteins, CRYIA (b) protein, CRYIA*

(c) protein, *CRY9C* protein, Gene, “Stacked” genes, *Opaque-2*, *High-methionine corn*, *High-lysine corn*, *B.t. kurstaki*, *Value-enhanced grains*, *Helicoverpa zea* (*H. zea*), *Chloroplast transit peptide (CTP)*, *Herbicide-tolerant crop*, *High-oil corn*, *European corn borer (ECB)*, *Aflatoxin*, *Fusarium*, *Corn rootworm*, *Volicitin*, *GA21*, *Transposable element*, *Transposon*, *Glutamate dehydrogenase*, *Black-layered (corn)*, *Monoclonal antibodies (MAb)*, *Photorhabdus luminescens*, *Cholesterol oxidase*, *MIR1-CP*, *cpB* gene.

### Corn Borer

See *European corn borer (ECB)*, *Asian corn borer*, *Southwestern corn borer*.

### Corn Earworm

Also known as soybean podworm (when found on soybean plants) and as the tomato fruitworm (when it is on tomato plants). See *Helicoverpa zea* (*H. zea*), *Corn*.

### Corn Rootworm

A complex of several strains of beetles, it refers to the larva stage of the corn rootworm beetle (*Diabrotica virgifera virgifera*), which historically has laid its eggs on corn/maize (*Zea mays* L.) plants. When they hatch, the larva must feed on the roots of the corn/maize plant in order to live. Adult corn rootworm beetles also feed on leaves and silks of corn/maize plants.

Some strains of *Bacillus thuringiensis* have proven to be effective against the corn rootworm, when sprayed onto them or genetically engineered into the corn/maize plant.

In 1992, a new genetic variant of corn rootworm known as the “Western phenotype” or Western corn rootworm (*Diabrotica virgifera virgifera* LeConte) was discovered in the United States. It prefers to lay its eggs on soybean plants instead of corn plants. During 2007, James Baum et al. showed that RNA interference (RNAi) could potentially be utilized to control this insect pest via double-stranded RNA (dsRNA) via oral delivery to the larvae (e.g., via corn plant tissues genetically engineered to contain relevant dsRNA). The relevant dsRNA is taken up by the larvae’s midgut cells and processed by its cells’ native RNAi machinery, which leads to specific knockdown of the applicable mRNA (e.g., targeted mRNA that encodes a protein required for an essential function in the insect’s cells).

Other genetic variants of the corn rootworm include the “Northern phenotype” or Northern corn rootworm (*Diabrotica barberi*) and the Mexican corn rootworm (*Diabrotica virgifera zea*). See also *Corn*, *Phenotype*, *Soybean plant*, *Strain*, *Bacillus thuringiensis* (*B.t.*), *Genetic engineering*, *CRY3B(b) protein*, *B.t. kumamotoensis*, *Antibiosis*, *Ribonucleic acid (RNA)*, *RNA interference (RNAi)*, *Double-stranded RNA (dsRNA)*.

### Coronary Heart Disease (CHD)

A disease of the heart and arteries, in which (among other effects) cholesterol is deposited on the interior walls (lumen endothelium), where it can sometimes later break off and cause death (e.g., via *heart attack*).

Risk factors (i.e., increased risk) for CHD include high blood levels of triglycerides, high levels of apolipoprotein B, high levels of LDLPs/VLDLs (the two lipoproteins that are most likely to deposit cholesterol on artery walls), and/or low levels of HDLPs

(the lipoproteins that help to clear-away cholesterol deposits from artery walls).

A human diet containing a large amount of certain phytosterols (e.g., CAMPESTEROL, BETA-SITOSTEROL, and/or STIGMASTEROL) has been shown to lower total serum (blood) cholesterol and low-density lipoprotein (LDLP) levels by approximately 10% and thereby lower the risk of CHD.

A human diet containing a large amount of oleic acid causes lower blood cholesterol levels, and can thus lower risk of CHD and atherosclerosis. See also *Cholesterol*, *Low-density lipoproteins (LDLPs)*, *Sitosterol*, *Very-low-density lipoproteins (VLDLs)*, *High-oleic oil soybeans*, *Phytosterols*, *Sterols*, *Campesterol*, *High-density lipoproteins (HDLP)*, *Beta-sitosterol (B-sitosterol)*, *Stigmasterol*, *Serum lifetime*, *Lycopene*, *Atherosclerosis*, *Resveratrol*, *Lumen*, *Endothelium*, *Triglycerides*, *Endothelin*, *Adipose*, *Homocysteine*.

### Cortical Microtubules

The microtubules that are located on the inner face of the plasma membrane of a cell. In plant cells, within the hypocotyl (i.e., stem of a germinating seedling), these microtubules are arranged with a predominant orientation that is perpendicular to the axis of expansion of the growing stem. In response to sunlight striking the stem, the cortical microtubules swiftly reorient themselves 90°, to become parallel to the axis of the growing stem. That new orientation of the cell’s cortical microtubules causes cellulose deposition (i.e., building of the structural-strength members of plant cell wall) to occur in a manner that causes the plant to *grow in the direction of the sunlight* (a phenomenon known as *phototropism*). See also *Microtubules*, *Cell*, *Plasma membrane*, *Cellulose*.

### Corticotropin

See *ACTH*.

### Cortisol

A steroid hormone that is utilized by the human body to regulate blood pressure (e.g., via increased water retention, by decreasing the kidney’s water-excretion rate).

A deficiency of cortisol causes *Addison’s disease*. See also *Transcription activators*, *Glycyrrhizic acid*, *Steroid*, *Hormone*, *Homeostasis*.

### Cosuppression

A significant decrease (“silencing”) in the expression of a gene (within an organism’s genome/DNA) that (often) results when man *inserts and causes to be expressed* a homologous gene.

For example, *high-oleic oil soybeans* result when the *GmFad2-1* gene (which codes for native  $\Delta 12$  desaturase enzyme) is inserted and expressed in traditional varieties of soybeans. That is because the inserted gene “silences” itself and the endogenous *GmFad2-1* gene (i.e., the one naturally/originally present in the soybean plant), which thus prevents formation of the  $\Delta 12$  desaturase enzyme (which normally causes most oleic acid within soybeans to be converted into polyunsaturated linolenic acid/linoleic acid). See also *Gene silencing*, *Oleic acid*, *Linoleic acid*, *Linolenic acid*, *Express*, *Gene*, *Post-transcriptional gene silencing (PTGS)*, *Knockout*, *Genome*, *Homologous (chromosomes or genes)*, *Soybean plant*, *High-oleic oil soybeans*,  *$\Delta 12$  desaturase*, *Antisense (DNA sequence)*, *FAD3 gene*, *RNA interference (RNAi)*.

## Cowpea Mosaic Virus (CpMV)

A virus that infects cowpea (*Vigna unguiculata*) plants (which are known as black-eyed peas in the United States), but does not infect animals. Researchers have discovered how to cause CpMV to express certain animal virus proteins (i.e., antigens) on its surface, via genetic engineering. These virus antigens hold potential to replace the antigens currently used in vaccines, which are fraught with problems due to their production in animal cells, bacterial cells, or yeast cells. In addition, CpMV acts as an intrinsic natural adjuvant to the (animal virus) antigens, since it provokes an immune response itself. See also *Virus, Cowpea trypsin inhibitor (CpTI), Express, Protein, Adjuvant (to a pharmaceutical), Immune response, Antigen*.

## Cowpea Trypsin Inhibitor (CpTI)

A chemical that is naturally coded for by a certain cowpea (*Vigna unguiculata*) plant gene. It kills certain insect larvae by inhibiting digestion of ingested trypsin by the larvae, thereby starving the larvae to death. See also *Trypsin, Trypsin inhibitors, Gene, Coding sequence*.

## COX

See *Cyclooxygenase*.

## COX Gene

It refers generally to any gene that codes for cyclooxygenase (COX), itself a term that refers to a *family* of enzymes (isozymes) that convert arachidonic acid to prostaglandins in the human body. Some of the different forms of cyclooxygenase cause the body to produce compounds that promote inflammation.

For example, the bodies of men whose DNA has a COX-2 gene variant called “rs4647310” have cyclooxygenase that produces inflammatory compounds (and a higher risk of developing advanced prostate cancer).

During 2009, John S. Witte showed that consumption of long-chain omega-3 fatty acids reduces the risk of prostate cancer, even in men possessing the COX-2 gene variant called “rs4647310.” See also *Gene, Coding sequence, Cyclooxygenase, Enzyme, Isozymes, Arachidonic acid (AA), Deoxyribonucleic acid (DNA), Prostate, Cancer, Omega-3 fatty acids, N-3 fatty acids*.

## COX-1

See *Cyclooxygenase*.

## COX-2

See *Cyclooxygenase*.

## COX-2 Gene

See *Cox gene, Cyclooxygenase*.

## COX-3

See *Cyclooxygenase*.

## CP4 EPSP Synthase

See *CP4 EPSPS*.

## CP4 EPSPS

The enzyme 5-enolpyruvyl-shikimate-3-phosphate synthase, which is naturally produced by an *Agrobacterium* species (strain CP4) of soil bacteria. CP4 EPSPS is essential for the functioning of that bacterium’s metabolism biochemical pathway. CP4 EPSPS happens to be unaffected by glyphosate-containing or sulfosate-containing herbicides, so introduction of the CP4 EPSPS gene into crop plants (e.g., soybeans) makes those plants essentially impervious to glyphosate-containing or sulfosate-containing herbicides. See also *Enzyme, Metabolism, Gene, Genetic engineering, EPSP synthase, Glyphosate, Sulfosate, Soybean plant, Glyphosate oxidase, Bacteria, Chloroplast transit peptide (CTP), Herbicide-tolerant crop, Pathway*.

## CpDNA

See *Cytoplasmic DNA*.

## CPMP

See *Committee for Proprietary Medicinal Products (CPMP)*.

## CpMV

See *Cowpea mosaic virus (CPMV)*.

## CPP

Acronym for cell-penetrating peptide. See *Peptide-oligonucleotide conjugates*.

## CpTI

See *Cowpea trypsin inhibitor (CPTI)*.

## CR

Acronym for *complete remission*.

## Crassulacean Acid Metabolism (CAM)

See *Metabolism, C4 photosynthesis*.

## C-Reactive Protein (CRP)

Discovered in 1929 by Oswald Avery, C-reactive protein (CRP) is a general inflammation *biomarker* (protein molecule) produced in humans in the liver in response to certain bacterial infections or certain physical trauma (which cause inflammation). Elevated blood levels of CRP are related to the degree of risk of arteriosclerosis, coronary heart disease, and heart attack.

Typical healthy humans (e.g., not suffering an infection) tend to have blood CRP levels of less than 3 mg/L. Blood levels of CRP increase 1000-fold or more when the individual becomes infected/inflamed.

Aspirin and statin-type pharmaceuticals (e.g., pravastatin, simvastatin, atorvastatin) help to lower inflammation and bloodstream CRP levels. Consumption of  $\alpha$ -linolenic acid causes a decline in bloodstream CRP levels. Blood levels of CRP also decline when (overweight) people lose weight.

Blood levels of CRP are increased by a person's

- Aging
- Obesity
- Type II diabetes
- Smoking and excess alcohol consumption
- Gum disease (periodontal disease)

See also *Biomarkers, Protein, Bacteria, Arteriosclerosis, Coronary heart disease (CHD), Chronic inflammation, Humoral immune response, Interleukin-6 (IL-6), Type II diabetes, Linolenic acid, Statins.*

### Cre-Lox System

Refers to the use of a particular phage/enzyme system to accomplish a site-specific (on organism's or virus's DNA) insertion or deletion of a specific DNA fragment. *Cre* is the name of an enzyme that specifically joins *LoxP* sites (on DNA molecule) that were earlier engineered into the DNA of both a shuttle vector (i.e., plasmid in this case) and the DNA of the "target" organism or virus.

Certain "knockouts" in transgenic organisms can be created via use of the Cre-Lox System. The Cre-Lox system is particularly useful for knocking-out (removing) a particular gene from only a specific subset of the organism's tissues. See also *Phage, Organism, Virus, Deoxyribonucleic acid (DNA), Deletions, Enzyme, Shuttle vector, Knockout.*

### CRISPR

Acronym for *clustered regularly interspaced short palindromic repeats*, which is one method for scientists to do genetic editing today. It was first described in 1987 for the bacterium *Escherichia coli*, in which it is a naturally occurring immune system process that confers some resistance to harmful exogenous genetic elements (*infectious agents*) such as plasmids and phages/viruses. It was later shown to also be present within archaea.

Bacteria and archaea utilize CRISPR in combination with *Cas proteins* (i.e., CRISPR-associated proteins) known as Cas1 and Cas2 to silence crucial segments of an invading infectious agent's genetic element content via a mechanism analogous to RNA interference and also to thereby retain immunity against invasion by that same infectious agent in the future. The latter is accomplished via a molecular complex (Cas1–Cas2) that can latch onto a specific segment of an invader's genetic content, copy it as DNA segment, and then insert that DNA segment into the bacteria's (or archaea's) DNA in the form of a *spacer* (which functions as an immune system memory to facilitate a swifter and stronger response to that particular invader next time). When, for example, a later-invading virus' DNA binds to such CRISPR segments in the bacteria's DNA, the Cas9 enzyme cuts up that viral DNA (thereby halting the viral invasion).

After initially being called other things, it was renamed CRISPR or CRISPR-Cas in 2002. See also *Gene, Gene editing, Palindrome, Bacteria, Archaea, Escherichia coliform (E. coli), Plasmid, Virus, Phage, Gene silencing, CRISPR/CAS9 gene-editing systems.*

### CRISPR/Cas9 Gene-Editing Systems

Acronym for transcription activator-like effector nucleases and *clustered regulatory interspaced short palindromic repeats*, a technology system for scientists to do precise genetic editing today. The CRISPR/Cas9 system utilizes tailored segments of man-made short *single guide RNA* (known as sgRNA or gRNA) to guide Cas9 nuclease (a DNA-cutting enzyme) to virtually any desired site on a DNA molecule.

Via the scientist supplying a carefully selected gene (DNA sequence) for the CRISPR system to use in its repair of the damage of that "cut," the CRISPR/Cas9 gene-editing system can be utilized to insert genes (e.g., to create a genetically engineered crop plant) to cure certain animal disorders/diseases caused by a single genetic mutation, to impart a new trait, etc. The Cas9-sgRNA recognizes targeted DNA based on complementarity between a sgRNA spacer (i.e., the leading sequence of sgRNA) and its (targeted) DNA.

In addition to inserting a gene (specific DNA sequence replacement), this sgRNA-guided endonuclease technology can be used to induce in/dels (indel mutations), insertions and large deletions, or genomic rearrangements at any specific selected location in the organism's genome, knock-in of a particular gene, knockout of a particular gene, and knockdown of a particular gene, or be utilized to mediate up- or downregulation of specific gene(s) within the organism's genome. CRISPR/Cas9 gene-editing systems can also be utilized to alter histone modifications or DNA methylation within the organism's genome.

See also *Deoxyribonucleic acid (DNA), Gene, Sequence (of a DNA molecule), Genome, Gene editing, Gene silencing, Organism, Palindrome, Ribonucleic acid (RNA), sgRNA, CAS9, CRISPR, Enzyme, Nuclease, Genomic surgery, Genetic engineering, Mutation, Indel mutations, Knockin, Knockout, Knockdown, Histones, Histone modifications, DNA methylation, Mutagenic chain reaction, Gene drive.*

### CRISPR/Cas9 Genome-Editing Systems

See *CRISPR/Cas9 gene-editing systems.*

### CRISPR-Cas

See *CRISPR.*

### CRISPR-Cas Immune System

See *CRISPR.*

### Critical Micelle Concentration

Also known as the CMC of a surfactant. It is the lowest surfactant concentration at which micelles are formed. That is, the CMC represents that concentration of surfactant at which the individual surfactant molecules aggregate into distinct, high-molecular-weight spherical entities called "micelles." Or from another viewpoint, it represents the concentration of a surfactant, above which micelles or reverse micelles will spontaneously form through the process of self-aggregation (self-assembly).

For example, liposomes in a water solution will self-assemble into micelles/vesicles if their concentration is higher than that liposome's CMC. See also *Micelle, Reverse micelle (RM), Liposomes.*

## Crohn's Disease

An intestinal disease of humans that can cause inflammation of the colon, abdominal pain, diarrhea, and weight loss and decrease the body's ability to absorb dietary-source vitamin D. See also *Commensal, Dendritic cells, Vitamin, Immunomodulating agent*.

## Crop Biologicals

Refers to microorganisms that are utilized by man (e.g., applied to crop seeds in the form of a seed treatment coating, sprayed onto plants, inserted into field topsoil) to enhance the growth of those crop plants (e.g., via increasing expression of applicable plant genes), to help those crop plants to better absorb plant nutrients (e.g., phosphorus, nitrogen) from soil, to resist pests (e.g., certain insects, phytoparasitic nematodes), to resist pathogens (e.g., harmful bacteria, harmful fungi, certain viruses), to fix nitrogen from the atmosphere for a crop plant's roots to absorb, etc. It can be applied to crops alone or in combination with other agents (e.g., biostimulants).

For example, the fungal pathogen *Nomuraea rileyi* is an effective biological control agent for the soybean podworm (*Helicoverpa zea*) insect pest in soybean plants.

For example, the parasitic-to-soybean cyst nematode (SCN) *Pasteuria* sp. bacteria can be applied to soybean seeds (e.g., as a crop biological coating) prior to planting, in order to help control soybean cyst nematodes. The *Pasteuria* bacteria must attach their spores (for reproduction) to the juvenile nematodes, so that the *Pasteuria* offspring can consume the SCN when those spores later germinate.

For example, the fungal pathogen *Coniothyrium minitans* (strain CON/ M/91-08) is an effective biological control agent for the soil-borne pathogenic fungi *Sclerotinia* spp.

Other crop biologicals include *rhizobia*, mycorrhizae, penicillium, trichoderma, and bacillus species/compounds. See also *Microorganism, Microbiology, Gene, Express, Expressivity, Bacteria, Pasteuria, Nitrogen fixation, Rhizobium (bacteria), Bradyrhizobium japonicum, Penicillium, Fungus, Pathogen, Nematodes, Soybean cyst nematodes (SCN), Biofertilizers, Biostimulants, Pharmacoenvirogenetics, Azadirachtin, Neem tree, Seed treatments, Systemic acquired resistance (SAR), Helicoverpa zea (H. zea), Sclerotinia* spp.

## Crop Rotation

Refers to the alternate growing of *different species* of crops in a given farm field during subsequent growing seasons (e.g., canola during the first growing season, soybean during the second growing season, maize/corn during the third growing season). In addition to decreasing the field populations of crop pests (e.g., certain crop-chewing insects such as the European corn borer, certain parasitic roundworms such as the soybean cyst nematode) via denying them their preferred food/host plant in the field, such crop rotation also increases the yields of the crops that are grown in such a (rotated) field. That is because crop rotation increases the biodiversity of microorganism within the field's topsoil, which benefits the health of subsequently grown in field crops' roots. See also *Canola, Soybean plant, Corn, Microorganism, Brassica, European corn borer (ECB), Soybean cyst nematodes (SCN)*.

## Cross-Reaction

When an antibody molecule (against one antigen) can combine with (bind to) a different (second) antigen. This sometimes occurs

because the second antigen's molecular structure (shape) is very similar to that of the first antigen. See also *Antibody, Antigen*.

## Cross-Reactivity

See *Cross-reaction*.

## Crossing Over

The reciprocal exchange of material between chromosomes that occurs during meiosis. The event is responsible for genetic recombination. The process involves the natural breaking of chromosomes, the exchange of chromosome pieces, and the reuniting of DNA molecules. See also *Linkage, Deoxyribonucleic acid (DNA), Chromosomes, Recombination*.

## Crown Gall

See *Agrobacterium tumefaciens*.

## CRP

Acronym for *catabolite regulator protein*. See *CAP*.

## CRP

Acronym for *C-reactive protein*. See *C-reactive protein (CRP)*.

## CRTL Gene

See *Golden rice, Gene*.

## Cruciferae

A taxonomic group (*family*) of plants that includes canola, mustard, oilseed rape, etc. See also *Brassica*.

## Cry Proteins

A class of proteins produced by *Bacillus thuringiensis* (*B.t.*) bacteria (or plants into which a *B.t.* gene has been inserted). Cry (i.e., *crystal-like*) proteins are toxic to certain categories of insects such as corn borers (e.g., *Ostrinia nubilalis*), corn rootworms (*Diabrotica virgifera virgifera*), armyworms (e.g., *Spodoptera frugiperda*), black cutworms (*Agrotis ipsilon*), velvetbean caterpillar (*Anticarsia gemmatalis*), mosquitoes, black flies, tobacco hornworm, and some types of beetles, but harmless to mammals and most beneficial insects. See also *Bacillus thuringiensis (B.t.), Protein, Bacteria, Gene, Protoxin, Corn, European corn borer (ECB), Corn rootworm, Armyworm, Tobacco hornworm, CRY1A(b) protein, CRY1A(c) protein, CRY3B(b) protein, CRY9C protein, mCRY3AA protein, Ion channels, Cotton, Toxicogenomics*.

## Cry1A (b) Protein

One of the *cry* (i.e., *crystal-like*) proteins, it is a protoxin that—when eaten by certain insects (e.g., *Lepidoptera* larvae such as the armyworm or tobacco hornworm or European corn borer)—is toxic to those crop-pest insects. However, if eaten by a mammal, the Cry1A(b) protein is digested within 1 min, harmlessly. See also

*Cry proteins, Protein, B.t. kurstaki, Protoxin, European corn borer (ECB), Armyworm, Tobacco hornworm, Ion channels.*

### Cry1A (c) Protein

One of the *cry* (i.e., *crystal-like*) proteins. See also *Cry proteins, Ion channels.*

### Cry1F Protein

One of the *cry* (i.e., *crystal-like*) proteins, it is a protoxin that—when eaten by the European corn borer (*Ostrinia nubilalis*), southwestern corn borer (*Diatraea grandiosella*), black cutworm (*Agrotis ipsilon*), fall armyworm (*Spodoptera frugiperda*), and Western bean cutworm—is toxic to those insects. See also *Cry proteins, Bacillus thuringiensis (B.t.), Protoxin, Protein, European corn borer (ECB), Armyworm, Ion channels.*

### Cry3A (a) Protein

One of the *cry* (i.e., *crystal-like*) proteins, it is a protoxin that—when eaten by certain insects (e.g., larvae of corn rootworm [*Diabrotica virgifera virgifera*])—is toxic to those insects. See also *Protein, Cry proteins, Protoxin, Corn rootworm, Ion channels, B.t. kumamotoensis.*

### Cry3B (b) Protein

One of the *cry* (i.e., *crystal-like*) proteins, it is a protoxin that—when eaten by certain insects (e.g., larvae of corn rootworm [*Diabrotica virgifera virgifera*])—is toxic to those insects. See also *Protein, Cry proteins, Protoxin, Corn rootworm, Ion channels, B.t. kumamotoensis.*

### Cry9C Protein

One of the *cry* (i.e., *crystal-like*) proteins, it is a protoxin that—when eaten by European corn borer (*Ostrinia nubilalis*), southwestern corn borer (*Diatraea grandiosella*), black cutworm (*Agrotis ipsilon*), and some species of armyworm (e.g., *Spodoptera frugiperda*)—is toxic to those insects. See also *Cry proteins, Bacillus thuringiensis (B.t.), B.t. tolworthi, Protoxin, Protein, European corn borer (ECB), Armyworm, Ion channels.*

### CSF

See *Colony-stimulating factors (CSFs).*

### CspB Gene

A naturally occurring gene within *Bacillus subtilis* bacteria that causes the production of a particular cold-shock (stress response) protein that acts as an RNA chaperone (i.e., helps to convey RNA molecule(s) to their ultimate destination(s) in the cell).

When inserted (via genetic engineering) into the DNA of a corn/maize (*Zea mays* L.) plant, the production of that cold-shock protein helps that plant cope better with the stress of drought conditions. That is because it decreases the rate at which the plant absorbs water from soil in dry conditions. See also *Corn, Gene, Genetic engineering, Drought tolerance, Drought tolerance trait, Cold-shock protein, Chaperones, Ribonucleic acid (RNA).*

### CT

Refers to conservation tillage practices of crop production. See also *Low-tillage crop production, No-tillage crop production, Glomalin.*

### CTAB

See also *Hexadecyltrimethylammonium bromide (CTAB).*

### CTC

Acronym for *circulating tumor cell* (i.e., those that are shed by tumors as part of the metastasis process). See also *Cell, Cancer, Tumor, Metastasis.*

### CTNBio

Acronym for Brazil's National Technical Commission on Bio-safety, which is the Brazilian government's regulatory body for granting formal approval to a new genetically engineered plant (e.g., a genetically engineered crop to be planted).

CTNBio is analogous to Germany's ZKBS (Central Commission on Biological Safety), Australia's GMAC (Genetic Manipulation Advisory Committee), Kenya's Biosafety Council, and India's Department of Biotechnology. See also *GMAC, Recombinant DNA Advisory Committee (RAC), ZKBS (Central Commission on Biological Safety), Genetic engineering, Kenya Biosafety Council, Indian Department of Biotechnology.*

### CTP

See *Chloroplast transit peptide (CTP).*

### Culture

Any population of cells (e.g., bacteria, algae, protozoa, virus, yeasts, plant cells, mammalian cells) growing on, or in, a medium that supports their growth. Typically used to refer to a population of the cells of a single species or a single strain. A medium that contains only one specific organism (e.g., *E. coli* bacteria) is known as a pure culture. A culture may be preserved (i.e., stored alive) via freezing, drying (in which the cells go dormant), subculturing on an agar medium, or other preservation methods. See also *Culture medium, Type specimen, Lyophilization, American type culture collection (ATCC), Species, Strain, Cell culture, Mammalian cell culture.*

### Culture Medium

Any nutrient system for the artificial cultivation of bacteria or other cells. It usually consists of a complex mixture of organic and inorganic materials. For example, the classic culture (growth) medium used for bacteria consists of nutrients (required by that bacteria) plus agar to solidify or semisolidify the nutrient-containing mass. See also *Medium, Agar, Cell culture, Mammalian cell culture, Airlift fermenter.*

### Curcumin

A polyphenol compound (naturally found in some plants) that acts as an antioxidant in the body's tissues when consumed by humans. Research has shown that it also acts to prevent inflammation of neurological tissues.

For example, curcumin is naturally produced in the roots of turmeric plant (*Curcuma longa*).

Research indicates that lifelong consumption of curcumin might help to prevent or delay symptoms of Alzheimer's disease, because of its amyloid  $\beta$ -protein-binding properties (inside applicable human tissues). See also *Oxidative stress, Antioxidants, Alzheimer's disease, Chronic inflammation, Protein, Amyloid precursor protein*.

### Curing Agent

A substance that increases the rate of loss of plasmids during bacterial growth. See also *Growth (microbial), Plasmid*.

### Current Good Manufacturing Practices

See *cGMP*.

### CUS

See *HSE*.

### Cut

An enzyme-induced, highly specific break in both strands of a DNA molecule (opposite one another). The enzymes involved are called "restriction enzymes." See also *Restriction endonucleases, Enzyme, Deoxyribonucleic acid (DNA)*.

### CVD

Acronym for cardiovascular disease. See *Atherosclerosis, Arteriosclerosis*.

### Cyclic AMP

A molecule of AMP (adenosine monophosphate) in which the phosphate group is joined to both the 3' and the 5' positions of the ribose, forming a cyclic (ring) structure. When cAMP binds to CAP, the complex is a positive regulator of prokaryotic transcription. See also *Adenosine monophosphate (AMP), CAP, Prokaryotes, Transcription, Adenylate cyclase*.

### Cyclic Phosphorylation

Synthesis (i.e., *manufacturing*) of adenosine triphosphate (chemical reaction) that occurs during photosynthesis in plants. Also called "photosynthetic phosphorylation" (photophosphorylation).

See also *ATP synthase, Adenosine triphosphate (ATP), Photosynthesis, Photosynthetic phosphorylation*.

### Cyclodextrin

A macrocyclic (doughnut-shaped) carbohydrate ring produced enzymatically from starch. The external surface is hydrophobic while the interior is hydrophilic in nature. The hole of the doughnut is large enough to accommodate guest molecules. Uses include solubilization, separation, and stabilization of molecules in the interior cavity of or in association with the cyclodextrin molecules.

For example, during 2005, Timothy Triche utilized cyclodextrins to carry some short interfering RNA (siRNA) into mouse tumors (after he attached a molecular tag specific to tumors to the exterior

of those cyclodextrins). After entry to the tumors, the siRNA inhibited growth of those tumors. See also *Carbohydrates, Short interfering RNA (siRNA), Tumor*.

### Cycloheximide

Also called Actidione. A chemical that inhibits protein synthesis by the 80S eucaryotic ribosomes; it does not, however, inhibit the 70S ribosomes of prokaryotes. The chemical blocks peptide bond formation by binding to the large ribosomal subunits. See also *Protein, Ribosomes*.

### Cyclooxygenase

Abbreviated COX, it refers to a *family* of enzymes (isozymes) that convert arachidonic acid to prostaglandins in the human body. There are at least three forms of cyclooxygenase:

- COX-1 (also known as PGHS-1) and COX-3, which convert arachidonic acid to *constitutive* prostaglandins, which help to maintain the tissues of the stomach, kidneys, and intestines. COX-1 is present in nearly all tissues of the body.
- COX-2 (also known as PGHS-2), which converts arachidonic acid to *inducible* prostaglandins, which can cause pain and inflammation in the body's joints when they accumulate in those joints. COX-2 is generally not present in body tissues until those tissues are *inflamed* by monocytes (macrophages)/mast cells or *injured* (via mechanical shear/abrasion of endothelial cells). Research indicates that overexpression of the *COX-2 gene* is one of the causative factors in onset of breast cancer. COX-2 also mediates the transformation of omega-3 fatty acids into electrophilic fatty acid oxidation products that help reduce oxidation and inflammation.
- COX-3, which results when *intron 1* is retained in the mRNA transcript during transcription of the COX-1 gene (i.e., alternative splicing).

Aspirin and some other pain-relieving drugs (e.g., ibuprofen, indomethacin) chemically block the earlier-described activity of COX-1 and COX-2. Long-term use of aspirin causes a reduction in incidents of colorectal cancer.

Nexrutine (an extract from the *Phellodendron amurense* tree) and certain pain-relieving drugs (celecoxib, rofecoxib, etc.) chemically block the earlier-described activity of COX-2, while *not* blocking the (beneficial) COX-1.

The pain-relieving drug acetaminophen chemically blocks the activity of COX-3, without blocking COX-1 or COX-2. See also *Enzyme, Isozymes, Arachidonic acid, Platelets, Inducible enzymes, Selective apoptotic anti-neoplastic drug (SAAND), Eicosanoids, Monocytes, Mast cells, Prostaglandins, Endothelial cells, PGHS, Intron, Transcription, Messenger RNA (mRNA), Gene, Cyclooxygenase, Gene, Expressivity, Alternative splicing, Cancer, COX gene, Omega-3 fatty acids, Oxidative stress, Macrophage*.

### Cyclosporin A

An immune-system-suppressing drug that was isolated from a mold in the mid-1970s by the Swiss firm F. Hoffmann-LaRoche & Co. AG. The drug is used to prevent (organ recipient's) immune system

from *rejecting* a transplanted organ and typically must be taken by the organ recipient for the duration of his/her lifetime.

Cyclosporin's mechanism of action is to prevent the divalent calcium cation (Ca<sup>2+</sup>) from entering T lymphocytes to activate certain genes within those T lymphocytes (which trigger the *rejection* process).

In 1996, Thomas Eisner reported that the mold *Tolypocladium inflatum*, from which cyclosporin is harvested, prefers a natural (wild) substrate of a deceased dung beetle.

During 2000, it was discovered that cyclosporin inhibits growth of the parasitic microorganism *Toxoplasma gondii* (which can cause loss of sight and neurological disease in humans). See also *T-lymphocytes*, *Fungus*, *Xenogeneic organs*, *Cation*, *Gene*, *Graft-versus-host disease (GVHD)*, *Human leukocyte antigens (HLA)*, *Major histocompatibility complex (MHC)*, *Microorganism*, *Growth (microbial)*.

## Cyclosporine

See *Cyclosporin A*.

## CYP

See *Cytochrome P450 (CYP)*.

## CYP3A4

See *Cytochrome P4503A4*.

## CYP46 Gene

A human gene that codes for a protein (within the brain) involved in the brain's usage/processing of cholesterol.

People whose DNA has a mutated version of the CYP46 gene are at a higher than average risk of getting Alzheimer's disease. See also *Gene*, *Protein*, *Genetic code*, *Cholesterol*, *Mutation*, *APOE4*, *Deoxyribonucleic acid (DNA)*, *Haplotype*, *Alzheimer's disease*.

## Cysteine (cys)

An amino acid of molecular weight (mol wt) 121 Da. It is incorporated in many proteins. It possesses a sulfhydryl group that makes cysteine a mild reducing agent. Cysteine can cross-link with another cysteine located on the same or on a different polypeptide chain to form disulfide bridges. The *free* cysteine group is called a "thiol group."

High levels of cysteine content in certain genetically engineered corn (maize) kernels have been shown to inhibit in-field production of mycotoxins in corn (e.g., by several species of fungi that can be carried into corn plants by insects). See also *Amino acid*, *Cystine*, *Disulfide bond*, *Homocysteine*, *Polypeptide (protein)*, *Protein*, *Mycotoxins*, *Reduction (in a chemical reaction)*.

## Cystic Fibrosis

See *Cystic fibrosis transmembrane regulator protein (CFTR)*.

## Cystic Fibrosis Transmembrane Regulator Protein (CFTR)

A protein, also known as *CF transmembrane conductance regulator*, that regulates proper chloride ion transport across the cell membranes of human lung airway epithelial cells.

When the gene that codes for the CFTR protein is damaged/mutated, the (mutant) CFTR protein fails to function properly (i.e., conducts chloride ions at a much slower rate, or not at all), which causes mucous (and bacteria) to accumulate in the lungs. This lung disease is known as Cystic Fibrosis, and more than ten different mutations of the gene that codes for CFTR protein can cause it. During 2014, the U.S. Food and Drug Administration approved KALYDECO® (ivacaftor) as a pharmaceutical to treat people ages 6 and older who have the R117H, G551D, G178R, S549N, S549R, G551S, G1244E, S1251N, S1255P, or G1349D mutations of that gene.

The SNP for cystic fibrosis was identified in 1989. See also *Protein*, *Gene*, *Mutation*, *Ion*, *Ion channels*, *Deoxyribocycleic acid (DNA)*, *Informational molecules*, *Genome*, *Genetic code*, *Ribosomes*, *Transcription*, *Single-nucleotide polymorphisms (SNPs)*, *Genomic surgery*.

## Cystine

Two cysteine amino acids that are covalently linked via a disulfide bond. These units are important in biochemistry in that disulfide bridges represent one important way in which the conformation of a protein is maintained in the active form. Cystine bridges lock the structure of the proteins in which they occur in place by disallowing certain types of (molecule) chain movement. When the disulfide bond is with a *free* cysteine (i.e., one that is not a part of the same protein molecule's amino acid backbone), the *free* cysteine is known as a *thiol group*. Cystine can be metabolized from methionine by certain animals (e.g., swine), but not vice versa. See also *Cysteine (cys)*, *Amino acid*, *Conformation*, *Protein*, *Methionine (met)*, *Metabolism*, *Disulfide bond*.

## CystX

Refers to a naturally occurring group of genes present in the genome (DNA) in some varieties of soybean plant, which confers on those particular soybean varieties (some) resistant to the soybean cyst nematode. Discovered via marker-assisted breeding and developed during the 1990s by Jamal Faghihi, John Ferris, Virginia Ferris, and Rick Vierling. See also *Soybean plant*, *Soybean cyst nematodes (SCN)*, *Gene*, *Marker assisted breeding*.

## Cytochrome

Any of the complex protein respiratory pigments (enzymes) occurring within plant and animal cells. They usually occur in mitochondria and function as electron carriers in biological oxidation. Cytochromes are involved in the *handing off* of electrons to each other in a stepwise fashion. In the process of *handing off*, other events take place, which result in the production of energy that the cell needs and is able to use. See also *Protein*, *Enzyme*, *Mitochondria*, *Cell*.

## Cytochrome P450

A *family* of enzymes within the liver that contain an iron-heme cofactor. They catalyze many different biological hydroxylation reactions (e.g., metabolism of certain compounds), epoxidation reactions, oxidative ring-coupling reactions, and heteroatom oxygenation/release reactions. Essentially, the enzyme renders fat-soluble (hydrophobic) molecules water soluble or *more water soluble* (by introduction of the hydrophilic hydroxyl group) so that the molecules may be

removed (i.e., filtered/washed) from the body's bloodstream via the kidneys and excreted.

These enzymes are being investigated for their potential as catalysts in the hydroxylation of specific (valuable) industrial chemicals.

In some plants such as sorghum (*Sorghum bicolor*), their cytochrome P450 molecules can help them to respond to certain kinds of stress (e.g. drought) if those cytochrome P450 molecules are present in high enough abundance. See also *Cytochrome, Enzyme, Cofactor, Heme, Hydroxylation reaction, Metabolism, Cytochrome P4503A4, Cytochrome P450(CYP), Microsomes, Pro-drug therapy*.

### Cytochrome P450 (CYP)

Refers to a class of liver enzymes (approximately 4000 known so far) that are responsible for the metabolism (breakdown) of more than 50% of human pharmaceuticals, when those pharmaceuticals enter the bloodstream.

For example, *cytochrome P4503A4* catalyzes the breakdown of some pharmaceutical sedatives, the antihistamine terfenadine, anti-hypertensives, and the immunosuppressant cyclosporin. *CYP2D6* catalyzes such rapid breakdown of the pain reliever codeine that patients within the haplotype whose liver contains large amounts of CYP2D6 derive virtually no benefit from taking the standard dose of codeine.

Another example is that consumption of the pharmaceuticals tolbutamide, warfarin, or phenytoin can be riskier for people who possess a mutation (i.e., an SNP that codes for less or no expression of *CYP2C9*) within their liver tissue. That is because CYP2C9 enzyme causes rapid metabolism of tolbutamide, warfarin, and phenytoin (and some other pharmaceuticals); so the *typical dose* could result in higher-than-expected bloodstream levels of those pharmaceuticals in people possessing that particular SNP. See also *Cytochrome P450, Cytochrome P4503A4, Cytochrome, Enzyme, Metabolism, Haplotype, Mutation, SNP, Coding sequence, Express, Expressivity, Pharmacogenetics, Pro-drug therapy*.

### Cytochrome P4503A4

An enzyme within the liver that, in humans, catalyzes reactions involved in the metabolism (breakdown) of estrogen plus approximately half of all modern pharmaceuticals. Those pharmaceuticals include some sedatives, antihypertensives, birth control pills, antihistamine terfenadine, and immunosuppressant cyclosporin.

Prior consumption of grapefruit juice decreases the activity of cytochrome P450 3A4 (lessening its ability to break down estrogen and some pharmaceuticals). Prior consumption of Saint John's wort (a plant native to Europe) increases its activity. See also *Enzyme, Cytochrome P450, Metabolism, Histamine, Cyclosporin, Metabolic pathway, Cytochrome, Saint John's wort*.

### Cytokines

A large class of glycoproteins similar to lymphokines but produced by nonlymphocytic cells such as normal macrophages, fibroblasts, keratinocytes and a variety of transformed cell lines. They participate in regulating immunological and inflammatory processes and can contribute to repair processes and to the regulation of normal cell growth and differentiation.

Although cytokines are not produced by glands, they are hormone-like in their intercellular regulatory functions. They are active at very low concentrations and for the most part appear to

function nonspecifically. For example, the cytokines stimulate the endothelial cells to express (synthesize and present) P-selectins and E-selectins on the internal surfaces (of blood vessels). These selectins protrude into the bloodstream, which causes passing white blood cells (leukocytes) to adhere to the selectins, and then leave the bloodstream by *squeezing* between adjacent endothelial cells. Cytokines are exemplified by the interferons. See also *Interleukin-1 (IL-1), Lymphokines, Interferons, Glycoprotein, Protein, T cells, Interleukin-6 (IL-6), Macrophage, Lectins, Fibroblasts, Hormone, Endothelial cells, Endothelium, Selectins, P-selectin, ELAM-1, Leukocytes, Adhesion molecule, Erythropoietin (EPO)*.

### Cytokinins

A widely occurring (i.e., in many species) category of plant hormones, most of which promote growth/cell division in plants.

During 2009, John Burke discovered that application of applicable man-made cytokinins to young cotton plants caused those plants' roots to quickly grow and spread (deeper in soil) faster than they otherwise would. This had the effect of making those cotton plants more resistant to drought. See also *Okant hormone, Stress hormones, Pink pigmented facultative methylotroph (PPFM)*.

### Cytolysis

The dissolution of cells, particularly by destruction of their surface membranes. See also *Lysis, Cecrophins, Lysozyme, Magainins, Complement, Complement cascade*.

### Cytomegalovirus (CMV)

A virus that infects different groups of people in varying amount, depending on their behavior. For example, 40%–90% of American heterosexuals and about 95% of homosexuals are infected with CMV. CMV normally produces a latent (nonclinical, nonobvious) infection because a healthy immune system's neutrophils produce a protein known as TRAIL that causes death of CMV-infected cells. However, when AIDS or other events (e.g., organ transplant) result in immune system suppression, CMV produces a febrile (fever-causing) illness that is usually mild in nature but can become retinitis (eye infection).

CMV can result in babies born to CMV-infected individuals being born blind, deaf, or brain damaged.

CMV can be treated (to halt life- and sight-threatening infection) in immunocompromised patients (i.e., transplant patients and AIDS victims) with Ganciclovir™, an antiviral compound developed by Syntex, or Foscarnet™, a compound developed by Astra Pharmaceuticals.

In 1996, Stephen E. Epstein found that latent CMV may cause changes in artery wall cells that aid clogging of arteries in adults (especially following balloon angioplasty). See also *Virus, Acquired immune deficiency syndrome (AIDS), Neutrophils*.

### Cytopathic

Damaging to cells. See also *Cell*.

### Cytoplasm

From the Greek words *kytos*, which means "vessel to hold liquid," and *plasma*, which means "form." Cytoplasm refers to the protoplasmic contents of the cell (e.g., plastids, mitochondria) not including

the nucleus. See also *Cell, Nucleus, Protoplasm, Cytoplasmic DNA, Plasma membrane, Plastid, Mitochondria, Chloroplasts*.

### Cytoplasmic DNA

The DNA within an organism (e.g., plant) that is not inside cell's nucleus. Cytoplasmic DNA (i.e., located in the cells' mitochondria and the chloroplasts) is not transferred from plant to plant via pollen as *nuclear DNA* is. See also *Deoxyribonucleic acid (DNA), Organism, Cell, Cytoplasm, Nucleus, Mitochondria, Mitochondrial DNA, Chloroplasts*.

### Cytoplasmic Genes

See *Cytoplasmic DNA*.

### Cytoplasmic Membrane

See *Plasma membrane*.

### Cytosine

A pyrimidine occurring as a fundamental unit (one of the bases) of nucleic acids. See also *Nucleic acids, Base (nucleotide)*.

### Cytoskeleton

This term refers to the *structural framework* of a cell/cytoplasm. Some antibiotics work (e.g., kill a bacterial cell) via inhibition of *cytoskeleton building/repair* by relevant bacterial cells.

During the late 1970s, scientists utilized fluorescent-labeled monoclonal antibodies to *show* (visually, under microscope) the existence of the cytoskeleton within cells.

Components of a cell's cytoskeleton include microtubules, actin, etc. See also *Cell, Cytoplasm, Plasma membrane, Bacteria, Antibiotic, Label (fluorescent), Monoclonal antibodies (MAb), Label (fluorescent), Microtubules, Actin*.

### Cytotoxic

Poisonous to cells. See also *Cell*.

### Cytotoxic Killer Lymphocyte

See *Cytotoxic T cells*.

### Cytotoxic T Cells

Also called "killer T cells." T cells that have been created by stimulated helper T cells. The T refers to cells of the cellular system rather than to cells of the humoral system (B cells). Cytotoxic T cells detect and destroy infected body cells by use of a special type of protein. The protein attaches to the infected cell's membrane and forms holes in it. This allows the uncontrolled leakage of ions out of and water into the cell, causing cell death. In general, the loss of the integrity of the cell membrane leads to death. The cytotoxic T cells also transmit a signal to the (leaking) infected cells that causes the cell to *chew up* its DNA. This includes its own DNA as well as that of the virus. See also *Cecrophins, Magainins, Interleukin-4 (IL-4), Helper T cells (T4 cells), Virus, T cells, Suppressor T cells, Protein, Interleukin-2 (IL-2), Deoxyribonucleic acid (DNA), Plasma membrane, Insulin-dependent diabetes mellitus*.

### CZE

Acronym for capillary zone electrophoresis. See *Capillary zone electrophoresis*.