Dictionary of Physics, Chemistry, Biology, Mathematics

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Global Media

Education For Everyone

Table of Contents

1. Chemistry Dictionary

2. Biology Dictionary

3. Physics Dictionary

4. Mathematics Dictionary

Chemistry Dictionary

Absolute Entropy (of a substance)

> The increase in the entropy of a substance as it goes from a perfectly ordered crystalline form at 0 °K (where its entropy is zero) to the temperature in question.

Absolute Zero

> The zero point on the absolute temperature scale; -273.15°C or 0 K; theoretically, the temperature at which molecular motion ceases.

Absorption Spectrum

> Spectrum associated with absorption of electromagnetic radiation by atoms (or other species) resulting from transitions from lower to higher energy states.

Accuracy

> How closely a measured value agrees with the correct value.

Acid

> A substance that produces H+(aq) ions in aqueous solution. Strong acids ionize completely or almost completely in dilute aqueous solution. Weak acids ionize only slightly.

Acid Anhydride

> The oxide of a nonmetal that reacts with water to form an acid.

Acid Anhydride

> Compound produced by dehydration of a carbonic acid; general formula is R--C--O--C--R

Acidic Salt

> A salt containing an ionizable hydrogen atom; does not necessarily produce acidic solutions.

Activation Energy

> Amount of energy that must be absorbed by reactants in their ground states to reach the transition state so that a reaction can occur.

Active Metal

> Metal with low ionization energy that loses electrons readily to form cations.

Activity (of a component of ideal mixture)

> A dimensionless quantity whose magnitude is: equal to molar concentration in an ideal solution; equal to partial pressure in an ideal gas mixture; and defined as 1 for pure solids or liquids.

Activity Series

> A listing of metals (and hydrogen) in order of decreasing activity

Actual Yield

> Amount of a specified pure product actually obtained from a given reaction. Compare with Theoretical Yield.

Actinides

> Elements 90 to 103 (after actinium)

Acyl Group

> Compound derived from a carbonic acid by replacing the --OH group with a halogen (X), usually --Cl; general formula is O R--C--X

Addition Reaction

A reaction in which two atoms or groups of atoms are added to a molecule, one on each side of a double or triple bond

Adhesive Forces
Forces of attraction between a liquid and another surface.

Adsorption
Adhesion of a species onto the surfaces of particles

Alcohol
Hydrocarbon derivative containing an --OH group attached to a carbon atom not in an aromatic ring.

Aldehyde
Compound in which an alkyl or aryl group and a hydrogen atom are attached to a carbonyl group and a hydrogen atom are attached to a carbonyl group; general formula, O-R-C-H

Alkali Metals
Metals of Group IA (Na, K, Rb).

Alkaline Battery
A dry cell in which the electrolyte contains KOH.

Alkaline Earth Metals
Group IIA metals

Alkenes (Olefins)
Unsaturated hydrocarbons that contain one or more carbon-carbon double bonds.

Alkyl Group
A group of atoms derived from an alkane by the removal of one hydrogen atom.

Alkylbenzene
A compound containing an alkyl group bonded to a benzene ring.

Alkynes
Unsaturated hydrocarbons that contain one or more carbon-carbon triple bonds.

Allotropes
Different forms of the same element in the same physical state.

Allotropic Modifications (Allotropes)
Different forms of the same element in the same physical state.

Alloying
Mixing of metal with other substances (usually other metals) to modify its properties.

Alpha Particle
A helium nucleus.

Alpha (a) Particle
Helium ion with 2+ charge; an assembly of two protons and two neutrons.

Alums
Hydrated sulfates of the general formula $M+M3+(SO4)2.12H2$).

Amide
Compound containing the O-C-N group.
Compound that can be considered a derivative of ammonia in which one or more hydrogens are replaced by a alkyl or aryl groups.

Amine

Derivatives of ammonia in which one or more hydrogen atoms have been replaced by organic groups.

Amine Complexes

Complex species that contain ammonia molecules bonded to metal ions.

Amino Acid

Compound containing both an amino and a carboxylic acid group.The --NH2 group.

For more information see:Amino Acids

Amorphous Solid

A noncrystalline solid with no well-defined ordered structure.

Ampere

Unit of electrical current; one ampere equals one coulomb per second.

Amphiprotism

Ability of a substance to exhibit amphiprotism by accepting donated protons.

Amphoterism

The ability to react with both acids and bases.

Ability of substance to act as either an acid or a base.

Anion

A negative ion; an atom or goup of atoms that has gained one or more electrons.

Anode

In a cathode ray tube, the positive electrode.

Electrode at which oxidation occurs.

Antibonding Orbital

A molecular orbital higher in energy than any of the atomic orbitals from which it is derived; lends instability to a molecule or ion when populated with electrons; denoted with a star (*) superscript or symbol.

Aromatic Hydrocarbons

Benzene and its derivatives.

Artificial Transmutation

An artificially induced nuclear reaction caused by the bombardment of a nucleus with subatomic particiles or small nucei.

Aryl Group

Group of atoms remaining after a hydrogen atom is removed from the aromatic system.

Associated Ions

Short-lived species formed by the collision of dissolved ions of opposite charges.

Atmosphere

A unit of pressure; the pressure that will support a column of mercury 760 mm high at 0 °C.

Atom

The smallest particle of an element

Atomic Mass Unit (amu)

One twelfth of a mass of an atom of the carbon-12 isotope; a unit used for stating atomic and formula weights; also called dalton.

Atomic Number

Integral number of protons in the nucleus; defines the identity of element.

Atomic Orbital
Region or volume in space in which the probability of finding electrons is highest.

Atomic Radius
Radius of an atom.

Atomic Weight
Weighted average of the masses of the constituent isotopes of an element; The relative masses of atoms of different elements.

Aufbau ('building up') Principle
Describes the order in which electrons fill orbitals in atoms.

Autoionization
An ionization reaction between identical molecules.

Avogadro's Law
At the same temperature and pressure, equal volumes of all gases contain the same number of molecules.

Avogadro's Number
The number (6.022×10^{23}) of atoms, molecules or particles found in exactly 1 mole of substance.

Background Radiation
Ratiation extraneous to an experiment. Usually the low-level natural radiation form cosmic rays and trace radioactive substances present in our environment.

Band
A series of very closely spaced, nearly continuous molecular orbitals that belong to the crystal as a whole.

Band of Stability
Band containing nonradioactive nuclides in a plot of number of neutrons versus atomic number.

Band Theory of Metals
Theory that accounts for the bonding and properties of metallic solids.

Barometer
A device for measuring pressure.

Base
A substance that produces OH (aq) ions in aqueous solution. Strong soluable bases are soluble in water and are completely dissociated. Weak bases ionize only slightly.

Basic Anhydride
The oxide of a metal that reacts with water to form a base.

Basic Salt
A salt containing an ionizable OH group.

Beta Particle
Electron emitted from the nucleus when a neuton decays to a proton and an electron.

Biodegradability
The ability of a substance to be broken down into simpler substances by bacteria.

Binary Acid
A binary compound in which H is bonded to one or more of the more electronegative nonmetals.

Binary Compound
     A compound consisting of two elements; may be ionic or covalent.
Binding Energy (nuclear binding energy)
     The energy equivalent ($E = mc^2$) of the mass deficiency of an atom.
     where: E = is the energy in joules, m is the mass in kilograms, and c is the speed
     of light in m/s^2
Boiling Point
     The temperature at which the vapor pressure of a liquid is equal to the applied
     pressure; also the condensation point
Boiling Point Elevation
     The increase in the boiling point of a solvent caused by the dissolution of a
     nonvolatile solute.
Bomb Calorimeter
     A device used to measure the heat transfer between system and surroundings at
     constant volume.
     For more information see Analytical Chemistry
Bond Energy
     The amount of energy necessary to break one mole of bonds of a given kind (in
     gas phase).
     The amount of energy necessary to break one mole of bonds in a substance,
     dissociating the sustance in the gaseous state into atoms of its elements in the
     gaseous state.
Bond Order
     Half the numbers of electrons in bonding orbitals minus half the number of
     electrons in antibonding orbitals.
Bonding Orbital
     A molecular orbit lower in energy than any of the atomic orbitals from which it is
     derived; lends stability to a molecule or ion when populated with electron
Bonding Pair
     Pair of electrons involved in a covalent bond.
Boron Hydrides
     Binary compounds of boron and hydrogen.
Born-Haber Cycle
     A series of reactions (and accompanying enthalpy changes) which, when
     summed, represents the hypothetical one-step reaction by which elements in their
     standard states are converted into crystals of ionic compounds (and the
     accompanying enthalpy changes.)
Boyle's Law
     At constant temperature the volume occupied by a definite mass of a gas is
     inversely proportional to the applied pressure.
Breeder Reactor
     A nuclear reactor that produces more fissionable nuclear fuel than it consumes.
Bronsted-Lowry Acid
     A proton donor.
Bronsted-Lowry Base
     A proton acceptor

Buffer Solution

    Solution that resists change in pH; contains either a weak acid and a soluble ionic salt of the acid or a weak base and a soluble ionic salt of the base.

Buret

    A piece of volumetric glassware, usually graduated in 0.1-mL intervals, that is used to deliver solutions to be used in titrations in a quantitative (dropwise) manner.

Calorie

    The amount of heat required to raise the temperature of one gram of water from 14.5°C to 15.5°C. 1 calorie = 4.184 joules.

Calorimeter

    A device used to measure the heat transfer between system and surroundings.
    For further information see <u>Analytical Chemistry</u>

Canal Ray

    Stream of positively charged particles (cations) that moves toward the negative electrode in cathode ray tubes; observed to pass through canals in the negative electrode.

Capillary

    A tube having a very small inside diameter.

Capillary Action

    The drawing of a liquid up the inside of a small-bore tube when adhesive forces exceed cohesive forces, or the depression of the surface of the liquid when cohesive forces exceed the adhesive forces.

Carbanion

    An organic ion carrying a negative charge on a carbon atom.

Carbonium ion

    An orgainic ion carrying a positive charge on a carbon atom.

Carcinogen

    A substance capable of causing or producing cancer in mammals.

Catalyst

    A substance that speeds up a chemical reaction without being consumed itself in the reaction.
    A substance that alters (usually increases) the rate at which a reaction occurs.

Catenation

    Bonding of atoms of the same element into chains or rings.
    The bonding together of atoms of the same element to form chains.
    The ability of an element to bond to itself.

Cathode

    Electrode at which reduction occurs
    In a cathode ray tube, the negative electrode.

Cathodic Protection

    Protection of a metal (making ir a cathode) against corrosion by attaching it to a sacrifical anode of a more easily oxidized metal.

Cathode Ray Tube

Closed glass tube containing a gas under low pressure, with electrodes near the ends and a luminescent screen at the end near the positive electrode; produces cathode rays when high voltage is applied.

Cation
A positive ion; an atom or group of atoms that has lost one or more electrons.

Cell Potential
Potential difference, Ecell, between oxidation and reduction half-cells under nonstandard conditions.

Central Atom
An atom in a molecule or polyatomic ion that is bonded to more than one other atom.

Chain Reaction
A reaction that, once initiated, sustains itself and expands.
This is a reaction in which reactive species, such as radicals, are produced in more than one step. These reactive species, radicals, propagate the chain reaction.

Chain Termination Step
The combination of two radicals, which removes the reactive species that propagate the change reaction.

Charle's Law
At constant pressure the volume occupied by a definite mass of gas is directly proportional to its absolute temperature.

Chemical Bonds
The attractive forces that hold atoms together in elements or compounds.

Chemical Change
A change in which one or more new substances are formed.

Chemical Equation
Description of a chemical reaction by placing the formulas of the reactants on the left and the formulas of products on the right of an arrow.

Chemical Equilibrium
A state of dynamic balance in which the rates of forward and reverse reactions are equal; there is no net change in concentrations of reactants or products while a system is at equilibrium.

Chemical Hygiene Officer (CHO)
A person or employee who is qualified by training or experience to provide technical guidance in the development and implementations of the provisions of a Chemical Hygiene Plan (CHP)

Chemical Hygiene Plan (CHP)
A written program developed and implemented by an employer designating proceedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals usid in that particular workplace.

Chemical Kinetics
The study of rates and mechanisms of chemical reactions and of the factors on which they depend.

Chemical Periodicity
The variations in properties of elements with their position in the periodic table

Cis-

 The prefix used to indicate that groups are located on the same side of a bon about which rotation is restricted.

Cis-Trans Isomerism

 A type of geometrical isomerism related to the angles between like ligands.

Clay

 A class of silicate and aluminosilicate minerals with sheet-like structures that have enormous surface areas that can absorb large amounts of water.

Cloud Chamber

 A device for observing the paths of speeding particiles as vapor molecules condense on them to form foglike tracks.

Coefficient of expansion

 The ratio of the change in length or volumen of a body to the original lengthor volume for a unit change in temperature.

Cohesive Forces

 All the forces of attraction among particles of a liquid.

Coke

 An impure form of carbon obtained by destructive distillation of coal or petroleum.

Colligative Properties

 Physical properties of solutions that depend upon the number but not the kind of solute particles present.

Collision Theory

 Theory of reaction rates that states that effective collisions between reactant molecules must occur in order for the reaction to occur.

Colloid

 A heterogeneous mixture in which solute-like particles do not settle out.

Combination Reaction

 Reaction in which two substances (elements or compounds) combine to form one compound.

 Reaction of a substance with oxygen in a highly exothermic reaction, usually with a visible flame.

Combustible

 Classification of liquid substances that will burn on the basis of flash points. A combustible liquid means any liquid having a flash point at or above 37.8°C (100°F) but below 93.3°C (200°F), except any mixture having components with flash points of 93.3°C (200°F) or higher, the total of which makes up 99 percent or more of the total volume of the mixture.

Common Ion Effect

 Suppression of ionization of a weak electrolyte by the presence in the same solution of a strong electrolyte containing one of the same ions as the weak electrolyte.

Complex Ions

 Ions resulting from the formation of coordinate covalent bonds between simple ions and other ions or molecules.

Composition Stoichiometry

Descibes the quantitative (mass) relationships among elements in compounds.

Compound

A substance of two or more elements in fixed proportions. Compounds can be decomposed into their constituent elements.

For more Information see Compounds

Compressed Gas

A gas or mixture of gases having, in a container an absolute pressure exceeding 40 psi at 21.1°C (70°F)

A gass or mixture having in a container, an absolute pressure exceeding 104 psi at 54.4°C (130°F) regardless of the pressure at (21.1°C (70°F)

A liquid having a vapour pressure exceeding 40 psi at 37.8°C (70°F) as determined by ASTM D-323-72.

Concentration

Amount of solute per unit volume or mass of solvent or of solution.

Condensation

Liquefaction of vapor.

Condensed Phases

The liquid and solid phases; phases in which particles interact strongly.

Condensed States

The solid and liquid states.

Conduction Band

A partially filled band or a band of vacant energy levels just higher in energy than a filled band; a band within which, or into which, electrons must be promoted to allow electrical conduction to occur in a solid.

Conjugate Acid-base Pair

In Bronsted-Lowry terminology, a reactant and product that differ by a proton, H+.

Conformations

Structures of a compound that differ by the extent of rotation about a single bond.

Continuous Spectrum

Spectrum that contains all wave-lengths in a specified region of the electromagnetic spectrum.

Control Rods

Rods of materials such as cadmium or boron steel that act as neutron obsorbers (not merely moderaters) used in nuclear reactors to control neutron fluxes and therfore rates of fission.

Conjugated Double Bonds

Double bonds that are separated from each other by one single bond -C=C-C=C-.

Contact Process

Industrial process by which sulfur trioxide and sulfuric acid are produced from sulfur dioxide.

Coordinate Covalent Bond

Covalent bond in which both shared electrons are furnished by the same species; bond between a Lewis acid and Lewis base.

Coordinate Covalent Bond

A covalent bond in which both shared electrons are donated by the same atom; a bond between a Lewis base and a Lewis acid.

Coordination Compound or Complex

A compound containing coordinate covalent bonds.

Coordination Isomers

Isomers involving exchanges of ligands between complex cation and complex anion of the same compound.

Coordination Number

In describing crystals, the number of nearest neighbours of an atom or ion.

The number of donor atoms coordinated to a metal.

Coordination Sphere

The metal ion and its coordinating ligands but not any uncoordinated counter-ions.

Corrosion

Oxidation of metals in the presence of air and moisture.

For more information see <u>Corrosion</u>

Coulomb

Unit of electrical charge.

Coulometry

The quantitative application of Faraday's Law to the analysis of materials. The current and time are the usual variables measured.

Covalent Bond

Chemical bond formed by the sharing of one or more electron pairs between two atoms.

Covalent Compounds

Compounds containing predominantly covalent bonds.

Critical Mass

The minimum mass of a particular fissionable nuclide in a given volume required to sustain a nuclear chain reaction.

Critical Point

The combination of critical temperature and critical pressure of a substance.

Critical Pressure

The pressure required to liquefy a gas (vapor) at its critical temperature.

Critical Temperature

The temperature above which a gas cannot be liquefied; the temperature above which a substance cannot exhibit distinct gas and liquid phases.

Crystal Field Stabilization Energy

A measure of the net energy of stabilization gained by a metal ion's nonbonding d electrons as a result of complex formation.

For more information see <u>Crystallography</u>

Crystal Field Theory

Theory of bonding in transition metal complexes in which ligands and metal ions are treated as point charges; a purely ionic model; ligand point charges represent the crystal (electrical) field perturbing the metal?s d orbitals containing nonbonding electrons.

For more information see <u>Crystallography</u>

Crystal Lattice
> A pattern of arrangement of particles in a crystal.
> For more information see <u>Crystallography</u>

Crystal Lattice Energy
> Amount of energy that holds a crystal together; the energy change when a mole of solid is formed from its constituent molecules or ions (for ionic compounds) in their gaseous state.
> The energy charge when one mole of formula units of a crystalline solid is formed from its ions, atoms, or molecules in the gas phase; always negative.
> For more information see <u>Crystallography</u>

Crystalline Solid
> A solid characterized by a regular, ordered arrangement of particles.
> For more information see <u>Crystallography</u>

Curie (Ci)
> The basic unit used to describe the intensity of radioactivity in a sample of material. One curie equals 37 billion disintegrations per second or approximately the amount of radioactivty given off by 1 gram of radium.

Cyclotron
> A device for accelerating charged particles along a spiral path.

Daughter Nuclide
> Nuclide that is produced in a nuclear decay.

Debye
> The unit used to express dipole moments.

Degenerate
> Of the same energy.

Delocalization
> Of electrons; refers to bonding electrons that are distributed among more than two atoms that are bonded together; occurs in species that exhibit resonance.
> The formation of a set of molecular orbitals that extend over more than two atoms; important in species that valence bond theory describes in terms of resonance.

Denaturation
> A process pertaining to a change in structure of a protein form regular to irregular arrangement of the polypeptide chains.

Denatured
> A commercial term used to describe ethanol that has been rendered unfit for human consumption because of the addition of harmful ingredients to make it sales tax-expempt.

Density
> Mass per unit Volume: D=MV

Deposition
> The direct solidification of a vapor by cooling; the reverse of sublimation.

Derivative
> A compound that can be imagined to arise from a partent compound by replacement of one atom with another atom or group of atoms. Used extensively in orgainic chemistry to assist in identifying compounds.

Dermal toxicity
    Adverse health effects resulting from skin exposure ot a substance.
Designated area
    An area that may be used for work with carcinogens, reproductive toxins, or
    substances that have a high degree of acute toxicity. A designated area may be the
    entire laboratory, an area of a laboratory, or a device such as a loboratory hood.
Detergent
    A soap-like emulsifer that contains a sulfate, SO_3 or a phosphate group instead of
    a carboxylate group.
Deuterium
    An isotope of hydrogen whose atoms are twice as massive as ordinary
    hydrogen;deuterion atoms contain both a proton and a neutron in the nucleus.
Dextrorotatory
    Refers to an optically active substance that rotates the plane of plane polarized
    light clockwise; also called dextro.
Diagonal Similarities
    Refers to chemical similarities in the Periodic Table of elements of Period 2 to
    elements of Period 3 one group to the right; especially evident toward the left of
    the periodic table.
Diamagnetism
    Weak repulsion by a magnetic field.
Differential Scanning Calorimetry (DSC)
    A technique for measuring the temperature, direction, and magnitude of thermal
    transitions in a sample material by heating/cooling and comparing the amount of
    energy required to maintain its rate of temperature increase or decrease with an
    inert reference material under similar conditions.
Differential Thermal Analysis (DTA)
    A technique for observing the temperature, direction, and magnitude of thermally
    induced transitions in a material by heating/cooling a sample and comparing its
    temperature with that of an inert reference material under similar conditions.
Differential Thermometer
    A thermometer used for accurate measurement of very small changes in
    temperature.
Dilution
    Process of reducing the concentration of a solute in solution, usually simply by
    mixing with more solvent.
Dimer
    Molecule formed by combination of two smaller (identical) molecules.
Dipole
    Refers to the separation of charge between two covalently bonded atoms
Dipole-dipole Interactions
    Attractive interactions between polar molecules, that is, between molecules with
    permanent dipoles.
Dipole Moment

The product of the distance separating opposite charges of equal magnitude of the charge; a measure of the polarity of a bond or molecule; a measured dipole moment refers to the dipole moment of an entire molecule.

Dispersing Medium

The solvent-like phase in a colloid.

Dispersed Phase

The solute-like species in a colloid.

Displacement Reactions

Reactions in which one element displaces another from a compound.

Disproportionation Reactions

Redox reactions in which the oxidizing agent and the reducing agent are the same species.

Dissociation

In aqueous solution, the process in which a solid ionic compound separates into its ions.

Dissociation Constant

Equilibrium constant that applies to the dissociation of a comples ion into a simple ion and coordinating species (ligands).

Distilland

The material in a distillation apparatus that is to be distilled.

Distillate

The material in a distillation apparatus that is collected in the receiver.

Distillation

The separation of a liquid mixture into its components on the basis of differences in boiling points.

The process in which components of a mixture are separated by boiling away the more volitile liquid.

Domain

A cluster of atoms in a ferromagnetic substance, all of which align in the same direction in the presence of an external magnetic field.

Donor Atom

A ligand atom whose electrons are shared with a Lewis acid.

D-Orbitals

Beginning in the third energy level, aset of five degenerate orbitals per energy level, higher in energy than s and p orbitals of the same energy level.

Dosimeter

A small, calibrated electroscope worn by laboratory personnel and designated to detect and measure incident ionizing radiation or chemical exposure.

Double Bond

Covalent bond resulting from the sharing of four electrons (two pairs) between two atoms.

Double Salt

Solid consisting of two co-crystallized salts.

Doublet

Two peaks or bands of about equal intensity appearing close together on a spectrogram.

Downs Cell
Electrolytic cell for the commercial electrolysis of molten sodium chloride.
For further information see Electrochemistry or Fuel Cells

DP number
The degree of polymerization; the average number of monomer units per polymer unit.

Dry Cells
Ordinary batteries (voltaic cells) for flashlights. radios, and so on; many are Leclanche cells.
For further information see Electrochemistry or Fuel Cells

D -Transition elements (metals)
B Group elements except IIB in the periodic table; sometimes called simply transition elements EX. Fe, Ni, Cu, Ti .
For further information see Metals

Dumas Method
A method used to determine the molecular weights of volatile liquids.

Dynamic Equilibrium
An equilibrium in which processes occur continuously, with no net change. When two (or more) processes occur at the same rate so that no net change occurs.

Effective Collisons
Collision between molecules resulting in a reaction; one in which the molecules collide with proper relative orientations and sufficient energy to react.

Effective Molality
The sum of the molalities of all solute particles in a solution.

Effective Nuclear Charge
The nuclear charge experienced by the outermost electrons of an atom; the actual nuclear charge minus the effects of shielding due to inner-shell electrons.
Example: Set of dx_2-y_2 and dz_2 orbitals; those d orbitals within a set with lobes directed along the x-, y-, and z-axes.

Electrical Conductivity
Ability to conduct electricity.

Electrochemistry
Study of chemical changes produced by electrical current and the production of electricity by chemical reactions.

Electrodes
Surfaces upon which oxidation and reduction half-reactions; occur in electrochemical cells.

Electrode Potentials
Potentials, E, of half-reactions as reductions versus the standard hydrogen electrode.

Electrolysis
Process that occurs in electrolytic cells.

Electrolyte
A substance whose aqueous solutions conduct electricity.

Electrolytic Cells

Electrochemical cells in which electrical energy causes nospontaneous redox reactions to occur.

An electrochemical cell in which chemical reactions are forced to occur by the application of an outside source of electrical energy.

Electrolytic Conduction

Conduction of electrical current by ions through a solution or pure liquid.

Electromagnetic Radiation

Energy that is propagated by means of electric and magnetic fields that oscillate in directions perpendicular to the direction of travel of the energy.

Electromotive Series

The relative order of tendencies for elements and their simple ions to act as oxidizing or reducing agents; also called the activity series.

Electron

A subatomic particle having a mass of 0.00054858 amu and a charge of 1-.

Electron Affinity

The amount of energy absorbed in the process in which an electron is added to a neutral isolated gaseous atom to form a gaseous ion with a 1- charge; has a negative value if energy is released.

Electron Configuration

Specific distribution of electrons in atomic orbitals of atoms or ions.

Electron Deficient Compounds

Compounds that contain at least one atom (other than H) that shares fewer than eight electrons

Electronic Transition

The transfer of an electron from one energy level to another.

Electronegativity

A measure of the relative tendency of an atom to attract electrons to itself when chemically combined with another atom.

Electronic Geometry

The geometric arrangement of orbitals containing the shared and unshared electron pairs surrounding the central atom of a molecule or polyatomic ion.

Electrophile

Positively charged or electron-deficient.

Electrophoresis

A technique for separation of ions by rate and direction of migration in an electric field.

Electroplating

Plating a metal onto a (cathodic) surface by electrolysis.

Element

A substance that cannot be decomposed into simpler substances by chemical means.

Eluant or eluent

The solvent used in the process of elution, as in liquid chromatography.

Eluate

Solvent (or mobile phase) which passes through a chromatographic column and removes the sample components from the stationary phase.

Emission Spectrum

Spectrum associated with emission of electromagnetic radiation by atoms (or other species) resulting from electronic transitions from higher to lower energy states.

Emulsifying Agent

A sustance that coats the particles of the dispersed phase and prevents coagulation of colloidal particles; an emulsifier.

Emulsion

Colloidal suspension of a liquid in a liquid.

Enantiomer

One of the two mirror-image forms of an optically active molecule.

Endothermic

Describes processes that absorb heat energy.

Endothermicity

The absorption of heat by a system as the process occurs.

End Point

The point at which an indicator changes colour and a titration is stopped.

Energy

The capacity to do work or transfer heat.

Enthalpy

The heat content of a specific amount of substance; defined as E= PV.

Entropy

A thermodynamic state or property that measures the degree of disorder or randomness of a system.

For more information see Thermochemistry

Enzyme

A protein that acts as a catalyst in biological systems.

Equation of State

An equation that describes the behavior of matter in a given state; the van der Waals equation describes the behavior of the gaseous state.

Equilibrium or Chemical Equilibrium

A state of dynamic balance in which the rates of forward and reverse reactions are equal; the state of a system when neither forward or reverse reaction is thermodynamically favored.

Equilibrium Constant

A quantity that characterizes the position of equilibrium for a reversible reaction; its magnitude is equal to the mass action expression at equilibrium. K varies with temperature.

Equivalence Point

The point at which chemically equivalent amounts of reactants have reacted.

Equivalent Weight

An oxidizing or reducing agent, who's mass gains (oxidizing agents) or loses (reducing agents) 6.022×10^{23} electrons in a redox reaction.

The mass of an acid or base that furnishes or reacts with 6.022×10^{23} H_3O+ or OH- ions.

Essential Oil

A plant extract that has a distinctive odour or flavour.

Ester

A Compound of the general formula R-C-O-R1 where R and R1 may be the same or different, and may be either aliphatic or aromatic.

Ether

Compound in which an oxygen atom is bonded to two alkyl or two aryl groups, or one alkyl and one aryl group.

Eutrophication

The undesirable overgrowth of vegetation caused by high concentrates of plant nutrients in bodies of water.

Evaporization

Vaporization of a liquid below its boiling point.

Evaporation Rate

The rate at which a particular substance will vapourize (evaporate) when compared to the rate of a known substance such as ethyl ether. This term is especially useful for health and fire-hazard considerations.

Excited State

Any state other than the ground state of an atom or molecule.

Exothermic

Describes processes that release heat energy.

Exothermicity

The release of heat by a system as a process occurs.

Explosive

A chemical or compound that causes a sudden, almost instantaneous release or pressure, gas, heat and light when subjected to sudden shock, pressure, high temperature or applied potential.

Explosive limits

The range of concentrations over which a flammable vapour mixed with proper ratios of air will ignite or explode if a source of ignitions is provided.

Extensive Property

A property that depends upon the amount of material in a sample.

Extrapolate

To estimate the value of a result outside the range of a series of known values. Technique used in standard additions calibration procedure.

Faraday

One faraday of electricity corresponds to the charge on 6.022×10^{23} electrons, or 96,487 coulombs.

Faraday's Law of Electrolysis

One equivalent weight of a substance is produced at each electrode during the passage of 96,487 coulombs of charge through an electrolytic cell.

Fast Neutron

A neutron ejected at high kinetic energy in a nuclear reaction.

Fat

Solid triester of glycerol and (mostly) saturated fatty acids.

Fatty Acids

An aliphatic acid; many can obtained from animal fats.

Ferromagnetism
>The ability of a substance to become permanently magnetized by exposure to an external magnetic field.

Film badge
>A small patch of photographic film worn on clothing to detect and measure accumulated incident ionizing radiation.

Flammable
>A liquid as defined by NFPD and DOT as having a flash point below 37.8°C (100°F).

Flash Point
>The temperature at which a liquid will yield enough flamable vapour to ignite. There are various recognized industrial testing methods; therefore the method used must be stated.

Fluorescence
>Absorption of high energy radiation by a substance and subsequent emission of visible light.

Fossil Fuels
>Substances consisting largely of hydrocarbons, derived from decay of organic materials under geological conditions of high pressure and temperature (metamorphism) include coal, petroleum, natural gas, peat and oil shale.
>For further information see Fuel Chemistry

Frasch Process
>Method by which elemental sulfur is mined or extracted. Sulfur is melted with superheated water (at 170°C under high pressure) and forced to the surface of the earth as a slurry.

First Law of Thermodynamics
>The total amount of energy in the universe is constant (also known as the Law of Conservation of Energy) energy is neither created nor destroyed in ordinary chemical reactions and physical changes.
>For further information see Thermochemistry

Flotation
>Method by which hydrophobic (water-repelling) particles of an ore are separated from hydrophilic (water-attracting) particles of a metallurgical pretreatment process.

Fluids
>Substances that flow freely; gases and liquids.

Flotation

Flux
>A substance added to react with the charge, or a product of its reduction, in metallurgy; usually added to lower a melting point.

Foam
>Colloidal suspension of a gas in a liquid.

Forbidden Zone
>A relatively large energy separation between an insulator's highest filled electron energy band and the next higher energy vacant band. Beginning in the fourth

energy level, a set of seven degenerate orbitals per energy level, higher in energy than s, p, and d orbitals of the same energy level.

Formal Charge

A method of counting electrons in a covalently bonded molecule or ion; counts bonding electrons as though they were equally shared between the two atoms.

Formula

Combination of symbols that indicates the chemical composition of a substance.

Formula Unit

The smallest repeating unit of a substance. The molecule for nonionic substances

Formula Weight

The mass of one formula unit of a substance in atomic mass units.

Fractional Distillation

The process in which a fractioning column is used in distillation apparatus to separate components of a liquid mixture that have different boiling points.

Fractional Precipitation

Removal of some ions from solution by precipitation while leaving other ions with similar properties in solution.

Free Energy, Gibbs Free Energy

The thermodynamic state function of a system that indicates the amount of energy available for the system to do useful work at constant T and P.

Free Energy Change

The indicator of spontaneity of a process at constnt T and P. If delta-G is negative, the process is spontaneous.

Free Radical

A highly reactive chemical species carrying no charge and having a single unpaired electron in an orbital.

Freezing Point Depression

The decrease in the freezing point of a solvent caused by the presence of a solute.

Frequency

The number of repeating corresponding points on a wave that pass a given observation point per unit time.

Fuel Cells

Voltaic cells in which the reactants (usually gases) are supplied continuously.

A voltaic cell that converts the chemical energy of a fuel and an oxidizing agent directly into electriacl energy on a continuous basis.

Functional Group

A group of atoms that represents a potential reaction site in an organic compound.

Gamma Ray

High energy electromagnetic radiation.

A highly penetrating type of nuclear radiation similar to x-ray radiation, except that it comes from within the nucleus of an atom and has a higher energy. Energywise, very similar to cosmic ray except that cosmic rays originate from outer space.

For more information see Electrochemistry

Galvanizing

Placing a thin layer of zinc on a ferrous material to protect the underlying surface from corrosion.

Gangue

Sand, rock, and other impurities surrounding the mineral of interest in an ore.

Geiger counter

A gas filled tube which discharges electriaclly when ionizing radiation passes through it.

Gel

Colloidal suspension of a solid dispersed in a liquid; a semirigid solid.

Gem-dimethyl group

Two methyl groups of the same carbon atom.

Geometrical Isomers

Compounds with different arrangements of groups on either side of a bond with restricted rotation, such as a double bond or a single bond in a ring; for example cis-trans isomers of certain alkenes.

Stereoisomers that are not mirror images of each other; also known as position isomers.

Graham's Law

The rates of effusion of gases are inversely proportional to the square roots of their molecular weights or densities.

Greenhouse Effect

Trapping of heat at the surface of the earth by carbon dioxide and water vapour in the atmosphere.

Ground State

The lowest energy state or most stable state of an atom, molecule or ion.

Group

A vertical column in the periodic table; also called a family.

For more information see Periodic Tables

Haber Process

A process for the catalyzed industrial production of ammonia from N_2 and H_2 at high temperature and pressure.

Half-Cell

Compartment in which the oxidation or reduction half-reaction occurs in a voltaic cell.

Half-Life

The time required for half of a reactant to be converted into product(s).

The time required for half of a given sample to undergo radioactive decay.

Half-Reaction

Either the oxidation part or the reduction part of a redox reaction.

Halogens

Group VIIA elements: F, Cl, Br, I

Hard Water

Water containing Fe^{3+}, Ca^{2+}, and Mg^{2+} ions, which forms precipates with soap.

Heat

A form of energy that flows between two samples of matter because of their differences in temperature.

Heat Capacity
> The amount of heat required to raise the temperature of a body (of any mass) one degree Celsius.

Heat of Condensation
> The amount of heat that must be removed from one gram of a vapor at it's condensation point to condense the vapour with no change in temperature.

Heat of Crystallization
> The amount of heat that must be removed from one gram of a liquid at its freezing point to freeze it with no change in temperature.

Heat of Fusion
> The amount of heat required to melt one gram of solid at its melting point with no change in temperature. Usually expressed in J/g. The molar heat of fusion is the amount of heat required to melt one mole of a solid at its melting point with no change in temperature and is usually expressed in kJ/mol.

Heat of Solution
> The amount of heat absorbed in the formation of solution that contains one mole of solute; the value is positive if heat is absorbed (endothermic) and negative if heat is released (exothermic).

Heat of Vaporization
> The amount of heat required to vaporize one gram of a liquid at its boiling point with no change in temperature. Usually expressed in J/g. The molar heat of vaporization is the amount of heat required to vaporize one mole of liquid at its boiling point with no change in temperature and usually expressed ion kJ/mol.

Heavy Water
> Water containing deuterium, a heavy isotope of hydrogen.

Heisenberg Uncertainty Principle
> It is impossible to determine accurately both the momentum and position of an electron simultaneously.

Henry's Law
> The pressure of the gas above a solution is proportional to the concentration of the gas in the solution.

Hess' Law of Heat Summation
> The enthalpy change for a reaction is the same whether it occurs in one step or a series of steps.

Heterocyclic Amine
> Amine in which the nitrogen is part of a ring.
> For further information see Heterocyclic Chemistry

Heterogeneous Catalyst
> A catalyst that exists in a different phase (solid, liquid or gas) from the reactants; a contact catalyst.

Heterogeneous Equilibria
> Equilibria involving species in more than one phase.

Heterogeneous Mixture
> A mixture that does not have uniform composition and properties throughout.

Heteronuclear
> Consisting of different elements.

High Spin Complex
  Crystal field designation for an outer orbital complex; all t2g and eg orbitals are singly occupied before any pairing occurs.
Homogeneous Catalyst
  A catalyst that exists in the same phase (solid, liquid or gas) as the reactants.
  For more information see Catalysis
Homogeneous Equilibria
  Equilibria involving only one species in a single phase. For example, all gases, all liquids or all solids.
Homogeneous Mixture
  A mixture which has uniform composition and properties throughout.
Homologous Series
  A series of compounds in which each member differs from the next by a specific number and kind of atoms.
Homonuclear
  Consisting of only one element.
Hund's Rule
  All orbitals of a given sublevel must be occupied by single electrons before pairing begins (see Aufbau Principle)
Hybridization
  Mixing a set of atomic orbitals to form a new set of atomic orbitals with the same total electron capacity and with properties and energies intermediate between those of the original unhybridized orbitals.
Hydrate
  A solid compound that contains a definite percentage of bound water.
Hydrate Isomers
  Isomers of crystalline complexes that differ in whether water is present inside or outside the coordination sphere
Hydration
  Reaction of a substance with water.
Hydration Energy
  The energy change accompanying the hydration of a mole of gase and ions.
Hydride
  A binary compound of hydrogen.
Hydrocarbons
  Compounds that contain only carbon and hydrogen.
Hydrogen Bond
  A fairly strong dipole-dipole interaction (but still considerably weaker than the covalent or ionic bonds) between molecules containing hydrogen directly bonded to a small, highly electronegative atom, such as N, O, or F.
Hydrogenation
  The reaction in which hydrogen adds across a double or triple bond.
Hydrogen-Oxygen Fuel Cell
  Fuel cell in which hydrogen is the fuel (reducing agent) and oxygen is the oxidizing agent.
Hydrolysis

The reaction of a substance with water or its ions.

Hydrolysis Constant

An equilibrium constant for a hydrolysis reaction.

Hydrometer

A device used to measure the densities of liquids and solutions.

Hydrophilic Colloids

Colloidal particles that repel water molecules.

For more information see Colloidal Chemistry

Inner Orbital Complex

Valence bond designation for a complex in which the metal ion utilizes d orbitals for one shell inside the outermost occupied shell in its hybridization.

Isomers

Different substances that have the same formula.

Ionization Isomers

Isomers that result from the interchange of ions inside and outside the coordination sphere.

Inert s-pair Effect

Characteristic of the post-transition minerals; tendency of the outermost s electrons to remain nonionized or un shared in compounds.

Insoluble Compound

A very slightly soluble compound.

Indicators

For acid-base titrations, organic compounds that exhibit different colors in solutions of different acidities; used to determine the point at which reaction between two solutes is complete.

Ionization Constant

Equilibrium constant for the ionization of a weak electrolyte.

Ion Product for Water

Equilibrium constant for the ionization of water, $Kw = [H_3O^+][OH^-] = 1.00 \times 10\text{-}14$ at 25 °C.

Inhibitory Catalyst

An inhibitor, a catalyst that decreases the rate of reaction.

For more information see Catalysis

Integrated Rate Equation

An equation giving the concentration of a reactant remaining after a specified time; has different mathematical form for different orders of reactants.

Ioniztion

The breaking up of a compound into separate ions.

Ideal Solution

A solution that obeys Raoult's Law exactly.

Insulator

Poor electric and heat conductor.

Intermolecular Forces

Forces between individual particles (atoms, molecules, ions) of a substance.

Isomorphous

Refers to crystals having the same atomic arrangement.

For more information see <u>Crystallography</u>

Ideal Gas

A hypothetical gas that obeys exactly all postulates of the kinetic-molecular theory.

Ideal Gas Law

The product of pressure and the volume of an ideal gas is directly proportional to the number of moles of the gas and the absolute temperature.

Ionization

In aqueous solution, the process in which a molecular compound reacts with water and forms ions.

Ionic Bonding

Chemical bonding resulting from the transfer of one or more electrons from one atom or a group of atoms to another.

Ionic Compunds

Compounds containing predominantly ionic bonding.

Ionic Geometry

The arrangement of atoms (not lone pairs of electrons) about the central atom of a polyatomic ion.

Isoelectric

Having the same electronic configurations

Ionization Energy

The minimum amount of energy required to remove the most loosely held electron of an isolated gaseous atom or ion.

Isotopes

Two or more forms of atoms of the same element with different masses; atoms containing the same number of protons but different numbers of neutrons.

Ion

An atom or a group of atoms that carries an electric charge.

Joule

A unit of energy in the SI system. One joule is 1 kg. $m2/s2$ which is also 0.2390 calorie

K Capture

Absorption of a K shell (n=1) electron by a proton as it is converted to a neutron.

Ketone

Compound in which a carbonyl group is bound to two alkyl or two aryl groups, or to one alkyl and one aryl group.

Kinetic Energy

Energy that matter processes by virtue of its motion.

Kinetic-molecular Theory

A theory, that attempts to explain macroscopic observations on gases in microscopic observations on gases in microscopic observations on gases in microscopic or molecular terms.

Lanthanides

Elements 58 to 71 (after lanthanum)

Lanthanide Contraction

A decrease in the radii of the elements following the lanthanides compared to what would be expected if there were no f-transition metals.

Law of Combining Volumes (Gay-Lussac's Law)

At constant temperature and pressure, the volumes of reacting gases (and any gaseous products) can be expressed as ratios of small whole numbers;

Law of Conservation of Energy

Energy cannot be created or destroyed; it may be changed from one form to another.

Law of Conservation of Matter

There is no detectable change in the quantity of matter during an ordinary chemical reaction.

Law of Conservation of Matter and Energy

The total amount of matter and energy available in the universe is fixed.

Law of Definite Proportions (Law of Constant Composition)

Different samples of a pure compound always contain the same elements in the same proportions by mass.

Law of Partial Pressures (Dalton's Law)

The total pressure exerted by a mixature of gases is the sum of the partial pressures of the individual gases.

Lead Storage Battery

Secondary voltaic cell used in most automobiles.

Leclanche Cell

A common type of dry cell.

Le Chatelier's Principle

States that a system at equilibrium, or striving to attain equilibrium, responds in such a way as to counteract any stress placed upon it.

If a stress (change of conditions) is applied to a system at equilibrium, the system shifts in the direction that reduces stress.

Leveling Effect

Effect by which all acids stronger than the acid that is characteristic of the solvent react with solvent to produce that acid; similar statement applies to bases. The strongest acid (base) that can exist in a given solvent is the acid (base) characteristic of the solvent.

Levorotatory

Refers to an optically active substance that rotates the plane of plane polarized light counterclockwise; also called levo.

Lewis Acid

Any species that can accept a share in an electron pair.

Lewis Base

Any species that can make available a share in an electron pair.

Lewis Dot Formula (Electron Dot Formula)

Representation of a molecule, ion or formula unit by showing atomic symbols and only outer shell electrons

Ligand

A Lewis base in a coordination compound.

Limiting Reactant

Substance that stoichiometrically limits the amount of product(s) that can be formed.

Linear Accelerator

A device used for accelerating charged particles along a straight line path.

Line Spectrum

An atomic emission or absorption spectrum.

Linkage Isomers

Isomers in which a particular ligand bonds to a metal ion through different donor atoms.

Liquid Aerosol

Colloidal suspension of liquid in gas.

London Forces

Very weak and very short-range attractive forces between short-lived temporary (induced) dipoles; also called dispersion Forces.

Lone Pair

Pair of electrons residing on one atom and not shared by other atoms; unshared pair.

Low Spin Complex

Crystal field designation for an inner orbital complex; contains electrons paired t2g orbitals before eg orbitals are occupied in octahedral complexes.

Magnetic Quantum Number (mc)

Quantum mechanical solution to a wave equation that designates the particular orbital within a given set (s, p, d, f) in which a electron resides.

Manometer

A two-armed barometer.

Mass

A measure of the amount of matter in an object. Mass is usually measured in grams or kilograms.

Mass Action Expression

For a reversible reaction, aA + bB cC + dD the product of the concentrations of the products (species on the right), each raised to the power that corresponds to its coefficient in the balanced chemical equation, divided by the product of the concentrations of reactants (species on the left), each raised to the power that corresponds to its coefficient in the balanced chemical equation. At equilibrium the mass action expression is equal to K; at other times it is Q.[C]c[D]d [A]a[B]b = Q, or at equilibrium K

Mass Deficiency

The amount of matter that would be converted into energy if an atom were formed from constituent particles.

Mass Number

The sum of the numbers of protons and neutrons in an atom; an integer.

Mass Spectrometer

An instrument that measures the charge-to-mass ratio of charged particles.

For further information see Mass Spectrometry

Matter

Anything that has mass and occupies space.

Mechanism

The sequence of steps by which reactants are converted into products.

Melting Point

The temperature at which liquid and solid coexist in equilibrium; also the freezing point.

Meniscus

The shape assumed by the surface of a liquid in a cylindrical container.

Metal

An element below and to the left of the stepwise division (metalloids) in the upper right corner of the periodic table; about 80% of the known elements are metals.

Metallic Bonding

Bonding within metals due to the electrical attraction of positively charges metal ions for mobile electrons that belong to the crystal as a whole.

Metallic Conduction

Conduction of electrical current through a metal or along a metallic surface.

Metalloids

Elements with properties intermediate between metals and nonmetals: B, Al, Si, Ge, As, Sb, Te, Po, and At.

Metallurgy

Refers to the overall processes by which metals are extracted from ores.

Metathesis Reactions

Reactions in which two compounds react to form two new compounds, with no changes in oxidation number. Reactions in which the ions of two compounds exchange partners.

Method of Initial Rates

Method of determining the rate-law expression by carrying out a reaction with different initial concentrations and analyzing the resultant changes in initial rates.

Miscibility

The ability of one liquid to mix with (dissolve in) another liquid.

Mixture

A sample of matter composed of two or more substances, each of which retains its identity and properties.

Moderator

A substance such as hydrogen, deuterium, oxygen or paraffin capable of slowing fast nuetrons upon collision.

Molality

Concentration expressed as number of moles of solute per kilogram of solvent.

Molarity

Number of moles of solute per litre of solution.

Molar Solubility

Number of moles of a solute that dissolve to produce a litre of saturated solution.

Molecular Equation

Equation for a chemical reaction in which all formulas are written as if all substances existed as molecules; only complete formulas are used.

Molecular Formula

Formula that indicates the actual number of atoms present in a molecule of a molecular substance.

Molecular Geometry

The arrangement of atoms (not lone pairs of electrons) around a central atom of a molecule or polyatomic ion.

Molecular Orbital

An orbit resulting from overlap and mixing of atomic orbitals on different atoms. An MO belongs to the molecule as a whole.

Molecular Orbital Theory

A theory of chemical bonding based upon the postulated existence of molecular orbitals.

Molecular Weight

The mass of one molecule of a nonionic substance in atomic mass units.

Molecule

The smallest particle of an element or compound capable of a stable, independent existence.

Mole Fraction

The number of moles of a component of a mixture divided by the total number of moles in the mixture.

Monoprotic Acid

Acid that can form only one hydronium ion per molecule; may be strong or weak. Acid that contains one ionizable hydrogen atom per formula unit.

Mother Nuclide

Nuclide that undergoes nuclear decay.

Native State

Refers to the occurrence of an element in an uncombined or free state in nature.

Natural Radioactivity

Spontaneous decomposition of an atom.

Nernst Equation

Corrects standard electrode potentials for nonstandard conditions.

Net Ionic Equation

Equation that results from canceling spectator ions and eliminating brackets from a total ionic equation.

Neutralization

The reaction of an acid with a base to form a salt and water. Usually, the reaction of hydrogen ions with hydrogen ions to form water molecules.

Neutron

A neutral subatomic particle having a mass of 1.0087 amu.

Nickel-cadmium cell (Nicad battery)

A dry cell in which the anode is Cd, the cathode is NiO_2, and the electrolyte is basic.

Nitrogenases

A class of enzymes found in bacteria within root nodules in some plants, which catalyze reactions by which N_2 molecules from the air are converted to ammonia. For more information see Enzymes

Nitrogen Cycle

The complex series of reactions by which nitrogen is slowly but continually recycled in the atmosphere, lithosphere and hydrosphere.

Noble Gases (Rare Gases)

Elements of the periodic Group 0; also called rare gases; formerly called inert gases, He,Ne,Ar, Kr, Xe, Rn.

Nodal Plane

A region in which the probability of finding an electron is zero.

Nonbonding Orbital

A molecular orbital derived only from an atomic orbital of one atom; lends neither stability nor instability to a molecule or ion when populated with electrons.

Nonelectrolyte

A substance whose aqueous solutions do not conduct electricity.

Nonpolar Bond

Covalent bond in which electron density is symmetrically distributed

Nuclear Binding Energy

Energy equivalent of the mass deficiency; energy released in the formation of an atom from the subatomic particles.

Nuclear Fission

The process in which a heavy nucleus splits into nuclei of intermediate masses and one or more protons are emitted.

Nuclear Reaction

Involves a change in the composition of a nucleus and can evolve or absorb an extraordinarily large amount of energy

Nuclear Reactor

A system in which controlled nuclear fisson reactions generate heat energy on a large scale, which is subsequently converted into electrical energy.

Nucleons

Particles comprising the nucleus; protons and neutrons.

Nucleus

The very small, very dense, positively charged center of an atom containing protons and neutrons, as well as other subatomic particles.

Nuclides

Refers to different atomic forms of all elements in contrast to ?isotopes?, which refer only to different atomic forms of a single element.

Nuclide Symbol

Symbol for an atom A/Z E, in which E is the symbol of an element, Z is its atomic number, and A is its mass number.

Octahedral

A term used to describe molecules and polyatomic ions that have one atom in the center and six atoms at the corners of a octahedron.

Octane Number

A number that indicates how smoothly a gasoline burns.

Octet Rule

Many representative elements attain at least a share of eight electrons in their valence shells when they form molecular or ionic compounds; there are some limitations.

Oil

Liquid triester of glycerol and unsaturated fatty acids.

Open Sextet

Refers to species that have only six electrons in the highest energy level of the central element (many Lewis acids).

Optical Activity

The rotation of plane polarized light by one of a pair of optical isomers.

Optical Isomers

Stereoisomers that differ only by being nonsuperimposable mirror images of each other, like right and left hands, also called enantiomers.

Ore

A natural deposit containing a mineral of an element to be extracted.

Organic Chemistry

The chemistry of substances that contain carbon-hydrogen bonds.

Osmosis

The process by which solvent molecules pass through a semipermable membrane from a dilute solution into a more concentrated solution.

Osmotic Pressure

The hydrostatic pressure produced on the surface of a semipermable membrane by osmosis.

Ostwald Process

A process for the industrial production of nitrogen oxide and nitric acid from ammonia and oxygen.

Outer Orbital Complex

Valence bond designation for a complex in which the metal ion utilizes d orbitals in the outermost (occupied) shell in hybridization.

Overlap

The interaction of orbitals on different atoms in the same region of space.

Oxidation

An algebraic increase in the oxidation number; may correspond to a loss of electrons.

Oxidation Numbers

Arbitrary numbers that can be used as mechanical aids in writing formulas and balancing equations; for single- atom ions they correspond to the charge on the ion; more electronegative atoms are assigned negative oxidation numbers (also called Oxidation states).

Oxidation-reduction Reactions

Reactions in which oxidation and reduction occur; also called redox reactions.

Oxide

A binary compound of oxygen.

Oxidizing Agent

The substance that oxidizes another substance and is reduced.

Pairing

A favourable interaction of two electrons with opposite m , values in the same orbital.

Pairing Energy

Energy required to pair two electrons in the same orbital.

Paramagnetism

Attraction toward a magnetic field, stronger than diamagnetism, but still weak compared to ferromagnetism.

Partial Pressure

The pressure exerted by one gas in a mixture of gases.

Particulate Matter

Fine divided solid particles suspended in polluted air.

Pauli Exclusion Principle

No two electrons in the same atom may have identical sets of four quantum numbers.

Percentage Ionization

The percentage of the weak electrolyte that ionizes in a solution of given concentration.

Percent by Mass

100% times the actual yield divided by theoretical yield.

Percent Composition

The mass percent of each element in a compound.

Percent Purity

The percent of a specified compound or element in an impure sample.

Period

The elements in a horizontal row of the <u>periodic table</u>.

Periodicity

Regular periodic variations of properties of elements with atomic number (and position in the periodic table).

Periodic Law

The properties of the elements are periodic functions of their atomic numbers.

<u>**Periodic Table**</u>

An arrangement of elements in order of increasing atomic numbers that also emphasizes periodicity.

Peroxide

A compound containing oxygen in the -1 oxidation state. Metal peroxides contain the peroxide ion, O_{22}^{-}

pH

Negative logarithm of the concentration (mol/L) of the $H_3O^+[H^+]$ ion; scale is commonly used over a range 0 to 14.

Phase Diagram

Diagram that shows equilibrium temperature-pressure relationships for different phases of a substance.

Phenol

Hydrocarbon derivative containing an [OH] group bound to an aromatic raing.

Photochemical Oxidants

Photochemically produced oxidizing agents capable of causing damage to plants and animals.

Photochemical Smog

A brownish smog occurring in urban areas receiving large amounts of sunlight; caused by photochemical (light-induced) reactions among nitrogen oxides, hydrocarbons and other components of polluted air that produce photochemical oxidants.

Photoelectric Effect

Emission of an electron from the surface of a metal caused by impinging electromagnetic radiation of certain minimum energy; current increases with increasing intensity of radiation.

Photon

A packet of light or electromagnetic radiation; also called quantum of light

Physical Change

A change in which a substance changes from one physical state to another but no substances with different composition are formed. Example Gas to Liquid - Solid.

Plasma

A physical state of matter which exists at extremely high temperatures in which all molecules are dissociated and most atoms are ionized.

Polar Bond

Covalent bond in which there is an unsymmetrical distribution of electron density.

Polarimeter

A device used to measure optical activity.

Polarization

The buildup of a product of oxidation or a reduction of an electrode, preventing further reaction.

Polydentate

Refers to ligands with more than one donor atom.

Polyene

A compound that contains more than one double bond per molecule.

Polymerization

The combination of many small molecules to form large molecules.

Polymer

A large molecule consisting of chains or rings of linked monomer units, usually characterized by high melting and boiling points.

Polymorphous

Refers to substances that crystallize in more than one crystalline arrangement.

Polyprotic Acid

An Acid that can form two or more hydronium ions per molecule; often a least one step of ionization is weak.

Positron

A Nuclear particle with the mass of an electron but opposite charge.

Potential Energy

Energy that matter possesses by virtue of its position, condition or composition.

Precipitate

An insoluble solid formed by mixing in solution the constituent ions of a slightly soluble solution.

Primary Standard

A substance of a known high degree of purity that undergoes one invariable reaction with the other reactant of interest.

Primary Voltaic Cells

Voltaic cells that cannot be recharged; no further chemical reaction is possible once the reactants are consumed.

Proton

A subatomic particle having a mass of 1.0073 amu and a charge of +1, found in thew nuclei of atoms.

PseudobinaryIonic Compounds

Compounds that contain more than two elements but are named like binary compounds.

Quantum Mechanics

Mathematical method of treating particles on the basis of quantum theory, which assumes that energy (of small particles) is not infinitely divisible.

Quantum Numbers

Numbers that describe the energies of electrons in atoms; derived from quantum mechanical treatment.

Radiation

High energy particles or rays emitted during the nuclear decay processes.

Radical

An atom or group of atoms that contains one or more unpaired electrons (usually very reactive species)

Radioactive Dating

Method of dating ancient objects by determining the ratio of amounts of mother and daughter nuclides present in an object and relating the ratio to the object?s age via half-life calculations.

Radioactive Tracer

A small amount of radioisotope replacing a nonradioactive isotope of the element in a compound whose path (for example, in the body) or whose decomposition products are to be monitored by detection of radioctivity; also called a radioactive label.

Radioactivity

The spontaneous disintegration of atomic nuclei.

Raoult's Law

The vapor pressure of a solvent in an ideal solution decreases as its mole fraction decreases.

Rate-determining Step

The slowest step in a mechanism; the step that determines the overall rate of reaction.

Rate-law Expression

Equation relating the rate of a reaction to the concentrations of the reactants and the specific rate of the constant.

Rate of Reaction

Change in the concentration of a reactant or product per unit time.

Reactants

Substances consumed in a chemical reaction.

Reaction Quotient

The mass action expression under any set of conditions (not necessarily equlibrium); its magnitude relative to K determines the direction in which the reaction must occur to establish equilibrium.

Reaction Ratio

The relative amounts of reactants and products involved in a reaction; maybe the ratio of moles. millimoles, or masses.

Reaction Stoichiometry

Description of the quantitative relationships among substances as they participate in chemical reactions.

Reducing Agent

The substance that reduces another substance and is oxidized.

Resonance

The concept in which two or more equivalent dot formulas for the same arrangement of atoms (resonance structures) are necessary to describe the bonding in a molecule or ion.

Reverse Osmosis

Forcing solvent molecules to flow through a semipermable membrane from a concentated solution into a dilute solution by the application of greater hydrostatic pressure on concentrated side than the osmotic pressure opposing it.

Reversible Reaction

Reactions that do not go to completion and occur in both the forward and reverse direction.

Salt Bridge

A U-shaped tube containing electrolyte, which connects two half-cells of a voltaic cell.

Saponification

Hydrolysis of esters in the presence of strong soluable bases.

Saturated Hydrocarbons

Hydrocarbons that contain only single bonds. They are also called alkanes or paraffin hydrocarbons.

Saturated Solution

Solution in which no more solute will dissolve.

Second Law of Thermodynamics

The universe tends toward a state of greater diorder in spontaneous processes.

Secondary Standard

a solution that has been titrated against a primary standard. A standard solution is a secondary standard.

Secondary Voltaic Cells

Voltaic cells that can be recharged; original reactanats can be regenerated be reversing the direction of the current flow.

Semiconductor

A substance that does not conduct electricity at low temperatures but does so at higher temperatures.

Semipermable Membrane

A thin partition between two solutions through which certain molecules can pass but others cannot.

Shielding Effect

Electrons in filled sets of s , p orbitals between the nucleus and outer shell electrons shield the outer shell electrons somewhat from the effect of protons in the nucleus; also called screening effect.

Sigma Bonds

Bonds resulting from the head-on overlap of atomic orbitals, in which the region of electron sharing is along and (cylindrically) symmetrical to the imaginary line connecting the bonded atoms.

Sigma Orbital

Molecular orbital resulting from head-on overlap of two atomic orbitals.

Silicones

Polymeric organosilicon compounds; contain individual or cross-linked Si-O chains or rings in which some oxygens of SiO_4 tetrahedra are replaced by other groups.

Single Bond

Covalent bond resulting from the sharing of two electrons (one pair) between two atoms.

Solubility Product Constant

Equilibrium constant that applies to the dissolution of a slightly soluble compound.

Solubility Product Principle

The solubility product constant expression for a slightly soluble compound is the product of the concentrations of the constituent ions, each raised to the power that corresponds to the number of ions in one formula unit.

Solute

The dispersed (dissolved) phase of a solution.

Solution

Homogeneous mixture of two or more substances.

Solvation

The process by which solvent molecules surround and interact with solute ions or molecules.

Solvent

The dispersing medium of a solution.

Solvolysis

The reaction of a substance with the solvent in which it is dissolved.

S Orbital

A spherically symmetrical atomic orbital; one per energy level.

Specific Gravity

The ratio of the density of a substance to the density of water.

Specific Heat

The amount of heat required to raise the temperature of one gram of substance one degree Celsius.

Specific Rate Constant

An experimentally determined (proportionality) constant, which is different for different reactions and which changes only with temperature; k in the rate-law expression: Rate = k [A] x [B]v.

Spectator Ions

Ions in a solution that do not participate in a chemical reaction.

Spectral Line

Any of a number of lines corresponding to definite wavelengths of an atomic emission or absorption spectrum; represents the energy difference between two energy levels.

Spectrochemical Series

Arrangement of ligands in order of increasing ligand field strength.

Spectrum

Display of component wavelengths (colours) of electromagnetic radiation.

Square Planar

A term used to describe molecules and polyatomic ions that have one atom in the center and four atoms at the corners of a square.

Square Planar Complex

Complex in which the metal is in the center of a square plane, with ligand donor atoms at each of the four corners

Standard Electrodes

Half-cells in which the oxidized and reduced forms of a species are present at unit activity; 1.0M solutions of dissolved ions, 1.0atm partial pressure of gases, and pure solids and liquids.

Standard Electrode Potential

By convention , potential, Eo, of a half-reaction as a reduction relative to the standard hydrogen electrode when all species are present at unit activity.

Standard Entropy

The absolute entropy of a substance in its standard state at 298 K.

Standard Molar Enthalphy of Formation

The amount of heat absorbed in the formation of one mole of a substance in a specified state from its elements in their standard states.

Standard Molar Volume

The volume occupied by one mole of an ideal gas under standard conditions; 22.4liters.

Standard Reaction

A reaction in which the numbers of moles of reactants shown in the balanced equation, all in their standard states, are completely converted to the numbers of moles of products shown in the balanced equation, also sall at their standard state.

Stereoisomers

Isomers that differ only in the way that atoms are oriented in space; consist of geometrical and optical isomers.

Stoichiometry

Description of the quantitative relationships among elements and compounds as they undergo chemical changes.

Strong Electrolyte

A substance that conducts electricity well in a dilute aqueous solution.

Strong Field Ligand

Ligand that exerts a strong crystal or ligand electrical field and generally forms low spin complexes with metal ions when possible.

Structural Isomers

Compounds that contain the same number of the same kinds of atoms in different geometric arrangements.

Sublimation

The direct vaporization of a sold by heating without passing through the liquid state.

Substance

Any kind of matter all specimens of which have the same chemical composition and physical properties.

Substitution Reaction

A reaction in which an atom or a group of atoms is replaced by another atom or group of atoms.

Supercooled Liquids

Liquids that, when cooled, apparently solidify but actually continue to flow very slowly under the influence of gravity.

Supercritical Fluid

A substance at temperature above its critical temperature.

Supersaturated Solution

A solution that contains a higher than saturation concentration of solute; slight disturbance or seeding causes crystallization of excess solute.

Suspension

A heterogeneous mixture in which solute-like particles settle out of solvent-like phase some time after their introduction.

Temperature

A measure of the intensity of heat, i.e. the hotness or coldness of a sample. or object.

Ternary Acid

A ternary compound containing H, O, and another element, often a nonmetal.

Ternary Compound

A compound consisting of three elements; may be ionic or covalent.

Tetrahedral

A term used to describe molecules and polyatomic ions that have one atom in center and four atoms at the corners of a tetrahedron.

Theoretical Yield

Maximum amount of a specified product that could be obtained from specified amounts of reactants, assuming complete consumption of limiting reactant according to only one reaction and complete recovery of product. (Compare with Actual Yield)

Thermal Cracking

Decomposition by heating a substance in the presence of a catalyst and in the absence of air.

Thermodynamics

The study of the energy transfers accompanying physical and chemical processes.

Thermonuclear Energy

Energy from nuclear fusion reactions.

Third Law of Thermodynamics

The entropy of a hypothetical pure, perfect, crystalline sustance at absolute zero temperature is zero.

Titration

A Procedure in which one solution is added to another solution until the chemical reaction between the two solutes is complete; the concentration of one solution is known and that of the other is unknown.

Total Ionic Equation

Equation for a chemical reaction written to show the predominant form of all species in aqueous solution or in contact with water.

Transition State Theory

Theory of reaction rates that states that reactants pass through high-energy transition states before forming products.

Tyndall Effect

The scattering of light by colloidal particles.

Unsaturated Hydrocarbons

Hydrocarbons that contain double or triple carbon-carbon bonds

Valence Bond Theory

Assumes that covalent bonds are formed when atomic orbitals on different atoms overlap and the electrons are shared.

Valence Electrons

Outermost electrons of atoms; usually those involved in bonding.

Valence Shell Electron Pair Repulsion Theory

Assumes that electron pairs are arranged around the central element of a molecule or polyatomic ion so that there is maximum separation (and minimum repulsion) among regions of high electron density.

van der Waals' Equation

An equation of state that extends the ideal gas law to real gases by inclusion of two empirically determined parameters, which are different for different gases.

Vapor

A gas formed by boiling or evaporating a liquid.

Vapor Pressure

The particle pressure of a vapor at the surface of its parent liquid.

Voltage

Potential difference between two electrodes; a measure of the chemical potential for a redox reaction to occur.

Voltaic Cells

Electrochemical cells in which spontaneous chemical reactions produce electricity; also called galvanic cells.

Water Equivalent

The amount of water that would absorb the same amount of heat as the calorimeter per degree temperature increase.

Weak Electrolyte

A substance that conducts electricity poorly in a dilute aqueous solution.

Weak Field Ligand

A Ligand that exerts a weak crystal or ligand field and ge- nerally forms high spin complexes with metals.

Zone Refining

A method of purifying a bar of metal by passing it through an induction heater; this causes impurties to move along a melted portion.

Biology dictionary

A

abiogenesis Early theory that held that some organisms originated from nonliving material.

abnormal hemoglobin Hemoglobin molecule with a different shape due to an altered amino acid sequence (ultimately caused by an altered DNA base sequence), such as in the inherited disease sickle-cell anemia.

abscisic acid A plant hormone that promotes dormancy in perennial plants and causes rapid closure of leaf stomata when a leaf begins to wilt.

absolute time One of the two types of geologic time (relative time being the other), with a definite age date established mostly by the decay of radioactive elements, although ages may also be obtained by counting tree rings, decay of a specific type of atom, or annual sedimentary layers (such as varves in lakes or layers in a glacier). The term is in some disfavor because it suggests an exactness that may not be possible to obtain.

absorption The process by which the products of digestion are transferred into the body's internal environment, enabling them to reach the cells.

absorptive feeders Animals such as tapeworms that ingest food through the body wall.

acetylcholine A chemical released at neuromuscular junctions that binds to receptors on the surface of the plasma membrane of muscle cells, causing an electrical impulse to be transmitted. The impulse ultimately leads to muscle contraction.

acetyl CoA An intermediate compound formed during the breakdown of glucose by adding a two-carbon fragment to a carrier molecule (Coenzyme A or CoA).

acid A substance that increases the number of hydrogen ions in a solution.

acid rain The precipitation of sulfuric acid and other acids as rain. The acids form when sulfur dioxide and nitrogen oxides released during the combustion of fossil fuels combine with water and oxygen in the atmosphere.

acoelomates Animals that do not have a coelom or body cavity; e.g., sponges and flatworms.

acquired immunodeficiency syndrome (AIDS) A collection of disorders that develop as a result of infection by the human immunodeficiency virus (HIV), which attacks helper T cells, crippling the immune system and greatly reducing the body's ability to fight infection; results in premature death brought about by various diseases that overwhelm the compromised immune system.

actin The protein from which microfilaments are composed; forms the contractile filaments of sarcomeres in muscle cells.

action potential A reversal of the electrical potential in the plasma membrane of a neuron that occurs when a nerve cell is stimulated; caused by rapid changes in membrane permeability to sodium and potassium.

active transport Transport of molecules against a concentration gradient (from regions of low concentration to regions of high concentration) with the aid of proteins in the cell membrane and energy from ATP.

adaptation Tendency of an organism to suit its environment; one of the major points of Charles Darwin's theory of evolution by natural selection: organisms adapt to their environment. Those organisms best adapted will have a greater chance of surviving and passing their genes on to the next generation.

adaptive radiation The development of a variety of species from a single ancestral form; occurs when a new habitat becomes available to a population. Evolutionary pattern of divergence of a great many taxa from a common ancestral species as a result of novel adaptations or a recent mass extinction. Examples: mammals during the Cenozoic Era after the extinction of dinosaurs at the close of the Mesozoic Era flowering plants during the Cretaceous Period diversified because of their reproductive advantages over gymnosperm and non-seed plants that dominated the floras of the world at that time.

adenine One of the four nitrogen-containing bases occurring in nucleotides, the building blocks of the organic macromolecule group known as nucleic acids (DNA and RNA). Adenine is also the base in the energy carrying molecule ATP (adenosine triphosphate) which is the energy coin of the cell.

adenosine diphosphate (ADP) Lower energy form of ATP, having two (instead of the three in ATP) phosphhate groups attached to the adenine base and ribose sugar.

adenosine triphosphate (ATP) A common form in which energy is stored in living systems; consists of a nucleotide (with ribose sugar) with three phosphate groups. The energy coin of the cell.

adhesion The ability of molecules of one substance to adhere to a different substance.

adrenocorticotropic hormone (ACTH) A hormone produced by the anterior pituitary that stimulates the adrenal cortex to release several hormones including cortisol.

adventitious roots Roots that develop from the stem following the death of the primary root. Branches from the adventitious roots form a fibrous root system in which all roots are about the same size; occur in monocots.

age structure The relative proportion of individuals in each age group in a population.

aggregates Fairly random associations of animals with little or no internal organization; form in response to a single stimulus and disperse when the stimulus is removed; one of the three broad classes of social organization.

albinism Genetic condition caused by the body's inability to manufacture pigments; an autosomal recessive trait.

aldosterone A hormone secreted by the adrenal glands that controls the reabsorption of sodium in the renal tubule of the nephron.

alleles Alternate forms of a gene.

allergens Antigens that provoke an allergic reaction.

alternation of generations A life cycle in which a multicellular diploid stage is followed by a haploid stage and so on; found in land plants and many algae and fungi. |

altitudinal gradient As altitude increases, a gradient of cooler, drier conditions occurs.

alveoli Tiny, thin-walled, inflatable sacs in the lungs where oxygen and carbon dioxide are exchanged.

amensalism A symbiotic relationship in which members of one population inhibit the growth of another population without being affected.

amino acids The subunits (monomers) from which proteins (polymers) are assembled. Each amino acid consists of an amino functional group, and a carboxyl acid group, and differs from other amino acids by the composition of an R group.

amino acid sequence Also known as the primary structure of a protein/polypeptide; the sequence of amino acids in a protein/polypeptide controlled by the sequence of DNA bases.

amniocentesis A method of prenatal testing in which amniotic fluid is withdrawn from the uterus through a needle. The fluid and the fetal cells it contains are analyzed to detect biochemical or chromosomal disorders**.**

amniote egg An egg with compartmentalized sacs (a liquid-filled sac in which the embryo develops, a food sac, and a waste sac) that allowed vertebrates to reproduce on land.

amoebocytes Amoeboid cells in sponges that occur in the matrix between the epidermal and collar cells. They transport nutrients.

amphibians Class of terrestrial vertebrates which lay their eggs (and also mate) in water but live on land as adults following a juvenile stage where they live in water and breathe through gills. Amphibians were the first group of land vertebrates; today they are mostly restricted to moist habitats.

anabolic reactions Reactions in cells in which new chemical bonds are formed and new molecules are made; generally require energy, involve reduction, and lead to an increase in atomic order.

anaerobic Refers to organisms that are not dependent on oxygen for respiration.

analogous structures Body parts that serve the same function in different organisms, but differ in structure and embryological development; e. g., the wings of insects and birds.

anaphase Phase of mitosis in which the chromosomes begin to separate.

anaphylactic shock See anaphylaxis.

anaphylaxis A severe allergic reaction in which histamine is released into the circulatory system; occurs upon subsequent exposure to a particular antigen; also called anaphylactic shock.

androecium Collective term applied to all of the male (stamen) parts of the flower.

aneuploidy Variation in chromosome number involving one or a small number of chromosomes; commonly involves the gain or loss of a single chromosome.

angina Chest pain, especially during physical exertion or emotional stress, that is caused by gradual blockage of the coronary arteries.

angiosperms Flowering plants. First appearing at least 110 million years ago from an unknown gymnosperm ancestor, flowering planbts have risen to dominance in most of the world's floras. The male gametophyte is 2-3 cells contained within a pollen grain; the female gametophyte is usually eight cells contained within an ovule which is retaind on the sporophyte phase of the plant's life cycle.

Animalia Animal Kingdom. Multicellular eukaryotic group characterized by heterotrophic nutritional mode, usually organ and tissue development, and motility sometime during the organism's life history.

annuals Plants that grow and reproduce sexually during one year.

antagonistic muscles A pair of muscles that work to produce opposite effects&emdash;one contracts as the other relaxes: for example, the bicep and tricep muscles on opposite sides of your upper arm.

anther The top of a stamen's filament; divided into pollen sacs in which the pollen grains form. |

antibiotics Substances produced by some microorganisms, plants, and vertebrates that kill or inhibit the growth of bacteria.

antibiotic resistance Tendency of certain bacteria to develop a resistance to commonly over-used antibiotics.

antibodies Proteins produced by immune system cells that bind to foreign molecules and microorganisms and inactivate them.

antibody-mediated immunity Immune reaction that protects primarily against invading viruses and bacteria through antibodies produced by plasma cells; also known as humoral immunity.

anticodon A sequence of three nucleotides on the transfer RNA molecule that recognizes and pairs with a specific codon on a messenger RNA molecule; helps control the sequence of amino acids in a growing polypeptide chain.

antidiuretic hormone (ADH) A hormone produced by the hypothalamus and released by the pituitary gland that increases the permeability of the renal tubule of the nephron and thereby increases water reabsorption; also known as vasopressin.

antigenic determinant The site on an antigen to which an antibody binds, forming an antigen-antibody complex.

antigens Molecules carried or produced by microorganisms that initiate antibody production; mostly proteins or proteins combined with polysaccharides.

antinutrients Chemicals produced by plants as a defense mechanism; inhibit the action of digestive enzymes in insects that attack and attempt to eat the plants.

anus The posterior opening of the digestive tract.

aorta The artery that carries blood from the left ventricle for distribution throughout the tissues of the body. The largest diameter and thickest walled artery in the body.

apical meristem A meristem (embryonic tissue) at the tip of a shoot or root that is responsible for increasing the plant's length.

apnea A disorder in which breathing stops for periods longer than 10 seconds during sleep; can be caused by failure of the automatic respiratory center to respond to elevated blood levels of carbon dioxide.

apocrine glands Sweat glands that are located primarily in the armpits and groin area; larger than the more widely distributed eccrine glands.

appendicular skeleton The bones of the appendages (wings, legs, and arms or fins) and of the pelvic and pectoral girdles that join the appendages to the rest of the skeleton; one of the two components of the skeleton of vertebrates.

appendix Blind sac at the end of the large intestine that usually ruptures during final exams; a vestigial organ in humans.

Archaea Proposed, but not widely accepted, sixth taxonomic kingdom that would include the archaebacteria.

Archaebacteria Ancient (over 3.5 billion years old) group of prokaryotes; some biologists want to place this group into a separate Kingdom, the Archaea. Most currently place it within the Kingdom Monera.

archaeocyathids An extinct group of animals that were part of Cambrian-aged reef environments, but which were extinct by the close of the Cambrian Period.

Archean/Proterozoic Era The period of time beginning 4.6 billion years ago with the formation of the Earth and ending 570 million years ago.

aridity The condition of receiving sparse rainfall; associated with cooler climates because cool air can hold less water vapor than warm air. Many deserts occur in relatively warm climates, however, because of local or global influences that block rainfall.

arrector pili A muscle running from a hair follicle to the dermis. Contraction of the muscle causes the hair to rise perpendicular to the skin surface, forming "goose pimples."

arteries Thick-walled vessels that carry blood away from the heart. Singular=artery.

arterioles The smallest arteries; usually branch into a capillary bed.

artificial selection The process in which breeders choose the variants to be used to produce succeeding generations.

ascomycetes Division of fungi that contains the yeasts and morels; ascomycetes produce an ascus (or sac) in which ascospores are produced.

ascus Structure produced by sac fungi in which sexual ascospores develop.

asexual reproduction A method of reproduction in which genetically identical offspring are produced from a single parent; occurs by many mechanisms, including fission, budding, and fragmentation.

assortment A way in which meiosis produces new combinations of genetic information. Paternal and maternal chromosomes line up randomly during synapsis, so each daughter cell is likely to receive an assortment of maternal and paternal chromosomes rather than a complete set from either.

aster Short fibers produced by cells during mitosis and meiosis. These radiate from the centriole (if it is present).

asteroid impacts Hypothesis that links certain mass extinction events with the impact of a comet or asteroid, most notably the mass extinction 65 million years that caused the disappearance of dinosaurs and many other reptilian groups. Asteroid impacts early in earth history also contributed to the formation of the atmosphere and oceans.

asthma A respiratory disorder caused by allergies that constrict the bronchioles by inducing spasms in the muscles surrounding the lungs, by causing the bronchioles to swell, or by clogging the bronchioles with mucus.

asymmetrical In animals, a term referring to organisms that lack a general body plan or axis of symmetry that divides the body into mirror-image halves.

atmosphere The envelope of gases that surrounds the Earth; consists largely of nitrogen (78%) and oxygen (21%).

atom The smallest indivisible particle of matter that can have an independent existence.

atomic number The number of protons in the nucleus of an atom.

atomic weight The sum of the weights of an atom's protons and neutrons, the atomic weight differs between isotopes of the same element.

atrioventricular (AV) node Tissue in the right ventricle of the heart that receives the impulse from the atria and transmits it through the ventricles by way of the bundles of His and the Purkinje fibers.

atrioventricular (AV) valve The valve between each auricle and ventricle of the heart.

auricle The chamber of the heart that receives blood from the body returned to the heart by the veins. Also referred to as atrium.

autonomic system The portion of the peripheral nervous system that stimulates smooth muscle, cardiac muscle, and glands; consists of the parasympathetic and sympathetic systems.

autosomes The chromosomes other than the sex chromosomes. Each member of an autosome pair (in diploid organisms) is of similar length and in the genes it carries.

autotrophic Refers to organisms that synthesize their nutrients and obtain their energy from inorganic raw materials.

autotrophs Organisms that synthesize their own nutrients; include some bacteria that are able to synthesize organic molecules from simpler inorganic compounds.

auxins A group of hormones involved in controlling plant growth and other functions; once thought responsible for phototropism by causing the cells on the shaded side of a plant to elongate, thereby causing the plant to bend toward the light.

axial skeleton The skull, vertebral column, and rib cage; one of the two components of the skeleton in vertebrates.

axillary buds Buds borne in the axil (where the leaf meets the stem) of a stem.

axons Long fibers that carry signals away from the cell body of a neuron.

B

bacteriophages Viruses that attack and kill bacterial cells; composed only of DNA and protein.

bark The outer layer of the stems of woody plants; composed of an outer layer of dead cells (cork) and an inner layer of phloem.

Barr body Inactivated X-chromosome in mammalian females. Although inactivated, the Barr body is replicated prior to cell division and thus is passed on to all descendant cells of the embryonic cell that had one of its X-chromosomes inactivated.

barriers to gene flow Factors, such as geographic, mechanical, and behavioral isolating mechanisms that restrict gene flow between populations, leading to populations with differing allele frequencies.

basal body A structure at the base of a cilium or flagellum; consists of nine triplet microtubules arranged in a circle with no central microtubule.

base A substance that lowers the hydrogen ion concentration in a solution.

basidia Specialized club-shaped structures on the underside of club fungi (Basidiomycetes) within which spores form (sing.: basidium).

basidiomycetes The club fungi, a major group of fungi that all produce a structure (basidium) on which basidiospores are produced. Includes mushrooms and toadstools.

basidiospores The spores formed on the basidia of club fungi (Basidiomycetes).

B cells Type of lymphocyte responsible for antibody-mediated immunity; mature in the bone marrow and circulate in the circulatory and lymph systems where they transform into antibody-producing plasma cells when exposed to antigens.

benthic zone One of the two basic subdivisions of the marine biome; includes the sea floor and bottom-dwelling organisms.

bicarbonate ions A weak base present in saliva that helps to neutralize acids in food.

big bang theory A model for the evolution of the universe that holds that all matter and energy in the universe were concentrated in one point, which suddenly exploded. Subsequently, matter condensed to form atoms, elements, and eventually galaxies and stars.

bilateral symmetry In animals, refers to those that have a single axis of symmetry.

biliary system The bile-producing system consisting of the liver, gallbladder, and associated ducts.

binary fission The method by which bacteria reproduce. The circular DNA molecule is replicated; then the cell splits into two identical cells, each containing an exact copy of the original cell's DNA.

binding sites Areas on the ribosome within which tRNA-amino acid complexes fit during protein synthesis.

binomial system of nomenclature A system of taxonomy developed by Linnaeus in the early eighteenth century. Each species of plant and animal receives a two-term name; the first term is the genus, and the second is the species.

biochemical cycle   The flow of an element through the living tissue and physical environment of an ecosystem; e. g., the carbon, hydrogen, oxygen, nitrogen, sulfur, and phosphorus cycles.

biochemical reactions Specific chemical processes that occur in living things.

biochemistry Chemical processes associated with living things.

biodiversity   Biological diversity; can be measured in terms of genetic, species, or ecosystem diversity.

biogeography The study of the distribution of plants and animals across the Earth.

bioluminescent Refers to organisms that emit light under certain conditions.

biomass The total weight of living tissue in a community.

biome A large-scale grouping that includes many communities of a similar nature.

biosphere All ecosystems on Earth as well as the Earth's crust, waters, and atmosphere on and in which organisms exist; also, the sum of all living matter on Earth.

birds Taxonomic class of terrestrial vertebrates that are characterized by endothermy and feathers; descended from some group of reptiles (or possibly dinosaurs).

birth rate   The ratio between births and individuals in a specified population at a particular time.

bladder A hollow, distensible organ with muscular walls that stores urine and expels it through the urethra.

blastocoel The fluid-filled cavity at the center of a blastula.

blastocyst The developmental stage of the fertilized ovum by the time it is ready to implant; formed from the morula and consists of an inner cell mass, an internal cavity, and an outer layer of cells (the trophoblast).

blastula A ball of cells surrounding a fluid-filled cavity (the blastocoel) that is produced by the repeated cleavage of a zygote.

blending Term applied to 19th century belief that parental traits "blended" in their offspring; disproven by Mendel's work.

blood group or type One of the classes into which blood can be separated on the basis of the presence or absence of certain antigens; notably, the ABO types and the Rh blood group.

B memory cells Long-lived B cells that are produced after an initial exposure to an antigen and play an important role in secondary immunity. They remain in the body and facilitate a more rapid responce if the antigen is encountered again.

body fossil The actual remains (however permineralized, compressed or otherwise post-mortem altered) of an organism; includes bones, shells, and teeth.

bolus A mass of chewed food mixed with salivary secretions that is propelled into the espohagus during the swallowing phase of digestion.

bony fish A term applied collectively to all groups of fish with bony (as opposed to cartilaginous) skeletons.

bottlenecks Drastic short-term reductions in population size caused by natural disasters, disease, or predators; can lead to random changes in the population's gene pool.

brachiopods A phylum of hinge-shelled animals that have left an excellent fossil record; brachiopods live on or in the ocean floor.

brachydactly Human genetic disorder that causes production of an extra digit; an autosomal dominant trait. Sometimes referred to as polydactly.

brain The most anterior, most highly developed portion of the central nervous system.

brain stem The portion of the brain that is continuous with the spinal cord and consists of the medulla oblongata and pons of the hindbrain and the midbrain.

bronchi Tubes that carry air from the trachea to the lungs (sing.: bronchus).

bronchioles Small tubes in the lungs that are formed by the branching of the bronchi; terminate in the alveoli.

bronchitis A respiratory disorder characterized by excess mucus production and swelling of the bronchioles; caused by long-term exposure to irritants such as cigarette smoke and air pollutants.

brown algae Multicellular protistans placed in the Division Phaeophyta, includes kelp.

brush border The collection of microvilli forming a border on the intestinal side of the epithelial cells of the small intestine.

bryophytes The nonvascular plants, characterized by life cycles dominated by the gametophyte phase. This group includes the mosses, liverworts, and hornworts, which lack lignified conducting tissues.

budding 1. Asexual production of new organisms; usually found in yeast; 2. the process by which HIV and similar viruses leave the cell (other than by lysing).

bud sports Buds that produce fruit that is different from the rest of the fruit on the tree; vegetatively propagated by grafting cuttings onto another plant.

buffers Chemicals that maintain pH values within narrow limits by absorbing or releasing hydrogen ions.

bulbourethral glands Glands that secrete a mucus-like substance that is added to sperm and provides lubrication during intercourse.

bursae Small sacs lined with synovial membrane and filled with synovial fluid; act as cushions to reduce friction between tendons and bones.

C

calcitonin A hormone produced by the thyroid that plays a role in regulating calcium levels.

calcium carbonate Chemical that also occurs in limestone and marble.

Calvin cycle (aka Calvin-Benson Cycle or Carbon Fixation) Series of biochemical, enzyme-mediated reactions during which atmospheric carbon dioxide is reduced and incorporated into organic molecules, eventually some of this forms sugars. In eukaryotes, this occurs in the stroma of the chloroplast.

cambium A lateral meristem in plants. Types of cambiums include vascular, cork, and intercalary.

Cambrian Geologic period that begins the Paleozoic Era 570 million years ago. Marked in its beginning by a proliferation of animals with hard, preservable parts, such as brachiopods, trilobites, and archaeocyathids.

campodactyly A dominant trait in which a muscle is improperly attached to bones in the little finger, causing the finger to be permanently bent.

capillaries Small, thin-walled blood vessels that allow oxygen to diffuse from the blood into the cells and carbon dioxide to diffuse from the cells into the blood.

capillary bed A branching network of capillaries supplied by arterioles and drained by venules.

capsid The protein "shell" of a free virus particle. This definition is from the **capsule** 1. Structure produced around certain bacteria; 2. Structure produced by the bryophyte sporophyte that contains spores produced by meiosis.

carbohydrates Organic molecules composed of carbon, hydrogen, and oxygen that serve as energy sources and structural materials for cells of all organisms.

cardiac cycle One heartbeat; consists of atrial contraction and relaxation, ventricular contraction and relaxation, and a short pause.

cardiac muscle The type of muscle that is found in the walls of the heart. Cardiac muscle is striated but branched, unlike the straight-shaped striated skeletal muscle cells.

cardiovascular system The human circulatory system consisting of the heart and the vessels that transport blood to and from the heart.

carnivores Term applied to a heterotroph, usually an animal, that eats other animals. Carnivores function as secondary, tertiary, or top consumers in food chains and food webs.

carotenoids Major group of accessory pigments in plants; includes beta carotene.

carpals The bones that make up the wrist joint.

carpels The female reproductive structures of a flower; consisting of the ovary, style, and stigma.

carrageenan Chemical extracted from red algae that is added to commercial ice creams as an emulsifying agent.

carrying capacity The maximum population size that can be regularly sustained by an environment; the point where the population size levels off in the logistic growth model.

Casparian strip In plants, an impermeable waxy layer between the cells of the endodermis that stops water and solutes from entering the xylem, except by passing through the cytoplasm of adjacent cells.

catabolic reactions Reactions in cells in which existing chemical bonds are broken and molecules are broken down; generally produce energy, involve oxidation, and lead to a decrease in atomic order.

catastrophism Once-popular belief that events in earth history had occurred in the past a sudden events and by processes unlike those operating today. Periods of catastrophic change were followed by long periods of little change. A subgroup, the Diluvialists, contended that Noah's Flood was the last of many floods which had occurred throughout earth history.

cell body In a neuron, the part that contains the nucleus and most of the cytoplasm and the organelles.

cell cycle The sequence of events from one division of a cell to the next; consists of mitosis (or division) and interphase.

cell-mediated immunity Immune reaction directed against body cells that have been infected by viruses and bacteria; controlled by T cells.

cell plate In plants, a membrane-bound space produced during cytokinesis by the vesicles of the Golgi apparatus. The cell plate fuses with the plasma membrane, dividing the cell into two compartments.

cells The smallest structural units of living matter capable of functioning independently.

cell theory One of the four (or five) unifying concepts in biology. The cell theory states that all living things are composed of at least one cell and that the cell is the fundamental unit of function in all organisms. Corollaries: the chemical composition of all cells is fundamentally alike; all cells arise from preexisting cells through cell division.

cellular respiration The transfer of energy from various molecules to produce ATP; occurs in the mitochondria of eukaryotes, the cytoplasm of prokaryotes. In the process, oxygen is consumed and carbon dioxide is generated.

cellulose A polysaccharide that is composed of unbranched chains of glucose; the major structural carbohydrate of plants, insoluble in water, and indigestible in the human intestine.

cell wall Structure produced by some cells outside their cell membrane; variously composed of chitin, peptidoglycan, or cellulose.

Cenozoic Era The period of geologic time beginning after the end of the Mesozoic Era 65 million years ago and encompassing the present. Commonly referred to as the age of mammals.

central nervous system (CNS) The division of the nervous system that includes the brain and spinal cord.

centriole Paired cellular organelle which functions in the organization of the mitotic spindle during cell division in eukaryotes.

centromere A specialized region on each chromatid to which kinetochores and sister chromatids attach.

cephalization The concentration of sensory tissues in the anterior part of the body (head).

cerebellum That part of the brain concerned with fine motor coordination and body movement, posture, and balance; is part of the hindbrain and is attached to the rear portion of the brain stem.

cerebral cortex The outer layer of gray matter in the cerebrum; consists mainly of neuronal cell bodies and dendrites in humans; associated with higher functions, including language and abstract thought.

cerebrum The part of the forebrain that includes the cerebral cortex; the largest part of the human brain.

cervix The lower neck of the uterus that opens into the vagina.

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

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

chemiosmosis The process by which ATP is produced in the inner membrane of a mitochondrion. The electron transport system transfers protons from the inner compartment to the outer; as the protons flow back to the inner compartment, the energy of their movement is used to add phosphate to ADP, forming ATP.

chemotrophs Organisms (usually bacteria) that derive energy from inorganic reactions; also known as chemosynthetic.

chiasma The site where the exchange of chromosome segments between homologous chromosomes takes place (crossing-over) (pl.: chiasmata).

chitin A polysaccharide contained in fungi; also forms part of the hard outer covering of insects.

chlamydia A sexually transmitted disease caused by a parasitic bacterium that lives inside cells of the reproductive tract.

chlorofluorocarbons (CFCs) Chemical substances used in refrigerators, air conditioners, and solvents that drift to the upper stratosphere and dissociate. Chlorine released by CFCs reacts with ozone, eroding the ozone layer.

chlorophyll The pigment in green plants that absorbs solar energy.

chlorophyll a The green photosynthetic pigment common to all photosynthetic organisms.

chlorophyll b An accessory chlorophyll found in green algae and plants.

chlorophyll c An accessory chlorophyll found in some protistans.

chloroplasts Disk-like organelles with a double membrane found in eukaryotic plant cells; contain thylakoids and are the site of photosynthesis. ATP is generated during photosynthesis by chemiosmosis.

cholecystokinin A hormone secreted in the duodenum that causes the gallbladder to release bile and the pancreas to secrete lipase.

chorion The two-layered structure formed from the trophoblast after implantation; secretes human chorionic gonadotropin.

chorionic villi sampling (CVS) A method of prenatal testing in which fetal cells from the fetal side of the placenta (chorionic villi) are extracted and analyzed for chromosomal and biochemical defects.

chromatid Generally refers to a strand of a replicated chromosome; consists of DNA and protein.

chromatin A complex of DNA and protein in eukaryotic cells that is dispersed throughout the nucleus during interphase and condensed into chromosomes during meiosis and mitosis.

chromosomes Structures in the nucleus of a eukaryotic cell that consist of DNA molecules that contain the genes.

chromosome theory of inheritance Holds that chromosomes are the cellular components that physically contain genes; proposed in 1903 by Walter Sutton and Theodore Boveri.

Chrysophytes Protistan division that is referred to as the golden brown algae; includes the diatoms.

cilia Hair-like organelles extending from the membrane of many eukaryotic cells; often function in locomotion (sing.: cilium).

circadian rhythms Biorhythms that occur on a daily cycle.

circulatory system One of eleven major body organ systems in animals; transports oxygen, carbon dioxide, nutrients, and waste products between cells and the respiratory system and carries chemical signals from the endocrine system; consists of the blood, heart, and blood vessels.

circulatory system, closed A system that uses a continuous series of vessels of different sizes to deliver blood to body cells and return it to the heart; found in echinoderms and vertebrates.

circulatory system, open A system in which the circulating fluid is not enclosed in vessels at all times; found in insects, crayfish, some mollusks, and other invertebrates.

classes Taxonomic subcategories of phyla.

clavicle The collar bone.

cleavage furrow A constriction of the cell membrane at the equator of the cell that marks the beginning of cytokinesis in animal cells. The cell divides as the furrow deepens.

climax community The stage in community succession where the community has become relatively stable through successful adjustment to its environment.

clitoris A short shaft with a sensitive tip located where the labia minora meet; consists of erectile tissue and is important in female sexual arousal.

clone An exact copy of a DNA segment; produced by recombinant DNA technology.

closed community A community in which populations have similar range boundaries and density peaks; forms a discrete unit with sharp boundaries.

codominance A type of inheritance in which heterozygotes fully express both alleles.

codon A sequence of three nucleotides in messenger RNA that codes for a single amino acid.

coelom In animals, a body cavity between the body wall and the digestive system that forms during preadult development.

coelomates Animals that have a coelom or body cavity lined with mesoderm.

coenzymes Chemicals required by a number of enzymes for proper functioning; also known as enzyme cofactors.

cohesion The force that holds molecules of the same substance together.

cohesion-adhesion theory Describes the properties of water that help move it through a plant. Cohesion is the ability of water molecules to stick together (held by hydrogen bonds), forming a column of water extending from the roots to the leaves; adhesion is the ability of water molecules to stick to the cellulose in plant cell walls, counteracting the force of gravity and helping to lift the column of water.

collenchyma One of the three major cell types in plants; are elongated and have thicker walls than parenchyma cells and are usually arranged in strands; provide support and are generally in a region that is growing.

colonial 1. Level of organization intermediate between unicellular and multicellular - organisms are composed of multiple cells but fail to exhibit specialization of those cells. Examples: *Volvox*, a colonial alga. Click HERE to view a series of images of *Volvox*. 2. Term applied to organisms that occur in a fixed location, with one generation growing atop previous generations, as in coral reefs.

commensalism A symbiotic relationship in which one species benefits and the other is not affected.

community All species or populations living in the same area.

community age One of the factors that helps cause the latitudinal diversity gradient. Tropical communities have had more time to evolve because they have been less disrupted by advancing ice sheets and other relatively recent climatic changes.

community simplification The reduction of overall species diversity in a community; generally caused by human activity.

community succession The sequential replacement of species in a community by immigration of new species and by local extinction of old ones.

compact bone The outer dense layer that forms the shaft of the long bones; made up of concentric layers of mineral deposits surrounding a central opening.

companion cells Specialized cells in the phloem that load sugars into the sieve elements and help maintain a functional plasma membrane in the sieve elements.

competition One of the biological interactions that can limit population growth; occurs when two species vie with each other for the same resource.

competitive exclusion Competition between species that is so intense that one species completely eliminates the second species from the area.

competitive release Occurs when one of two competing species is removed from an area, thereby releasing the remaining species from one of the factors that limited its population size.

complementary nucleotides The bonding preferences of nucleotides, Adenine with Thymine, and Cytosine with Guanine. Also referred to as complementary base pairing.

complement system A chemical defense system that kills microorganisms directly, supplements the inflammatory response, and works with, or complements, the immune system.

complete dominance The type of inheritance in which both heterozygotes and dominant homozygotes have the same phenotype.

compound A substance formed by two or more elements combined in a fixed ratio.

compound leaf A leaf in which the blade forms small leaflets. Compound leaves that have several small leaflets originating from a central axis are termed pinnately compound; example: rose. Compound leaves that have their leaflets originating from a common point are termed palmately compound; example: palm.

conditioned response The response to a stimulus that occurs when an animal has learned to associate the stimulus with a certain positive or negative effect.

cones Light receptors in primates' eyes that operate in bright light; provide color vision and visual acuity.

conifers Group of gymnosperms that reproduce by cones and have needle-like leaves (in general); includes the pines.

connective tissue Animal tissue composed of cells embedded in a matrix (gel, elastic fibers, liquid, or inorganic minerals). Includes loose, dense, and fibrous connective tissues that provide strength (bone, cartilage), storage (bone, adipose), and flexibility (tendons, ligaments).

consumers The higher levels in a food pyramid; consist of primary consumers, which feed on the producers, and secondary consumers, which feed on the primary consumers.

continuous variation Occurs when the phenotypes of traits controlled by a single gene cannot be sorted into two distinct phenotypic classes, but rather fall into a series of overlapping classes.

contrast In relation to microscopes, the ability to distinguish different densities of structures.

convergent evolution The development of similar structures in distantly related organisms as a result of adapting to similar environments and/or strategies of life. Example: wings of birds and insects, the body shape of dolphins, sharks, and the extinct marine reptiles known as ichthyosaurs.

convergent plate boundary The boundary between two plates that are moving toward one another.

coprolites Fossilized feces.

cork The outer layer of the bark in woody plants; composed of dead cells.

cork cambium A layer of lateral meristematic tissue between the cork and the phloem in the bark of woody plants.

coronary arteries Arteries that supply the heart's muscle fibers with nutrients and oxygen.

corpus callosum Tightly bundled nerve fibers that connect the right and left hemispheres of the cerebrum.

corpus luteum A structure formed from the ovulated follicle in the ovary; secretes progesterone and estrogen.

cortex 1) The outer part of an organ, e.g., the adrenal cortex, which produces several steroid hormones; 2) in plants, the region of the stem or root between the epidermis and the vascular bundle(s).

cortisol The primary glucocorticoid hormone; released by the adrenal cortex.

cotyledon A leaf-like structure that is present in the seeds of flowering plants; appears during seed germination and sometimes is referred to as a seed leaf.

countercurrent flow An arrangement by which fish obtain oxygen from the water that flows through their gills. Water flows across the respiratory surface of the gill in one direction while blood flows in the other direction through the blood vessels on the other side of the surface.

courtship behavior   Behavioral sequences that precede mating.

covalent bond A chemical bond created by the sharing of electrons between atoms.

cranium The braincase; composed of several bones fitted together at immovable joints.

cristae Structures formed by the folding of the inner membrane of a mitochondrion (sing.: crista).

crossing-over During the first meiotic prophase, the process in which part of a chromatid is physically exchanged with another chromatid to form chromosomes with new allele combinations.

crossopterygians A type of lobe-finned fish with lungs that were ancestral to amphibians.

crustaceans A large taxonomic class of arthropods that includes lobsters, shrimps, and crabs.

cuticle   A film composed of wax and cutin that occurs on the external surface of plant stems and leaves and helps to prevent water loss.

cyanobacteria   Blue-green bacteria; unicellular or filamentous chains of cells that carry out photosynthesis.

cycads Group of gymnosperm seed plants that have large fern-like leaves and reproduce by cones but not flowers.

cycle A recurring sequence of events; e. g., the secretion of certain hormones at regular intervals.

cyclin A protein found in the dividing cells of many organisms that acts as a control during cell division.

cystic fibrosis An autosomal recessive genetic disorder that causes the production of mucus that clogs the airways of the lungs and the ducts of the pancreas and other secretory glands.

cytokinesis The division of the cytoplasm during cell division.

cytokinins A group of hormones that promote cell division and inhibit aging of green tissues in plants.

cytology The branch of biology dealing with cell structure.

cytoplasm The viscous semiliquid inside the plasma membrane of a cell; contains various macromolecules and organelles in solution and suspension.

cytosine One of the pyrimidine nitrogenous bases occurring in both DNA and RNA.

cytoskeleton A three-dimensional network of microtubules and filaments that provides internal support for the cells, anchors internal cell structures, and functions in cell movement and division.

cytoxic T cells T cells that destroy body cells infected by viruses or bacteria; also attack bacteria, fungi, parasites, and cancer cells and will kill cells of transplanted organs if they are recognized as foreign; also known as killer T cells.

D

dark reactions The photosynthetic process in which food (sugar) molecules are formed from carbon dioxide from the atmosphere with the use of ATP; can occur in the dark as long as ATP is present.

death rate The ratio between deaths and individuals in a specified population at a particular time.

deciduous Term applied to trees that lose the leaves and have a dormancy period at least once per year.

deletion The loss of a chromosome segment without altering the number of chromosomes.

dendrites Short, highly branched fibers that carry signals toward the cell body of a neuron.

dendrochronology The process of determining the age of a tree or wood used in structures by counting the number of annual growth rings.

deoxyribonucleic acid (DNA) A nucleic acid composed of two polynucleotide strands wound around a central axis to form a double helix; the repository of genetic information. Nucleic acid that functions as the physical carrier of inheritance for 99% of all species. The molecule is double-stranded and composed of two strands in an antiparallel and complementary arrangement. The basic unit, the nucleotide, consists of a molecule of deoxyribose sugar, a phosphate group, and one of four nitrogenous bases.

deoxyribose Five-carbon sugar found in nucleotides of DNA.

depth diversity gradient The increase in species richness with increasing water depth until about 2000 meters below the surface, where species richness begins to decline.

dermal system Plant organ system that provides the covering for the plant.

dermis One of the two layers of skin; a connective tissue layer under the epidermis containing elastic and collagen fibers, capillary networks, and nerve endings.

desert biome Characterized by dry conditions and plants and animals that have adapted to those conditions; found in areas where local or global influences block rainfall.

desmosome A circular region of membrane cemented to an adjacent membrane by a molecular glue made of polysaccharides; found in tissues that undergo stretching.

deuterostomes Animals in which the first opening that appears in the embryo becomes the anus while the mouth appears at the other end of the digestive system. Main groups include chordates and echinoderms.

diabetes mellitus, Types I and II A disorder associated with defects in insulin action. Type I diabetes is characterized by inadequate insulin secretion; Type II diabetes is characterized by impaired insulin secretion in response to elevated blood glucose levels or by loss of sensitivity to insulin by target cells.

diaphragm A dome-shaped muscle that separates the thoracic and abdominal cavities.

diastole The filling of the ventricle of the heart with blood.

diatomaceous earth Fossilized deposits of diatoms; used for abrasives, polishes and as a filtering agent.

dicots One of the two main types of flowering plants; characterized by having two cotyledons, floral organs arranged in cycles of four or five, and leaves with reticulate veins; include trees (except conifers) and most ornamental and crop plants.

dictyosomes Organelles in plant cells composed of a series of flattened membrane sacs that sort, chemically modify, and package proteins produced on the rough endoplasmic reticulum. Also known as the Golgi Apparatus.

diencephalon Part of the forebrain; consists of the thalamus and hypothalamus.

diffusion The spontaneous movement of particles from an area of higher concentration to an area of lower concentration.

digestion The process of breaking down food into its molecular and chemical components so that these nutrient molecules can cross plasma membranes.

digestive system One of eleven major body organ systems in animals; converts food from the external environment into nutrient molecules that can be used and stored by the body and eliminates solid wastes; involves five functions: movement, secretion, digestion, absorption, and elimination.

dihybrid cross In genetics, a cross that involves two sets of characteristics.

dinoflagellates Single-celled to colonial protistans characterized by two flagella, one girdling the cell and the other trailing the cell.

dinosaurs Any of the Mesozoic reptiles belonging to the groups designated as ornithischians and saurischians.

diploid Cells that contain homologous chromosomes. The number of chromosomes in the cells is the diploid number and is equal to 2n (n is the number of homologous pairs).

directional selection A process of natural selection that tends to favor phenotypes at one extreme of the phenotypic range.

disaccharides 1. Sugars made up of two monosaccharides held together by a covalent bond; e.g., sucrose and lactose. 2. Type of sugar (saccharide) composed of two sugar molecules bonded together with an ester (covalent) bond examples include sucrose, maltose, and lactose.

discontinuous variation Occurs when the phenotypes of traits controlled by a single gene can be sorted into two distinct phenotypic classes.

disruptive selection A process of natural selection that favors individuals at both extremes of a phenotypic range.

distal tubule The section of the renal tubule where tubular secretion occurs.

divergent evolution The divergence of a single interbreeding population or species into two or more descendant species.

divergent plate boundary The boundary between two tectonic plates that are moving apart.

diversity The different types of organisms that occur in a community.

DNA hybridization The formation of hybrid DNA molecules that contain a strand of DNA from two different species. The number of complementary sequences in common in the two strands is an indication of the degree of relatedness of the species.

DNA ligase In recombinant DNA technology, an enzyme that seals together two DNA fragments from different sources to form a recombinant DNA molecule.

DNA polymerase In DNA replication, the enzyme that links the complementary nucleotides together to form the newly synthesized strand.

dominance The property of one of a pair of alleles that suppresses the expression of the other member of the pair in heterozygotes.

dominance hierarchy A social structure among a group of animals in which one is dominant and the others have subordinate nonbreeding positions.

dominant Refers to an allele of a gene that is always expressed in heterozygotes.

double fertilization A characteristic of angiosperms in which a pollen tube carries two sperm cells to the female gametophyte in the ovule. One sperm cell fuses with the egg cell and gives rise to a diploid embryo The other sperm cell fuses with the two polar cells to form a triploid cell that develops into the endosperm.

duodenum The upper part of the small intestine.

duplication An extra copy of a chromosome segment without altering the number of chromosomes.

dystrophin Protein making up only 0.002% of all protein in skeletal muscle but which appears vital for proper functioning of the muscle. Sufferers of muscular dystrophy appear to lack dystrophin.

E

eccrine glands Sweat glands that are linked to the sympathetic nervous system and are widely distributed over the body surface.

ecological niche The role an organism occupies and the function it performs in an ecosystem; closely associated with feeding.

ecological time A timescale that focuses on community events that occur on the order of tens to hundreds of years.

ecology The study of how organisms interact with each other and their physical environment.

ecosystem The community living in an area and its physical environment.

ecotones Well-deÞned boundaries typical of closed communities.

ecotype A subdivision of a species; a stage in the formation of a species such that reproductive isolation has occurred.

ectoderm The outer layer of cells in embryonic development; gives rise to the skin, brain, and nervous system. Also, the outermost tissue layer in þatworms.

ectotherms Animals with a variable body temperature that is determined by the environment. Examples: fish, frogs, and reptiles.

effector In a closed system, the element that initiates an action in response to a signal from a sensor. In human systems, a muscle or gland often serves as an effector.

ejaculatory duct In males, a short duct that connects the vas deferens from each testis to the urethra.

electron A subatomic particle with a negative charge. Electrons circle the atom's nucleus in regions of space known as orbitals.

electron acceptor A molecule that forms part of the electron transport system that transfers electrons ejected by chlorophyll during photosynthesis. Part of the energy carried by the electrons is transferred to ATP, part is transferred to NADPH, and part is lost in the transfer system.

electron transport 1) A series of coupled oxidation/reduction reactions where electrons are passed like hot potatoes from one membrane-bound protein/enzyme to another before being finally attached to a terminal electron acceptor (usually oxygen or NADPH). ATP is formed by this process. 2) coupled series of oxidation/reduction reactions during which ATP is generated by energy transfer as electrons move from high reducing state to lower reducing state. |

electrostatic attraction The attraction between atoms of opposite charge that holds the atoms together in ionic bonds.

element A substance composed of atoms with the same atomic number; cannot be broken down in ordinary chemical reactions.

elongation During protein synthesis, the growth of the polypeptide chain through the addition of amino acids; the second step in translation. |

embryo Term applied to the zygote after the beginning of mitosis that produces a multicellular structure.

embryo sac Alternate term applied to the angiosperm female gametophyte contained within a megaspore.

emphysema Lung disease characterized by shortness of breath, often associated with smoking.

endergonic Chemical reactions that require energy input to begin.

endochondral ossification The process by which human bones form from cartilage.

endocrine system One of eleven major body organ systems in animals; a system of glands that works with the nervous system in controlling the activity of internal organs, especially the kidneys, and in coordinating the long-range response to external stimuli.

endocytosis The incorporation of materials from outside the cell by the formation of vesicles in the plasma membrane. The vesicles surround the material so the cell can engulf it.

endoderm The inner layer of cells in embryonic development that gives rise to organs and tissues associated with digestion and respiration. Also, the inner tissue layer in þatworms.

endodermis A layer of cells surrounding the vascular cylinder of plants.

endometrium The inner lining of the uterus.

endoplasmic reticulum (ER) A network of membranous tubules in the cytoplasm of a cell; involved in the production of phospholipids, proteins, and other functions. Rough ER is studded with ribosomes; smooth ER is not.

endoskeleton An internal supporting skeleton with muscles on the outside; in vertebrates, consists of the skull, spinal column, ribs, and appendages.

endosperm A food storage tissue that provides nutrients to the developing embryo in angiosperms; formed from the triploid cell produced when a sperm cell fertilizes the central cell. Some endosperm is solid (as in corn), some is liquid (as in coconut).

endosymbiosis Theory that attempts to explain the origin of the DNA-containing mitochondria and chloroplasts in early eukaryotes by the engulfing of various types of bacteria that were not digested but became permanent additions to the ancestral "eukaryote".

endothermic A reaction that gives off energy. The product is in a lower energy state than the reactants.

endotherms Animals that have the ability to maintain a constant body temperature over a wide range of environmental conditions.

endothermy The internal control of body temperature; the ability to generate and maintain internal body heat.

energy The ability to bring about changes or to do work.

energy flow The movement of energy through a community via feeding relationships.

energy of activation The minimum amount of energy required for a given reaction to occur; varies from reaction to reaction.

entropy The degree of disorder in a system. As energy is transferred from one form to another, some is lost as heat; as the energy decreases, the disorder in the system&emdash;and thus the entropy&emdash;increases.

enzymes Protein molecules that act as catalysts in biochemical reactions.

epidermis 1. The outermost layer of skin consisting of several layers of epithelial cells&emdash;notably, keratinocytes&emdash;and, in the inner layer of the epidermis, basal cells and melanocytes. 2. The outer layer of cells in the plant body, often covered by a waxy cuticle.

epididymis A long, convoluted duct on the testis where sperm are stored.

epiglottis A þap of tissue that closes off the trachea during swallowing.

epinephrine A hormone produced by the adrenal medulla and secreted under stress; contributes to the "Þght or þight" response.

epistasis The masking of the effects of one gene by the action of another, example: widow's peak masked by the baldness gene.

epithelial tissue Cells in animals that are closely packed in either single or multiple layers, and which cover both internal and external surfaces of the animal body. Also referred to as epithelium.

eras One of the major divisions of the geologic time scale.

erythrocytes Red blood cells; doubly concave, enucleated cells that transport oxygen in the blood.

esophagus The muscular tube extending between and connecting the pharynx to the stomach.

estrogen A female sex hormone that performs many important functions in reproduction.

ethylene A gaseous plant hormone that stimulates fruit ripening and the dropping of leaves.

Eubacteria The subunit of the Monera that includes the true bacteria such as *E. coli*. One of the three major groups of prokaryotes in the Kingdom Monera. The eubacteria have cell walls containing peptidoglycan.

Euglenoids Term applied to a division of protozoans that have one long flagellum, no cell wall, and which may have chloroplasts.

eukaryote A type of cell found in many organisms including single-celled protists and multicellular fungi, plants, and animals; characterized by a membrane-bounded nucleus and other membraneous organelles; an organism composed of such cells. The first eukaryotes are encountered in rocks approximately 1.2-1.5 billion years old.

euphotic zone The upper part of the marine biome where light penetrates and photosynthesis occurs; usually extends to about 200 meters below the water surface.

eutrophication "Runaway" growth of aquatic plants that occurs when agricultural fertilizers containing phosphorus and nitrogen run off into lakes and ponds; also ultimately increases the plant death rate with the result that the bacterial decomposition of the dead plants uses up oxygen, causing Þsh and other organisms to suffocate.

evaporation The part of the hydrologic cycle in which liquid water is converted to vapor and enters the atmosphere.

evolution 1) The change in life over time by adaptation, variation, over-reproduction, and differential survival/reproduction, a process referred to by Charles Darwin and Alfred Wallace as natural selection. 2) Descent with modification.

evolutionary tree A diagram showing the evolutionary history of organisms based on differences in amino acid sequences. Organisms with fewer differences are placed closer together while those with more differences are further apart.

excretion The process of removing the waste products of cellular metabolism from the body.

excretory system One of eleven major body systems in animals; regulates the volume and molecular and ionic constitution of internal body þuids and eliminates metabolic waste products from the internal environment.

exine Outer covering of pollen grains, often containing sporopollenin, an acid-resistant polysaccharide that allows pollen grains to become fossils.

exocytosis The process in which a membrane-enclosed vesicle Þrst fuses with the plasma membrane and then opens and releases its contents to the outside.

exon The DNA bases that code for an amino acid sequence. Exons are separated by introns that code for no amino acid sequences.

exoskeleton A hard, jointed, external covering that encloses the muscles and organs of an organism; typical of many arthropods including insects.

exothermic A reaction where the product is at a higher energy level than the reactants.

exponential rate An extremely rapid increase, e.g., in the rate of population growth.

expression In relation to genes, the phenotypic manifestation of a trait. Expression may be age-dependent (e.g., Huntington disease) or affected by environmental factors (e.g., dark fur on Siamese cats).

extinction The elimination of all individuals in a group, both by natural (dinosaurs, trilobites) and human-induced (dodo, passenger pigeon, liberals [:)]) means.

extracellular digestion A form of digestion found in annelids, crustaceans, and chordates including vertebrates; takes place within the lumen of the digestive system, and the resulting nutrient molecules are transferred into the blood or body þuid.

extracellular route Path taken by water through the root in which water moves through the spaces between cell walls of the cortex parenchyma.

eyespot 1. A pigmented photoreceptor in euglenoids. The eyespot senses light and orients the cell for maximum rates of photosynthesis. . Term applied to a photosenstive area in starfish.

F

families 1. In taxonomy, term applied to subcategories within orders. 2. Term applied to a group of similar things, such as languages, chromosomes, etc.

fats 1. Triglycerides that are solid at room temperature. 2. A legendary pool player from Minnesota?

fauna Term referring collectively to all animals in an area. The zoological counterpart of flora.

feces Semisolid material containing undigested foods, bacteria, bilirubin, and water that is produced in the large intestine and eliminated from the body. Frequently noted as "hitting the fan".

femur The upper leg bone.

fermentation The synthesis of ATP in the absence of oxygen through glycolysis. |

fertilization The fusion of two gametes (sperm and ovum) to produce a zygote that develops into a new individual with a genetic heritage derived from both parents. Strictly speaking, fertilization can be divided into the fusion of the cells (plasmogamy) and the fusion of nuclei (karyogamy).

fibroblast A term applied to a cell of connective tissue that is separated from similar cells by some degree of matrix material; fibroblasts secrete elastin and collagen protein fibers.

fibrous root A root system found in monocots in which branches develop from the adventitious roots, forming a system in which all roots are about the same size and length.

filaments Slender, thread-like stalks that make up the stamens of a þower; topped by the anthers.

filter feeders Organisms such as sponges that feed by removing food from water that Þlters through their body.

filtration The removal of water and solutes from the blood; occurs in the glomerulus of the nephron.

first law of thermodynamics (conservation) Energy is neither created nor destroyed, it changes from one form to another.

fitness A measure of an individual's ability to survive and reproduce; the chance that an individual will leave more offspring in the next generation than other individuals.

flagella long, whip-like locomotion organelles found in both prokaryotic and eukaryotic cells; sing.: flagellum. Eukaryotic flagella have an internal arrangement of microtubules in a $9 + 2$ array.

flame cell A specialized cell at the blind end of a nephridium that Þlters body þuids.

flora Term collectively applied to all of the plants in an area. The botanical counterpart of fauna.

flowers The reproductive structures in angiosperm sporophytes where gametophytes are generated.

fluid feeders Animals such as aphids, ticks, and mosquitoes that pierce the body of a host plant or animal and obtain food from ingesting its þuids.

fluid-mosaic Widely accepted model of the plasma membrane in which proteins (the mosaic) are embedded in lipids (the þuid).

follicles (ovary) Structures in the ovary consisting of a developing egg surrounded by a layer of follicle cells.

follicles (thyroid) Spherical structures that make up the thyroid gland; contain a gel-like colloid surrounded by a single layer of cells, which secrete thyroglobulin into the colloid.

follicle-stimulating hormone (FSH) A hormone secreted by the anterior pituitary that promotes gamete formation in both males and females.

fontanels Membranous areas in the human cranial bones that do not form bony structures until the child is 14 to 18 months old; know as "soft spots."

food chain The simplest representation of energy þow in a community. At the base is energy stored in plants, which are eaten by small organisms, which in turn are eaten by progressively larger organisms; the food chain is an oversimpliÞcation in that most animals do not eat only one type of organism.

food pyramid A way of depicting energy þow in an ecosystem; shows producers (mostly plants or other phototrophs) on the Þrst level and consumers on the higher levels.

food web A complex network of feeding interrelations among species in a natural ecosystem; more accurate and more complex depiction of energy þow than a food chain.

foraminifera Single-celled protists that secrete a shell or test. Accumulations of the shells of dead foraminifera and other microscopic sea creatures form chalk deposits. |

forebrain The part of the brain that consists of the diencephalon and cerebrum.

fossil 1. The remains or traces of prehistoric life preserved in rocks of the Earth's crust. 2. Any evidence of past life.

fossil fuels Fuels that are formed in the Earth from plant or animal remains; e.g., coal, petroleum, and natural gas.

fossil record 1. The observed remains of once-living organisms taken as a whole. 2. the album **Meet the Beatles.**

founder effect The difference in gene pools between an original population and a new population founded by one or a few individuals randomly separated from the original population, as when an island population is founded by one or a few individuals; often accentuates genetic drift.

fovea The area of the eye in which the cones are concentrated.

freshwater biome The aquatic biome consisting of water containing fewer salts than the waters in the marine biome; divided into two zones: running waters (rivers, streams) and standing waters (lakes, ponds).

frontal lobe The lobe of the cerebral cortex that is responsible for motor activity, speech, and thought processes.

fruit A ripened ovary wall produced from a flower.

fucoxanthin Brown accessory pigment found in and characteristic of the brown algae.

Fungi Nonmobile, heterotrophic, mostly multicellular eukaryotes, including yeasts and mushrooms.

G

Gaia A hypothetical superorganism composed of the Earth's four spheres: the biosphere, hydrosphere, lithosphere, and atmosphere.

gametes Haploid reproductive cells (ovum and sperm).

gametophyte The haploid stage of a plant exhibiting alternation of generations, generates gametes by the process of mitosis.

ganglia Clusters of neurons that receive and process signals; found in þatworms and earthworms.

gap junctions Junctions between the plasma membranes of animal cells that allow communication between the cytoplasm of adjacent cells.

gastric pits The folds and grooves into which the stomach lining is arranged.

gastrin A hormone produced by the pyloric gland area of the stomach that stimulates the secretion of gastric acids.

gastroesophageal sphincter A ring of muscle at the junction of the esophagus and the stomach that remains closed except during swallowing to prevent the stomach contents from entering the esophagus.

gene pool The sum of all the genetic information carried by members of a population. Note: there is *no* diving in the deep end of the gene pool!

genera Taxonomic subcategories within families (sing.: genus), composed of one or more species.

genes SpeciÞc segments of DNA that control cell structure and function; the functional units of inheritance. Sequence of DNA bases usually code for a polypeptide sequence of amino acids.

gene therapy The insertion of normal or genetically altered genes into cells through the use of recombinant DNA technology; usually done to replace defective genes as part of the treatment of genetic disorders.

genetic code The linear series of nucleotides, read as triplets, that speciÞes the sequence of amino acids in proteins. Each triplet speciÞes an amino acid, and the same codons are used for the same amino acids in almost all life-forms, an indication of the universal nature of the code.

genetic divergence The separation of a population's gene pool from the gene pools of other populations due to mutation, genetic drift, and selection. Continued divergence can lead to speciation.

genetic drift Random changes in the frequency of alleles from generation to generation; especially in small populations, can lead to the elimination of a particular allele by chance alone.

genetic maps Diagrams showing the order of and distance between genes; constructed using crossover information.

genetics The study of the structure and function of genes and the transmission of genes from parents to offspring.

genital herpes A sexually transmitted disease caused by the herpes virus; results in sores on the mucus membranes of the mouth or genitals.

genome 1. The set of genes carried by an individual. 2. The set of genes shared by members of a reproductive unit such as a population or species.

genotype The genetic (alleleic) makeup of an organism with regard to an observed trait.

geographic isolation Separation of populations of a species by geographic means (distance, mountains, rivers, oceans, etc.) that lead to reproductive isolation of those populations.

geographic range The total area occupied by a population.

geological time The span of time that has passed since the formation of the Earth and its physical structures; also, a timescale that focuses on events on the order of thousands of years or more.

geotropism Plants' response to gravity: roots grow downward, showing positive geotropism, while shoots grow upward in a negative response.

germ cells Collective term for cells in the reproductive organs of multicellular organisms that divide by meiosis to produce gametes.

gestation Period of time between fertilization and birth of an animal. Commonly called pregnancy.

gibberellins A group of hormones that stimulate cell division and elongation in plants. Gibberellic acid (GA), the first of this class to be discovered, causes bolting (extreme elongation) of stems. GA is also applied to certain plants to promote larger fruits.

gill slits Opening or clefts between the gill arches in Þsh. Water taken in by the mouth passes through the gill slits and bathes the gills. Also, rudimentary grooves in the neck region of embryos of air-breathing vertebrates such as humans; a characteristic of chordates.

ginkgos Group of seed plants today restricted to a single genus (*Ginkgo biloba*); ginkgos were more diverse during the Mesozoic Era.

glial cells Nonconducting cells that serve as support cells in the nervous system and help to protect neurons.

glomerulus A tangle of capillaries that makes up part of the nephron; the site of Þltration.

glucagon A hormone released by the pancreas that stimulates the breakdown of glycogen and the release of glucose, thereby increasing blood levels of glucose. Glucagon and insulin work together to maintain blood sugar levels.

glucocorticoids A group of steroid hormones produced by the adrenal cortex that are important in regulating the metabolism of carbohydrates, fats, and proteins.

glucose A six-carbon single sugar; the most common energy source.

glycogen Polysaccharide consisting of numerous monosaccharide glucoses linked together. The animal equivalent of starch.

glycolipids Polysaccharides formed of sugars linked to lipids, a part of the cell membrane.

glycolysis The universal cellular metabolic process in the cell's cytoplasm where 6-carbon glucose is split into two 3-carbon pyruvate molecules, and some ATP and NADH are produced. Click here to view the On-Line Biology Book chapter on glycolysis.

glycoproteins Polysaccharides formed of sugars linked to proteins. On the outer surface of a membrane, they act as receptors for molecular signals originating outside the cell.

gnetales Group of seed plants restricted to three genera today (*Gnetum*, *Ephedra*, and *Welwitschia*); the possible outgroup for flowering plants.

golden brown algae Common name applied to the protistan division Chrysophyta.

Golgi complex Organelles in animal cells composed of a series of þattened sacs that sort, chemically modify, and package proteins produced on the rough endoplasmic reticulum.

gonadotropin-releasing hormone (GnRH) A hormone produced by the hypothalamus that controls the secretion of luteinizing hormone.

gonadotropins Hormones produced by the anterior pituitary that affect the testis and ovary; include follicle-stimulating hormone and luteinizing hormone.

gonads The male and female sex organs.

Gondwana Name applied to the ancient (Paleozoic-early Mesozoic) southern hemisphere supercontinent that rifted apart to form present-day Antarctica, India, Africa, Australia, and South America. The southern part of Pangaea.

gonorrhea A sexually transmitted disease that is caused by a bacterium that inþames and damages epithelial cells of the reproductive system.

grana A series of stacked thylakoid disks containing chlorophyll; found in the inner membrane of chloroplasts.

grasslands biome Occurs in temperate and tropical regions with reduced rainfall or prolonged dry seasons; characterized by deep, rich soil, an absence of trees, and large herds of grazing animals.

green algae Common name for algae placed in the division Chlorophyta.

greenhouse effect The heating that occurs when gases such as carbon dioxide trap heat escaping from the Earth and radiate it back to the surface; so-called because the gases are transparent to sunlight but not to heat and thus act like the glass in a greenhouse.

ground system Plant tissue system, composed mainly of parenchyma cells with some collenchyma and sclerenchyma cells, that occupies the space between the epidermis and the vascular system; is involved in photosynthesis, water and food storage, and support; one of the four main tissue systems in plants.

growth hormone (GH) A peptide hormone produced by the anterior pituitary that is essential for growth.

growth rings Features of woody stems produced by plants growing in areas with seasonal (as opposed to year-long) growth. The growth ring marks the position of the vascular cambium at the cessation of the previous year's growth.

guard cells Specialized epidermal cells that flank stomates and whose opening and closing regulates gas exchange and water loss. |

guanine One of the nitrogenous bases in nucleic acids, guanine is one of the two purine bases.

gymnosperms Flowerless, seed-bearing land plants; the Þrst seed plants; living groups include the pines, ginkgos, and cycads. Naked seeds.

gynoecium Collective term for all of the carpels (or pistils) in a flower. Some flowers have many pistils that are partially or wholly fused.

H

habitat disruption A disturbance of the physical environment in which a population lives.

hair bulb The base of a hair; contains cells that divide mitotically to produce columns of hair cells.

hair root The portion of a hair that extends from the skin's surface to the hair bulb.

hair shaft The portion of a hair that extends above the skin's surface.

half-life The time required for one-half of an original unstable radioactive element to be converted to a more stable daughter element.

halophiles A group of archaebacteria that are able to tolerate high salt concentrations.

haploid Cells that contain only one member of each homologous pair of chromosomes (haploid number = n). At fertilization, two haploid gametes fuse to form a single cell with a diploid number of chromosomes.

hardwoods Term applied to dicot trees, as opposed to softwoods, a term applied to gymnosperms.

Haversian canal The central opening of compact bone; contains nerves and blood vessels.

heart The multicellular, chambered, muscular structure that pumps blood through the circulatory system by alternately contracting and relaxing.

heartwood Inner rings of xylem that have become clogged with metabolic by-products and no longer transport water; visible as the inner darker areas in the cross section of a tree trunk.

helper T cells A type of lymphocyte that stimulates the production of antibodies by activating B cells when an antigen is present.

hemizygous Having one or more genes that have no allele counterparts. Usually applied to genes on the male's X chromosome (in humans).

hemoglobin A red pigment in red blood cells that can bind with oxygen and is largely responsible for the blood's oxygen-carrying capacity. Hemoglobin is composed of four polypeptide chains, two alpha (α) and two beta (β) chains.

hemophilia A human sex-linked recessive genetic disorder that results in the absence of certain blood-clotting factors, usually Factor VII. Hemophiliacs suffer from an inability to clot their blood.

hepatitis B A potentially serious viral disease that affects the liver; can be transmitted through sexual contact or through contact with infected blood.

herbaceous Term applied to a nonwoody stem/plant with minimal secondary growth.

herbivores Term pertaining to a heterotroph, usually an animal, that eats plants or algae. Herbivores function in food chains and food webs as primary consumers.

heterogametic sex The sex with two different chromosomes, such as males in humans and *Drosophila*.

heterotrophic Refers to organisms, such as animals, that depend on preformed organic molecules from the environment (or another organism) as a source of nutrients/energy.

heterotrophs Organisms that obtain their nutrition by breaking down organic molecules in foods; include animals and fungi.

heterozygous Having two different alleles (one dominant, one recessive) of a gene pair.

histamine A chemical released during the inþammatory response that increases capillary blood þow in the affected area, causing heat and redness.

histone proteins Proteins associated with DNA in eukaryote chromosomes.

homeobox genes Pattern genes that establish the body plan and position of organs in response to gradients of regulatory molecules.

homeostasis The ability to maintain a relatively constant internal environment.

hominid Primate group that includes humans and all fossil forms leading to man only.

hominoid Primate group that includes common ancestors of humans and apes.

homologous structures Body parts in different organisms that have similar bones and similar arrangements of muscles, blood vessels, and nerves and undergo similar embryological development, but do not necessarily serve the same function; e.g., the þipper of a whale and the forelimb of a horse.

homologues A pair of chromosomes in which one member of the pair is obtained from the organism's maternal parent and the other from the paternal parent; found in diploid cells. Also commonly referred to as homologous chromosomes.

homozygous Having identical alleles for a given gene.

hormones Chemical substances that are produced in the endocrine glands and travel in the blood to target organs where they elicit a response.

human chorionic gonadotropin (hCG) A peptide hormone secreted by the chorion that prolongs the life of the corpus luteum and prevents the breakdown of the uterine lining.

Human Genome Project Federally funded project to determine the DNA base sequence of every gene in the human genome.

human immunodeficiency virus (HIV) The retrovirus that attacks T-cells in the human immune system, destroying the body's defenses and allowing the development of AIDS.

Huntington disease A progressive and fatal disorder of the nervous system that develops between the ages of 30 and 50 years; caused by an expansion of a trinucleotide repeat and inherited as a dominant trait.

hydrogen bond A weak bond between two atoms (one of which is hydrogen) with partial but opposite electrical charges.

hydrophilic Water-loving. Term applied to polar molecules that can form a hydrogen bond with water.

hydrophobic Water-fearing.Term applied to nonpolar molecules that cannot bond with water.

hydrophytic leaves The leaves of plants that grow in water or under conditions of abundant moisture.

hydrosphere The part of the physical environment that consists of all the liquid and solid water at or near the Earth's surface.

hydrostatic skeleton Fluid-Þlled closed chambers that give support and shape to the body in organisms such as jellyÞsh and earthworms. No to be confused with the water-vascular system of echinoderms.

hypertension High blood pressure; blood pressure consistently above 140/90.

hypertonic A solution having a high concentration of solute.

hyphae The multinucleate or multicellular Þlaments that make up the mycelium (body) of a fungus (sing.: hypha).

hypothesis An idea that can be experimentally tested; an idea with the lowest level of confidence.

hypothalamus A region in the brain beneath the thalamus; consists of many aggregations of nerve cells and controls a variety of autonomic functions aimed at maintaining homeostasis.

hypotonic A solution having a low concentration of solute.

I

ice age Interval of geologic time between 2 million and 10,000 years ago during which the northern hemisphere experienced several episodes of continental glacial advance and retreat along with a climatic cooling. The icing over of Antarctica was also completed during this time.

ileum The third and last section of the small intestine.

immovable joint A joint in which the bones interlock and are held together by Þbers or bony processes that prevent the joint from moving; e.g., the bones of the cranium.

immune system One of the eleven major body organ systems in vertebrates; defends the internal environment against invading microorganisms and viruses and provides defense against the growth of cancer cells.

immunoglobulins The five classes of protein to which antibodies belong (IgD, IgM, IgG, IgA, IgE).

implantation The process in which the blastocyst embeds in the endometrium.

incomplete dominance A type of inheritance in which the heterozygote has a phenotype intermediate to those of the homozygous parents.

incus One of the three bones comprising the middle ear of mammals.

inflammation A reaction to the invasion of microorganisms through the skin or through the epithelial layers of the respiratory, digestive, or urinary system; characterized by four signs: redness, swelling, heat, and pain.

inflammatory response The body's reaction to invading infectious microorganisms; includes an increase in blood flow to the affected area, the release of chemicals that draw white blood cells, an increased flow of plasma, and the arrival of monocytes to clean up the debris.

ingestive feeders Animals that ingest food through a mouth.

inheritance of acquired characteristics Lamarck's view that features acquired during an organism's lifetime would be passed on to succeeding generations, leading to inheritable change in species over time.

initiation The first step in translation; occurs when a messenger RNA molecule, a ribosomal subunit, and a transfer RNA molecule carrying the first amino acid bind together to form a complex; begins at the start codon on mRNA.

initiation codon (AUG) Three-base sequence on the messenger RNA that codes for the amino acid methionine; the start command for protein synthesis.

insertion A type of mutation in which a new DNA base is inserted into an existing sequence of DNA bases. This shifts the reference frame in protein synthesis, resulting (sometimes) in altered amino acid sequences.

insulin A hormone secreted by the pancreas that stimulates the uptake of glucose by body cells. Insulin works antagonistically with glucagon to control blood sugar levels.

integration The process of combining incoming information; one of the functions of the nervous system.

integument Something that covers or encloses, e.g., the skin.

integumentary system The skin and its derivatives (hair, nails, feathers, horns, antlers, and glands), which in multicellular animals protect against invading foreign microorganisms and prevent the loss or exchange of internal þuids.

interferons Proteins released by cells in response to viral infection; activate the synthesis and secretion of antiviral proteins.

internal environment In multicellular organisms, the aqueous environment that is outside the cells but inside the body.

interneurons Neurons that process signals from one or more sensory neurons and relay signals to motor neurons. Aka connector neurons.

internodes The stem regions between nodes in plants.

interphase The period between cell divisions when growth and replacement occur in preparation for the next division; consists of gap 1 (G1), synthesis (S), and gap 2 (G2).

interstitial Being situated within a particular organ or tissue.

interstitial fluid Fluid surrounding the cells in body tissues; provides a path through which nutrients, gases, and wastes can travel between the capillaries and the cells.

intracellular digestion A form of digestion in which food is taken into cells by phagocytosis; found in sponges and most protozoa and coelenterates.

intracellular parasites Viruses that enter a host cell and take over the host's cellular machinery to produce new viral particles.

intracellular route Path taken by water through the cells of the root between the epidermis and the xylem, moving through plasmodesmata.

intron In eukaryotes, bases of a gene transcribed but later excised from the mRNA prior to exporting from the nucleus and subsequent translation of the message into a polypeptide.

inversion A reversal in the order of genes on a chromosome segment.

ion An atom that has lost or gained electrons from its outer shell and therefore has a positive or negative charge, respectively; symbolized by a superscript plus or minus sign and sometimes a number, e.g., H^+, Na^{+1}, Cl^{-2}.

ionic bond A chemical bond in which atoms of opposite charge are held together by electrostatic attraction.

isotonic Term applied to two solutions with equal solute concentrations.

isotopes Atoms with the same atomic number but different numbers of neutrons; indicated by adding the mass number to the element's name, e.g., carbon 12 or ^{12}C.

J K

jejunum The second portion of the small intestine. Also, a popular month for weddings!

Jurassic Period Middle period of the Mesozoic Era, between 185-135 million years ago. Characterized by the (possible) origin of angiosperms and the continued split of the worldwide supercontinent of Pangaea.

karyotype The chromosomal characteristics of a cell; also, a representation of the chromosomes aligned in pairs.

keratin A Þbrous protein that Þlls mature keratinocytes near the skin's surface.

keratinocytes The basic cell type of the epidermis; produced by basal cells in the inner layer of the epidermis.

kidney stones Crystallized deposits of excess wastes such as uric acid, calcium, and magnesium that may form in the kidney.

killer T cells See cytoxic T cells.

kilocalorie The energy needed to heat 1000 grams of water from 14.5 to 15.5 degrees C.

kinetochores Structures at the centromeres of the chromosomes to which the Þbers of the mitotic spindle connect.

kingdoms Five broad taxonomic categories (Monera, Protista, Plantae, Fungi, Animalia) into which organisms are grouped, based on common characteristics.

Klinefelter syndrome In humans, a genetically determined condition in which the individual has two X and one Y chromosome. Affected individuals are male and typically tall and infertile.

Kreb's cycle Biochemical cycle in cellular aerobic metabolism where acetyl CoA is combined with oxaloacetate to form citric acid; the resulting citric acid is converted into a number of other chemicals, eventually reforming oxaloacetate; NADH, some ATP, and $FADH_2$ are produced and carbon dioxide is released.

L

labia majora The outer folds of skin that cover and protect the genital region in women.

labia minora Thin membranous folds of skin outside the vaginal opening.

lactose intolerance A genetic trait characterized by the absence of the enzyme lactase, which breaks down lactose, the main sugar in milk and other dairy products.

Langerhans' cells Epidermal cells that participate in the inþammatory response by engulfing microorganisms and releasing chemicals that mobilize immune system cells.

large intestine Consists of the cecum, appendix, colon, and rectum; absorbs some nutrients, but mainly prepares feces for elimination.

larva A stage in the development of many insects and other organisms including sea urchins and sponges. In sponges, sexual reproduction results in the production of motile ciliated larvae.

larynx A hollow structure at the beginning of the trachea. The vocal cords extend across the opening of the larynx.

lateral roots Roots extending away from the main (or taproot) root.

latitudinal diversity gradient The decrease in species richness that occurs as one moves away from the equator.

latitudinal gradient As latitude increases, a gradient of cooler, drier conditions occurs.

law of the minimum Holds that population growth is limited by the resource in shortest supply.

L-dopa A chemical related to dopamine that is used in the treatment of Parkinson's disease.

leaf primordia Young leaves, recently formed by the shoot apical meristem, located at the tip of a shoot.

leaf veins Vascular tissue in leaves, arranged in a net-like network (reticulate vennation) in dicots, and running parallel (parallel vennation) to each other in monocots.

leaves The site of photosynthesis; one of the three major organs in plants.

leukocytes White blood cells; primarily engaged in fighting infection.

lichens Autotrophic organisms composed of a fungus (sac or club fungus) and a photosynthetic unicellular organism (e.g., a cyanobacterium or alga) in a symbiotic relationship; are resistant to extremes of cold and drought and can grow in marginal areas such as Arctic tundra.

life history The age at sexual maturity, age at death, and age at other events in an individual's lifetime that inþuence reproductive traits.

ligaments Dense parallel bundles of connective tissue that strengthen joints and hold the bones in place.

light reactions The photosynthetic process in which solar energy is harvested and transferred into the chemical bonds of ATP; can occur only in light.

lignin A polymer in the secondary cell wall of woody plant cells that helps to strengthen and stiffen the wall; related term lignified.

linkage The condition in which the inheritance of a specific chromosome is coupled with that of a given gene. The genes stay together during meiosis and end up in the same gamete.

lipids One of the four classes of organic macromolecules. Lipids function in the long-term storage of biochemical energy, insulation, structure and control. Examples of lipids include the fats, waxes, oils and steroids (e.g. testosterone, cholesterol).

lipases Enzymes secreted by the pancreas that are active in the digestion of fats.

lithosphere The solid outer layer of the Earth; includes both the land area and the land beneath the oceans and other water bodies.

lobe-finned Fish with muscular fins containing large jointed bones that attach to the body; one of the two main types of bony fish.

logistic growth model A model of population growth in which the population initially grows at an exponential rate until it is limited by some factor; then, the population enters a slower growth phase and eventually stabilizes.

long-day plants Plants that þower in the summer when nights are short and days are long; e.g., spinach and wheat.

loop of Henle A U-shaped loop between the proximal and distal tubules in the kidney.

lungfish A type of lobe-finned fish that breathe by a modified swim bladder (or lung) as well as by gills.

lungs Sac-like structures of varying complexity where blood and air exchange oxygen and carbon dioxide; connected to the outside by a series of tubes and a small opening. In humans, the lungs are situated in the thoracic cavity and consist of the internal airways, the alveoli, the pulmonary circulatory vessels, and elastic connective tissues.

luteal phase The second half of the ovarian cycle when the corpus luteum is formed; occurs after ovulation.

luteinizing hormone (LH) A hormone secreted by the anterior pituitary gland that stimulates the secretion of testosterone in men and estrogen in women.

lymph Interstitial þuid in the lymphatic system.

lymphatic circulation A secondary circulatory system that collects þuids from between the cells and returns it to the main circulatory system; the circulation of the lymphatic system, which is part of the immune system.

lymphatic system A network of glands and vessels that drain interstitial þuid from body tissues and return it to the circulatory system.

lymph hearts Contractile enlargements of vessels that pump lymph back into the veins; found in fish, amphibians, and reptiles.

lymphocytes White blood cells that arise in the bone marrow and mediate the immune response; include T cells and B cells.

Lyon hypothesis Idea proposed by Mary Lyon that mammalian females inactivate one or the other X-chromosome during early embryogenesis. This deactivated chromosome forms the Barr body. |

lysosomes Membrane-enclosed organelles containing digestive enzymes. The lysosomes fuse with food vacuoles and enzymes contained within the lysosome chemically breakdown and/or digest the food vacuole's contents.

M

macroevolution The combination of events associated with the origin, diversification, extinction, and interactions of organisms which produced the species that currently inhabit the Earth. Large scale evolutionary change such as the evolution of new species (or even higher taxa) and extinction of species.

macromolecules Large molecules made up of many small organic molecules that are often referred to as monomers; e.g., carbohydrates, lipids, proteins, and nucleic acids. Macromolecules are polymers of monomers.

macronucleus In ciliates, the large nucleus that carries up to several hundred copies of the genome and controls metabolism and asexual reproduction.

macronutrients 1. Elements needed by plants in relatively large (primary) or smaller (secondary) quantities. 2. Foods needed by animals daily or on a fairly regular basis.

macrophages A type of white blood cell derived from monocytes that engulf invading antigenic molecules, viruses, and microorganisms and then display fragments of the antigen to activate helper T cells; ultimately stimulating the production of antibodies against the antigen.

malleus One of the bones comprising the middle ear of mammals.

Malpighian tubules The excretory organs of insects; a set of long tubules that open into the gut.

mammal-like reptiles Group of Permian-Triassic reptiles having some possible mammalian features, notably a more prominent dentary (tooth-bearing) bone and reduction of the incus and malleus (which are part of the reptilian jaw along with the dentary). The mammal-like reptiles are thought to have been the reptile group from which the mammals later evolved.

mantle In mollusks, a membranous or muscular structure that surrounds the visceral mass and secretes a shell if one is present.

marine biome The aquatic biome consisting of waters containing 3.5% salt on average; includes the oceans and covers more than 70% of the Earth's surface; divided into benthic and pelagic zones.

marsupials Pouched mammals. The young develop internally, but are born while in an embryonic state and remain in a pouch on the mother's abdomen until development is complete; this group includes kangaroos, koalas, and opossums. One of the three reproductive "strategies" of living mammals g-laying and placental being the other two), marsupials finish development in a pouch or under hairy coverings attached to the mother.

mass extinction A time during which extinction rates are generally accelerated so that more than 50% of all species then living become extinct; results in a marked decrease in the diversity of organisms. Mass extinctions are thought to have occurred numerous times in Earth history, often from a variety of reasons: impacts, tectonism, changes in primary productivity of the seas, etc.

mast cells Cells that synthesize and release histamine, as during an allergic response; found most often in connective tissue surrounding blood vessels.

matter Anything that has mass and occupies space.

matter cycling The þow of matter through various organisms and the physical environment of an ecosystem.

maximum sustainable yield (MSY) The maximum number of a food or game population that can be harvested without harming the population's ability to grow back.

medulla 1. A term referring to the central portion of certain organs; e.g., the medulla oblongata of the brain and the adrenal medulla, which synthesizes epinephrine and norepinephrine. 2. In more common usage, the area in the brain that regulates breathing, heartbeat, blood pressure and similar activities.

medulla oblongata The region of the brain that, with the pons, makes up the hindbrain; controls heart rate, constriction and dilation of blood vessels, respiration, and digestion.

medusa The motile bell-shaped form of body plan in cnidarians; e.g., jellyfish.

megakarocytes Cells found in the bone marrow that produce platelets.

megaspores Four haploid cells produced by meiosis in the ovule of a þower. Usually, three of these cells degenerate, with the remaining cell becoming the female gametophyte phase of the plant's life cycle. Large (palynologists consider the megaspores to generally be above 200 micrometers in diameter) spores that develop into the megagametophyte, which in turn produces eggs.

megaspore mother cell Cells that undergo meiosis to produce megaspores.

meiosis Cell division in which the chromosomes replicate, followed by two nuclear divisions. Each of the resulting gametes (in animals, spores in plants) receives a haploid set of chromosomes. Reduction/division by which ploidy, the number of sets of homologous chromosomes, is reduced in the formation of haploid cells that become gametes (or gametophytes in plants).

Meissner's corpuscles Sensory receptors concentrated in the epidermis of the fingers and lips that make these areas very sensitive to touch.

melanin A pigment that gives the skin color and protects the underlying layers against damage by ultraviolet light; produced by melanocytes in the inner layer of the epidermis.

melanocytes The cells in the inner layer of the epidermis that produce melanin.

membrane-attack complex (MAC) A large cylindrical multiprotein complex formed by the complement system; kills invading microorganisms by embedding in their plasma membrane, creating a pore through which þuid þows, ultimately causing the cell to burst.

menstrual cycle The recurring secretion of hormones and associated uterine tissue changes; typically 28 days in length.

menstruation The process in which the uterine endometrium breaks down and sheds cells, resulting in bleeding; occurs approximately once a month. The first day marks the beginning of the menstrual and ovarian cycles.

meristematic tissue Embryonic tissue located at the tips of stems and roots and occasionally along their entire length; can divide to produce new cells; one of the four main tissue systems in plants.

mesentary Epithelial cells supporting the digestive organs.

mesoderm The middle layer of cells in embryonic development; gives rise to muscles, bones, and structures associated with reproduction. The middle embryonic tissue layer. Cells and structures arising from the mesoderm include the bone, blood, muscle, skin, and reproductive organs.

mesoglea A gel-like matrix that occurs between the outer and inner epithelial layers in cnidarians.

mesophyll Layer of leaf tissue between the epidermis layers; literally meaning "middle of the leaf".

mesophytic leaves The leaves of plants that grow under moderately humid conditions with abundant soil and water.

Mesozoic Era The period of geologic time beginning 245 million years ago and ending 65 million years ago; the age of the dinosaurs and cycads, the Mesozoic falls between the Paleozoic and Cenozoic Eras and includes the Triassic, Jurassic, and Cretaceous Periods.

messenger RNA (mRNA) "Blueprint" for protein synthesis that is transcribed from one strand of the DNA (gene) and which is translated at the ribosome into a polypeptide sequence.

metabolic pathway A series of individual chemical reactions in a living system that combine to perform one or more important functions. The product of one reaction in a pathway serves as the substrate for the following reaction. Examples include glycolysis and Kreb's cycle.

metabolism The sum of all chemical reactions (energy exchanges) in cells.

metamorphosis The process of changing from one form to another; e.g., in insects, from the larval stage to the pupal stage to the reproductive adult stage.

metaphase The stage of eukaryotic cell division (mitosis or meiosis) in which the chromosomes line up at the equator of the cell.

metastasis The process in which cancer cells break away from the original tumor mass and establish new tumor sites elsewhere in the body.

methanogens A group of archaebacteria that produce methane as a by product of their metabolism.

methionine The amino acid coded for by the initiation codon; all polypeptides begin with methionine, although post-translational reactions may remove it.

micelles Structures formed when bile salts surround digested fats in order to enable the water-insoluble fats to be absorbed by the epithelial cells lining the small intestine.

microevolution A small-scale evolutionary event such as the formation of a species from a preexisting one or the divergence of reproductively isolated populations into new species.

microfilaments Rods composed of actin that are found in the cytoskeleton and are involved in cell division and movement. |

microgametophyte Stage of the plant life cycle that develops from or within a microspore. The microgametophyte produces sperm in specialized structures known as antheridia.

micronucleus In the protistan group known as the ciliates, the small nucleus containing a single copy of the genome that is used for sexual reproduction.

micronutrients Elements that are required by plants in very small quantities, but are toxic in large quantities: iron, manganese, molybdenum, copper, boron, zinc, and chloride.

micropyle The end of the embryo sac where the egg cell and synergids are located.

microsporangia Structures of the sporophyte in which microspores are produced by meiosis. In flowering plants the microsporangia are known as anther sacs.

microspore mother cell Cells in the microsporangium that undergo meiosis to produce microspores. In flowering plants the microspore is known as the pollen grain, and contains a three-celled male.

microspores Four haploid cells produced by the meiotic division in the pollen sacs of þowers or microsporangia of gymnosperms. Microspores undergo mitotic division and become encased in a thick protective wall to form pollen grains. Small, size usually less than 200 micrometers, spores produced by meiosis. Microspores either germinate into the male gametophyte or have the male gametophyte develop inside the microspore wall.

microtubules Filaments about 25 nanometers in diameter found in cilia, þagella, and the cytoskeleton.

microvilli Hair-like projections on the surface of the epithelial cells of the villi in the small intestine; increase the surface area of the intestine to improve absorption of digested nutrients.

midbrain A network of neurons that connects with the forebrain and relays sensory signals to other integrating centers.

middle lamella A layer composed of pectin that cements two adjoining plant cells together.

migration Movement of organisms either permanently (as in the migration of humans to the Americas) or temporarily (migratory birds such as Canadian geese).

mineralocorticoids A group of steroid hormones produced by the adrenal cortex that are important in maintaining electrolyte balance.

minerals Trace elements required for normal metabolism, as components of cells and tissues, and in nerve conduction and muscle contraction.

minimum viable population (MVP) The smallest population size that can avoid extinction due to breeding problems or random environmental þuctuations.

mitochondria Self-replicating membrane-bound cytoplasmic organelles in most eukaryotic cells that complete the breakdown of glucose, producing NADH and ATP (singular term: mitochondrion). The powerhouse of the cell. Organelles within eukaryotes that generate (by chemiosmosis) most of the ATP the cell needs to function and stay alive.

mitosis The division of the cell's nucleus and nuclear material of a cell; consists of four stages: prophase, metaphase, anaphase, and telophase. Cell xeroxing. Mitosis occurs only in eukaryotes. The DNA of the cell is replicated during interphase of the cell cycle and then segregated during the four phases of mitosis.

mitotic spindle A network of microtubules formed during prophase. Some microtubules attach to the centromeres of the chromosomes and help draw the chromosomes apart during anaphase.

mole Avogadro's number (6.02 X 10^{23} atoms) of a substance.

molecules Units of two or more atoms held together by chemical bonds. The combination of atoms by chemical bonds with the component atoms in definite porportions, such as water (two H to one O).

molecular biology Field of biology that studies the molecular level of organization.

Monera Prokaryotic kingdom that includes (in the most widely accepted classification system) archaebacteria, eubacteria, and cyanobacteria. Members of this kingdom were among the first forms of life over 3.5 billion years ago.

monocots One of the two major types of þowering plants; characterized by having a single cotyledon, þoral organs arranged in threesd or multiples of three, and parallel-veined leaves; include grasses, cattails, lilies, and palm trees. One of the two major groups in the Angiosperms, monocots are characterized by

having a single seed leaf (cotyledon), flower parts in 3's or multiples of 3, monoaperturate pollen (although some dicots also have this feature), parallel veins in their leaves, and scattered vascular bundles in their stems.

monoculture The growth of only one species in a given area; such as a cornfield or other agricultural field.

monocytes White blood cells that clean up dead viruses, bacteria, and fungi and dispose of dead cells and debris at the end of the inþammatory response.

monohybrid cross In genetics, a cross that involves only one characteristic.

monomer An organic chemical unit linked to other units (usually by a covalent bond formed by the removal of water) to produce a larger molecule (macromolecule) known as a polymer.

monophyletic group A group of organisms descended from a common ancestor. For example: your immediate family may be considered such a group, being descended from a common ancestral group (grandparents, etc.).

monosaccharides Simple carbohydrates, usually with a five- or six-carbon skeleton; e.g., glucose and fructose. A carbohydrate composed of a single sugar unit, such as glucose, ribose, deoxyribose, etc.

monotremes Egg-laying mammals; e.g., the spiny anteater and the duck-billed platypus.

morph A distinct phenotypic variant within a population.

morphological convergence The evolution of basically dissimilar structures to serve a common function. For example: the wings of birds and insects.

morula The solid-ball stage of the pre-emplantation embryo.

mosaic evolution A pattern of evolution where all features of an organism do not evolve at the same rate. Some characteristics are retained from the ancestral condition while others are more recently evolved.

motor neurons Neurons that receive signals from interneurons and transfer the signals to effector cells that produce a response. Nerve cells connected to a muscle or gland. Sometimes also known as effector neurons.

motor output A response to the stimuli received by the nervous system. A signal is transmitted to organs that can convert the signals into action, such as movement or a change in heart rate.

motor (efferent) pathways The portion of the peripheral nervous system that carries signals from the central nervous system to the muscles and glands.

motor units Consist of a motor neuron with a group of muscle fibers; form the units into which skeletal muscles are organized; enable muscles to contract on a graded basis.

mouth The oral cavity; the entrance to the digestive system where food is broken into pieces by the teeth and saliva begins the digestion process.

mucus A thick, lubricating fluid produced by the mucous membranes that line the respiratory, digestive, urinary, and reproductive tracts; serves as a barrier against infection and, in the digestive tract, moistens food, making it easier to swallow.

multicellular Organisms composed of multiple cells and exhibiting some division of labor and specialization of cell structure and function.

multinucleate Cells having more than one nucleus per cell.

muscle fibers Long, multinucleated cells found in skeletal muscles; made up of myofibrils. One of the four major groups of vertebrate cell/tissue types. Muscle cells contract/relax, allowing movement of and/or within the animal. | |

muscular system One of eleven major body organ systems in animals; allows movement and locomotion, powers the circulatory, digestive, and respiratory systems, and plays a role in regulating temperature.

mutation Any heritable change in the nucleotide sequence of DNA; can involve substitutions, insertions, or deletions of one or more nucleotides.

mutation rate The average occurrence of mutations in a species per a given unit of time.

mutualism A form of symbiosis in which both species benefit. A type of symbiosis where both organisms benefit. The classic example is lichens, which

is a symbiosis between an alga and a fungus. The alga provides food and the fungus provides water and nutrients.

mycelium The mass of interwoven filaments of hyphae in a fungus.

mycorrhiza Occurs when a fungus (basidiomycete or zygomycete) weaves around or into a plant's roots and forms a symbiotic relationship. Fungal hyphae absorb minerals from the soil and pass them on to the plant roots while the fungus obtains carbohydrates from the plant (pl.: mycorrhizae).

myelin sheath Layers of specialized glial cells, called Schwann cells, that coat the axons of many neurons.

myofibrils Striated contractile microfilaments in skeletal muscle cells.

N

nares Nostrils; the openings in the nose through which air enters.

nastic movement A plant's response to a stimulus in which the direction of the response is independent of the direction of the stimulus. Non-directional plant movements.

natural selection The process of differential survival and reproduction of Þtter genotypes; can be stabilizing, directional, or disruptive. Better adapted individuals are more likely to survive to reproductive age and thus leave more offspring and make a larger contribution to the gene pool than do less Þt individuals. The differential survival and reproductive successes of individuals in a variable population that powers the evolutionary process. When all individuals survive and reproduce (except for chance occurrences) natural selection works at a lower rate, if at all.

nectaries Nectar-secreting organs in þowering plants that serve as insect feeding stations and thus attract insects, which then assist in the transfer of pollen.

negative feedback The stopping of the synthesis of an enzyme by the accumulation of the products of the enzyme-mediated reaction.

negative feedback control Occurs when information produced by the feedback reverses the direction of the response; regulates the secretion of most hormones.

negative feedback loop A biochemical pathway where the products of the reaction inhibit production of the enzyme that controlled their formation.

nektonic organisms "Swimmers"; one of the two main types of organisms in the pelagic zone of the marine biome.

nephridium The excretory organ in þatworms and other invertebrates; a blind-ended tubule that expels waste through an excretory pore.

nephron A tubular structure that is the þltering unit of the kidney; consists of a glomerulus and renal tubule.

nerve cord A dorsal tubular cord of nervous tissue above the notochord of a chordate.

nerve net An interconnected mesh of neurons that sends signals in all directions; found in radially symmetrical marine invertebrates, such as jellyþsh and sea anemones, that have no head region or brain.

nerves Bundles of neuronal processes enclosed in connective tissue that carry signals to and from the central nervous system.

nervous system One of eleven major body organ systems in animals; coordinates and controls actions of internal organs and body systems, receives and processes sensory information from the external environment, and coordinates short-term reactions to these stimuli. | |

net primary productivity (NPP) The rate at which producer (usually plants) biomass is created in a community.

net secondary productivity (NSP) The rate at which consumer and decomposer biomass is produced in a community.

neural tube A tube of ectoderm in the embryo that will form the spinal cord.

neuromuscular junction The point where a motor neuron attaches to a muscle cell.

neurons Highly specialized cells that generate and transmit bioelectric impulses from one part of the body to another; the functional unit of the nervous system. A cell of the nerve tissue having a cell body input zone of dendrites and

an output zone of an axon (of varying length). The electrochemical nerve impulse/message is transmitted by neurons. |

neurotoxin Chemical that paralyzes nerves. Neurotoxins are produced by a variety of organisms, most notably some of the heterotrophic dinoflagellates.

neurotransmitters Chemicals released from the tip of an axon into the synaptic cleft when a nerve impulse arrives; may stimulate or inhibit the next neuron. The chemical that crosses the synaptic cleft and causes the transmission of the nerve message in an adjacent neuron or the stimulation of an effector cell (muscle or gland).

neutron An uncharged subatomic particle in the nucleus of an atom. The large (mass approximately equal to 1 atomic mass unit), electrically neutral particle that may occur in the atomic nucleus.

niche The biological role played by a species.

niche overlap The extent to which two species require similar resources; speciÞes the strength of the competition between the two species.

nicotine adenine dinucleotide phosphate (NADP$^+$) A substance to which electrons are transferred from photosystem I during photosynthesis; the addition of the electrons reduces NADP, which acquires a hydrogen ion to form NADPH, which is a storage form of energy that can be transferred to the Calvin Cycle for the production of carbohydrate.

node The stem region of a plant where one or more leaves attach. Where leaves are attached to stems.

node of Ranvier A gap between two of the Schwann cells that make up an axon's myelin sheath; serves as a point for generating a nerve impulse.

nondisjunction The failure of chromosomes to separate properly during cell division. The unequal segregation of chromosomes during meiosis. This forms cells with either too many (possibly one or more single or sets of chromosomes too many) or too few chromosomes. Thought to be a common cause for Down Syndrome, where sufferers often have an extra copy of chromosome 21.

nonvascular plants Plants lacking lignified vascular tissue (xylem), vascularized leaves, and having a free-living, photosynthetic gametophyte stage that dominates the life cycle. Common examples are the mosses and liverworts.

norepinephrine A hormone produced in the adrenal medulla and secreted under stress; contributes to the "Þght or þight" response.

notochord In chordates, a cellular rod that runs the length of the body and provides dorsal support. Also, a structure of mesoderm in the embryo that will become the vertebrae of the spinal column. The stiff rod-like structure that all members of the Phylum Chordata develop at some stage during their life.

nuclear area In prokaryotic cells, a region containing the cell's genetic information. Unlike the nucleus in eukaryotic cells, it is not surrounded by a membrane.

nuclear pores Openings in the membrane of a cell's nuclear envelope that allow the exchange of materials between the nucleus and the cytoplasm.

nucleic acids Polymers composed of nucleotides; e.g., DNA and RNA.

nucleoid The area of the prokaryotic cytoplasm where the chromatin is localized.

nucleolus A round or oval body in the nucleus of a eukaryotic cell; consists of DNA and RNA and produces ribosomal RNA (pl.: nucleoli).

nucleosomes Spherical bodies formed by coils of chromatin. The nucleosomes in turn are coiled to form the Þbers that make up the chromosomes.

nucleotide sequences The genetic code encrypted in the sequence of bases along a nucleic acid.

nucleotides The subunits of nucleic acids; composed of a phosphate, a sugar, and a nitrogen-containing base. The fundamental structural unit of the nucleic acid group of organic macromolecules. Some nucleotides are involved in information storage (as nucleotides in DNA), protein synthesis (as nucleotides in RNA), and energy transfers (as single nucleotide ATP, GTP, and double nucleotide NADH and NADPH).

nucleus (atom) An atom's core; contains protons and one or more neutrons (except hydrogen, which has no neutrons).

nucleus (cell) The largest, most prominent organelle in eukaryotic cells; a round or oval body that is surrounded by the nuclear envelope and contains the genetic information necessary for control of cell structure and function.

nyctinasty A nastic movement in a plant that is caused by light and dark.

O

occipital lobe The lobe of the cerebral cortex located at the rear of the head; is responsible for receiving and processing visual information.

oils Triglycerides that are liquid at room temperature.

oncogenes Genes that can activate cell division in cells that normally do not divide or do so only slowly. A gene that when over-expressed leads to cancer, but which normally functions in cell division.

"one gene, one enzyme hypothesis Holds that a single gene controls the production, specificity, and activity of each enzyme in a metabolic pathway. Thus, mutation of such a gene changes the ability of the cell to carry out a particular reaction and disrupts the entire pathway.

"one gene one polypeptide hypothesis" A revision of the one gene, one enzyme hypothesis. Some proteins are composed of different polypeptide chains encoded by separate genes, so the hypothesis now holds that mutation in a gene encoding a specifc polypeptide can alter the ability of the encoded protein to function and thus produce an altered phenotype.

oocyte A cell that will/is undergo/ing development into a female gamete.

oogenesis The production of ova. The development of a diploid cell into a haploid ovum or egg cell.

open community A community in which the populations have different density peaks and range boundaries and are distributed more or less randomly.

opposable The capability of being placed against the remaining digits of a hand or foot; e.g., the ability of the thumb to touch the tips of the fingers on that hand.

opsins Molecules in cone cells that bind to pigments, creating a complex that is sensitive to light of a given wavelength.

orders Taxonomic subcategories of classes.

Ordovician extinction Paleozoic-aged mass extinction possibly related to glaciation in the southern-hemisphere supercontinent Gondwana.

Ordovician Period Geologic period of the Paleozoic Era after the Cambrian Period between 500 and 435 million years ago. Major advances during this period include the bony fish and possibly land plants (during the late Ordovician).

organelles Cell components that carry out individual functions; e.g., the cell nucleus and the endoplasmic reticulum. Subcellular structures (usually membrane-bound and unique to eukaryotes) that perform some function, e.g. chloroplast, mitochondrion, nucleus. |

organism An individual, composed of organ systems (if multicellular). Multiple organisms make up a population.

organs Differentiated structures consisting of tissues and performing some specific function in an organism. Structures made of two or more tissues which function as an integrated unit. e.g. the heart, kidneys, liver, stomach.

organ systems Groups of organs that perform related functions.

orgasm Rhythmic muscular contractions of the genitals (sex organs) combined with waves of intense pleasurable sensations; in males, results in the ejaculation of semen.

osmoconformers Marine organisms that have no system of osmoregulation and must change the composition of their body þuids as the composition of the water changes; include invertebrates such as jellyÞsh, scallops, and crabs.

osmoregulation The regulation of the movement of water by osmosis into and out of cells; the maintenance of water balance within the body.

osmoregulators Marine vertebrates whose body þuids have about one-third the solute concentration of seawater; must therefore undergo osmoregulation.

osmosis Diffusion of water molecules across a membrane in response to differences in solute concentration. Water moves from areas of high-water/low-solute concentration to areas of low-water/high-solute concentration. Diffusion of water across a semi-permeable barrier such as a cell membrane, from high water potential (concentration) to lower water potential (concentration).

osmotic pressure Pressure generated by water moving by osmosis into or out of a cell.

ossification The process by which embryonic cartilage is replaced with bone.

osteoarthritis A degenerative condition associated with the wearing away of the protective cap of cartilage at the ends of bones. Bone growths or spurs develop, restricting movement and causing pain.

osteoblasts Bone-forming cells.

osteoclasts Cells that remove material to form the central cavity in a long bone.

osteocytes Bone cells that lay down new bone; found in the concentric layers of compact bone. Bone cell, a type of connective tissue.

osteoporosis A disorder in which the mineral portion of bone is lost, making the bone weak and brittle; occurs most commonly in postmenopausal women.

out of Africa hypothesis Holds that modern human populations (*Homo sapiens*) are all derived from a single speciation event that took place in a restricted region in Africa.

ovaries 1) In animals, the female gonads, which produce eggs (ova) and female sex hormones.) In þowers, part of the female reproductive structure in the carpel; contain the ovules, where egg development occurs. The lower part of the carpel that contains the ovules within which the female gametophyte develops.

overkill The shooting, trapping, or poisoning of certain populations, usually for sport or economic reasons.

oviducts Tubes that connect the ovaries and the uterus; transport sperm to the ova, transport the fertilized ova to the uterus, and serve as the site of fertilization; also called the fallopian tubes or uterine tubes.

ovulation The release of the oocyte onto the surface of the ovary; occurs at the midpoint of the ovarian cycle. The release of the ovum (egg) from the ovary after the peaking of luteinizing hormone concentration in the blood during the menstrual cycle. |

ovule In seed plants, a protective structure in which the female gametophyte develops, fertilization occurs, and seeds develop; contained within the ovary. Structures inside the ovary of the flower within which the female gametophyte develops after megasporogenesis has produced a megaspore inside each ovule.

ovum The female gamete, egg.

oxidation The loss of electrons from the outer shell of an atom; often accompanied by the transfer of a proton and thus involves the loss of a hydrogen ion. The loss of electrons or hydrogens in a chemical reaction.

oxytocin A peptide hormone secreted by the posterior pituitary that stimulates the contraction of the uterus during childbirth.

ozone A triatomic (O_3) form of oxygen that is formed in the stratosphere when sunlight strikes oxygen atoms. This atmospheric ozone helps Þlter radiation from the sun.

P Q

pacemaker. See sinoatrial node.

Pacinian corpuscles Sensory receptors located deep in the epidermis that detect pressure and vibration.

paleontology The study of ancient life by collection and analysis of fossils.

Paleozoic Era The period of time beginning 570 million years ago ending 245 million years ago; falls between the Proterozoic and Mesozoic Eras and is divided into the Cambrian, Ordovician, Silurian, Devonian, Carboniferous, and Permian Periods.

palindrome A sequence that reads the same in either direction; in genetics, refers to an enzyme recognition sequence that reads the same on both strands of DNA.

palisade Layer of mesophyll cells in leaves that are closely placed together under the epidermal layer of the leaf. Palisade parenchyma: Columnar cells located just below the upper epidermis in leaves the cells where most of the light absorbtion in photosynthesis occurs. |

palynology The study of palynomorphs and other acid-resistant microfossils usually produced by plants, protists, and fungi

palynomorph Generic term for any object a palynologist studies.

pancreas A gland in the abdominal cavity that secretes digestive enzymes into the small intestine and also secretes the hormones insulin and glucagon into the blood, where they regulate blood glucose levels. A digestive organ that produces trypsin, chymotrypsin and other enzymes as a pancreatic juice, but which also has endocrine functions in the production of the hormones somatostatin, insulin, and glucagon.

pancreatic islets Clusters of endocrine cells in the pancreas that secrete insulin and glucagon; also known as islets of Langerhans.

Pangaea The name proposed by German meteorologist Alfred Wegener for a supercontinent that existed at the end of the Paleozoic Era and consisted of all the Earth's landmasses.

parallel evolution The development of similar characteristics in organisms that are not closely related (not part of a monophyletic group) due to adaptation to similar environments and/or strategies of life.

parasites Organisms that live in, with, or on another organism. The parasites beneÞt from the association without contributing to the host, usually they cause some harm to the host.

parasitism A form of symbiosis in which the population of one species beneÞts at the expense of the population of another species; similar to predation, but differs in that parasites act more slowly than predators and do not always kill the host. A type of symbiosis in which one organism benefits at the expense of the other, for example the influenza virus is a parasite on its human host. Viruses, are obligate intracellular parasites.

parasympathetic system The subdivision of the autonomic nervous system that reverses the effects of the sympathetic nervous system. Part of the autonomic nervous system that controls heartbeat, respiration and other vital functions.

parenchyma One of the three major cell types in plants. Parenchyma cells have thin, usually multisided walls, are unspecialized but carry on photosynthesis and cellular respiration and can store food; form the bulk of the plant body; found in the þeshy tissue of fruits and seeds, photosynthetic cells of leaves, and

the vascular system. Generalized plant cells whose numerous functions include photosynthesis, storage, bulk of herbaceous stem tissues, lateral transport in woody stems. Parenchyma are variously shaped but are characterized by thin walls and remain alive at functional maturity.

parietal lobe The lobe of the cerebral cortex that lies at the top of the brain; processes information about touch, taste, pressure, pain, and heat and cold.

passive transport Diffusion across a plasma membrane in which the cell expends no energy.

pectin A substance in the middle lamella that cements adjoining plant cells together.

pectoral girdle In humans, the bony arch by which the arms are attached to the rest of the skeleton; composed of the clavicle and scapula.

pedigree analysis A type of genetic analysis in which a trait is traced through several generations of a family to determine how the trait is inherited. The information is displayed in a pedigree chart using standard symbols.

pelagic zone One of the two basic subdivisions of the marine biome; consists of the water above the sea þoor and its organisms.

pelvic girdle In humans, the bony arch by which the legs are attached to the rest of the skeleton; composed of the two hipbones.

pelvis The hollow cavity formed by the two hipbones.

penicillin The first of the so-called wonder drugs; discovered by Sir Alexander Fleming.

pepsin An enzyme produced from pepsinogen that initiates protein digestion by breaking down protein into large peptide fragments. An enzyme, produced by the stomach, that chemically breaks down peptide bonds in polypeptides and proteins.

pepsinogen An inactive form of pepsin; synthesized and stored in cells lining the gastric pits of the stomach.

peptic ulcer Damage to the epithelial layer of the stomach lining; generally caused by bacterial infection.

peptide bond A covalent bond that links two amino acids together to form a polypeptide chain. A covalent bond between the amine end of one amino acid and the acid end of another amino acid.

peptides Short chains of amino acids.

perichondrium A layer of connective tissue that forms around the cartilage during bone formation. Cells in the perichondrium lay down a peripheral layer that develops into compact bone.

perennials Plants that persist in the environment for more than one year (as in the case of annuals).

period The fundamental unit in the hierarchy of time units; a part of geologic time during which a particular sequence of rocks designated as a system was deposited. Units of geological time that are the major subdivisions of Eras.

periosteum A Þbrous membrane that covers bones and serves as the site of attachment for skeletal muscles; contains nerves, blood vessels, and lymphatic vessels.

peripheral nervous system The division of the nervous system that connects the central nervous system to other parts of the body. Components of the nervous system that transmit messages to the central nervous system.

peristalsis Involuntary contractions of the smooth muscles in the walls of the esophagus, stomach, and intestines that propel food along the digestive tract. Waves of muscle contraction in the esophagus that propel food from the oral cavity to the stomach.

Permian Period The last geologic time period of the Paleozoic Era, noted for the greatest mass extinction in earth history, when nearly 96% of species died out.

peroxisomes Membrane-bound vesicles in eukaryotic cells that contain oxidative enzymes.

pesticides Chemicals that are applied to agricultural crops or domesticated plants and which kill or inhibit growth of insects.

petals Usually brightly colored elements of a þower that may produce fragrant oils; nonreproductive structures that attract pollinators. Sterile leaf-like (white,

colorless, but usually colored) structures in flowers that serve to attract pollinators.

petiole The generally non-leafy part of the leaf that attaches the leaf blade to the stem; celery and rhubarb are examples of a leaf petiole that we use as food. The stalk connecting the leaf blade to the stem.

PGA (phosphoglycerate) A three-carbon molecule formed when carbon dioxide is added to ribulose biphosphate (RuBP) during the dark reaction of photosynthesis (Calvin, or Calvin-Benson Cycle). PGA is converted to PGAL, using ATP and NADPH.

PGAL (phosphoglyceraldehyde) A substance formed from PGA during the dark reaction of photosynthesis. Some PGAL leaves the cycle and can be converted to glucose, while other PGAL molecules are used to reform ribulose biphosphate (RuBP) to continue the dark reaction.

pH The negative logarithm of the H^+ ion concentration. The pH is a measure of the acidity or basic character of a solution. Since it measures a fraction, the larger the pH number, the less H ions are present in a solution.

phagocytes White blood cells that can engulf (by phagocytosis) and destroy microorganisms including viruses and bacteria; cells in this category include neutrophils and monocytes.

phagocytosis A form of endocytosis in which white blood cells surround and engulf invading bacteria or viruses.

pharynx The passageway between the mouth and the esophagus and trachea. Food passes from the pharynx to the esophagus, and air passes from the pharynx to the trachea.

phenotype The observed properties or outward appearance of a trait. The physical expression of the alleles posessed by an organism.

pheromones Chemical signals that travel between organisms rather than between cells within an organism; serve as a form of communication between animals.

phloem Tissue in the vascular system of plants that moves dissolved sugars and other products of photosynthesis from the leaves to other regions of the plant. Phloem tissue consists of cells called sieve tubes and companion cells. Cells of the

vascular system in plants that transport food from leaves to other areas of the plant. | |

phosphate group A chemical group composed of a central phosphorous bonded to three or four oxygens. The net charge on the group is negative.

phospholipids Asymmetrical lipid molecules with a hydrophilic head and a hydrophobic tail. Lipids with a phosphate group in place of one of the three fatty acid chains. Phospholipids are the building blocks of cellular membranes. Phospholipids have hydrophilic heads (glycerol and phosphate) and hydrophobic tails (the non-polar fatty acids).

phosphorylation The chemical attachment of phosphorous to a molecule, usually associated with the storage of energy in the covalent bond that is also formed. Example: attachment of the third phosphate group to ADP in the formation of the higher energy form, ATP. Photophosphorylation is a type of phosphorylation associated with the formation of ATP in the photosynthesis process.

photic zone The layer of the ocean that is penetrated by sunlight; extends to a depth of about 200 meters.

photoperiodism The ability of certain plants to sense the relative amounts of light and dark in a 24-hour period; controls the onset of þowering in many plants.

photosynthesis The process by which plant cells use solar energy to produce ATP. The conversion of unusable sunlight energy into usable chemical energy, associated with the actions of chlorophyll.

photosystems Clusters of several hundred molecules of chlorophyll in a thylakoid in which photosynthesis takes place. Eukaryotes have two types of photosystems: I and II. The series of green photoreceptive pigments involved in the light reactions, which occur in the thylakoids of the chloroplast (in eukaryotes). Energy from light is passed to the electrons as they move through the photosystem pigments. | | |

phototrophs Organisms that use sunlight to synthesize organic nutrients as their energy source; e.g., cyanobacteria, algae, and plants.

phototropism The reaction of plants to light in which the plants bend toward the light. Plant response to light by unequal growth caused by concentration of

the plant hormone Indole Acetic Acid (IAA, an auxin) on the darker side of the plant shoot.

phycocyanin An accessory pigment found in cyanobacteria and the chloroplasts of red algae.

phycoerythrin An accessory pigment found in cyanobacteria and the chloroplasts of red algae.

phylogeny 1) the study of evolutionary relationships within a monophyletic group. 2) evolutionary hypotheses represented as a dendrogram or branching diagram. |

phylogenetic Pertaining to a phylogeny.

phylum The broadest taxonomic category within kingdoms (pl.: phyla).

phytochrome A pigment in plant leaves that detects day length and generates a response; partly responsible for photoperiodism.

phytoplankton A þoating layer of photosynthetic organisms, including algae, that are an important source of atmospheric oxygen and form the base of the aquatic food chain.

pilus Projection from surface of a bacterial cell (F+) that can donate genetic material to another (F-).

pineal gland A small gland located between the cerebral hemispheres of the brain that secretes melatonin.

pioneer community The initial community of colonizing species.

pistil Female reproductive structures in flowers, consisting of the stigma, style, and ovary. Also known as a carpel in some books. |

pith Central area in plant stems, largely composed of parenchyma tissue modified for storage. |

pituitary gland A small gland located at the base of the brain; consists of an anterior and a posterior lobe and produces numerous hormones. The master gland of the endocrine system, the pituitary releases hormones that have specific targets as well as those that stimulate other glands to secrete hormones. Part of the pituitary is nerve tissue, the rest is glandular epithelium. |

placenta An organ produced from interlocking maternal and embryonic tissue in placental mammals; supplies nutrients to the embryo and fetus and removes wastes.

placental mammals One of three groups of mammals that carry their young in the mother's body for long periods during which the fetus is nourished by the placenta. Humans are placental mammals.

planaria Small free-living þatworms (Phylum Platyhelminthes) with bilateral symmetry and cephalization. The freshwater type is often used as an experimental organism.

planktonic organisms "Floaters"; one of the two main types of organisms in the pelagic zone of the marine biome.

Plantae The plant kingdom; nonmobile, autotrophic, multicellular eukaryotes. Kingdom of the plants, autotrophic eukaryotes with cellulose in their cell walls and starch as a carbohydrate storage product, with chlorophylls a and b as photosynthesis pigments.

plasma The liquid portion of the blood. Along with the extracellular þuid, it makes up the internal environment of multicellular organisms.

plasma cells Cells produced from B cells that synthesize and release antibodies.

plasmids Self-replicating, circular DNA molecules found in bacterial cells; often used as vectors in recombinant DNA technology. Small circles of double-stranded DNA found in some bacteria. Plasmids can carry from four to 20 genes. Plasmids are a commonly used vector in recombinant DNA studies.

plasmodesmata Junctions in plants that penetrate cell walls and plasma membranes, allowing direct communication between the cytoplasm of adjacent cells (sing.: plasmodesma).

plasmolysis Osmotic condition in which a cell loses water to its outside environment.

plastids Membrane-bound organelles in plant cells that function in storage (of food or pigments) or food production. Term for any double membrane-bound organelle. Chloroplasts contain the chemicals for photosynthesis, amyloplasts (also known as leukoplasts) store starch, chromoplasts contain colorful pigments such as in the petals of a flower or epidermis of a fruit.

platelets In vertebrates, cell fragments that bud off from the megakaryocytes in the bone marrow; carry chemicals needed for blood clotting. Cell fragment functioning in blood clotting.

plate tectonics The movement of the plates that make up the surface of the Earth. The revolutionary paradigm in geology that the earth's crust is composed of rigid segments (plates) in constant (although considered slow in a human-scale time frame) motion (tectonics) relative to each other.

pleiotropic A term describing a genotype with multiple phenotypic effects. For example: sickle-cell anemia produces a multitude of consequences in those it affects, such as heart disease, jidney problem, etc.

Pleistocene The first geologic epoch of the Quaternary Period of the Cenozoic Era that ended 10,000 years ago with the retreat of the last glaciers.

pleura A thin sheet of epithelium that covers the inside of the thoracic cavity and the outer surface of the lungs.

pleural cavity The space between the sheets of pleura (one covering the inside of the thoracic cavity, the other covering the outside of the lungs).

polar covalent bond A covalent bond in which atoms share electrons in an unequal fashion. The resulting molecule has regions with positive and negative charges. The presence of polar covalent bonds allows other polar molecules to surround molecule: example: glucose sugar in water.

pollen grains The containers for male gametophytes of seed plants produced in a microsporangium by meiosis. Microspores produced by seed plants that contain the male gametophyte.

pollen tube Structure produced by the tube nucleus in the pollen grain through which the sperm nucleus (or nuclei in angiosperms) proceed to travel through to reach the egg.

pollination The transfer of pollen from the anthers to the stigma by a pollinating agent such as wind, insects, birds, bats, or in a few cases the opening of the flower itself.

polygenic inheritance Occurs when a trait is controlled by several gene pairs; usually results in continuous variation.

polymer Organic molecule composed of smaller units known as monomers. A large molecule composed of smaller subunits, for example starch is a polymer of glucose, proteins are polymers of amino acids.

polymerase chain reaction (PCR) A method of amplifying or copying DNA fragments that is faster than cloning. The fragments are combined with DNA polymerase, nucleotides, and other components to form a mixture in which the DNA is cyclically amplified.

polynucleotides Long chains of nucleotides formed by chemical links between the sugar and phosphate groups.

polyp The sessile form of life history in cnidarians; e.g., the freshwater hydra.

polyploidy Abnormal variation in the number of chromosome sets. The condition when a cell or organism has more than the customary two sets of chromosomes. This is an especially effective speciation mechanism in plants since the extra chromosomes will establish reproductive isolation with the parental population(s), an essential for speciation. |

polysaccharides Long chains of monosaccharide units bonded together; e.g., glycogen, starch, and cellulose.

pons The region that, with the medulla oblongata, makes up the hindbrain, which controls heart rate, constriction and dilation of blood vessels, respiration, and digestion.

population A group of individuals of the same species living in the same area at the same time and sharing a common gene pool. A group of potentially interbreeding organisms in a geographic area.

population dynamics The study of the factors that affect the growth, stability, and decline of populations, as well as the interactions of those factors.

portal system An arrangement in which capillaries drain into a vein that opens into another capillary network.

positive feedback Biochemical control where the accumulation of the product stimulates production of an enzyme responsible for that product's production.

positive feedback control Occurs when information produced by the feedback increases and accelerates the response.

precambrian Informal term describing 7/8 of geologic time from the beginning of the earth to the beginning of the Cambrian Period of the Paleozoic Era. During this time the atmosphere and oceans formed, life originated (or possibly "colonized" Earth), eukaryotes and simple animals evolved and by the end of the precambrian they began to accumulate hard preservable parts, the common occurrence of which marks the beginning of the Cambrian.

precipitation The part of the hydrologic cycle in which the water vapor in the atmosphere falls to Earth as rain or snow.

predation One of the biological interactions that can limit population growth; occurs when organisms kill and consume other living organisms.

predatory release Occurs when a predator species is removed from a prey species such as by great reduction in the predator's population size or by the migration of the prey species to an area without major predators. The removal of the predator releases the prey from one of the factors limiting its population size.

prehensile movement The ability to seize or grasp.

prenatal testing Testing to detect the presence of a genetic disorder in an embryo or fetus; commonly done by amniocentesis or chorionic villi sampling.

presymptomatic screening Testing to detect genetic disorders that only become apparent later in life. The tests are done before the condition actually appears, such as with Huntington disease.

prey switching The tendency of predators to switch to a more readily available prey when one prey species becomes rare; allows the Þrst prey population to rebound and helps prevent its extinction.

primary cell wall The cell wall outside the plasma membrane that surrounds plant cells; composed of the polysaccharide cellulose.

primary body Those parts of a plant produced by the shoot and root apical meristems.

primary compounds Chemicals made by plants and needed for the plant's own metabolism.

primary growth Cells produced by an apical meristem. The growth a plant by the actions of apical meristems on the shoot and root apices in producing plant primary tisues.

primary macronutrients Elements that plants require in relatively large quantities: nitrogen, phosphorus, and potassium.

primary meristems The apical meristems on the shoot and root apices in plants that produce plant primary tissues.

primary root The Þrst root formed by a plant.

primary structure The sequence of amino acids in a protein.

primates The taxonomic order of mammals that includes prosimians (lemurs and tarsiers), monkeys, apes, and humans; characteristics include large brain, stereoscopic vision, and grasping hand.

principle of independent assortment Mendel's second law; holds that during gamete formation, alleles in one gene pair segregate into gametes independently of the alleles of other gene pairs. As a result, if enough gametes are produced, the collective group of gametes will contain all combinations of alleles possible for that organism.

principle of segregation Mendel's Þrst law; holds that each pair of factors of heredity separate during gamete formation so that each gamete receives one member of a pair.

prions Infectious agents composed only of one or more protein molecules without any accompanying genetic information.

producers The Þrst level in a food pyramid; consist of organisms that generate the food used by all other organisms in the ecosystem; usually consist of plants making food by photosynthesis.

progesterone One of the two female reproductive hormones secreted by the ovaries.

prokaryote Type of cell that lacks a membrane-bound nucleus and has no membrane organelles; a bacterium. Prokaryotes are more primitive than eukaryotes. Cells lacking membrane-bound organelles and having a single

circular chromosome, and ribosomes surrounded by a cell membrane. Prokaryotes were the first forms of life on earth, evolving over 3.5 billion years ago.

prolactin A hormone produced by the anterior pituitary; secreted at the end of pregnancy when it activates milk production by the mammary glands.

promoter The speciÞc nucleotide sequence in DNA that marks the beginning of a gene.

prophase 1) The Þrst stage of mitosis during which chromosomes condense, the nuclear envelope disappears, and the centrioles divide and migrate to opposite ends of the cell. 2) The first stage of mitosis and meiosis (although in meiosis this phase is denoted with either a roman numeral I or II) where the chromatin condenses to form chromosomes, nucleolus dissolves, nuclear envelope dissolves, and the spindle begins to form.

prostaglandins A class of fatty acids that has many of the properties of hormones; synthesized and secreted by many body tissues and have a variety of effects on nearby cells.

prostate gland A gland that is located near and empties into the urethra; produces a secretion that enhances sperm viability. Gland involved in the reproductive system in males, the prostate secretes a sperm activating chemical into the semen during the arousal/ejaculation response.

proteinoids Polymers of amino acids formed spontaneously from inorganic molecules; have enzyme-like properties and can catalyze chemical reactions.

proteins Polymers made up of amino acids that perform a wide variety of cellular functions. One of the classes of organic macromolecules that function as structural and control elements in living systems. Proteins are polymers of amino acids linked together by peptide bonds.

prothallus In ferns, a small heart-shaped bisexual gametophyte.

Protista The taxonomic Kingdom from which the other three eukaryotic kingdoms (Fungi, Animalia and Plantae) are thought to have evolved. The earliest eukaryotes were single-celled organisms that would today be placed in this admittedly not monophyletic group. The endosymbiosis theory suggests that eukaryotes may have evolved independently several times.

protists Single-celled organisms; a type of eukaryote. Protista

proton A subatomic particle in the nucleus of an atom that carries a positive charge. The positively charged (+1) subatomic particle located in the atomic nucleus and having a mass slightly less than that of a neutron. Elements differ by the number of protons in their atoms.

protostomes Animals in which the þrst opening that appears in the embryo becomes the mouth; e.g., mollusks, annelids, and arthropods.

protozoa Single-celled protists grouped by their method of locomotion. This group includes *Paramecium*, *Amoeba*, and many other commonly observed protists. |

proximal tubule The winding section of the renal tubule where most reabsorption of water, sodium, amino acids, and sugar takes place.

pseudocoelom In nematodes, a closed þuid-containing cavity that acts as a hydrostatic skeleton to maintain body shape, circulate nutrients, and hold the major body organs.

pseudocoelomates Animals that have a body cavity that is in direct contact with the outer muscular layer of the body and does not arise by splitting of the mesoderm; e.g., roundworms.

pseudopodia Temporary cytoplasmic extensions from a cell that enables it to move (sing.: pseudopodium).

pulmonary artery The artery that carries blood from the right ventricle of the vertebrate heart to the lungs. Artery carrying oxygen-poor blood from the heart to the lungs.

pulmonary circuit The loop of the circulatory system that carries blood to and from the lungs.

pulmonary vein The vein that carries oxygenated blood from the lungs to the left atrium of the heart. Veins carrying oxygenated blood from the lungs to the heart.

punctuated equilibrium A model that holds that the evolutionary process is characterized by long periods with little or no change interspersed with short periods of rapid speciation.

purine One of the groups of nitrogenous bases that are part of a nucleotide. Purines are adenine and guanine, and are double-ring structures.

pyloric sphincter The ring of muscle at the junction of the stomach and small intestine that regulates the movement of food into the small intestine.

pyrimidine One of the groups of nitrogenous bases that are part of a nucleotide. Pyrimidines are single ringed, and consist of the bases thymine (in DNA), uracil (replacing thymine in RNA), and cytosine.

quantum models of speciation Models of evolution that hold that speciation sometimes occurs rapidly as well as over long periods, as the classical theory proposed.

Quaternary Period The most recent geologic period of the Cenozoic Era, the Quaternary began 2 million years ago with the growth of northern hemisphere continental glaciers and the ice age.

quaternary structure In some proteins, a fourth structural level created by interactions with other proteins. Aspect of protein structure determined by the number and arrangement of polypeptides in a large protein such as hemoglobin.

R

race A subdivision of a species that is capable of interbreeding with other members of the species.

radially symmetrical In animals, refers to organisms with their body parts arranged around a central axis. Such animals tend to be circular or cylindrical in shape.

radiation Energy emitted from the unstable nuclei of radioactive isotopes.

radioactive decay The spontaneous decay of an atom to an atom of a different element by emission of a particle from its nucleus (alpha and beta decay) or by electron capture.

ray-finned Taxonomic group of fish, such as trout, tuna, salmon, and bass, that have thin, bony supports holding the Þns away from the body and an internal swim bladder that changes the buoyancy of the body; one of the two main types of bony Þshes.

reabsorption The return to the blood of most of the water, sodium, amino acids, and sugar that were removed during Þltration; occurs mainly in the proximal tubule of the nephron.

receptacle The base that attaches a þower to the stem.

receptor Protein on or protruding from the cell surface to which select chemicals can bind. The opiate receptor in brain cells allows both the natural chemical as well as foreign (opiate) chemicals to bind.

recessive Refers to an allele of a gene that is expressed when the dominant allele is not present. An allele expressed only in homozygous form, when the dominant allele is absent.

recombinant DNA molecules New combinations of DNA fragments formed by cutting DNA segments from two sources with restriction enzyme and then joining the fragments together with DNA ligase. Interspecies transfer of genes usually through a vector such as a virus or plasmid.

recombinant DNA technology A series of techniques in which DNA fragments are linked to self-replicating forms of DNA to create recombinant DNA molecules. These molecules in turn are replicated in a host cell to create clones of the inserted segments.

recombination A way in which meiosis produces new combinations of genetic information. During synapsis, chromatids may exchange parts with other chromatids, leading to a physical exchange of chromosome parts; thus, genes from both parents may be combined on the same chromosome, creating a new combination.

red algae Common name for the algae placed in the division Rhodophyta.

red blood cell Component of the blood that transports oxygen with the hemoglobin molecule. See also erythrocyte

red tides Phenomenon associated with population explosions (blooms) of certain types of dinoflagellates; red structures inside the dinoflagellates cause the water to have a reddish color.

reduction The gain of an electron or a hydrogen atom. The gain of electrons or hydrogens in a chemical reaction.

reductional division The Þrst division in meiosis; results in each daughter cell receiving one member of each pair of chromosomes.

reflex A response to a stimulus that occurs without conscious effort; one of the simplest forms of behavior.

reflex arc Pathway of neurons, effector(s) and sensory receptors that participate in a reflex.

region of division The area of cell division in the tip of a plant root.

region of elongation The area in the tip of a plant root where cells grow by elongating, thereby increasing the length of the root.

region of maturation (differentiation) The area where primary tissues and root hairs develop in the tip of a plant root.

relative time Type of geologic time (absolute time being the other) that places events in a sequence relative to each other.

renal tubule The portion of the nephron where urine is produced.

renin An enzyme secreted by the kidneys that converts angiotensinogen into angiotensin II.

replication Process by which DNA is duplicated prior to cell division.

reproductive isolating mechanism Biological or behavioral characteristics that reduce or prevent interbreeding with other populations; e.g., the production of sterile hybrids. Establishment of reproductive isolation is considered essential for development of a new species.

reproductive system One of eleven major body organ systems in animals; is responsible for reproduction and thus the survival of the species.

reptiles Taxonomic class of vertebrates characterized by scales and amniotic eggs; the first truly terrestrial vertebrate group.

resolution In relation to microscopes, the ability to view adjacent objects as distinct structures.

resource partitioning The division of resources such that a few dominant species exploit most of the available resources while other species divide the

remainder; helps explain why a few species are abundant in a community while others are represented by only a few individuals.

respiration 1) breathing as part of gas exchange; or 2) cellular metabolism.

respiratory surface A thin, moist, epithelial surface that oxygen can cross to move into the body and carbon dioxide can cross to move out of the body.

respiratory system One of eleven major body organ systems in animals; moves oxygen from the external environment into the internal environment and removes carbon dioxide from the body.

resting potential The difference in electrical charge across the plasma membrane of a neuron.

restriction enzymes A series of enzymes that attach to DNA molecules at speciÞc nucleotide sequences and cut both strands of DNA at those sites. A bacterial enzyme that cuts DNA at a specific recognition sequence. This is a bacterial defense against viral DNA and plasmid DNA and is now used as an important tool in biotechnology.

restriction fragment length polymorphism (RFLP) A heritable difference in DNA fragment length and fragment number; passed from generation to generation in a codominant way.

retina The inner, light-sensitive layer of the eye; includes the rods and cones.

retroviruses Viruses that contain a single strand of RNA as their genetic material and reproduce by copying the RNA into a complementary DNA strand using the enzyme reverse transcriptase. The single-stranded DNA is then copied, and the resulting double-stranded DNA is inserted into a chromosome of the host cell. | | |

reverse transcriptase An enzyme used in the replication of retroviruses; aids in copying the retrovirus's RNA into a complementary strand of DNA once inside the host cell. | |

reverse transcription Process of transcribing a single-stranded DNA from a single-stranded RNA (the reverse of transcription); used by retroviruses as well as in biotechnology.

rheumatoid arthritis A crippling form of arthritis that begins with inþammation and thickening of the synovial membrane, followed by bone degeneration and disÞgurement.

rhizoids Filamentous structures in the plants group known as bryophytes that attach to a substrate and absorb moisture. The term is also applied to similar structures found outside the bryophytes.

rhizome In ferns, a horizontal stem with upright leaves containing vascular tissue.

rhodopsin A visual pigment contained in the rods of the retina in the eye..

ribonucleic acid (RNA) Nucleic acid containing ribose sugar and the base Uracil; RNA functions in protein synthesis. The single starnded molecule transcribed from one strand of the DNA. There are three types of RNA, each is involved in protein synthesis. RNA is made up nucleotides containing the sugar ribose, a phosphate group, and one of four nitrogenous bases (adenine, uracil, cytosine or guanine).

ribose Sugar found in nucleotides of RNA and in ATP.

ribosomal RNA One of the three types of RNA; rRNA is a structural component in ribosomes.

ribosomal subunits Two units that combine with mRNA to form the ribosomal-mRNA complex at which protein synthesis occurs.

ribosomes Small organelles made of rRNA and protein in the cytoplasm of prokaryotic and eukaryotic cells; aid in the production of proteins on the rough endoplasmic reticulum and ribosome complexes. The site of protein synthesis. The ribosome is composed of two subunits that attach to the mRNA at the beginning of protein synthesis and detach when the polypeptide has been translated.

RNA polymerase During transcription, an enzyme that attaches to the promoter region of the DNA template, joins nucleotides to form the synthesized strand of RNA and detaches from the template when it reaches the terminator region.

RNA transcript Term applied to RNA transcribed in the nucleus.

rods Light receptors in primates' eyes that provide vision in dim light.

root cap Structure that covers and protects the apical meristem in plant roots. Cells forming a protective series of layers over the root meristem.

root hairs Extensions of the root epidermis that increase the root's ability to absorb water.

root-leaf-vascular system axis Refers to the arrangement in vascular plants in which the roots anchor the plant and absorb water and nutrients, the leaves carry out photosynthesis, and the vascular system connects the roots and leaves, carrying water and nutrients to the leaves and carrying sugars and other products of photosynthesis from the leaves to other regions of the plant.

roots Organs, usually occurring underground, that absorb nutrients and water and anchor the plant; one of the three major plant organ systems.

root system Plant organ systems that anchors the plant in place, stores excess sugars, and absorbs water and mineral nutrients. That part of the plant below ground level.

RuBP Ribulose biphosphate; the 5-carbon chemical that combines with carbon dioxide at the beginning of the Calvin Cycle.

S

S phase That period of interphase when new DNA is synthesized as part of replication of the chromatin.

salivary amylase An enzyme secreted by the salivary glands that begins the breakdown of complex sugars and starches.

salivary glands Glands that secrete salvia into the mouth.

saprophytes Organisms that obtain their nutrients from decaying plants and animals. Saprophytes are important in recycling organic material.

sapwood Layers of secondary xylem that are still functional in older woody plants; visible as the outer lighter areas in the cross section of a tree trunk.

sarcomeres The functional units of skeletal muscle; consist of Þlaments of myosin and actin.

saturated fat A fat with single covalent bonds between the carbons of its fatty acids.

Schwann cells Specialized glial cells that form the myelin sheath that coats many axons. Cells surrounding the axons of some neurons, thus forming the myelin sheath.

scientific method Systematic apporach of observation, hypothesis formation, hypothesis testing and hypothesis evaluation that forms the basis for modern science.

sclereids Plant cells with thick secondary walls that provide the gritty textures in pears.

sclerenchyma One of the three major cell types in plants; have thickened, rigid, secondary walls that are hardened with lignin; provide support for the plant. Sclerenchyma cells include Þbers and sclereids. Plant tissue type consisting of elongated cells with thickened secondary walls for support of the plant. |

scrotum In mammals, a pouch of skin located outside the body cavity into which the testes descend; provides proper temperature for the testes.

secondary cell wall In woody plants, a second wall inside the primary cell wall; contains alternating layers of cellulose and lignin.

secondary compounds Plant products that are not important in metabolism but serve other purposes, such as attracting animals for pollination or killing parasites.

secondary extinction The death of one population due to the extinction of another, often a food species.

secondary growth Cells in a plant that are produced by a cambium. Increase in girth of a plant due to the action of lateral meristems such as the vascular cambium. The main cell produced in secondary growth is secondary xylem, better known as wood. | |

secondary immunity Resistance to an antigen the second time it appears. Because of the presence of B and T memory cells produced during the Þrst exposure to the antigen, the second response is faster and more massive and lasts longer than the primary immune response.

secondary macronutrients Elements that plants require in relatively small quantities: calcium, magnesium, and sulfur.

secondary (lateral) meristems Plant meristems that produce secondary growth from a cambium.

secondary phloem Phloem produced by the vascular cambium in a woody plant stem or root.

secondary structure The structure of a protein created by the formation of hydrogen bonds between different amino acids; can be a pleated sheet, alpha helix, or random coil. Shape of a protein caused by attraction between R-groups of amino acids.

secondary xylem Xylem produced by the vascular cambium in a woody plant stem or root; wood.

second law of thermodynamics (entropy) The energy available after a chemical reaction is less than that at the beginning of a reaction; energy conversions are not 100% efficient.

second messenger The mechanism by which nonsteroid hormones work on target cells. A hormone binds to receptors on the cell's plasma membrane activating a molecule&emdash;the second messenger&emdash;that activates other intracellular molecules that elicit a response. The second messenger can be cyclic AMP, cyclic GMP, inositol triphosphate, diacrylglycerol, or calcium. | |

secretin A hormone produced in the duodenum that stimulates alkaline secretions by the pancreas and inhibits gastric emptying.

secretion The release of a substance in response to the presence of food or speciÞc neural or hormonal stimulation.

sediment Loose aggregate of solids derived from preexisting rocks, or solids precipitated from solution by inorganic chemical processes or extracted from solution by organisms.

sedimentary rock Any rock composed of sediment, i.e., solid particles and dissolved minerals. Examples include rocks that form from sand or mud in riverbeds or on the sea bottom.

seed Structure produced by some plants in which the next generation sporophyte is surrounded by gametophyte nutritive tissues. An immature sporophyte in an arrested state of development, surrounded by a protective seed coat.

seed coat The tough outer layer of the seed, derived from the outer layers of the ovule.

segments Repeating units in the body parts of some animals.

segregation Separation of replicated chromosomes to opposite sides of the cell. Distribution of alleles on chromosomes into gametes during meiosis.

selective breeding The selection of individuals with desirable traits for use in breeding. Over many generations, the practice leads to the development of strains with the desired characteristics.

selectively permeable Term describing a barrier that allows some chemicals to pass but not others. The cell membrane is such a barrier.

semen A mixture of sperm and various glandular secretions.

semiconservative replication Process of DNA replication in which the DNA helix is unwound and each strand serves as a template for the synthesis of a new complementary strand, which is linked to the old strand. Thus, one old strand is retained in each new molecule.

semilunar valve A valve between each ventricle of the heart and the artery connected to that ventricle.

seminal vesicles Glands that contribute fructose to sperm. The fructose serves as an energy source. The structures that add fructose and hormones to semen.

seminiferous tubules Tubules on the interior of the testes where sperm are produced.

sensor In a closed system, the element that detects change and signals the effector to initiate a response.

sensory cortex A region of the brain associated with the parietal lobe.

sensory input Stimuli that the nervous system receives from the external or internal environment; includes pressure, taste, sound, light, and blood pH.

sensory neurons Neurons that carry signals from receptors and transmit information about the environment to processing centers in the brain and spinal cord. Neurons carrying messages from sensory receptors to the spinal cord. Sometimes referred to as an afferent neuron.

sensory (afferent) pathways The portion of the peripheral nervous system that carries information from the organs and tissues of the body to the central nervous system.

sepals Modified leaves that protect a flower's inner petals and reproductive structures. Small, leaf-like structures in flowers that enclose and protect the developing flower. These are often green, but in many monocots they are the same color as the petals (in which case the term tepal is applied since sepals and petals look so much alike).

separation Splitting of the cytoplasm by cytokinesis (= cytokinesis).

severe combined immunodeficiency (SCID) A genetic disorder in which afþicted individuals have no functional immune system and are prone to infections. Both the cell-mediated immune response and the antibody-mediated response are absent.

sex chromosomes The chromosomes that determine the sex of an organism. In humans, females have two X chromosomes, and males have one X chromosome and one Y chromosome. Chromosome that determines the gender (sex) of the individual. Human males have a large X and a smaller Y sex chromosomes, while human females have two X sex chromosomes.

sex hormones A group of steroid hormones produced by the adrenal cortex. Hormones that are produced in the gonads and promoted development and maintainence of the secondary sex characteristics and structures, prepare the female for pregnancy, and aid in development of gametes. Males produce testosterone, while females produce estrogen and progesterone.

sex linkage The condition in which the inheritance of a sex chromosome is coupled with that of a given gene; e.g., red-green color blindness and hemophilia in humans. Traits located on the X-chromosome.

sexual reproduction A system of reproduction in which two haploid sex cells (gametes) fuse to produce a diploid zygote.

shoot The plant stem; provides support for the leaves and þowers; one of the three major plant organs; also referred to as the shoot system.

short-day plants Plants that þower during early spring or fall when nights are relatively long and days are short; e.g., poinsettia and dandelions.

sickle cell anemia Human autosomal recessive disease that causes production of abnormal red blood cells that collapse (or sickle) and cause circulatory problems.

sieve cells Conducting cells in the phloem of vascular plants. See sieve elements

sieve elements Tubular, thin-walled cells that form a system of tubes extending from the roots to the leaves in the phloem of plants; lose their nuclei and organelles at maturity, but retain a functional plasma membrane.

sieve plates Pores in the end walls of sieve elements that connect the sieve elements together. The end walls of sieve tube cells that are perforated (sieves).

sieve tube members Phloem cells that form long sieve tubes. See sieve elements.

silica Silicon dioxide.

Silurian Period The geological time period of the Paleozoic Era following the Ordovician, between 435 and 395 million years ago, when plants colonized the land.

simple leaf A leaf in which the blade does not form leaflets.

sink A body or process that acts as a storage device or disposal mechanism; e.g., plants and the oceans act as sinks absorbing atmospheric carbon dioxide. Also, a location in a plant where sugar is being consumed, either in metabolism or by conversion to starch.

sinoatrial (SA) node A region of modiÞed muscle cells in the right atrium that sends timed impulses to the heart's other muscle cells, causing them to contract; the heart's pacemaker.

sister chromatids Chromatids joined by a common centromere and carrying identical genetic information (unless crossing-over has occurred)**.**

sleep movement In legumes, the movement of the leaves in response to daily rhythms of dark and light. The leaves are horizontal in daylight and folded vertically at night.

skeletal muscle Muscle that is generally attached to the skeleton and causes body parts to move; consists of muscle fibers. Voluntary muscle cells that have a striated appearance. These muscles control skeletal movements and are normally under conscious control.

skeletal system One of eleven major body organ systems in animals; supports the body, protects internal organs, and, with the muscular system, allows movement and locomotion.

skin One of eleven major body organ systems in animals; the outermost layer protecting multicellular animals from the loss or exchange of internal fluids and from invasion by foreign microorganisms; composed of two layers: the epidermis and dermis.

sliding filament model Model of muscular contraction in which the actin filaments in the sarcomere slide past the myosin filaments, shortening the sarcomere and therefore the muscle. | | |

slime molds Protistans that may represent a transition between protistans and fungi.

small intestine A coiled tube in the abdominal cavity that is the major site of chemical digestion and absorption of nutrients; composed of the duodenum, jejunum, and ileum.

smog A local alteration in the atmosphere caused by human activity; mainly an urban problem that is often due to pollutants produced by fuel combustion.

smooth muscle Muscle that lacks striations; found around circulatory system vessels and in the walls of such organs as the stomach, intestines, and bladder. Involuntary, not striated cells that control autonomic functions such as digestion and artery contraction.

social behavior Behavior that takes place in a social context and results from the interaction between and among individuals.

societies The most highly organized type of social organization; consist of individuals that show varying degrees of cooperation and communication with one another; often have a rigid division of labor.

sodium-potassium pump The mechanism that uses ATP energy to reset the sodium and potassium ions after transmission of a nerve impulse.

soil Weathered rocks and minerals combined with air, water and organic matter that can support plants.

somatic Relating to the non-gonadal tissues and organs of an organism's body.

somatic cell A cell that is not or will not become a gamete; the cells of the body.

somatic senses All senses except vision, hearing, taste, and smell; include pain, temperature, and pressure.

somatic nervous system The portion of the peripheral nervous system consisting of the motor neuron pathways that innervate skeletal muscles.

somatostatin Pancreatic hormone that controls the rate of nutrient absorption into the bloodstream.

somites Mesodermal structures formed during embryonic development that give rise to segmented body parts such as the muscles of the body wall.

special senses Vision, hearing, taste, and smell.

species One or more populations of interbreeding or potentially interbreeding organisms that are reproductively isolated in nature from all other organisms. Populations of individuals capable of interbreeding and producing viable, fertile offspring. The least inclusive taxonomic category commonly used.

species diversity The number of living species on Earth.

species packing The phenomenon in which present-day communities generally contain more species than earlier communities because organisms have evolved more adaptations over time.

species richness The number of species present in a community.

sperm The male gamete.

spermatogenesis The development of sperm cells from spermatocytes to mature sperm, including meiosis.

spicules Needle-shaped skeletal elements in sponges that occur in the matrix between the epidermal and collar cells.

spinal cord A cylinder of nerve tissue extending from the brain stem; receives sensory information and sends output motor signals; with the brain, forms the central nervous system. Nerve cell collections extending from the base of the brain to just below the last rib vertebrae.

spindle apparatus Microtubule construction that aligns and segregates chromosomes during eukaryotic cell division.

spleen An organ that produces lymphocytes and stores erythrocytes.

spongy bone The inner layer of bone; found at the ends of long bones and is less dense than compact bone. Some spongy bone contains red marrow.

spongy mesophyll Parenchyma cells found in plant leaves that are irregularly shaped and have large intracellular spaces. |

sporangia The structures in which spores are produced (sing.: sporangium).

spores Impervious structures formed by some cells that encapsulate the cells and protect them from the environment; haploid cells that can survive unfavorable conditions and germinate into new haploid individuals or act as gametes in fertilization.

sporophyte The diploid stage of a plant exhibiting alternation of generations. The diploid, spore producing phase of the plant life cycle.

Sporozoans Members of the protists that are referred to as slime molds; may include organisms resembling the ancestors of fungi.

stability One of the phases of a population's life cycle. The population's size remains roughly constant, þuctuating around some average density. Also, the ability of a community to persist unchanged.

stabilizing selection A process of natural selection that tends to favor genotypic combinations that produce an intermediate phenotype; selection against the extremes in variation.

stalk A leaf's petiole; the slender stem that supports the blade of a leaf and attaches it to a larger stem of the plant.

stamens The male reproductive structures of a þower; usually consist of slender, thread-like filaments topped by anthers. The male reproductive structures in the flower, composed of a filament and anther.

stapes One of the three bones that function in hearing.

start codon The codon (AUG) on a messenger RNA molecule where protein synthesis begins.

stem cells Cells in bone marrow that produce lymphocytes by mitotic division.

sternum The breastbone.

steroids Compounds with a skeleton of four rings of carbon to which various side groups are attached; one of the three main classes of hormones.

sticky ends Term applied to DNA sequences cut with restriction enzymes where the cuts will bond with each other or with another sequence cut with the same enzyme.

stigma Part of the female reproductive structure of the carpel of a þower; the sticky surface at the tip of the style to which pollen grains attach. The receptive surface of the pistil (of the flower) on which pollen is placed by a pollinator. |

stimulus A physical or chemical change in the environment that leads to a response controlled by the nervous system.

stolons Stems that grow along the surface of the ground; a method of plant vegetaive propagation.

stomach The muscular organ between the esophagus and small intestine that stores, mixes, and digests food and controls the passage of food into the small intestine.

stomata Pores on the underside of leaves that can be opened or closed to control gas exchange and water loss. Openings in the epidermis (usually of the leaf) that allow gas exchange. |

stomatal apparatus The stomata and guard cells that control the size of the stoma. |

stop codon The codon on a messenger RNA molecule where protein synthesis stops.

stratification The division of water in lakes and ponds into layers with different temperatures and oxygen content. Oxygen content declines with depth, while the uppermost layer is warmest in summer and coolest in winter.

stressed community A community that is disturbed by human activity, such as road building or pollution, and is inadvertently simpliÞed. Some species become superabundant while others disappear.

stroma The matrix surrounding the grana in the inner membrane of chloroplasts. The area between membranes (thylakoids, grana) inside the chloroplast.

style Part of the female reproductive structure in the carpel of a þower; formed from the ovary wall. The tip of the style carries the stigma to which pollen grains attach. Part of the pistil that separates the stigma from the ovary. |

subatomic particles The three kinds of particles that make up atoms: protons, neutrons, and electrons.

suberin Waxy, waterproof chemical in some plant cells, notably cork (in stems) and endodermis cells (in roots).

subspecies A taxonomic subdivision of a species; a population of a particular region genetically distinguishable from other such populations and capable of interbreeding with them.

substitution A type of mutation in which one base is substituted for another.

substrate feeders Animals such as earthworms or termites that eat the soil or wood through which they burrow.

sudden infant death syndrome (SIDS) A disorder resulting in the unexpected death during sleep of infants, usually between the ages of two weeks and one year. The causes are not fully understood, but are believed to involve failure of automatic respiratory control.

superior vena cava Blood from the head returns to the heart through this main vein.

suppressor T cells T cells that slow down and stop the immune response of B cells and other T cells. Immune system cells that shut off the antibody production when an infection is under control.

suprachiasmic nucleus (SCN) A region of the hypothalamus that controls internal cycles of endocrine secretion.

symbiosis An interactive association between two or more species living together; may be parasitic, commensal, or mutualistic. The relationship between two organisms.

sympathetic system The subdivision of the autonomic nervous system that dominates in stressful or emergency situations and prepares the body for strenuous physical activity, e.g., causing the heart to beat faster.

synapse The junction between an axon and an adjacent neuron.

synapsis The alignment of chromosomes during meiosis I so that each chromosome is beside its homologue.

synaptic cleft The space between the end of a neuron and an adjacent cell.

synaptic vesicles Vesicles at the synapse end of an axon that contain the neurotransmitters.

synergid Cells in the embryo sac of angiosperms that flank the egg cell. The pollen tube grows through one (usually the smaller) of the synergids.

synovial joint The most movable type of joint. The bones are covered by connective tissue, the interior of which is Þlled with synovial þuid, and the ends of the bones are covered with cartilage.

syphilis A sexually transmitted disease caused by a bacterial infection that produces an ulcer on the genitals and can have potentially serious effects if untreated.

systematics The classiÞcation of organisms based on information from observations and experiments; includes the reconstruction of evolutionary relatedness among living organisms. Currently, a system that divides organisms into Þve kingdoms (Monera, Protista, Plantae, Fungi, Animalia) is widely used.

systemic circuit The loop of the circulatory system that carries blood through the body and back to the heart.

systole The contraction of the ventricles that opens the semilunar valve and forces blood into the arteries.

systolic pressure The peak blood pressure when ventricles contract.

T

taiga biome The region of coniferous forest extending across much of northern Europe, Asia, and North America; characterized by long, cold winters and short, cool summers and by acidic, thin soils.

tap root A primary root that grows vertically downward and gives off small lateral roots; occurs in dicots. Root system in plants characterized by one root longer than the other roots. Example: carrot.

target cell A cell that a particular hormone effects by its direct action (either passing through the membrane or binding to a surface receptor). |

tarsals The bones that make up the ankle joint.

taxis The behavior when an animal turns and moves toward or away from an external stimulus (pl.: taxes).

taxon Term applied group of organisms comprising a given taxonomic category

taxonomy A systematic method of classifying plants and animals. Classification of organisms based on degrees of similarity purportedly representing evolutionary (phylogenetic) relatedness.

T cells The type of lymphocyte responsible for cell-mediated immunity; also protects against infection by parasites, fungi, and protozoans and can kill cancerous cells; circulate in the blood and become associated with lymph nodes and the spleen.

tectonic plates Segments of the lithosphere that comprise the surface of the Earth much the way a turtle shell is composed of its plates.

telophase The Þnal stage of mitosis in which the chromosomes migrate to opposite poles, a new nuclear envelope forms, and the chromosomes uncoil. The last phase of nuclear division in eukaryotes when the segregated chromosomes uncoil and begin to reform nuclei. This is immediately followed (in most cases) by cytokinesis.

temperate forest biome Extends across regions of the northern hemisphere with abundant rainfall and long growing seasons. Deciduous, broad-leaved trees are the dominant plants.

template strand The strand of DNA that is transcribed to make RNA.

temporal lobe The lobe of the cerebral cortex that is responsible for processing auditory signals.

tendons Bundles of connective tissue that link muscle to bone. Fibrous connective tissue that connects muscle to bone.

terminal buds Buds located at the end of a plant shoot.

termination The end of translation; occurs when the ribosome reaches the stop codon on the messenger RNA molecule and the polypeptide, the messenger RNA, and the transfer RNA molecule are released from the ribosome.

termination codon One of three three-base sequences that initiate termination of the protein synthesis process. See stop codon.

tertiary structure The folding of a protein's secondary structure into a functional three-dimensional conÞguration. Shape assumed by protein due to interactions between amino acids far apart on the chain.

test cross Genetic crossing of an organism with known genotype (one that exhibits the recessive phenotype) with an individual expressing the dominant phenotype but of unknown heritage.

testes The male gonad; produce spermatozoa and male sex hormones. Male gonads in mammals. Singular, testis. Paired organs that contain seminiferous tubules in which sperm are produced. |

testosterone Male sex hormone that stimulates sperm formation, promotes the development of the male duct system in the fetus, and is responsible for secondary sex characteristics such as facial hair growth.

tetrad The four chromatids in each cluster during synapsis; formed by the two sister chromatids in each of the two homologous chromosomes.

thalamus The brain region that serves as a switching center for sensory signals passing from the brain stem to other brain regions; part of the diencephalon.

thecodonts An informal term for a variety of Permian and Triassic reptiles that had teeth set in individual sockets. Small, bipedal thecodontians are the probable ancestors of dinosaurs.

theory A hypothesis that has withstood extensive testing by a variety of methods, and in which a higher degree of certainty may be placed. A theory is NEVER a fact, but instead is an attempt to explain one or more facts.

thermacidophiles A group of archaebacteria that are able to tolerate high temperatures and acidic pH.

thermiogenesis The generation of heat by raising the body's metabolic rate; controlled by the hypothalamus.

thermoregulation The regulation of body temperature.

thigmotropism Plants' response to contact with a solid object; e.g., tendrils' twining around a pole. Plant response to touch.

thoracic cavity The chest cavity in which the heart and lungs are located.

thorax In many arthropods, one of three regions formed by the fusion of the segments (others are the head and abdomen).

thorns Stems modified to protect the plant.

thoroughfare channels Shortcuts within the capillary network that allow blood to bypass a capillary bed.

thylakoids The specialized membrane structures in which photosynthesis takes place. Internal membranes in the chloroplast where the light reaction chemicals are embedded. Collections of thylakoids form the grana.

thymine One of the pyrimidine bases in DNA, thymine is replaced by uracil in RNA.

thyroid-stimulating hormone A hormone produced by the anterior pituitary that stimulates the production and release of thyroid hormones.

tight junctions Junctions between the plasma membranes of adjacent cells in animals that form a barrier, preventing materials from passing between the cells.

tissues Groups of similar cells organized to carry out one or more specific functions. Groups of cells performing a function in a multicellular organism.

toxins Term applied to poisons in living systems.

trace fossil Any indication of prehistoric organic activity, such as tracks, trails, burrows, or nests.

trachea In insects and spiders, a series of tubes that carry air directly to cells for gas exchange; in humans, the air-conducting duct that leads from the pharynx to the lungs. |

tracheids Long, tapered cells with pitted walls that form a system of tubes in the xylem and carry water and solutes from the roots to the rest of the plant. One type of xylem cells. Tracheids are long and relatively narrow, and transport materials from the roots upward. Tracheids are dead at maturity and have lignin in their secondary walls. |

transcription The synthesis of RNA from a DNA template. The making of RNA from one strand of the DNA molecule.

transfer RNAs (tRNAs) Small, single-stranded RNA molecules that bind to amino acids and deliver them to the proper codon on messenger RNA. The trucks of protein synthesis that carry the specified amino acid to the ribosome. Abbreviated tRNA.

transformation In Griffth's experiments with strains of pneumonia bacterium, the process by which hereditary information passed from dead cells of one strain into cells of another strain, causing them to take on the characteristic virulence of the first strain.

transforming factor Griffth's name for the unknown material leading to transformation; later found to be DNA.

transition reaction Biochemical process of converting 3-carbon pyruvate into 2-carbon acetyl and attaching it to coenzyme A (CoA) so it can enter Kreb's cycle. Carbon dioxide is also released and NADH is formed (from NAD and H) in this process.

translation The synthesis of protein on a template of messenger RNA; consists of three steps: initiation, elongation, and termination. Making of a polypeptide

sequence by translating the genetic code of an mRNA molecule associated with a ribosome.

translocation 1) The movement of a segment from one chromosome to another without altering the number of chromosomes. 2) the movement of þuids through the phloem from one part of a plant to another, with the direction of movement depending on the pressure gradients between source and sink regions.

transpiration The loss of water molecules from the leaves of a plant; creates an osmotic gradient; producing tension that pulls water upward from the roots. | |

Triassic Period The first period of the Mesozoic Era between 225 and 185 million years ago. Pangaea began to breakup during this time. The ancestors of dinosaurs were present, as were early mammals and mammal-like reptiles.

trichomes Extensions from the epidermis of the plant that provide shade and protection for the plant.

trichocysts Barbed, thread-like organelles of ciliated protozoans that can be discharged for defense or to capture prey.

trilobites A group of benthonic, detritus-feeding, extinct marine invertebrate animals (phylum Arthropoda), having skeletons of an organic compound called chitin.

triplet Three-base sequence of mRNA that codes for a specific amino acid or termination codon.

trisomy A condition where a cell has an extra chromosome.

trophoblast The outer layer of cells of a blastocyst that adhere to the endometrium during implantation.

tropical rain forest biome The most complex and diverse biome; found near the equator in South America and Africa; characterized by thin soils, heavy rainfall, and little þuctuation in temperature.

tropic hormone Hormone made by one gland that causes another gland to secrete a hormone.

tropism The movement of plant parts toward or away from a stimulus in the plant's environment. Plant movement in response to an environmental stimulus.

true-breeding Occurs when self-fertilization gives rise to the same traits in all offspring, generation after generation. Now interpreted as equivalent to homozygous.

trypanosomes A type of roundworm, responsible for human disease associated with eating raw or undercooked pork.

tubal ligation A contraceptive procedure in women in which the oviducts are cut, preventing the ova from reaching the uterus.

tubal pregnancy Occurs when the morula remains in the oviduct and does not descend into the uterus.

tube-within-a-tube system A type of body plan in animals. The organism has two openings&emdash;one for food and one for the elimination of waste&emdash;and a specialized digestive system.

tube nucleus One of the cells in the male gametophyte in seed plants. The tube nucleus grows through the stigma, style, and into the ovule, clearing the way for the sperm nuclei to enter the embryo sac.

tubers Swollen underground stems in plants that store food, such as the irish potato.

tubular secretion The process in which ions and other waste products are transported into the distal tubules of the nephron.

tubulins The protein subunits from which microtubules are assembled.

tumor suppressor genes Genes that normally keep cell division under control, preventing the cell from responding to internal and external commands to divide.

tundra biome Extensive treeless plain across northern Europe, Asia, and North American between the taiga to the south and the permanent ice to the north. Much of the soil remains frozen in permafrost, and grasses and other vegetation support herds of large grazing mammals.

turgor pressure Pressure caused by the cytoplasm pressing against the cell wall.

Turner syndrome In humans, a genetically determined condition in which an individual has only one sex chromosome (an X). Affected individuals are always female and are typically short and infertile.

U

umbilical cord The structure that connects the placenta and the embryo; contains the umbilical arteries and the umbilical vein.

unicellular Single-celled.

uniformitarianism The idea that geological processes have remained uniform over time and that slight changes over long periods can have large-scale consequences; proposed by James Hutton in 1795 and reÞned by Charles Lyell during the 1800s. The principle on which modern geology was founded: processes operating today on the earth operated in much the same way in the geologic past. Sometimes expressed as "the present is the key to the past".

uninucleate Term applied to cells having only a single nucleus.

unsaturated fat A triglyceride with double coavent bonds between some carbon atoms.

uracil The pyrimidine that replaces thymine in RNA molecules and nucleotides.

ureter A muscular tube that transports urine by peristaltic contractions from the kidney to the bladder.

urethra A narrow tube that transports urine from the bladder to the outside of the body. In males, it also conducts sperm and semen to the outside.

urine Fluid containing various wastes that is produced in the kidney and excreted from the bladder.

uterus The organ that houses and nourishes the developing embryo and fetus. The womb. Female reproductive organ in which the fertilized egg implants

V

vaccination The process of protecting against infectious disease by introducing into the body a vaccine that stimulates a primary immune response and the production of memory cells against the disease-causing agent.

vaccine A preparation containing dead or weakened pathogens that when injected into the body elicit an immune response.

vacuoles Membrane-bound þuid-Þlled spaces in plant and animal cells that remove waste products and store ingested food.

vagina The tubular organ that is the site of sperm deposition and also serves as the birth canal.

vascular bundle Groups of xylem, phloem and cambium cells in stems of plants descended from the procambium embryonic tissue layer.

vascular cambium A layer of lateral meristematic tissue between the xylem and phloem in the stems of woody plants. Lateral meristem tissue in plants that produces secondary growth.

vascular cylinder A central column formed by the vascular tissue of a plant root; surrounded by parenchymal ground tissue.

vascular parenchyma Specialized parenchyma cells in the phloem of plants.

vascular plants Group of plants having lignified conducting tissue (xylem vessels or tracheids).

vascular system Specialized tissues for transporting þuids and nutrients in plants; also plays a role in supporting the plant; one of the four main tissue systems in plants.

vas deferens The duct that carries sperm from the epididymis to the ejaculatory duct and urethra. The tube connecting the testes with the urethra.

vasectomy A contraceptive procedure in men in which the vas deferens is cut and the cut ends are sealed to prevent the transportation of sperm. Surgical separation of the vas deferens so that sperm, while still produced, do not leave the body.

vasopressin See antidiuretic hormone.

vectors Self-replicating DNA molecules that can be joined with DNA fragments to form recombinant DNA molecules.

veins Thin-walled vessels that carry blood to the heart. Units of the circulatory system that carry blood to the heart.

ventilation The mechanics of breathing in and out through the use of the diaphragm and muscles in the wall of the thoracic cavity.

ventral Term applied to the lower side of a fish, or to the chest of a land vertebrate.

ventricle The chamber of the heart that pumps the blood into the blood vessels that carry it away from the heart. The lower chamber of the heart through which blood leaves the heart.

venules The smallest veins. Blood þows into them from the capillary beds. Small veins that connect a vein with capillaries.

vernalization ArtiÞcial exposure of seeds or seedlings to cold to enable the plant to þower.

vertebrae The segments of the spinal column; separated by disks made of connective tissue (sing.: vertebra).

vertebrate Any animal having a segmented vertebral column; members of the subphylum Vertebrata; include reptiles, Þshes, mammals, and birds.

vesicles Small membrane-bound spaces in most plant and animal cells that transport macromolecules into and out of the cell and carry materials between organelles in the cell.

vessel elements Short, wide cells arranged end to end, forming a system of tubes in the xylem that moves water and solutes from the roots to the rest of the plant. Large diameter cells of the xylem that are extremely specialized and efficient at conduction. An evolutionary advance over tracheids. Most angiosperms have vessels.

vestigial structures Nonfunctional remains of organs that were functional in ancestral species and may still be functional in related species; e.g., the dewclaws of dogs.

villi Finger-like projections of the lining of the small intestine that increase the surface area available for absorption. Also, projections of the chorion that extend into cavities Þlled with maternal blood and allow the exchange of nutrients between the maternal and embryonic circulations. Projections of the inner layer of the small intestine that increase the surface area for absorbtion of food.

viroids Infective forms of nucleic acid without a protective coat of protein; unencapsulated single-stranded RNA molecules. Naked RNA, possibly of degenerated virus, that infects plants.

virus Infectious chemical agent composed of a nucleic acid (DNA or RNA) inside a protein coat.

vitamins A diverse group of organic molecules that are required for metabolic reactions and generally cannot be synthesized in the body.

vulva A collective term for the external genitals in women.

W X Y Z

white blood cell Component of the blood that functions in the immune system. Also known as a leukocyte.

wood The inner layer of the stems of woody plants; composed of xylem.

X-chromosome One of the sex chromosomes.

xerophytic leaves The leaves of plants that grow under arid conditions with low levels of soil and water. Usually characterized by water-conserving features such as thick cuticle and sunken stomatal pits.

x-ray diffraction Technique utilized to study atomic structure of crystalline substances by noting the patterns produced by x-rays shot through the crystal.

xylem Tissue in the vascular system of plants that moves water and dissolved nutrients from the roots to the leaves; composed of various cell types including tracheids and vessel elements. Plant tissue type that conducts water and nutrients from the roots to the leaves.

zebroid A hybrid animal that results from breeding zebras and horses.

Z lines Dense areas in myoÞbrils that mark the beginning of the sarcomeres. The actin Þlaments of the sarcomeres are anchored in the Z lines.

zone of differentiation Area in plant roots where recently produced cells develop into different cell types.

zone of elongation Area in plant roots where recently produced cells grow and elongate prior to differentiation.

zone of intolerance The area outside the geographic range where a population is absent; grades into the zone of physiological stress.

zone of physiological stress The area in a population's geographic range where members of population are rare due to physical and biological limiting factors.

zygomycetes One of the division of the fungi, characterized by the production of zygospores; includes the bread molds.

zygospore In fungi, a structure that forms from the diploid zygote created by the fusion of haploid hyphae of different mating types. After a period of dormancy, the zygospore forms sporangia, where meiosis occurs and spores form.

zygote A fertilized egg. A diploid cell resulting from fertilization of an egg by a sperm cell.

Physics Dictionary

Accurate. Conforming closely to some standard. Having very small error of any kind. See: Uncertainty. Compare: precise.

Absolute uncertainty. The uncertainty in a measured quantity is due to inherent variations in the measurement process itself. The uncertainty in a result is due to the combined and accumulated effects of these measurement uncertainties which were used in the calculation of that result. When these uncertainties are expressed in the same units as the quantity itself they are called absolute uncertainties. Uncertainty values are usually attached to the quoted value of an experimental measurement or result, one common format being: (quantity) ± (absolute uncertainty in that quantity).

Compare: relative uncertainty.

Action. This technical term is a historic relic of the 17th century, before energy and momentum were understood. In modern terminology, action has the dimensions of energy×time. Planck's constant has those dimensions, and is therefore sometimes called *Planck's quantum of action*. Pairs of measurable quantities whose product has dimensions of energy×time are called *conjugate quantities* in quantum mechanics, and have a special relation to each other, expressed in Heisenberg's uncertainty principle. Unfortunately the word action persists in textbooks in meaningless statements of Newton's third law: 'Action equals reaction.' This statement is useless to the modern student, who hasn't the foggiest idea what action is. See: Newton's 3rd law for a useful definition. Also see Heisenberg's uncertainty principle.

Avogadro's constant. Avogadro's constant has the unit $mole^{-1}$. It is *not* merely a number, and should *not* be called Avogadro's number. It *is* ok to say that the number of particles *in* a gram-mole is 6.02×10^{23}. Some older books call this value Avogadro's number, and when that is done, no units are attached to it. This can be confusing and misleading to students who are conscientiously trying to learn how to balance units in equations.

One *must* specify whether the value of Avogadro's constant is expressed for a gram-mole or a kilogram-mole. A few books prefer a kilogram-mole. The unit name for a gram-mole is simply mol. The unit name for a kilogram-mole is kmol. When the kilogram-mole is used, Avogadro's constant should be written: 6.02252×10^{26} $kmol^{-1}$. The fact that Avogadro's constant has units further convinces us that it is **not** 'merely a number.'

Though it seems inconsistent, the SI base unit is the gram-mole. As Mario Iona reminds me, SI is not an MKS system. Some textbooks still prefer to use use the kilogram-mole, or worse, use it and the gram-mole. This affects their quoted values for the universal gas constant and the Faraday Constant.

Is Avogadro's constant just a number? What about those textbooks which say 'You could have a mole of stars, grains of sand, or people.' In science we do use entities which are just numbers, such as   , e, 3, 100, etc. Though these are used in science, their definitions are independent of science. No experiment of science can ever determine their value, except approximately. Avogadro's constant, however, *must* be determined experimentally, for example by counting the number of atoms in a crystal. The value of Avogadro's number found in handbooks is an *experimentally* determined number. You won't discover its value experimentally by counting stars, grains of sand, or people. You find it only by counting atoms or molecules in

something of known relative molecular mass. And you won't find it playing any role in any equation or theory about stars, sand, or people.

The reciprocal of Avogadro's constant is numerically equal to the unified atomic mass unit, u, that is, 1/12 the mass of the carbon 12 atom.

1 u = 1.66043 x 10^{-27} kg = 1/6.02252 x 10^{23} mole^{-1}.

Because. Here's a word best avoided in physics. Whenever it appears one can be almost certain that it's a filler word in a sentence which says nothing worth saying, or a word used when one can't think of a good or specific reason. While the use of the word because as a link in a chain of logical steps is benign, one should still replace it with words more specifically indicative of the type of link which is meant. See: why.

Illustrative fable: The seeker after truth sought wisdom from a Guru who lived as a hermit on top of a Himalayan mountain. After a long and arduous climb to the mountain-top the seeker was granted an audience. Sitting at the feet of the great Guru, the seeker humbly said: 'Please, answer for me the eternal question: Why?' The Guru raised his eyes to the sky, meditated for a bit, then looked the seeker straight in the eye and answered, with an air of sagacious profundity, **'Because!'**

Capacitance. The *capacitance* of a capacitor is measured by this procedure: Put equal and opposite charges on its plates and then measure the potential between the plates. Then C = |Q/V|, where Q is the charge on one of the plates.

Capacitors for use in circuits consist of two conductors (plates). We speak of a capacitor as 'charged' when it has charge Q on one plate, and -Q on the other. Of course the net charge of the entire object is zero; that is, the charged capacitor hasn't had net charge added to it, but has undergone an internal separation of charge. Unfortunately this process is usually called charging the capacitor, which is misleading because it suggests adding charge to the capacitor. In fact, this process usually consists of moving charge from one plate to the other. The capacity of a single object, say an isolated sphere, is determined by considering the other plate to be an infinite sphere surrounding it. The object is given charge, by moving charge from the infinite sphere, which acts as an infinite charge reservoir ('ground'). The potential of the object is the potential between the object and the infinite sphere.

Capacitance depends only on the geometry of the capacitor's physical structure and the dielectric constant of the material medium in which the capacitor's electric field exists. The size of the capacitor's capacitance is the same whatever the charge and potential (assuming the dielectric constant doesn't change). This is true even if the charge on both plates is reduced to zero, and therefore the capacitor's potential is zero. If a capacitor with charge on its plates has a capacitance of, say, 2 microfarad, then its capacitance is also 2 microfarad when the plates have no charge. This should remind us that C = |Q/V| is **not** by itself the definition of capacitance, but merely a formula which allows us to relate the capacitance to the charge and potential when the capacitor plates have equal and opposite charge on them.

A common misunderstanding about electrical capacitance is to assume that capacitance represents the maximum amount of charge a capacitor can store. That is misleading because capacitors don't store charge (their total charge being zero) but their plates have equal and opposite charge. It is wrong because the maximum charge one may put on a capacitor plate is determined by the potential at which dielectric breakdown occurs. Compare: capacity.

We probably should avoid the phrase 'charged capacitor' or 'charging a capacitor'. Some have suggested the alternative expression 'energizing a capacitor' because the process is one of giving the capacitor electrical potential energy by rearranging charges in it.

Capacity. This word is used in names of quantities which express the relative amount of some quantity with respect to a another quantity upon which it depends. For example, heat capacity is dU/dT, where U is the internal energy and T is the temperature. Electrical capacity, or *capacitance* is another example: $C = |dQ/dV|$, where Q is the magnitude of charge on each capacitor plate and V is the potential diference between the plates.

Centrifugal force. When a non-inertial rotating coordinate system is used to analyze motion, Newton's law **F** = m**a** is **not** correct unless one adds to the real forces a *fictitious force* called the *centrifugal force.* The centrifugal force required in the non-inertial system is equal and opposite to the *centripetal force* calculated in the inertial system. Since the centrifugal and centripetal forces are concepts used in two different formulations of the problem, they can not in any sense be considered a pair of reaction forces. Also, they act on the same body, not different bodies. See: centripetal force, action, and inertial systems.

Centripetal force. The *centripetal force* is the radial component of the net force acting on a body when the problem is analyzed in an inertial system. The force is inward toward the instantaneous center of curvature of the path of the body. The size of the force is mv^2/r, where r is the instantaneous radius of curvature. See: centrifugal force.

cgs. The system of units based upon the fundamental metric units: centimeter, gram and second.

Classical physics. The physics developed before about 1900, before we knew about relativity and quantum mechanics. See: modern physics.

Closed system. A physical system on which no outside influences act; closed so that nothing gets in or out of the system and nothing from outside can influence the system's observable behavior or properties.

Obviously we could never make measurements on a closed system unless we were in it[†], for no information about it could get out of it! In practice we loosen up the condition a bit, and only insist that there be no interactions with the outside world which would affect those properties of the system which are being studied.

† Besides, when the experimenter is a part of the system, all sorts of other problems arise. This is a dilemma physicists must deal with: the fact that if we take measurements, we are a part of the system, and must be very certain that we carry out experiments so that fact doesn't distort or prejudice the results.

Conserved. A quantity is said to be *conserved* if under specified conditions it's value does not change with time.

Example: In a closed system, the charge, mass, total energy, linear momentum and angular momentum of the system are conserved. (Relativity theory allows that mass can be converted to energy and vice-versa, so we modify this to say that the mass-energy is conserved.)

Current. The time rate at which charge passes through a circuit element or through a fixed place in a conducting wire, I = dq/dt.

Misuse alert. A very common mistake found in textbooks is to speak of 'flow of current'. Current itself is a flow of charge; what, then, could 'flow of current' mean? It is either redundant, misleading, or wrong. This expression should be purged from our vocabulary. Compare a similar mistake: 'The velocity moves West.'

Data. The word data is the plural of datum. Examples of correct usage:

'The data are reasonable, considering the…'
'The data were taken over a period of three days.'
'How well do the data confirm the theory?'

Derive. To derive a result or conclusion is to show, using logic and mathematics, how a conclusion follows logically from certain given facts and principles.

Dimensions. The fundamental measurables of a unit system in physics—those which are defined through operational definitions. All other measurable quantities in physics are defined through mathematical relations to the fundamental quantities. Therefore any physical measurable may be expressed as a mathematical combination of the dimensions. See: operational definitions.

Example: In the MKSA (meter-kilogram-second-ampere) system of units, length, mass, time and current are the fundamental measurables, symbolically represented by L, M, T, and I. Therefore we say that velocity has the dimensions LT^{-1}. Energy has the dimensions ML^2T^{-2}.

Discrepancy. (1) Any deviation or departure from the expected. (2) A difference between two measurements or results. (3) A difference between an experimental determination of a quantity and its standard or accepted value, usually called the *experimental discrepancy.*

Empirical law. A law strictly based on experiment, which may lack theoretical foundation.

Electricity. This word names a branch or subdivision of physics, just as other subdivisions are named 'mechanics', 'thermodynamics', 'optics', etc.

Misuse alert: Sometimes the word *electricity* is colloquially misused as if it named a physical quantity, such as 'The capacitor stores electricity,' or 'Electricity in a resistor produces heat.' Such usage should be *avoided!* In all such cases there's available a more specific or precise word, such as 'The capacitor stores *electrical energy*,' 'The resistor is heated by the electric *current*,' and 'The utility company charges me for the *electric energy* I use.' (I am not being charged based on the *power*, so these companies shouldn't call themselves Power companies. Some already have changed their names to something like '... Energy')

Energy. Energy is a property of a body, not a material substance. When bodies interact, the energy of one may increase at the expense of the other, and this is sometimes called a transfer of energy. This does not mean that we could intercept this energy in transit and bottle some of it. After the transfer one of the bodies may have higher energy than before, and we speak of it as having 'stored energy'. But that doesn't mean that the energy is 'contained in it' in the same sense as water in a bucket.

Misuse example: 'The earth's auroras—the northern and southern lights—illustrate how energy from the sun travels to our planet.' —*Science News, 149*, June 1, 1996. This sentence blurs understanding of the process by which energetic charged particles from the sun interact with the earth's magnetic field and our atmosphere to result in the aurorae.

Whenever one hears people speaking of 'energy fields', 'psychic energy', and other expressions treating energy as a 'thing' or 'substance', you know they aren't talking physics, they are talking moonshine.

In certain quack theories of oriental medicine, such as qi gong (pronounced chee gung) something called qi is believed to circulate through the body on specific, mappable pathways called meridians. This idea pervades the contrived explanations/rationalizations of acupuncture, and the qi is generally translated into English as energy. No one has ever found this so-called

'energy', nor confirmed the uniqueness of its meridian pathways, nor verified, through proper double-blind tests, that any therapy or treatment based on the theory actually works. The proponents of qi can't say whether it is a fluid, gas, charge, current, or something else, and their theory requires that it doesn't obey any of the physics of known carriers of energy. But, as soon as we hear someone talking about it as if it were a thing we know they are not talking science, but quackery.

The statement 'Energy is a property of a body' needs clarification. As with many things in physics, the size of the energy depends on the coordinate system. A body moving with speed V in one coordinate system has kinetic energy *½mV²*. The same body has zero kinetic energy in a coordinate system moving along with it at speed V. Since no inertial coordinate system can be considered 'special' or 'absolute', we shouldn't say 'The kinetic energy of the body is ...' but should say 'The kinetic energy of the body moving in this reference frame is ...'

Equal. [Not all 'equals' are equal.] The word equal and the symbol '=' have many *different* uses. The dictionary warns that equal things are 'alike or in agreement in a specified sense with respect to specified properties.' This we must be careful about the specified sense and specified properties.

The meaning of the the the mathematical symbol, '=' depends upon what stands on either side of it. When it stands between vectors it symbolizes that the vectors are equal in both size *and* direction.

In algebra the equal sign stands between two algebraic expressions and indicates that two expressions are related by a reflexive, symmetric and transitive relation. The mathematical expressions on either side of the '=' sign are mathematically identical and interchangeable in equations.

When the equal sign stands between two mathematical expressions with physical meaning, it means something quite different. In physics we may correctly write 12 inches = 1 foot, but to write 12 = 1 is simply wrong. In the first case, the equation tells us about physically equivalent measurements. It has physical meaning, and the units are an indispensable part of the quantity.

When we write $\mathbf{a} = d\mathbf{v}/dt$, we are *defining* the acceleration in terms of the time rate of change of velocity. One does not verify a definition by experiment. Experiment can, however, show that in certain cases (such as a freely falling body) the acceleration of the body is constant.

The three-lined equal sign, $\equiv$, is often used to mean 'defined equal to'. Unfortunately this symbol is not part of the HTML character set, so in this document we use an underlined equal sign instead.
When we write $\mathbf{F} = m\mathbf{a}$, we are expressing a relation between measurable quantities, one which holds under specified conditions, qualifications and limitations. There's more to it than the equation. One must, for example, specify that all measurements are made in an inertial frame, for if they aren't, this relation isn't correct as it stands, and must be modified. Many physical laws, including this one, also include definitions. This equation may be considered a definition of force, if m and a are previously defined. But if F was previously defined, this may be taken as a definition of mass. But the fact that this relation can be experimentally tested, and possibly be shown to be false (under certain conditions) demonstrates that it is **more** than a mere definition.

Additional discussion of these points may be found in Arnold Arons' book A Guide to Introductory Physics Teaching, section 3.23, listed in the references at the end of this document.

Usage note: When **reading** equations aloud we often say, 'F equals m a'. This, of course, says that the two things are mathematically equal in equations, and that one may replace the other. It is **not** saying that F **is** physically the same thing as m**a**. Perhaps equations were not meant to be read aloud, for the spoken word does not have the subtleties of meaning necessary for the task. At least we should realize that spoken equations are at best a shorthand approximation to the meaning; a verbal description of the symbols. If we were to try to speak the physical meaning, it would be something like: 'Newton's law tells us that the net vector force acting on a body of mass m is mathematically equal to the product of its mass and its vector acceleration.' In a textbook, words like that would appear in the text near the equation, at least on the first appearance of the equation.

Error. In colloquial usage, 'a mistake'. In technical usage *error* is a synonym for the *experimental uncertainty* in a measurement or result. See: uncertainty.

Error analysis. The mathematical analysis done to show quantitatively how uncertainties in data produce uncertainty in calculated results, and to find the sizes of the uncertainty in the results. [In mathematics the word *analysis* is synonymous with *calculus*, or 'a method for mathematical calculation.' Calculus courses used to be named Analysis.]

See: uncertainty **Extensive property.** A measurable property of a thermodynamic system is extensive if, when two identical systems are combined into one, the value of that property of the combined system is double its original value in each system. Examples: mass, volume, number of moles. See: intensive variable and specific.

Experimental error. The uncertainty in the value of a quantity. This may be found from (1) statistical analysis of the scatter of data, or (2) mathematical analysis showing how data uncertainties affect the uncertainty of calculated results.

Misuse alert: In elementary lab manuals one often sees: experimental error = |your value - book value| /book value. This **should** be called the *experimental discrepancy.* See: discrepancy.

Factor. One of several things multiplied together.

Misuse alert: Be careful that the reader does not confuse this with the colloquial usage: 'One factor in the success of this experiment was…'

Fictitious force. See: inertial frames. **Focal point.** The focal point of a lens is defined by considering a parallel bundle or beam of light incident upon the lens, parallel to the optic (symmetry) axis of the lens. The focal point is that point to which the rays converge or from which they diverge. The first case is that of a *converging* (positive) lens. The second case is that of a *diverging* (negative) lens. It's easy to tell which kind of lens you have, for converging lenses are thicker at their center than at the edges, and diverging lenses are thinner at the center than at the edges.

FPS. The system of units based on the fundamental units of the 'English system': foot, pound and second.

Heat. Heat, like work, is a measure of the amount of energy *transferred* from one body to another because of the temperature difference between those bodies. Heat is *not* energy *possessed* by a body. We should *not* speak of the 'heat *in* a body.' The energy a body possesses due to its temperature is a different thing, called internal thermal energy. The misuse of this word probably dates back to the 18th century when it was still thought that bodies undergoing thermal processes exchanged a substance, called caloric or phlogiston, a substance later called heat. We now know that heat is not a substance. Reference: Zemansky, Mark W. The Use and Misuse of the Word 'Heat' in Physics Teaching' **The Physics Teacher, 8**, 6 (Sept 1970) p. 295-300. See: work.

Heisenberg's Uncertainty Principle. Pairs of measurable quantities whose product has dimensions of energy×time are called *conjugate quantities* in quantum mechanics, and have a special relation to each other, expressed in Heisenberg's uncertainty principle. It says that the product of the uncertainties of the two quantities is no smaller than h/2 . Thus if you improve the measurement precision of one quantity the precision of the other gets worse.

Misuse alert: Folks who don't pay attention to details of science, are heard to say 'Heisenberg showed that you can't be certain about anything.' We also hear some folk justifying belief in esp or psychic phenomena by appeal to the Heisenberg principle. This is wrong on several counts. (1) The precision of *any* measurement is never perfectly certain, and we knew that before Heisenberg. (2) The Heisenberg uncertainty principle tells us we can measure anything with arbitrarily small precision, but in the process some *other* measurement gets worse. (3) The uncertainties involved here affect only microscopic (atomic and molecular level phenomena) and have no applicability to the macroscopic phenomena of everyday life.

Hypothesis. An untested statement about nature; a scientific conjecture, or educated guess. Formally, a hypothesis is made prior to doing experiments designed to test it. Compare: law and theory.

Ideal-lens equation. *1/p + 1/q = 1/f*, where p is the distance from object to lens, q is the distance from lens to image, and f is the focal length of the lens. This equation has important limitations, being only valid for *thin* lenses, and for *paraxial rays.* Thin lenses have thickness small compared to p, q, and f. Paraxial rays are those which make angles small enough with the optic axis that the approximation *(angle in radian measure) = sin(angle)* may be used. See: optical sign conventions, and image.

Inertia A descriptive term for that property of a body which resists change in its motion. Two kinds of changes of motion are recognized: changes in translational motion, and changes in rotational motion.

In modern usage, the measure of translational inertia is mass. Newton's first law of motion is sometimes called the 'Law of Inertia', a label which adds nothing to the meaning of the first law. Newton's first and second laws together are required for a full description of the consequences of a body's inertia.

The measure of a body's resistance to rotation is its Moment of Inertia.

Inertial frame. A non-accelerating coordinate system. One in which *F = ma* holds, where *F* is the sum of all real forces acting on a body of mass m whose acceleration is *a*. In classical mechanics, the real forces on a body are those which are due to the influence of another body. [Or, forces on a part of a body due to other parts of that body.] Contact forces, gravitational, electric, and magnetic forces are real. Fictitious forces are those which arise solely from formulating a problem in a non-inertial system, in which *ma = F + (fictitious force terms)*

Intensive variable. A measurable property of a thermodynamic system is intensive if when two identical systems are combined into one, the variable of the combined system is the same as the original value in each system. Examples: temperature, pressure. See: extensive variable, and specific.

Image. (Optics) A surprising number of physics glossaries omit a definition of this! No wonder. It's difficult to put in a few words, and still be comprehensive in scope. Try this. **Image:** A point mapping of luminous points of an object located in one region of space to points in another region of space, formed by refraction or reflection of light in a manner which causes light from each point

of the object to converge to or diverge from a point somewhere else (on the image). The images which are useful generally have the character that adjacent points of the object map to adjacent points of the image without discontinuity, and is a recognizable (though perhaps somewhat distorted) mapping of the object. See: real image and virtual image.

Law. A statement, usually mathematical, which describes some physical phenomena. Compare: hypothesis and theory.

Lens. A transparent object with two refracting surfaces. Usually the surfaces are flat or spherical (spherical lenses). Sometimes, to improve image quality. Lenses are deliberately made with surfaces which depart slightly from spherical (aspheric lenses).

Kinetic energy. The energy a body has by virtue of its motion. The kinetic energy is the work done by an external force to bring the body from rest to a particular state of motion. See: work.

Common misconception: Many students think that kinetic energy is *defined* by $\frac{1}{2}mv^2$. It is not. That happens to be approximately the kinetic energy of objects moving slowly, at small fractions of the speed of light. If the body is moving at relativistic speeds, its kinetic energy is mc^2, which can be expressed as $\frac{1}{2}mv^2$ + *an infinite series of terms*. $^2 = 1/(1-(v/c)^2)$, where *c* is the speed of light in a vacuum.

Macro-. A prefix meaning 'large'. See: micro-

Macroscopic. A physical entity or process of large scale, the scale of ordinary human experience. Specifically, any phenomena in which the individual molecules and atoms are neither measured, nor explicitly considered in the description of the phenomena. See: microscopic.

Magnification.

Two kinds of magnification are useful to describe optical systems and they must not be confused, since they aren't synonymous. Any optical system which produces a real image from a real object is described by its linear magnification. Any system which one looks through to view a virtual image is described by its angular magnification. These have different definitions, and are based on fundamentally different concepts.

Linear Magnification is the ratio of the size of the object to the size of the image.

Angular Magnification is the ratio of the angular size of the object as seen through the instrument to the angular size of the object as seen with the 'naked eye'. The 'naked eye' view is without use of the optical instrument, but under optimal viewing conditions.

Certain 'gotchas' lurk here. What are 'optimal' conditions? Usually this means the conditions in which the object's details can be seen most clearly. For a small object held in the hand, this would be when the object is brought as close as possible and still seen clearly, that it, to the near point of the eye, about 25 cm for normal eyesight. For a distant mountain, one can't bring it close, so when determining the magnification of a telescope, we assume the object is very distant, or at infinity.

And what is the 'optimal' position of the image? For the simple magnifier, in which the magnification depends strongly on the image position, the image is best seen at the near point of the eye, 25 cm. For the telescope, the image size doesn't change much as you fiddle with the focus, so you likely will put the image at infinite distance for relaxed viewing. The microscope is

an intermediate case. Always striving for greater resolution, the user may pull the image close, to the near point, even though that doesn't increase its size very much. But usually, users will place the image farther away, at the distance of a meter or two, or even at infinity. But, because the object is very near the focal point, the magnification is only weakly dependent on image position.

Some texts express angular magnification as the ratio of the angles, some express it as the ratio of the tangents of the angles. If all of the angles are small, there's negligible difference between these two definitions. However, if you examine the derivation of the formula these books give for the magnification of a telescope f_o/f_e, you realize that they must have been using the tangents. The tangent form of the definition is the traditionally correct one, the one used in science and industry, for nearly all optical instruments which are designed to produce images which preserve the linear geometry of the object.

Micro-. A prefix meaning 'small', as in 'microscope', 'micrometer', 'micrograph'. Also, a metric prefix meaning 10^{-6}. See: macro-

Microscopic. A physical entity or process of small scale, too small to directly experience with our senses. Specifically, any phenomena on the molecular and atomic scale, or smaller. See: macroscopic.

MKSA. The system of physical units based on the fundamental metric units: meter kilogram, second and ampere.

Modern physics. The physics developed since about 1900, which includes relativity and quantum mechanics. See: classical physics.

Mole. The term *mole* is short for the name gram-molar-weight; it is *not* a shortened form of the word molecule. (However, the word molecule does also derive from the word molar.) See: Avogadro's constant.

Misuse alert: Many books emphasize that the mole is 'just a number,' a measure of the number of particles in a collection. They say that one can have a mole of *any* kind of particles, baseballs, atoms, stars, grains of sand, etc. It doesn't have to be molecules. This is misleading.

To say that the mole is 'just a number' is simply wrong, from physical, pedagogical, philosophical and historical points of view. There's no physical significance to a mole of stars or a mole of grains of sand, or a mole of people. The physical significance of the mole as a measure of quantity arises *only* when dealing with physical laws about matter on the molecular scale. The only physical and chemical *laws* which use the mole are those dealing with gases, or systems behaving like gases.

Molecular mass. The *molecular mass* of something is the mass of **one mole** of it (in cgs units), or **one kilomole** of it (in MKS units). The units of molecular mass are gram and kilogram, respectively. The cgs and MKS values of molecular mass are numerically equal. The molecular mass is **not** the mass of one molecule. Some books still call this the molecular weight.

One dictionary definition of *molar* is 'Pertaining to a body of matter as a whole: contrasted with *molecular* and *atomic*.' The mole is a measure appropriate for a *macro*scopic amount of material, as contrasted with a *micro*scopic amount (a few atoms or molecules). See: mole, Avogadro's constant, microscopic, macroscopic.

Newton's first and second laws of motion. $F = d(mv)/dt$.

F is the *net* (total) force acting on the body of mass m. The individual forces acting on m must be summed vectorially. In the special case where the mass is constant, this becomes $F = ma$.

Newton's third law of motion. When body A exerts a force on body B, then B exerts and equal and opposite force on A. The two forces related by this law act on *different bodies*. The forces need not be *net* forces.

Ohm's law. $V = IR$, where V is the potential across a circuit element, I is the current through it, and R is its resistance. This is **not** a generally applicable definition of resistance. It is only applicable to *ohmic* resistors, those whose resistance R is constant over the range of interest and V obeys a strictly linear relation to I.

Materials are said to be *ohmic* when V depends linearly on R. Metals are ohmic so long as one holds their temperature constant. But changing the temperature of a metal changes R slightly. Therefore such a device as an electric light bulb increases its temperature as it warms up, which is why it glows slightly brighter for a very brief time just after it is turned on.

For non-ohmic resistors, R is a function of current and the definition $R = dV/dI$ is far more useful. This is sometimes called the *dynamic resistance*. Solid state devices such as thermistors are non-ohmic, and non-linear. A thermistor's resistance decreases as it warms up, so its dynamic resistance is negative. Tunnel diodes and some electrochemical processes have a complicated *I-V* curve with a negative resistance region of operation.

The dependence of resistance on current is partly due to the change in the device's temperature with increasing current, but other subtle processes also contribute to change in resistance in solid state devices.

Operational definition. A definition which describes an *experimental procedure* by which a numeric value of the quantity may be determined. See dimensions.

Example: Length is operationally defined by specifying a *procedure* for subdividing a standard of length into smaller units to make a measuring stick, then laying that stick on the object to be measured, etc..
Very few quantities in physics need to be operationally defined. They are the *fundamental* quantities, which include length, mass and time. Other quantities are defined from these through mathematical relations.

Optical sign conventions. In introductory (freshman) courses in physics a sign convention is used for objects and images in which the lens equation must be written *1/p + 1/q = 1/f*. Often the rules for this sign convention are presented in a convoluted manner. A simple and easy to remember rule is this: *p* is the *object-to-lens* distance. *q* is the *lens to image* distance. The coordinate axis along the optic axis is in the direction of passage of light through the lens, this defining the *positive* direction. Example: If the axis and the light direction is left-to-right (as is usually done) and the object is to the left of the lens, the object-to-lens distance is positive. if the object is to the right of the lens (virtual object), the object-to-lens distance is negative. It works the same for images.

For refractive surfaces, define the surface radius to be the directed distance from a surface to its center of curvature. Thus a surface convex to the incident light is positive, one concave to the incident light is negative. The surface equation is then *n/s + n'/s' = (n'-n)/R* where *s* and *s'* are the

object and image distances, and *n* and *n'* the refractive index of the incident and emergent media, respectively.

For mirrors, the equation is usually written *1/s + 1/s' = 2/R = 1/f*. A diverging mirror is convex to the incoming light, with negative *f*. From this fact we conclude that *R* is also negative. This form of the equation is consistent with that of the lens equation, and the interpretation of sign of focal length is the same also. But violence is done to the definition of *R* we used above, for refraction. One can say that the mirror folds the length axis at the mirror, so that emergent rays to a real image at the left represent a positive value of *s'*. We are forced also to declare that the mirror also flips the sign of the surface radius. For reflective surfaces, the radius of curvature is defined to be the directed distance from a surface to its center of curvature, *measured with respect to the axis used for the emergent light.* With this qualification the convention for the signs of *s'* and *R* is the same for mirrors as for refractive surfaces.

In advanced optics courses, a **cartesian** sign convention is used in which all things to the left of the lens are negative, all those to the right are positive. When this is used, the lens equation must be written *1/p + 1/f = 1/q*. (The sign of the *1/p* term is opposite that in the other sign convention). This is a particularly meaningful version, for *1/p* is the measure of vergence (convergence or divergence) of the rays as they enter the lens, *1/f* is the amount the lens changes the vergence, and *1/q* is the vergence of the emergent rays.

Pascal's Principle of Hydrostatics. Pascal actually has three separate principles of hydrostatics. When a textbook refers to Pascal's Principle it should specify which is meant.

Pascal 1: The pressure at any point in a liquid exerts force equally in all directions. This means that an infinitessimal surface area placed at that point will experience the same force due to pressure no matter what its orientation.

Pascal 2: When pressure is changed (increased or decreased) at any point in a homogenous, incompressible fluid, all other points experience the same change of pressure.

Except for minor edits and insertion of the words 'homogenous' and 'incompressible', this is the statement of the principle given in John A. Eldridge's textbook College Physics (McGraw-Hill, 1937). Yet over half of the textbooks I've checked, including recent ones, omit the important word 'changed'. Some textbooks add the qualification 'enclosed fluid'. This gives the false impression that the fluid must be in a closed container, which isn't a necessary condition of Pascal's principle at all.

Some of these textbooks do indicate that Pascal's principle applies only to changes in pressure, but do so in the surrounding text, not in the bold, highlighted, and boxed statement of the principle. Students, of course, read the emphasized statement of the principle and not the surrounding text. Few books give any examples of the principle applied to anything other than enclosed liquids. The usual example is the hydraulic press. Too few show that Pascal's principle is derivable in one step from Bernoulli's equation. Therefore students have the false impression that these are independent laws.

Pascal 3. The hydraulic lever. The hydraulic jack is a problem in fluid equilibrium, just as a pulley system is a problem in mechanical equilibrium (no accelerations involved). It's the static situation in which a small force on a small piston balances a large force on a large piston. No change of pressure need be involved here. A constant force on one piston slowly lifts a different piston with a constant force on it. At all times during this process the fluid is in near-equilibrium. This 'principle' is no more than an application of the definition of pressure as *F/A*, the quotient of

net force to the area over which the force acts. However, it also uses the principle that pressure in a fluid is uniform throughout the fluid at all points of the same height.

This hydraulic jack lifitng process is done at constant speed. If the two pistons are at different levels, as they usually are in real jacks used for lifting, there's a pressure difference between the two pistons due to height difference *(rho)gh*. In textbook examples this is generally considered small enough to neglect and may not even be mentioned.

Pascal's own discussion of the principle is not concisely stated and can be misleading if hastily read. See his On the Equilibrium of Liquids, 1663. He inroduces the principle with the example of a piston as part of an enclosed vessel and considers what happens if a force is applied to that piston. He concludes that each portion of the vessel is pressed in proportion to its area. He does mention parenthetically that he is 'excluding the weight of the water..., for I am speaking only of the piston's effect.'

Percentage. Older dictionaries suggested that *percentage* be used when a non-quantitative statement is being made: 'The percentage growth of the economy was encouraging.' But use *percent* when specifying a numerical value: 'The gross national product increased by 2 percent last year.' Though newer dictionaries are more permissive, I find the indiscriminate and unnecessary use of the ugly word *percentage* to be overdone and annoying, as in 'The experimental percentage uncertainty was 9%.' Much more graceful is: 'The experimental uncertainty was 9%.'

Related note: Students have the strange idea that results are better when expressed as percents. Some experimental uncertainties must *not* be expressed as percents. Examples: (1) temperature in Celsius or Fahrenheit measure, (2) index of refraction, (3) dielectric constants. These measurables have arbitrarily chosen 'fixed points'. Consider a 1 degree uncertainty in a temperature of 99 degrees C. Is the uncertainty 1%? Consider the same error in a measurement of 5 degrees. Is the uncertainty now 20%? Consider how much smaller the percent would be if the temperature were expressed in degrees Kelvin. This shows that percent uncertainty of Celsius and Fahrenheit temperature measurements is meaningless. However, the absolute (Kelvin) temperature scale has a physically meaningful fixed point (absolute zero), rather than an arbitrarily chosen one, and in some situations a percent uncertainty of an absolute temperature *is* meaningful.

Per unit. In my opinion this expression is a barbarism best avoided. When a student is told that electric field is force per unit charge and in the MKS system one unit of charge is a coulomb (a *huge* amount) must we obtain that much charge to measure the field? Certainly not. In fact, one must take the limit of **F**/q as q goes to zero. Simply say: 'Force divided by charge' or 'F over q' or even 'force per charge'. Unfortunately there is no graceful way to say these things, other than simply writing the equation.

Per is one of those frustrating words in English. The *American Heritage Dictionary* definition is: 'To, for, or by each; for every.' Example: '40 cents per gallon.' We must put the blame for per unit squarely on the scientists and engineers.

Precise. Sharply or clearly defined. Having small experimental uncertainty. A precise measurement may still be inaccurate, if there were an unrecognized determinate error in the measurement (for example, a miscalibrated instrument). Compare: accurate.

Proof. A term from logic and mathematics describing an argument from premise to conclusion using strictly logical principles. In mathematics, theorems or propositions are established by

logical arguments from a set of axioms, the process of establishing a theorem being called a proof.

The colloquial meaning of 'proof' causes lots of problems in physics discussion and is best avoided. Since mathematics is such an important part of physics, the mathematician's meaning of proof should be the only one we use. Also, we often ask students in upper level courses to do proofs of certain theorems of mathematical physics, and we are *not* asking for experimental demonstration!

So, in a laboratory report, we should not say 'We proved Newton's law.' Rather say, 'Today we *demonstrated* (or *verified*) the validity of Newton's law in the particular case of…'

Radioactive material. A material whose nuclei spontaneously give off nuclear radiation. Naturally radioactive materials (found in the earth's crust) give off alpha, beta, or gamma particles. Alpha particles are Helium nuclei, beta particles are electrons, and gamma particles are high energy photons.

Radioactive. A word distinguishing radioactive materials from those which aren't. Usage: 'U-235 is radioactive; He-4 is not.'

Note: *Radioactive* is least misleading when used as an adjective, not as a noun. It is sometimes used in the noun form as an shortened stand-in for *radioactive material*, as in the example above.
Radioactivity. The process of emitting particles from the nucleus. Usage: 'Certain materials found in nature demonstrate radioactivity.'
Misuse alert: Radioactivity is a *process*, not a *thing*, and not a *substance*. It is just as incorrect to say 'U-235 emits radioactivity' as it is to say 'current flows.' A malfunctioning nuclear reactor does not release radioactivity, though it may release radioactive materials into the surrounding environment. A patient being treated by radiation therapy does not absorb radioactivity, but does absorb some of the *radiation* (alpha, beta, gamma) given off by the radioactive materials being used.

This misuse of the word *radioactivity* causes many people to incorrectly think of radioactivity as something one can get by being near radioactive materials. There is only one process which behaves anything like that, and it is called *artificially induced radioactivity*, a process mainly carried out in research laboratories. When some materials are bombarded with protons, neutrons, or other nuclear particles of appropriate energy, their nuclei may be transmuted, creating unstable isotopes which are radioactive.

Rate. A quantity of one thing compared to a quantity of another. [Dictionary definition]

In physics the comparison is generally made by taking a quotient. Thus speed is defined to be the dx/dt, the 'time rate of change of position'.

Common misuse: We often hear non-scientists say such things as 'The car was going at a high rate of speed.' This is redundant at best, since it merely means 'The car was moving at high speed.' It is the sort of mistake made by people who don't think while they talk.
Ratio. The quotient of two similar quantities. In physics, the two quantities must have the same units to be 'similar'. Therefore we may properly speak of the ratio of two lengths. But to say 'the ratio of charge to mass of the electron' is improper. The latter is properly called 'the specific charge of the electron.' See: specific.

Reaction. Reaction forces are those equal and opposite forces of Newton's Third Law. Though they are sometimes called an action and reaction pair, one never sees a single force referred to as an action force. See: Newton's Third Law.

Real force. See: inertial frame.

Real image. The point(s) to which light rays converge as they emerge from a lens or mirror. See: virtual image.

Real object. The point(s) from which light rays diverge as they enter a lens or mirror. See: virtual object.

Relative. Colloquially 'compared to'. In the *theory of relativity* observations of moving observers are quantitatively compared. These observers obtain different values when measuring the same quantities, and these quantities are said to be *relative.* The theory, however, shows us how the differing measured values are precisely related to the relative velocity of the two observers. Some quantities are found to be the same for all observers, and are called *invariant.* One postulate of relativity theory is that the speed of light is an invariant quantity. When the theory is expressed in four dimensional form, with the appropriate choice of quantities, new invariant quantities emerge: the world-displacement *(x + y + z +ict)*, the energy-momentum four-vector, and the electric and magnetic potentials may be combined into an invariant four-vector. Thus relativity theory might properly be called *invariance theory.*

Misuse alert: One hears some folks with superficial minds say 'Einstein showed that everything is relative.' In fact, special relativity shows that only certain measurable things are relative, but in a precisely and mathematically specific way, and other things are, *not* relative, for all observers agree on them.

Relative uncertainty. The uncertainty in a quantity compared to the quantity itself, expressed as a ratio of the absolute uncertainty to the size of the quantity. It may also be expressed as a percent uncertainty. The relative uncertainty is dimensionless and unitless. See: absolute uncertainty.

Scale-limited. A measuring instrument is said to be *scale-limited* if the experimental uncertainty in that instrument is smaller than the smallest division readable on its scale. Therefore the experimental uncertainty is taken to be half the smallest readable increment on the scale.

Specific. In physics and chemistry the word specific in the name of a quantity usually means 'divided by an extensive measure that is, divided by a quantity representing an amount of material. Specific volume means volume divided by mass, which is the reciprocal of the density. Specific heat capacity is the heat capacity divided by the mass. See: extensive, and capacity.

Tele-. A prefix meaning at a distance, as in telescope, telemetry, television.

Term. One of several quantities which are added together.

Confusion can arise with another use of the word, as when one is asked to "Express the result in terms of mass and time." This means "as a function of mass and time," obviously it doesn't mean that mass and time are to be added as terms.

Truth. This is a word best avoided entirely in physics except when placed in quotes, or with careful qualification. Its colloquial use has so many shades of meaning from 'it seems to be correct' to the absolute truths claimed by religion, that it's use causes nothing but misunderstanding. Someone once said 'Science seeks proximate (approximate) truths.' Others speak of provisional or tentative truths. Certainly science claims no final or absolute truths.

Theoretical. Describing an idea which is part of a theory, or a consequence derived from theory.

Misuse alert: Do not call an authoritative or 'book' value of a physical quantity a theoretical value, as in: 'We compared our experimentally determined value of index of refraction with the theoretical value and found they differed by 0.07.' The value obtained from index of refraction tables comes *not* from theory, but from experiment, and therefore should not be called theoretical. The word theoretically suffers the same abuse. Only when a numeric value **is** a prediction from theory, can one properly refer to it as a 'theoretical value'.

Theory. A *well-tested* mathematical model of some part of science. In physics a theory usually takes the form of an equation or a group of equations, along with explanatory rules for their application. Theories are said to be successful if (1) they synthesize and unify a significant range of phenomena; (2) they have predictive power, either predicting new phenomena, or suggesting a direction for further research and testing. Compare: hypothesis, and law.

Uncertainty. Synonym: *error.* A measure of the the inherent variability of repeated measurements of a quantity. A prediction of the probable variability of a result, based on the inherent uncertainties in the data, found from a mathematical calculation of how the data uncertainties would, in combination, lead to uncertainty in the result. This calculation or process by which one predicts the size of the uncertainty in results from the uncertainties in data and procedure is called *error analysis.*

See: absolute uncertainty and relative uncertainty. Uncertainties are always present; the experimenter's job is to keep them as small as required for a useful result. We recognize two kinds of uncertainties: *indeterminate* and *determinate.* Indeterminate uncertainties are those whose size and sign are unknown, and are sometimes (misleadingly) called *random.* Determinate uncertainties are those of definite sign, often referring to uncertainties due to instrument miscalibration, bias in reading scales, or some unknown influence on the measurement.

Units. Labels which distinguish one type of measurable quantity from other types. Length, mass and time are distinctly different physical quantities, and therefore have different unit names, meters, kilograms and seconds. We use several systems of units, including the metric (SI) units, the English (or U.S. customary units) , and a number of others of mainly historical interest.

Note: Some dimensionless quantities are assigned unit names, some are not. Specific gravity has no unit name, but density does. Angles are dimensionless, but have unit names: degree, radian, grad. Some quantities which are physically different, and have different unit names, may have the same dimensions, for example, torque and work. Compare: dimensions.

Virtual image. The point(s) from which light rays converge as they emerge from a lens or mirror. The rays do not actually pass through each image point, but diverge from it. See: real image.

Virtual object. The point(s) to which light rays converge as they enter a lens. The rays pass through each object point. See: real object.

Weight. The size of the external force required to keep a body at rest in its frame of reference.

Mathematics Dictionary

abacus
> An oriental counting device and calculator.

Abelian group
> A group in which the binary operation is commutative, that is, ab=ba for all elements a abd b in the group.

abscissa
> The x-coordinate of a point in a 2-dimensional coordinate system.

absolute value
> The positive value for a real number, disregarding the sign. Written |x|. For example, |3|=3, |-4|=4, and |0|=0.

abundant number
> A positive integer that is smaller than the sum of its proper divisors.

acceleration
> The rate of change of velocity with respect to time.

acute angle
> An angle that is less than 90 degrees

addition
> The process of adding two numbers to obraint heir sum.

algebraic equation
> An equation of the form f(x)=0 where f is a polynomial.

algebraic number
> A number that is the root of an algebraic polynomial. For example, sqrt(2) is an algebraic number because it is a solution of the equation x^2=2.

alphametic
> A cryptarithm in which the letters, which represent distinct digits, form related words or meaningful phrases.

altitude
> The altitude of a triangle is the line segment from one vertex that is perpendicular to the opposite side.

amicable numbers
> Two numbers are said to be amicable if each is equal to the sum of the proper divisors of the other.

angle
> The figure formed by two line segments or rays that extend from a given point.

annulus
> The region enclosed by two concentric circles.

arc
> A portion of a circle.

area
> The amount of surface contained by a figure.

arithmetic
> The type of mathematics that studies how to solve problems involving numbers (but no variables).

arithmetic mean

The arithmetic mean of n numbers is the sum of the numbers divided by n.

automorphism

An isomorphism from a set onto itslef.

average

Typically this refers to the arithmetic mean.

ball

A sphere together with its interior.

bar graph

A type of chart used to compare data in which the length of a bar represents the size of the data.

base

In the expression x^y, x is called the base and y is the exponent.

Bayes's Rule

A rule for finding conditional probability.

binary number

A number written to base 2.

binary operation

A binary operation is an operation that involves two operands. For example, addition and subtraction are binary operations.

bijection

A one-to-one onto function.

binomial

An expression that is the sum of two terms.

binomial coefficient

The coefficients of x in the expansion of $(x+1)^n$.

biquadratic equation

A polynomial equation of the 4th degree.

bisect

to cut in half.

bit

A binary digit.

braces

The symbols { and } used for grouping or to represent a set.

byte

The amount of memory needed to represent one character on a computer, typically 8 bits.

Calculator

A machine for performing arithemtical calculations.

Caliban puzzle

A logic puzzle in which one is asked to infer one or more facts from a set of given facts.

cardinal number

A number that indicates the quantity but not the order of things.

catenary

A curve whose equation is $y = (a/2)(e^{x/a}+e^{-x/a})$. A chain suspended from two points forms this curve.

ceiling function
    The ceiling function of x is the smallest integer greater than or equal to x.

central angle
    An angle between two radii of a circle.

centroid
    The center of mass of a figure. The centroid of a triangle is the intersection of the medians.

cevian
    A line segment extending from a vertex of a triangle to the opposite side.

Chebyshev polynomials
    $T_n(x) = \cos(n \arccos x)$ and
    $U_n(x) = \sin[(n+1) \arccos x]/\sin(\arccos x)$.

chord
    The line joining two points on a curve is called a chord.

circle
    The set of points equidistant from a given point (the center).

circular cone
    A cone whose base is a circle.

circumcenter
    The circumcenter of a triangle is the center of the circumscribed circle.

circumcircle
    The circle circumscribed about a figure.

circumference
    The boundary of a circle.

cissoid
    A curve with equation $y^2(a-x)=x^3$.

coefficient
    The constant multipliers of the indeterminate variable in a polynomial. For example, in the polynomial x^2+3x+7, the coefficients are 1, 3, and 7.

common denominator
    A multiple shared by the denominators of two or more fractions.

complementary angles
    Two angles whose sum is 90°.

complex number
    The sum of a real number and an imaginary number, for example 3+4i where i=sqrt(-1).

compute
    To solve problems that use numbers.

concave
    curved from the inside.

cone
    A three-dimensional solid that rises froma circular base to a single point at the top.

congruent figures
    two geometric figures that are identical in size and shape.

conic section

The cross section of a right circular cone cut by a plane. An ellipse, parabola, and hyperbola are conic sections.

coordinates

Numbers that determine the position of a point.

coprime

Integers m and n are coprime if gcd(m,n)=1.

cryptarithm

A number puzzle in which an indicated arithmetical operation has some or all of its digits replaced by letters or symbols and where the restoration of the original digits is required. Each letter represents a unique digit.

cube

A solid figure bounded by 6 congruent squares.

cubic equation

A polynomial equation of degree 3.

cyclic polygon

A polygon whose vertices lie on a circle.

cylinder

A rounded three-dimensional solid that has a flat circular face at each end.

data

Facts that have been collected but not yet interpreted.

decagon

A polygon with 10 sides.

decimal number

A number written to the base 10.

decimal point

The period in a deimal number separating the integer part from the fractional part.

deficient number

A positive integer that is larger than the sum of its proper divisors.

degree

The degree of a term in one variable is the exponent of that variable. For example, the degree of $7x^5$ is 5.

denominator

In the fraction x/y, x is called the numerator and y is called the denominator.

diagonal

In a polygon, the line segment joining a vertex with another (non-adjacent) vertex is called a diagonal.

diameter

The longest chord of a figure. In a circle, a diameter is a chord that passes through the center of the circle.

difference

The difference between two numbers is what you get when you subtract one from the other.

differential calculus

That part of calculus that deals with the opeation of differentiation of functions.

digimetic
　　　A cryptarithm in which digits represent other digits.

digit
　　　In the decimal system, one of the numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

dihedral angle
　　　The angle formed by two planes meeting in space.

dimension
　　　The indication of how far something extends in space.

disc
　　　A circle together with its interior.

distributive law
　　　The formula a(x+y)=ax+ay.

dividend
　　　In the expression "a divided by b", a is the divident and b is the divisor.

division
　　　A basic arithmetical operation determining how many times one quantity is contained within another.

divisor
　　　In the expression "a divided by b", a is the divident and b is the divisor.

divisor
　　　The nonzero integer d is a divisor of the integer n if n/d is an integer.

Diophantine equation
　　　An equation that is to be solved in integers.

dodecagon
　　　A polygon with 12 sides.

dodecahedron
　　　A solid figure with 12 faces A regular dodecahedron is a regular polyhedron with 12 faces. Each face is a rgular pentagon.

domain
　　　The domain of a function f(x) is the set of x values for which the function is defined.

domino
　　　Two congruent squares joined along an edge.

duodecimal number system
　　　The system of numeration with base 12.

Egyptian fraction
　　　A number of the form 1/x where x is an integer is called an Egyptian fraction.

eigenvalue
　　　characteristic value

elementary function
　　　one of the functions: rational functions, trigonometric functions, exponential functions, and logarithmic functions.

ellipse
　　　A plane figure whose equation is $x^2/a^2+y^2/b^2=1$.

ellipsoid
A solid figure whose equation is $x^2/a^2+y^2/b^2+z^2/c^2=1$.

empty set
The set with no elements in it.

enumerable set
A countable set.

equation
A statement that two expressions are equal to each other.

equiangular polygon
A polygon all of whose interior angles are equal.

equichordal point
A point inside a closed convex curve in the plane is called an equichordal point if all chords through that point have the same length.

equilateral polygon
A polygon all of whose sides are equal.

equilateral triangle
A triangle with three equal sides.

escribed circle
An escribed circle of a triangle is a circle tangent to one side of the triangle and to the extensions of the other sides.

estimate
A rough guess at the value of a number.

Euler line
The Euler line of a triangle is the line connecting the centroid and the circumcenter.

Euler's constant
The limit of the series $1/1+1/2+1/3+...+1/n-\ln n$ as n goes to infinity. Its value is approximately 0.577216.

even function
A function f(x) is called an even function if f(x)=f(-x) for all x.

even number
An integer that is divisible by 2.

excenter
The center of an excircle.

excircle
An escribed circle of a triangle.

exponent
In the expression x^y, x is called the base and y is called the exponent.

exponential function
The function $f(x)=e^x$.

expoential function to base a
The function $f(x)=a^x$.

exradius
An exradius of a triangle is the radius of an escribed circle.

face angle

The plane angle formed by adjacent edges of a polygonal angle in space.

factor (noun)
    An exact divisor of a number. This 7 is a factor of 28.

factor (verb)
    To find the factors of a number.

factorial
    n! (read n factorial) is equal to the product of the integers from 1 to n.

Farey sequence
    The sequence obtained by arranging in numerical order all the proper fractions having denominators not greater than a given integer.

Fermat number
    A number of the form $2^{2^n}+1$.

Fermat's spiral
    A parabolic spiral.

Fibonacci number
    A member of the sequence 0, 1, 1, 2, 3, 5,... where each number is the sum of the previous two numbers.

figurate numbers
    polygonal numbers

finite group
    A group containing a finite number of elements.

floor function
    The floor function of x is the greatest integer in x, i.e. the largest integer less than or equal to x.

focal chord
    A chord of a conic that passes through a focus.

focal radius
    A line segment from the focus of an ellipse to a point on the perimeter of the ellipse.

foot of altitude
    The intersection of an altitude of a triangle with the base to which it is drawn.

foot of line
    The point of intersection of a line with a line or plane.

formula
    A concise statement expressing the symbolic relationship between two or more quantities.

Fourier series
    A periodic function with period 2 pi.

fraction
    An expression of the form a/b.

frequency
    The number of times a value occurs in some time interval.

frustum
    For a given solid figure, a related figure formed by two parallel planes meeting the given solid. In particular, for a cone or pyramid, a frustum is determined by

the plane of the base and a plane parallel to the base. NOTE: this word is frequently incorrectly misspelled as frustrum.

Gaussian curve
A normal curve.
geoboard
A flat board into which nails have been driven in a regular rectangular pattern. These nails represent the lattice points in the plane.
geodesic
The arc on a surface of shortest length joining two given points.
geodesy
A branch of mathematics dealing with the shape, size, and curvature of the Earth.
geometric mean
The geometric mean of n numbers is the nth root of the product of the numbers.
geometric progression
A sequence in which the ratio of each term to the preceding term is a given constant.
geometric series
A series in which the ratio of each term to the preceding term is a given constant.
geometric solid
The bounding surface of a 3-dimensional portion of space.
geometry
The branch of mathematics that deals with the nature of space and the size, shape, and other properties of figures as well as the transformations that preserve these properties.
Gergonne point
In a triangle, the lines from the vertices to the points of contact of the opposite sides with the inscribed circle meet in a point called the Gergonne point.
gnomon magic square
A 3 X 3 array in which the elements in each 2 X 2 corner have the same sum.
golden ratio
(1+Sqrt[5])/2.
golden rectangle
A rectangle whose sides are in the golden ratio.
graceful graph
A graph is said to be graceful if you can number the n vertices with the integers from 1 to n and then label each edge with the difference between the numbers at the vertices, in such a way that each edge receives a different label.
grad (or grade)
1/100th of a right angle
graph
A graph is a set of points (called vertices) and a set of lines (called edges) joinging these vertices.
great circle
A circle on the surface of a sphere whose center is the center of the sphere.
greatest common divisor

The greatest common divisor of a sequence of integers, is the largest integer that divides each of them exactly.

greatest common factor

Same as greatest common divisor.

greatest lower bound

The greatest lower bound of a set of real numbers, is the largest real number that is smaller than each of the numbers in the set.

group

A mathematical system consisting of elements from a set G and a binary operation * such that

1. x*y is a member of G whenever x and y are
2. (x*y)*z=x*(y*z) for all x, y, and z
3. there is an identity element e such that e*x=x*e=e for all x
4. each member x in G has an inverse element y such that x*y=y*x=e

half-line

A ray.

half-plane

The part of a plane that lies on one side of a given line.

Hankel matrix

A matrix in which all the elements are the same along any diagonal that slopes from northeast to southwest.

harmonic analysis

The study of the representation of functions by means of linear operations on characteristic sets of functions.

harmonic division

A line segment is divided harmonically by two points when it is divided externally and internally int he same ratio.

harmonic mean

The harmonic mean of two numbers a and b is 2ab/(a + b).

hectare

A unit of measurement in the metric system equal to 10,000 square meters (approximately 2.47 acres).

helix

The path followed by a point moving on the surface of a right circular cylinder that moves along the cylinder at a constant ratio as it moves around the cylinder. The parameteric equation for a helix is

x=a cos t

y=a sin t

z=bt

heptagon

A polygon with 7 sides.

hexagon

A polygoin with 6 sides.

hexagonal number
    A number of the form n(2n-1).

hexagonal prism
    A prism with a hexagonal base.

hexahedron
    A polyhedron having 6 faces. The cube is a regular hexahedron.

hexomino
    A six-square polyomino.

Heronian triangle
    A triangle with integer sides and integer area.

homeomorphism
    A one-to-one continuous transformation that preserves open and closed sets.

homomorphism
    A function that preserve the operators associated with the specified structure.

horizontal line
    A line parallel to the earth's surface or the bottom of a page.

hyperbola
    A curve with equation $x^2/a^2-y^2/b^2=1$.

hyperbolic spiral
    The curve whose equation in polar coordinates is r*theta=a.

hyperboloid
    A geometric solid whose equation is $x^2/a^2+y^2/b^2-z^2/c^2=1$ or $x^2/a^2+y^2/b^2-z^2/c^2=-1$.

hypotenuse
    The longest side of a right triangle.

icosahedron
    A polyhedron with 20 faces.

idempotent
    The element x in some algebraic structure is called idempotent if x*x=x.

imaginary axis
    The y-axis of an Argand diagram.

imaginary number
    A complex number of the form xi where x is real and i=sqrt(-1).

imaginary part
    The imaginary part of a complex number x+iy where x and y are real is y.

incenter
    The incenter of a triangle is the center of its inscribed circle.

incircle
    The circle inscribed in a given figure.

inequality
    The statement that one quantity is less than (or greater than) another.

infinite
    becoming large beyond bound.

infinitesimal
    A variable that approaches 0 as a limit.

infinity

A reference to a quantity larger than any specific integer.

inflection

A point of inflection of a plane curve is a point where the curve has a stationary tangent, at which the tangent is changing from rotating in one direction to rotating in the oppostie direction.

injection

A one-to-one mapping.

inscribed angle

The angle formed by two chords of a curve that meet at the same point on the curve.

integer

One of the numbers ..., -3, -2, -1, 0, 1, 2, 3, ...

intersect

Two figures are said to intersect if they meet or cross each other.

irrational number

A number that is not rational.

isogonal conjugate

Isogonal lines of a triangle are cevians that are symmetric with respect to the angle bisector. Two points are isogonal conjugates if the corresponding lines to the vertices are isogonal.

isometry

A length preserving map.

isosceles tetrahedron

A tetrahedron in which each pair of opposite sides have the same length.

isosceles triangle

A triangle with two equal sides.

isosceles trapezoid

Ain which the two non-parallel sides have the same length.

isotomic conjugate

Two points on the side of a triangle are isotomic if they are equidistant from the midpoint of that side. Two points inside a triangle are isotomic conjugates if the corresponding cevians through these points meet the opposite sides in isotomic points.

joint probability function

A function that gives the probability that each of two or more random variables takes at a particular value.

joint variation

A variation in which the values of one variable depend upon those of 2 or more variables.

Jordan curve

A simple closed curve.

Jordan matrix

A matrix whose diagonal elements are all equal (and nonzero) and whose elements above the principal diagonal are equal to 1, but all other elements are 0.

joule
> A unit of energy or work.

jump discontinuity
> A discontinuity in a function where the left and righ-hand limits exist but are not equal to each other.

kilometer
> A unit of length equal to 1,000 meters.

kinematics
> A branch of mechanics dealing with the motion of rigid bodies without reference to their masses or the forces acting on the bodies.

kite
> A quadrilateral which has two pairs of adjacent sides equal.

knight's tour
> A knight's tour of a chessboard is a sequence of moves by a knight such that each square of the board is visited exactly once.

knot
> A curve in space formed by interlacing a piece of string and then joining the ends together.

knot
> a unit of speed in navigation equal to one nautical mile per hour.

L-tetromino
> A tetromino in the shape of the letter L.

latera recta
> plural of lattice rectum.

latin square
> An n X n array of numbers in which only n numbers appear. No number appears more than once in any row or column.

latitude
> The angular distance of a point on the Earth from the equator, measured along the meridian through that point.

lattice point
> A point with integer coordinates.

latus rectum
> A chord of an ellipse passing through a focus and perpendicular to the major axis of the ellipse.Plural: latera recta.

least common multiple
> The least common multiple of a set of integers is the smallest integer that is an exact multiple of every number in the set.

least upper bound
> The least upper bound of a set of numbers is the smallest number that is larger than every member of the set.

lemata
> plural of lemma.

lemma

A proposition that is useful mainly for the proof of some other theorem.

length

The straight line distance between two points.

Legendre polynomials

$$P_n(x) = \frac{1}{2^n n!} \frac{d^n}{dx^n} (x^2 - 1)^n.$$

line

A geometrical figure that has length but no width.

linear function

A function of the form y=ax+b.

line graph

A chart that shows data by means of points connected by lines.

line segment

The part of a line between two given distinct points on that line (including the two points).

locus

The set of all points meeting some specified condition.

logic

The study of the formal laws of reasoning.

lowest common denominator

The smallest number that is exactly divisible by each denominator of a set of fractions.

loxodrome

On a sphere, a curve that cuts all parallels under the same angle.

lowest common denominator

The smallest multiple shared by the denominators of a set of fractions.

lowest terms

A fraction is said to be in lowest terms if its numerator and denominator have no common factor.

Lucas number

A member of the sequence 2, 1, 3, 4, 7,... where each number is the sum of the previous two numbers. $L_0=2$, $L_1=1$, $L_n=L_{n-1}+L_{n-2}$.

lune

The portion of a sphere between two great semicircles having common endpoints (including the semicircles).

magic square

A square array of n numbers such that sum of the n numbers in any row, column, or main diagonal is a constant (known as the magic sum).

magic tour

If a chess piece visits each square of a chessboard in succession, this is called a tour of the chessboard. If the successive squares of a tour on an n X n chessboard are numbered from 1 to n^2, in order, the tour is called a magic tour if the resulting square is a magic square.

main diagonal

In the matrix $[a_{ij}]$, the elements a_{11}, a_{22}, ..., a_{nn}.

major axis

The major axis of an ellipse is it's longest chord.

Malfatti circles

Three equal circles that are mutually tangent and each tangent to two sides of a given triangle.

maximum

The largest of a set of values.

matrix

A rectangular array of elements.

mean

Same as average.

medial triangle

The triangle whose vertices are the midpoints of the sides of a given triangle.

median

The median of a triangle is the line from a vertex to the midpoint of the opposite side.

median

When a set of numbers is ordered from smallest to largest, the median number is the one in the middle of the list.

Mersenne number

A number of the form 2^p-1 where p is a prime.

Mersenne prime

A Mersenne number that is prime.

midpoint

The point M is the medpoint of line segment AB if AM=MB. That is, M is halfway between A and B.

minor axis

The minor axis of an ellipse is its smallest chord.

minimum

The smallest of a set of values.

mode

The most frequently occurring value in a sequence of numbers.

modulo

The integers a and b are said to be congruent modulo m if a-b is divisible by m.

monomial

An algebraic expression consisting of just one term.

monotone

A sequence is monotone if its terms are increasing or decreasing.

monic polynomial

A polynomial in which the coefficient of the term of highest degree is 1.

monochromatic triangle

A triangle whose vertices are all colored the same.

multinomial

An algebraic expression consisting of 2 or more terms.

multiple

The integer b is a multiple of the integer a if there is an integer d such that b=da.

multiplication

The basic arithemtical operation of repeated addition.

nadir
	The point on the celestial spehere in the direction downwards of the plumb-line.
Nagel point
	In a triangle, the lines from the vertices to the points of contact of the opposite
	sides with the excircles to those sides meet in a point called the Nagel point.
natural number
	Any one of the numbers 1, 2, 3, 4, 5, ...
negative number
	A number smaller than 0.
nine point center
	In a triangle, the circumcenter of the medial triangle is called the nine point
	center.
nine point circle
	In a triangle, the circle that passes through the midpoints of the sides is called the
	nine point circle.
nomograph
	A graphical device used for computation which uses a straight edge and several
	scales of numbers.
nonagonal number
	A number of the form n(7n-5)/2.
nonary
	associated with 9
normal
	perpendicular
null hypothesis
	The null hypothesis is the hypothesis that is being tested in a hypothesis-testing
	situation.
null set
	the empty set
number line
	A line on which each point represents a real number.
number theory
	The study of integers.
numeral
	A symbol that stands for a number.
numerator
	In the fraction x/y, x is called the numerator and y is called the denominator.
numerical analysis
	The study of methods for approximation of solutions of various classes of
	mathematical problems including error analysis.

oblate spheroid
	An ellipsoid produced by rotating an ellipse through 360° about its minor axis.

oblique angle
     an angle that is not 90°
oblique coordinates
     A coordinate system in which the axes are not perpendicular.
oblique triangle
     A triangle that is not a right triangle.
obtuse angle
     an angle larger than 90° but smaller than 180°
obtuse triangle
     A triangle that contains an obtuse angle.
octagon
     A polygon with 8 sides.
octahedron
     A polyhedron with 8 faces.
octant
     any one of the 8 portions of space dtermined by the 3 coordinate planes.
odd function
     A function f(x) is called an odd function if f(x)=-f(-x) for all x.
odd number
     An integer that is not divisible by 2.
one to one
     A function f is said to be one to one if f(x)=f(y) implies that x=y.
onto
     A function f is said to map A onto B if for every b in B, there is some a in A such
     f(a)=b.
open interval
     An interval that does not include its two endpoints.
ordered pair
     A pair of numbers in which one number is distinguished as the first number and
     the other as the second number of the pair
ordinal number
     A number indicating the order of a thing in a series
ordinate
     The y-coordinate of a point in the plane.
origin
     The point in a coordinate plane with coordinates (0,0).
orthic triangle
     The triangle whose vertices are the feet of the altitudes of a given triangle.
orthocenter
     The point of intersection of the altitudes of a triangle.

palindrome
     A positive integer whose digits read the same forward and backwards.
palindromic
     A positive integer is said to be palindromic with respect to a base b if its
     representation in base b reads the same from left to right as from right to left.

pandiagonal magic square
    A magic square in which all the broken diagonals as well as the main diagonals
    add up to the magic constant.
pandigital
    A decimal integer is called pandigital if it contains each of the digits from 0 to 9.
paraboloid
    A paraboloid of revolution is a surface of revolution produced by rotating a
    parabola about its axis.
parallel
    Two lines in the plane are said to be parallel if they do not meet.
parallelogram
    A quadrilateral whose opposite sides are parallel.
parallelepiped
    A prism whose bases are parallelograms.
parentheses
    The symbols (and) used for grouping expressions.
Pascal's triangle
    A triangular array of binomial coefficients.
pedal triangle
    The pedal triangle of a point P with respect to a triangle ABC is the triangle
    whose vertices are the feet of the perpendiculars dropped from P to the sides of
    triangle ABC.
Pell number
    The nth term in the sequence 0, 1, 2, 5, 12,... defined by the recurrence
    $P_0=0$, $P_1=1$, and $P_n=2P_{n-1}+P_{n-2}$.
pentagon
    A polygon with 5 sides.
pentagonal number
    A number of the form n(3n-1)/2.
pentomino
    A five-square polyomino.
percent
    A way of expressing a number as a fraction of 100.
perfect cube
    An integer is a perfect cube if it is of the form m^3 where m is an integer.
perfect number
    A positive integer that is equal to the sum of its proper divisors. For example, 28
    is perfect because 28=1+2+4+7+14.
perfect power
    An integer is a perfect power if it is of the form m^n where m and n are integers
    and n>1.
perfect square
    An integer is a perfect square if it is of the form m^2 where m is an integer.
perimeter
    The distance around the edge of a multisided figure.
perpendicular

Two straight lines are said to be perpendicular if they meet at right angles.

pi
>The ratio of the circumference of a circle to its diameter.

pie chart
>A type of chart in which a circle is divided up into portions in which the area of each portion represents the size of the data.

place value
>Within a number, each digit is given a place value depending on it's location within the number.

plane
>A two-dimensional area in geometry.

point
>In geometry, a point represents a position, but has no size.

polygon
>A plane figure with many sides.

polyomino
>A planar figure consisting of congruent squares joined edge-to-edge.

positive number
>A number larger than 0.

power
>A number multiplied by itself a specified number of times.

practical number
>A practical number is a positive integer m such that every natural number n not exceeding m is a sum of distinct divisors of m.

prime
>A prime number is an integer larger than 1 whose only positive divisors are 1 and itself.

primitive Pythagorean triangle
>A right triangle whose sides are relatively prime integers.

primitive root of unity
>The complex number z is a primitive nth root of unity if $z^n=1$ but z^k is not equal to 1 for any positive integer k less than n.

probability
>The chance that a particular event will happen.

product
>The result of multiplying two numbers.

pronic number
>A number of the form $n(n+1)$.

proper divisor
>The integer d is a proper divisor of the integer n if $0<d<n$ and d is a divisor of n.

proportion
>A comparison of ratios.

pyramid
>A three-dimensional solid whose base is a polygon and whose sides are triangles that come to a point at the top.

Pythagorean triangle

A right triangle whose sides are integers.

Pythagorean triple

An ordered set of three positive integers (a,b,c) such that $a^2+b^2=c^2$.

QED

Abbreviation for quod erat demonstrandum, used to denote the end of a proof.

quadrangle

A closed broken line in the plane consisting of 4 line segments.

quadrangular prism

A prism whose base is a quadrilateral.

quadrangular pyramid

A pyramid whose base is a quadrilateral.

quadrant

Any one of the four portions of the plane into which the plane is divided by the coordinate axes.

quadratfrie

square free

quadratic equation

An equation of the form f(x)=0 where f(x) is a second degree polynomial. That is, $ax^2+bx+c=0$.

quadrature

The quadrature of a geometric figure is the determination of its area.

quadric curve

The graph of a second degree equation in two variables.

quadric surface

The graph of a second degree equation in three variables.

quadrilateral

A geometric figure with four sides.

quadrinomial

An algebraic expression consisting of 4 terms.

quartic polynomial

A polynomial of degree 4.

quartile

The first quartile of a sequence of numbers is the number such that one quuarter of the numbers in the sequence are less than this number.

quintic polynomial

A polynomial of degree 5.

quotient

The result of a division.

radian

A unit of angular measurement such that there are 2 pi radians in a complete circle. One radian = 180/pi degrees. One radian is approximately 57.3^o.

radical axis

the locus of points of equal power with respect to two circle.

radical center

The radical center of three circles is the common point of interesection of the radical axes of each pair of circles.

radii

Plural of radius.

radius

The length of a stright line drown from the center of a circle to a point on its circumference.

radix point

The generalization of decimal point to bases of numeration other than base 10.

range

The set of values taken on by a function.

rate

A way of comparing two quantities.

ratio

quotient of two numbers.

rational number

A rational number is a number that is the ratio of two integers. All other real numbers are said to be irrational.

real axis

The x-axis of an Argand diagram.

real part

The real number x is called ther eal part of the complex number x+iy where x and y are real and i=sqrt(-1).

real variable

A variable whose value ranges over the real numbers.

reciprocal

The reciprocal of the number x is the number 1/x.

rectangle

A quadrilateral with 4 right angles.

reflex angle

An angle between 180° and 360°.

remainder

The number left over when one number is divided by another.

repdigit

An integer all of whose digits are the same.

repeating decimal

A decimal whose digits eventually repeat.

repunit

An integer consisting only of 1's.

rhombus

A parallelogram with four equal sides.

right angle

an angle formed by two perpendicular lines; a 90° angle.

right triangle

A triangle that contains a right angle.

roman numerals

A system of numeration used by the ancient Romans.

root of unity

A solution of the equation $x^n=1$, where n is a positive integer.

round-off error

The error accumulated during a calculation due to rounding intermediate results.

rounding

The process of approximating a number to a nearby one.

ruled surface

A surface formed by moving a straight line (called the generator).

rusty compass

A pair of compasses that are fixed open in a given position.

scalene triangle

A triangle with unequal sides.

secant

A straight lien that meets a curve in two or more points.

semi-magic square

A square array of n numbers such that sum of the n numbers in any row or column is a constant (known as the magic sum).

sequence

A collection of numbers in a prescribed order: a_1, a_2, a_3, a_4, ...

series

The sum of a finite or infinite sequence

set

A collection of objects.

similar figures

Two geometric figures are similar if their sides are in proportion and all their angles are the same.

skeleton division

A long division in which most or all of the digits have been replaced by asterisks to form a cryptarithm.

slide rule

A calculating device consisting of two sliding logarithmic scales.

solid

A three-dimensional figure.

solid of revolution

A solid formed by rotation a plane figure about an axis in three-space.

solidus

The slanted line in a fraction such as a/b dividing the numerator from the denominator.

sphere

The locus of pointsin three-space that are a fixed distance froma given point (called the center).

spherical trigonometry

The branch of mathematics dealing with measurements on the sphere.

square

A quadrilateral with 4 equal sides and 4 right angles.

square free

An integer is said to be square free if it is not divisible by a perfect square, n^2, for $n > 1$.

square number

A number of the form n^2.

square root

The number x is said to be a square root of y if $x^2 = y$.

Stirling numbers

$\left\{ {n \atop k} \right\}$ are Stirling numbers of the second kind.

$\left[{n \atop k} \right]$ are Stirling numbers of the first kind.

$x^{\overline{n}} = \sum_k \left[{n \atop k} \right] x^k$ and $x^n = \sum_k \left\{ {n \atop k} \right\} x^{\underline{k}}$.

subtraction

A basic operation of arithemtic in which you take away one number from another.

sum

The result of adding two or more numbers.

supplementary

Two angels are supplementary of they add up to 180°.

surface area

The measure of a surface of a three-dimensional solid indicating how large it is.

symmedian

Reflection of a median of a triangle about the corresponding angle bisector.

tangent

A line that meets a smooth curve at a single point and does not cut across the curve.

tautology

A sentence that is true because of its logical structure.

tetrahedron

A polyhedron with four faces.

tetromino

A four-square polyomino.

Toeplitz matrix

A matrix in which all the elements are the same along any diagonal that slopes from northwest to southeast.

torus

A geometric solid in the shape of a donut.

trace

The trace of a matrix is the sum of the terms along the principal diagonal.

transcendental number

A number that is not algebraic.

trapezium

A quadrilateral in which no sides are parallel.

trapezoid

A quadrilateral in which two sides are parallel.

tree

A tree is a graph with the property that there is a unique path from any vertex to any other vertex traveling along the edges.

triangle

A geometric figure with three sides.

triangular number

A number of the form n(n+1)/2.

trinomial

An algebraic expression consisting of 3 terms.

tromino

A three-square polyomino.

truncated pyramid

A section of a pyramid between its base and a plane parallel to the base.

twin primes

Two prime numbers that differ by 2. For example, 11 and 13 are twin primes.

unilateral surface

A surface with only one side, such as a Moebius strip.

unimodal

A finite sequence is unimodal if it first increases and then decreases.

unimodular

A square matrix is unimodular if its determinant is 1.

unit circle

A unit circle is a circle with radius 1.

unit cube

A cube with edge length 1.

unit fraction

A fraction whose numerator is 1.

unit square

A unit square is a square of side length 1.

unitary divisor

A divisor d of c is called unitary if gcd(d,c/d) = 1.

unity

one

variable

A symbol whose value can change.

velocity

The rate of change of position.

vertical line

A line that runs up and down and is perpendicular to a horizontal line.

vigesimal

related to intervals of 20.

vinculum

The horizontal bar in a fraction separating the numerator from the denominator.

volume

The measure of spce occupied by a solid body.

vulgar fraction
>A common fraction.

weak inequality
>An inequality that permits the equality case. For example, a is less than or equal to b.

wff
>A well-formed formula.

whole number
>A natural number.

winding number
>The number of times a closed curve in the plane passes around a given point in the counterclockwise direction.

witch of Agnesi
>A curve whose equation is $x^2y=4a^2(2a-y)$.

X
>Roman numeral for 10.

x-axis
>The horizontal axis in the plane.

x-intercept
>The point at which a line crosses the x-axis.

X-pentomino
>A pentomino in the shape of the letter X.

y-axis
>The vertical axis in the plane.

y-intercept
>The point at which a line crosses the y-axis.

yard
>A measure of length equal to 3 feet.

year
>A measure of time equal to the period of one revolution of the earth about the sun. Approximately equal to 365 days.

z-intercept
>The point at which a line crosses the z-axis.

zero
>0

zero divisors
>Nonzero elements of a ring whose product is 0.

zero element
>The element 0 is a zero element of a group if a+0=a and 0+a=a for all elements a.

zeta function

$\zeta(s)$ stands for the Riemann Zeta Function:
$$\zeta(s) = \sum_{n=1}^{\infty} 1/n^s.$$

zone

The portion of a sphere between two parallel planes.