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GLOSSARY

supporting “Processes in Biological Vision”

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This Glossary is a record of the paradigm shift in the visual sciences cataloged in the accompanying text, “Processes in Biological Vision.” The definitions provided here take precedence over other definitions in the literature. For a broader glossary of many Biological and medical terms (except those introduced here), the reader might look at the Online Medical Dictionary at www.cancerweb.ncl.ac.uk/omd/.

- A glossary of the neurosciences appears in Review of Neurosciences, 2nd ed. by Pansky, et. al. (LC call # WL 101 P196r, 1988).
- Oyster has also recently (1999) provided an extensive glossary at the rear of his text (LC call # WW 103 O98h, 1999).
- Miller & Newman have provided a glossary of terms associated with cerebral visual defects (LC call # WW 140 w223 1998).
- Two glossaries covering the human brain are useful and complementary, Nolte & Angevine (LC call WL 17 n798h 2000) and Orrison (LC call WL 17)75a 1995).
- Hunt provides a table of units for photometric, radiometric and quantal measurements. (LC call # QC 495 H84 1991).
- Byrne & Hilbert have provided a broad glossary related to vision (LC call # QC 495 R32 1997)

A 670 page, 300 KB, copy of this Glossary may be downloaded in [PDF format](#) .

2AFC—Two alternative forced choice

7-TMS proteins—A group of G-proteins that have seven trans-membrane-segments. These segments are arranged adjacent to each other with their axes approximately parallel.

Abducens--Either of the sixth pair of cranial nerves that convey motor impulses to the rectus muscle on the lateral side of each eye.

Abduct-- *Physiology*. To draw away from the midline of the body or from an adjacent part or limb

Abscissa—Distance from the vertical axis in a two dimensional plot.

Absolute intensity threshold—Frequently described as the absolute luminous intensity threshold, and simultaneously a function of angular source size. The absolute intensity threshold as a function of wavelength required to elicit the achromatic perception of a light source.

Absorption Spectra--The composite signature of a chemical under electromagnetic stimulation. It generally includes ultraviolet, visible, infrared and radio frequency components. The various signature elements associated with a material can be related to specific electronic, and mechanical, structures within the molecules. In the Retinoids, the relevant ultraviolet and visible signatures are:

~187 nm. = π - π^* electronic transition associated with an isolated carbonyl group

~285 nm. = n- π^* electronic transition associated with an isolated carbonyl group

~380 nm. =

~493 nm. = delocalization transition associated with the length of the monopolar *conjugated* chain.

Frequently reported as 502 nm in order to agree with the putative peak in the C.I.E. Scotopic Luminous Efficiency Function.

2-Processes in Animal Vision

~342, 437, 532 or 625 = delocalization transition associated with the length of the dipolar *resonant* chain

Accommodation—The process of adjusting the power of the physiological optical system to focus on a given element in object space.

Accommodation error—The error in diopters of the visual system when attempting to focus under specified conditions. If attempting to focus at infinity, the error is known as the basal accommodation error. The error may include two components, one refractive and one neural. The refractive error can be corrected with auxiliary optics of the numerically negative value in diopters. The neural component is not correctable with auxiliary optics.

Accommodation level—The level of accommodation required to view a scene at a specified distance, usually expressed in diopters.

Acetylcholine— A material commonly found to interfere with the normal operation of a neuron. The acid ester of choline. Ubiquitous in the brain in the form of the phosphatide, lecithin.

Achromatic--Without hue; achromatic color--a color that does not elicit hue; achromatic point--point in a chromaticity diagram representing an achromatic stimulus (The Science of Color)

Achromatopsia—A serious genetic eye disease involving many symptoms (a syndrome) and caused by a failure in the distribution amplifier of the photoreceptor cells. The resulting symptoms include achromatopia, photophobia, nystagmus and neural myopia.

Actinism—The intrinsic property in radiation that produces photochemical activity. Generally refers to molecular ionization (disassociation) as opposed to molecular excitation.

Action potential— An individual pulse generated in the axoplasm of a stage 3 encoding neuron. Also regenerated by Nodes of Ranvier. The leading edge is formed by the discharge of the axoplasm of the neuron through the Activa. Discharge proceeds until Activa saturation, e. g. the time when the axoplasm potential approaches the podoplasm potential. At that point, the Activa becomes an open circuit. Recharging is by the electrostenolytic supply re-establishing the resting potential of the axoplasm (usually near -150 mV relative to the INM). The discharge current through the Activa corresponds to the putative inrush of sodium ions (the NA^+ current) proposed by Hodgkin & Huxley. The recharging current through the electrostenolytic source corresponds to the putative outrush of potassium ions (the K^+ current).

Action spectra--(inconsistently defined in the literature) Rodieck (pg 264) says an Action Spectra is a plot against wavelength of the intensity of a monochromatic source that produces the same measured response. It generally relates to a spectra obtained by psychophysical experiment.

Activa— A three-terminal liquid-crystalline state semiconducting device that achieves electrical gain (amplification) when biased properly. Discovered and patented by James T. Fulton. Patent #5,946,185. See also Transistor. *Plural* Activas

Active transport—

1. the net movement of material from a region of lower to one of higher electrochemical potential. From Mullins *in* Bolis, et. al., 1971)
2. The transport and accumulation of substrate against a concentration gradient without chemical

modification of the substrate. See also group translocation. From Cramer & Knaff, 1990

Acuity– **1. visual**–Defined as the reciprocal of the visual angle, in minutes of arc, subtended by a just resolvable stimulus. The critical dimension can be the gap in a Landolt C, the spatial period of a grating or the offset of a vernier, etc. Also used to define relative acuity with the aid of a common (Snellen) Eye Chart using block letters of the alphabet. Determined by both physiological optics and neurological mechanisms. The mean of the population is given as 20/16, with anything better than 20/20 considered normal.

2. Pattern or hyperacuity– A term based on the assumption that the performance of the retina is related to the spacing of the photoreceptor mosaic rather than the motion of the eye due to tremor. It describes the apparent acuity of the visual system to exceed the value of 30.0-35.0" subtense of the smallest photoreceptors (Westheimer, 1979). The term actually relates to the correlation performance of the analytical channel of the visual system (the G' channel associated with the Precision Optical System). This channel is frequently able to perceive unique geometric properties of images. Williams (1987) introduced an alternate term, super-Nyquist resolution, that would cause Shannon great problems.

3. Vernier acuity– The ability to detect the horizontal offset between two vertical lines. Performance is a function of the length and width of the lines. Typical performance is 5.0 seconds of arc, well below the size of a photoreceptor cell.

Acyl–a chemical group consisting of R-C=O with an open ligand on C

Acylation–A specific form of esterification involving the open ligand of an Acyl group.

Adaptation– The mechanism of changing the gain of the photoreceptor channels to provide constancy.

1. The gain changes in unison among all channels to maintain brightness constancy.
2. The gain changes differentially among the channels to maintain color constancy.

Addition–Used in the conventional mathematical sense; **not** used in the physiological sense of “the co-operation of subliminal effects in such a way that the total effect is supraliminal”.

Adduct– *Physiology*. To draw inward toward the median axis of the body or toward an adjacent part or limb

Aerial image modulation–A description of a photosensitive recording material that combines the intrinsic modulation transfer function of the medium combined with its noise performance. See also its complement, the Airy image modulation.

Afferent–Carrying inward to a central organ or section, as nerves that conduct impulses from the periphery of the body to the brain or spinal cord. See also efferent.

Agnosia–An inability to perceive objects through otherwise normally functioning sensory channels. Subject may not be able to appreciate words, objects, places, concepts or faces (see prosopagnosia). Can be divided into a variety of special cases, such as alexia.

Agonist–*Physiology*; a contracting muscle that is resisted or counteracted by another muscle, the antagonist.

Biochemistry; A substance that can combine with a nerve receptor to produce a reaction typical for that substance.

4-Processes in Animal Vision

Airy Image– (*in honor of Airy*) A term for the two dimensional spread function representing the illumination at the image plane of an optical system. Expanded in precision, especially aerial, photography to include the effects of optics, vibration and atmospheric on the overall image applied to the recording medium. See also its complement, the Aerial Image Modulation function.

Airy image modulation--A description of the two dimensional optical modulation transfer function for the image formed by an optical system. See also its complement, the Airy image modulation.

Aldimine–See Schiff-base

Alexia–The inability to read complex character groups and symbols. Varies in degree from the inability to read multiple symbol syllables to global alexia, the inability to recognize individual numbers, letters and symbols.

Aliquot--*Mathematics*. Of, relating to, or denoting an exact divisor or factor of a quantity, especially of an integer.

Allele–*commonly*, one member of a set. *specifically*, one member of a pair or series of genes that occupy a specific position on a specific chromosome.

Alychne--“Without light”; a term used to describe an arbitrary situation on the C.I.E. Chromaticity Diagram where the axis $y=0$ is **defined** as having no luminance.

Amblyopia–Poor spatial performance of the POS at nominal illumination without any morphological cause. Lazy eye. Defined more conceptually, and less functionally, by Duke-Elder (1973) as a monocular acuity deficit which is not due to refractive error or any organic abnormality. A neural condition.

Amercine– (Greek *a*, “negative;” *makros*, “long;” having no long processes) Cajal introduced the name for “cells lacking an (obvious) axon” based primarily on histological observations of the times. He further delineated diffuse and stratified types. Diffuse exhibiting a vertical branching structure and the stratified exhibiting primarily a horizontal branching.

Amine–The group NH_2

Amphiphathic–See amphiphile

Amphiphile--A compound having a polar head (ionic) which tends to dissolve in water (hydrophilic) and a water insoluble (hydrophobic) organic tail.

Anadromous--An animal that transitions from a fresh water environment to a salt water environment. Simultaneously, its visual system adapts from a Vitamin A2 to a Vitamin A1 based one. See also catadromous. Generally associated with a fish that lives in saltwater but spawns in freshwater. Typical of *Salmonidae*.

Anagenesis--A term used by Kuhne to describe the spontaneous association in vision of the visual chromophore with the substrate protein. It has generally been considered to be an exothermic reaction.

Analog– A term used variously in biochemistry. Generally refers to the structural analog of a compound. It can be extended to refer to a resonant homolog. More general than homolog. See homolog. In physiology, it refers to a system that behaves in a manner similar to the system under study. In anatomy, it refers to structures of similar function but different phylogeny.

Analogous Circuit--A term used to describe an electronic circuit used to emulate the performance of a system that does not employ free electrons as a medium, i. e. hydraulic or mechanical systems. In this work, excited electrons bound within a crystalline structure are not considered free.

Anamorphic-- In optics, a lens system where the image does not display the same aspect ratios as in the original scene. There is geometric distortion between scene and image.

Anatomy--The science of the shape and structure of organisms and their parts, generally without the aid of a microscope. See also morphology, histology and cytology.

Anaxonal neuron--In morphology, a neuron that does not exhibit a clearly defined axon. Informally called an amercine neuron based on Cajal's original definition.

Angioid streaks-- Diagnostically visible low contrast structure in Bruch's membrane.

Annelida--Segmented worms

Anode current-- *Electrons* leave the electrolyte through the electrode connected to the positive side of the external supply. This electrode is called the anode. The reaction at this electrode is always an oxidation. The *conventional current* enters the electrolyte through the electrode labeled the anode.

Anosagnosia-- A condition in which a subject denies the existence of a deficit clearly visible to others, such as paralysis of one side of the body, or blindness.

Antagonist--(See agonist)

Anterior--Nearer the head in Zoology.

Antidromic--In a direction counter to the normal signal flow in the nervous system.

APB-- 2-amino-4-phosphonobutyrate. Described as an analog of glutamate by Stockton & slaughter. It may interfere with the glutamate cycle at electrostenolytic sites.

Aperture Stop--The physical diameter which limits the size of the cone of radiation which an optical system will accept from an axial point on the object. For off-axis points, the limiting aperture may be defined by more than one physical feature of the optical system.

Aphakia--The condition resulting from the removal of the lens in the human eye. Patients in this condition have reported a visual sensation at wavelengths of 310-360 nm.

Aphasia-- A deficit in spoken language. Frequently divided into an inability to comprehend (damage to Wernicke's area) or to produce (damage to Broca's area) speech.

Apical--Of, relating to, located at, or constituting an apex; top. Sometimes used to indicate the focal point of a process.

Apo--combination form meaning "away from" or "separate." Used in this work primarily to describe the form of the retinol binding proteins prior to their binding with a retinoid.

6-Processes in Animal Vision

Apoptosis—The shedding of the cytoplasm of one cell into another cell or membrane (example, RPE cytoplasm into Bruch's membrane).

Apposition Eye—Conventionally, a compound eye where the rhabdoms receive light only from their "own" corneal facets. See also Superposition Eye. The photoreceptors of the apposition eye are optically isolated from adjoining corneal facets. Some authors have extended the concept to include computational as well as optical forms.

Aqueous humor—The fluid between the cornea and the lens in chordata. See vitreous humor.

Arcuate structure—An arc shaped structure seen in electronmicrographs of the axonal termination of photoreceptor cells within the synaptic complex. It is described as a location of significant electron density by investigators.

Argentea—See Tapetum

ARMD—Age related macular degeneration.

Arrestin—A putative material in the glutamate cascade theory of photodetection that participates in terminating the cascade. A 48 kDa S-antigen.

Articulation—A vague concept found in the field of psychology purporting to explain color constancy by means of a series of characteristics of the observed scene that are independent of the original irradiance.

Aspheric lens—A fundamentally spherical lens that has been intentionally deformed in order to offer optimal aberration correction. See also non-spherical lens

Association fibers—Large groups of neurons projecting between engines of the brain. Those covering long distances are labeled long association fibers and include many paths named fasciculus and the cingulum. Those covering shorter distances are labeled short or u-fibers and designated gyri. Groups of fibers constitute much of the white matter of the brain. See also Commissure fibers and Corpus Callosum.

Astrocytes—The name used for cells in the central nervous system equivalent of Schwann cells in the peripheral neural system. They are frequently described as providing myelination to the axons of neurons. A more recent view suggests they may be providing supplementary lactate to the neurons in the area of Nodes of Ranvier.

Ataxia—The inability to reach for and grasp objects appropriately despite being able to identify them visually.

Attention searchlight—A synonym for the angular beam in object space projected onto the foveola of each eye. Nominally 1.2 degrees in diameter centered on the point of fixation. A concept taken from the ancient Greek wherein light radiated from the eyes.

ATP—Adenosine triphosphate, a major source of energy in the operation of an organism.

Attractor—A mathematical term meaning any self-sustained and stable state of a dynamical system, such as a neural network. (Wang, 2003)

Aura—A loosely defined subjective visual symptom frequently associated with migraine headaches and similar conditions. Symptoms are frequently transient but may last indefinitely following a stroke or accident. Patterns

are frequently spatially stationary following a stroke although they may appear to scintillate. Under other conditions, they frequently appear to move across a quadrant of the visual field, thereby suggesting the location of their underlying source in the visual cortex. See also snowy vision.

Autonomous nervous system—The nerves controlling the involuntary functions of the body that do not ordinarily relate to consciousness. Usually involves neurons emanating from the hind brain or midbrain. Includes the POS and the oculomotor system. Some autonomous neural functions can be inhibited, for at least a period of time, through training and or volition.

Autosomal dominant inheritance (AD)—Every generation is affected. Males and females are affected with equal frequency. The trait is transmitted only by an affected individual. Those without the trait do not transmit it.

Autosomal recessive inheritance (AR)—Only members of the same generation are affected. The trait is transmitted from asymptomatic carrier parents who each have one affected chromosome. Expression of the trait requires that both members of a chromosome be affected. Males and females are affected with equal frequency. Every child of a affected person is a carrier of the trait.

Auxochrome—A polar atom which is capable of existing in two adjacent states of covalency; usually oxygen or nitrogen, less frequently sulphur or phosphorus.

Avalanche multiplication—Current multiplication in a semiconductor device due to the initiation of a chain reaction where the electrical field is strong enough for individual free charges to achieve sufficient energy to knock other bound charged in a lattice free, thereby contributing to the total current subject to the electrical field.

Awareness— The act of taking account of an object or state of affairs. It does not imply assessment of nor attention to the qualities or nature of an object.

Axon— The generally one output conduit of a neuron. The axon frequently bifurcates into two conduits external to the neuron soma and may terminate in a number of individual pedicles that make contact with boutons on the neuritic conduits of the orthodromic neuron

Axon segment—The conduit between two Nodes of Ranvier. Exhibits the characteristics of an axon at the input terminal and the properties of a dendrite at the output terminal.

β -carotene—One of the simplest member of the carotenoid family of natural dyes. It is a polyene with 22 conjugated methine groups terminated on each end by a β -ionone group.

Basal --Of, relating to, located at, or forming a base.

Bathochromic spectral shift— A spectral shift toward a longer wavelength. See also hypsochromic spectral shift.

Bayer pattern— A prevalent mosaic filter pattern used in video cameras with two times as many green filters as red and blue filters, represented as a proportion that correlates well with human retinal sensitivities.

BCVA— Best corrected visual acuity

Beer's Law—The absorption coefficient for light passing through a solution of a given salt in a non-absorbing solvent is proportional to the concentration. For base 10 logarithms, the law is written as $I = I_0 10^{-\epsilon c x}$ where ϵ is known as the molar *extinction* coefficient, c is the concentration in moles per liter, and x is the thickness of the transmitting layer. When written in natural logarithms, the ϵ is replaced by α , the molar *absorption* coefficient. Law does not apply to liquid crystalline materials. The coefficients are “average” values over the wavelength region determined by the filter width used. Law developed from Bouguer's Law and Lambert's Law. Law does

8-Processes in Animal Vision

not apply to the liquid crystalline state.

Bi-exciton--An excitonic molecule formed by two excitons. See exciton.

Bifurcation--A dividing of a structure. When used to describe a signaling channel, it supports two separate interpretations. The subchannels within the structure may *branch* in order to go to two distinct terminals simultaneously, or some subchannels may *be routed* differently than others in order to serve individual destinations. Each optic nerve bifurcates twice in the process of terminating in the brain.

Binding Proteins--RBP, CRBP, CRABP, CRALBP, IRBP, SRBP. All are based on the original retinal binding protein (RBP) concept. However, the concept must be broadened to one of retinoid binding protein (RBP) to account for the actual mechanisms involved and the fact that the retinoid need not be a retinene. "C" stands for cellular, "RA" for retinoic acid, "RAL" for retinaldehyde, "I" for the location, Inter-photoreceptor-matrix, and "S" for serum.

Binocular disparity-- A less precise term than stereoptic disparity. Used widely in the clinic. Generally, the angle between the two lines of fixation when the eyes are fixated on a target. Equal to the target disparity under closed loop conditions. Associated almost totally with stereopsis and the limited field of view associated with the foveola.

Binocular view-- the view obtained using both eyes. It is normally merged by the POS if the target is imaged onto the foveola.

Binocular visual direction-- The direction of a target in object space relative to the intersection of the vertical and horizontal planes of the subject (see **Figure 2.2.1-1**). (S & C pg 200)

Bleach-- (archaic) Used colloquially in vision; not as "to make white" but as "to make transparent." Associated with the fact that chromophores become transparent when quantum-mechanically excited and not provided with the normal neurological de-excitation mechanism. The effect is not directly associated with any single subsequent process, such as isomeric changes. It is not directly related to the sensitivity of the visual system which is more directly associated with the gain of the adaptation amplifiers.

Blind sight--Sight wherein all of the sensory functions of the visual system are operating normally but one or more of the feature extraction engines and/or the associated recognition functions have failed (Weiskrantz, '74 & '77). This condition can be congenital, due to disease, or due to an accident. Stroke frequently leads to this type of problem. In some cases, the individual will respond to danger related to elements in its field of vision but not be able to perceive or recognize the element. Recent alternates to this definition appear in Zeki & Ffytche, 1998.

Bloch's Law--(circa. 1885) For pulse illumination employing an interval below a critical value, the perceptual threshold is described by a constant equal to the product of the intensity and the interval. For the cat, the breakpoint is ~32 msec. (Levick W. & Zacks, J. (1968) *J. Physiol.* (London), vol. 196, pg 1P-2P.

BLM--Bilayer membrane. A frequent abbreviation for a cell membrane. Usually consisting of two liquid crystalline films consisting of phosphoglycerides with their hydrophobic surfaces facing each other and separated by a space as observed with an electron microscope. Frequently labeled a three-layer membrane in other literature because of the dark-light-dark appearance in the electron microscope.

BOLD-- Blood oxygenation level dependent (contrast). Used in fMRI studies.

Boehm's brushes--A parafoveal entoptic image apparently due to intraocular light scattering that exhibits a

sensitivity to polarization. Only encountered when the e-vector of the radiation is rotating at about 360 degrees/second in humans. See Waterman (1975) for details.

Boltzman-Maxwell distribution law—A probabilistic description of the energy distribution of particles in a material without regard to the Pauli Exclusion Principle of quantum mechanics. For electrons, the more specific Fermi-Dirac distribution based n quantum mechanics must be used.. See Guttman & Lyons (1981), pg. 10.

Boutons—The generic name for the frequently knob-like swellings forming terminations on neurites that connect to axons.

Brachium— (Latin) Morphologically, an arm or extension of the main body. Used to designate a region between the geniculate nuclei and the colliculi (quadrigemina). Physiologically, the brachium of the superior colliculus is equivalent to the visual perigeniculate nuclei. The brachium of the inferior colliculus is equivalent to the auditory perigeniculate nuclei.

Brain—The anterior part of the neural tube lying within the cranium (in chordates). Generally, the brain contains the following enumerated sections:

Brain Stem	Cerebral cortex
Diencephalon	Frontal lobe
Thalamus (LGN–Pret.)	Parietal lobe (upper medial lobe)
Hypothalamus	Temporal lobes (lower side lobes)
Midbrain	Occipital lobe (rear lobe)
Auxiliary Optical Nucleus	Primary Visual Cortex
Pons	
Medulla	

Brightness— The attribute of a visual sensation according to which a given visual stimulus appears to be more or less intense; or, according to which the area in which the visual stimulus is presented appears to emit more or less light W&S, page 487).

Calcium ion current— A term in the vernacular for the putative flow of calcium ions from the INM into a plasma of a neuron affecting the signaling capability of that neuron. Frequently used when discussion various materials known in the vernacular as neurotransmitters and usually of the neuro-inhibitor family.

Calyx—The outer collar of the cup formed at the distal end of the Inner Segment and used as an extrusion die in the formation of the disks of the Outer Segment. *Archaic*: The structure surrounding the cilia as they enter the photoreceptor cell adjacent to the cup at the distal end of the Inner Segment. See ciliary transport.

Calorimetry—Measurement of the amount of heat evolved or absorbed in a chemical reaction, change of state, or formation of a solution

Canavan’s disease— A progressive, degenerative disorder of the central nervous system characterized by spongy changes in the white matter. Usually develops before 3-4 months and is terminal before 24 months of age.

Candela— The standard of luminous flux. (*Current narrow band definition, 1979*) The candela is the luminous intensity, in a given direction, of a source which is emitting monochromatic radiant energy of frequency $540 \cdot 10^{12}$ Hertz (555.016 nm in standard air) and whose radiant intensity in that direction is 1/683 Watt ($4.092 \cdot 10^{17}$ photons) per steradian. (*Previous broad band definition*) The candela was the luminous intensity, in the perpendicular direction, of a surface of 1/600,000 square meter of a blackbody at the temperature of freezing platinum under a pressure of 10,325 newtons per square metre.

10-Processes in Animal Vision

Capsule-- structure associated with but external to the terminal structure of a sensory neuron

Carapace-- A hard bony or chitinous outer covering of the dorsal portion of the head and thorax of an animal.

Carbohydrates-- Polyhydroxy aldehydes, polyhydroxy ketones, or compounds that can be hydrolyzed to these forms. Synonymous with saccharides. A carbohydrate that cannot be hydrolyzed to a simpler carbohydrate is called a monosaccharide. Monosaccharides of five or six carbons are generally classed as sugars.

Cardinal Points--The six points defined in geometrical optics to define the performance of a given lens or lenses. The Focal Points, Principal Points and Nodal Points (which occur in pairs).

Carotenoids--A large and important group of organic compounds containing the carotenes (hydrocarbons) and xanthophylls (carbohydrates or oxygen containing hydrocarbons).

Catabolism--The metabolic breakdown of complex molecules into simpler ones, often resulting in a release of energy.

Catadromous-- An animal that transitions from a salt water environment to a fresh water environment. Simultaneously, its visual system adapts from a Vitamin A1 to a Vitamin A2 based one. See anadromous

Cathode current-- *Electrons* enter the electrolyte through the electrode connected to the negative side of the external supply. This electrode is called the cathode. The reaction at this electrode is always a reduction. The *conventional current* leaves the electrolyte through the electrode labeled the cathode.

Caudal--Posterior

Central Limit Theorem-- A basic proposition of statistical mathematics that says the product of multiple distributions approaches a Gaussian Distribution as a limit.

Central nervous system-- (anatomy, neurology) Pertaining to the brain, cranial nerves and spinal cord. It does not include muscles or peripheral nerves.

1. In invertebrates, the central nervous system is composed of the segmental ganglia of the ventral nerve cord together with the fused ganglia or brain at the anterior end.

Cephalic eyes--eyes located on the head. As opposed to pallial eyes located on the mantle.

Cephalin--ethanolamine phosphoglyceride, also known as phosphatidyl ethanolamine.

Cerebellum--The region behind the mid or old brain and below the cerebral hemispheres or new brain. Functions primarily as a long term memory and translation table supporting the interpretation of sensory inputs and the coordination of muscular activity. While most of the CNS is arranged ipsilaterally with respect to sensory inputs, the cerebellum is not. (Hubel, '88, pg 64)

Cerebral blindness--blindness from damage to any portion of both visual pathways posterior to the midbrain. See also cortical blindness.

Cerebral cortex--(The pallium) See Cerebral hemispheres.

Cerebral hemispheres--The new brain, especially prominent in the higher chordates, and primarily concerned

w*ith the evaluation of the environment both external and internal to the animal.

Cerebrum—The new brain or neo-cortex. Frequently described inappropriately as the cortex. Consists of the two cerebral hemispheres in the higher animals. Each hemisphere is made up of the frontal (anterior) lobe, the parietal (top) lobe, the posterior lobe and the two temporal (side) lobes.

cGMP-- Guanosine 3',5' cyclic monophosphate. Frequently written as cyclic guanosine 3',5' monophosphate.

Charge transfer impedance— The impedance associated with the transfer of charge from a metal to an ion at a metal-electrolyte interface.

Chemical marker— See Marker.

Chief ray--The ray that enters the lens midway between the highest and lowest rays of an oblique beam is called the chief ray of the beam. In the absence of vignetting, the chief ray and the principal ray are identical.

Chiral --Of or relating to the structural characteristic of a molecule that makes it impossible to superimpose it on its mirror image

Chlorolab—(obsolete) A conceptual name associated with Rhodone(4), the middle wavelength chromophore of vision. See Rhodone.

Cholesterol— A sterol. It contains only one oxygen atom in a hydroxyl group. It is neither a triglyceride or a phospholipid although it mixes readily with these materials. It is abundant in the plasma membranes of many animal cells and appears to provide for the transport of water through such membranes (Lehninger, pg 202).

Cholinergic— The result of neural stimulation opposite to that obtained upon application of GABA to the same situation. See Sections 8.7.4 & 15.1.2.3.5.

Chordata— One of three (along with *Arthropoda* and *Mollusca*) major phyla of taxonomy. Dominated by one major subphylum, *Vertabrata*. Sharks and other members of class *Chondrichthyes* are considered either members of *Chordata* leading to *Vertabrata* or degenerate members of *Vertabrata*.

Chromatic metameres— See metameres.

Chromogen--A molecule which may be considered a precursor to a chromophore.

Chromophore--A group of associated atoms which can exist in at least two states of energy, a ground state of relatively low energy and an excited state to which it may be raised by the absorption of light energy from a specified region of the radiation spectrum.

Chromophore, visual spectrum--An organic dye molecule which contains at least 2 polar atoms joined by a conjugated chain of (usually) carbon atoms with alternating double and single bonds, equal numbers of each, thus forming a resonance hybrid. The most important chromophoric systems are the Amidinium-ion, Carboxyl-ion and Amidic

CIE-- *International Committee on Illumination*; responsible for standards in this area. Most well known for the CIE Chromaticity Diagram of 1931 (2 degree Standard Observer) and the CIE Photopic Observer Curve of 1931 (2 degree Standard Observer) and the CIE Scotopic Observer curve of 1951 (2 degree Standard Observer)

-cil- --a combining form meaning "hair", particularly those of the eyelid

12-Processes in Animal Vision

Ciliary transport--See Colax.

Cilium--multiple definitions: *histology*; a rod-like structure composed of various materials
Gray, Dictionary of Biological Sciences

1. a row of hairs or bristles on arthropods
2. a vibrative organelle process found on many cells throughout the animal kingdom. Each cilium consists of nine pairs of peripheral filaments wrapped round a central pair, the whole embedded in a matrix.
3. pseudo-cilium a structure resembling a cilium in form but not in function.

Circadian rhythm-- a repetitive cycle of activity based on a 24 hour period.

Cis-trans isomerism--Rotation about a double bond following excitation. In the *cis*- form, the two ligands of the molecule are on the same side relative to the bond. In the *trans*- form, they are on opposite sides. (Davson, pg 244). Notation is archaic. See Z- and E-.

Cis-trans in cell transport-- Used to describe the antidromic and orthodromic sides of a cell membrane. The amino acids (and other materials) move from the cis-chamber to the trans-chamber side of the membrane (Yudilevich, pg 5, 1987).

Cisternae--The inner compartments of endoplasmic reticulum

Cleft-- A fissure, slit or crack in a single piece of material. Not used in this work in reference to a synapse.

Codec-- The general name for an algorithm and or mechanism (coder-decoder) used in the coding and decoding of signals without the introduction of an electronic carrier signal. Analogous to a modem (modulator-demodulator) used to impress a signal on a higher frequency electrical carrier.

Colax-- The structural element through which pseudo-cilia (aka: more precisely dendrites but also known as microtubules) exit the photoreceptor cell in the area of the junction between the Inner Segment and the Outer Segment. Also known as the ciliary collar, the ciliary stalk, the connecting stalk or the ciliary transport.

Color--consists of the characteristics of light other than spatial and temporal inhomogeneities; light being that aspect of radiant energy of which a visual sensing system is sensitive.

Color in object space is defined as *psychophysical* color and is described in terms of radiation intensity and spectral distribution. Historically, the intensity has been in terms of energy. It should be in terms of photon flux.

Color in perceptual space is defined as *psychological* color and is described in terms of hue saturation and brightness.

The characterization of light under the above two scenarios can take several forms. In this work, the color of a non radiating material will defined in terms of several primary situations;

Psychophysical designations

1. the *intrinsic color* of an object as represented by the spectral profile of the material independent of how it is observed,
2. the *sampled color* of an object as observed by an instrument that samples the light emanating from an illuminated object,

3. the *sampled trichromatic color* of an object as observed by an instrument that samples the light emanating from an object using spectrally selective radiometers analogous to those of the long wavelength trichromatic animal eye,
4. the *applied color* of an object in terms of its spectral content at the Petzval surface of an optical system,

Psychological designations

5. the *adapted color* of an object as found at the pedicels of the photoreceptor cells of the animal eye,
6. the *encoded color* of an object as represented by the signals within the chrominance channels of the visual system,
7. the *perceived color* of an object reported by an animal, and
8. the *cognitive color* of an object assigned to the vector image of the object by the cortex.

Color, perceived--a *perceived color* for a long wavelength trichromat is defined precisely by the pair of values, (P,Q). The individual is taught, within his cultural and semantic environment, to associate a name to each set of perceived P,Q values.

Color Constancy--A concept used in neurophysiology to describe the apparent stability of the color of objects under changes in illumination. Actually related to the stabilizing action of the three separate adaptation amplifiers in the human visual system which support a stabilizing of the perceived response.

Color globules--Isolated compartments of chromophore material found within the cytosol of the cells of the RPE.

Colorimetry--The branch of color science concerned, in the first instance, with specifying numerically the color of a physically defined visual stimulus. Subject to further division into,

1. Object space colorimetry
2. Perceptual colorimetry

Command--A neural message executable by the PNS (including the oculomotor subsystem) and generally originating in the superior colliculus and associated structures. Usually using a bit-serial word format and transmitted over a single (or redundant) neuron. See Instruction.

Commissure--Major bundles of neurons connecting distant locations of the central nervous system. The optic nerve, optic tract and optic radiation can be considered commissure. More minor bundles are tracts.

Comparator--A nominally analog differencing circuit, that may be operated in synchrony with a clock or asynchronously, incorporating sufficient gain to force the output signal into saturation. Such circuits are typically used to provide one or more of three indications, $X > Y$, $X < Y$ or $X = Y$. By using multiple individual comparators in logic circuits, significant characterization of a large group of input signals can be provided.

Complete metameres-- See metameres.

Compound eye--The eye of most insects and some crustaceans, which is composed of many light-sensitive elements, each having its own refractive system and each forming a portion of an image.

Computational anatomy--A descriptor referring to anatomical features that contribute to the computational task by introducing delay or spatial reorganization among neural signals.

CON--Constricted axon segment. The location of a Node of Ranvier plus the areas of the associated stereotypical internodal regions (STIN) that form electrical lumped constant circuit elements. The morphological equivalent of the conexus.

Conduction--Used in two distinct senses. 1; to describe currents flowing in and out of biological membranes, and

14-Processes in Animal Vision

2. to describe currents flowing by diffusion subject to an electrical field within conduits.

Conexus—From the Latin, meaning to join. A specialized site of functional interaction between neurites and axons. The site contains an Activa and its supporting lumped constant electrical elements. It is found in three forms:

1. A location within the bulk of every neuron
2. At locations (known as Nodes of Ranvier) along an axon of a projection neuron.
3. At locations (known as synapses) connecting the axon of one neuron to a neurite of an orthodromic neuron.

The term is used most frequently to describe the otherwise un-named conexus within a tonic neuron or the hillock of a phasic neuron. *Plural* conexuses.

Conformal projection—A map that maintains the correct angular relationships between elements of the original object. See the more general “conformal transformation.”

Conformal transformation—A mathematical manipulation from one multi-dimensional space to a second multi-dimensional space that maintains a one-to-one correlation between data points in the two spaces but does not insure any specific angular or scalar relationship between two points in the original space and the same two points in the new space. See conformal projection.

Conjugated—Used variously in biochemistry and organic chemistry.

1. *Biochemistry* Describes the combination of the simple portion and the prosthetic portion of a protein.
2. *Organic chemistry* Describes a hydrocarbon backbone with alternating single and double bonds between the carbon atoms.

Conjunctive motions—motions where the two eyes rotate in the same direction.

Consciousness—A sense of awareness of ones self and the environment. See Awareness.

Contralateral— *Biology*: Situated on, pertaining to or affecting the opposite side.

Vision: Affecting the opposite side of object space relative to the body.

Contrast—Always defined as $(L_{\max} - L_{\min}) / (L_{\max} + L_{\min})$ in object space, where L is the luminosity in photon flux units integrated over the spectral range of interest. Values of contrast are always between zero and one. The term is closely associated with the term modulation which is defined as the amplitude of the signal varying about the mean value of the above luminosity, $(L_{\max} + L_{\min}) / 2$. This amplitude may be due to a stimulus with a random, simple or complex structure. The relationship between contrast and modulation requires a knowledge of this structure. A corrected contrast can be defined at the retina that takes into account the spectral absorption of the physiological optics (lenses and macular absorption). Within the electrolytic circuits of the neural system, the signals generally require more precise terms than contrast or modulation to describe them. It is frequently necessary to account for a DC offset that plays no role with regard to the signal used to transmit the information.

Convergence—

1. Evolutionary convergence is where one species evolves a structure similar to that found in a different species, family or phylum because of its utility.
2. Mechanical convergence is the aligning of two eyes having binocular capability to point their lines of fixation toward a common point in object space.

Copunctal points—(*Archaic*) Points defined on a CIE Chromaticity Diagram by extending tangents to two series of

points until they intersect. Based on the assumption that the CIE Diagram represents the performance of the visual system in a conformal presentation. It does not. Tangents in biological color space are curved lines when projected onto the CIE Diagram.

Core conductor concept—The concept of a neural conduit as a long thin walled tube filled with a conducting medium and bathed in a second conducting medium. There is an implicit assumption that the mediums are conductive to the transport of large ions.

Corpus Callosum—The commissural fiber bundle connecting corresponding parts of the cerebral hemispheres. See also commissural fiber and association fiber.

Correlation—Used with two meanings in modern optics. The first is synonymous with collimation, referring to the spatial planarity of a wavefront. The second is temporal correlation between the wavefronts of two different optical bundles. This temporal correlation is usually achieved over short intervals of distance by obtaining the wavefronts from a common laser source.

Corresponding points— See Cover points.

Cortical blindness— loss of vision due to damage to the striated cortex, the “primary visual cortex.” See also the more general term, cerebral blindness.

Cortex —Used inconsistently in the literature.

1. The forebrain, consisting of the diencephalon and the telencephalon (cerebral hemispheres).
2. The cerebral cortex, the two cerebral hemispheres.
3. That area of the brain of the higher animals associated with the sensory evaluation, cognitive activities, and higher level command generation activities of the brain. Divided into four distinct lobes and further divided into a large number of morphologically indistinct regions using a variety of notations. More specifically, the cortex is the gray matter consisting of the signal processing engines of the brain as opposed to the white matter that consists of the association fibers of the signal projection stage of neurology.

Cover points— Points in the two retinas that would be overlaid if the two retinas were juxtaposed.

Cover region— A region of the foveola in one eye that is within the coherence distance of the spatial correlator of the perigeniculate nucleus with regard to a point in the foveola of the other eye.

Cranial—Anterior

Crossed Disparate— A descriptor for a scene element located within the Vieth-Muller circle. It has a larger target vergence than the point of fixation. Equivalent to the term convergent when discussing relative disparity. See also uncrossed disparate.

CSF—The cerebral-spinal fluid containing the brain and acting as the electrical ground plane for the neurons of the brain

Current availability curve— A term used in the vernacular to describe the static potential and current sourcing capability of the electrostenolytic process supporting a plasma in a neuron.

Cyanopsin—A conceptual name synonymous with Rhodone(5) in the liquid crystalline form and derived from its observed broadband absorption. This anisotropic absorption exhibits a spectral absorption peak at 625 nm.

16-Processes in Animal Vision

Cyanolab– (obsolete) A conceptual name associated with Rhodospirillum rubrum(3), the short wavelength chromophore of vision. See Rhodospirillum.

Cyclofusion– The mechanism leading to fusion of quasi-parallel lines presented to the eyes dichoptically. Consists of both a physical component (a limited rotation of the eyes) and a neurological component. (220 & 330, S&C)

Cyclohexenyl ring--a carbon structure ring exhibiting two methylene groups attached at position 1 and a third methylene attached at position 3 with a single double bond between position 2 and 3. The β variant has a ligand attachment point on the carbon at position 2.

Cyclopean– Or cyclopaean.

Used variously according to Tyler & Scott, 1979.

1. (Julesz, 1971) The stereoscopic information first present at a binocular level in the cortex.
(This work) The stereoscopic information first present within the thalamus of the midbrain.
2. (Hering, 1858) The position in the head from which binocular visual direction is perceived.

Cycloplegia– Failure of the eye to perform its normal accommodation function. Cycloplegia drops are used to paralyze (relax) this function temporarily.

Cyclovergence– The angular correction required in vergence due to the non-orthogonality of the vertical and lateral ocular muscles. (214, S&C)

Cyprinid fishes--Any of numerous often small *freshwater* fishes of the family Cyprinidae, which includes the minnows, carps, and shiners.

Cytology--The study of biological cells, generally at the level requiring an electron- microscope

Cytosol--Generally equated to cytoplasm, or to the free cytoplasm without considering any inclusions therein.

Dark accommodation– A misnomer since accommodation is based on the edges associated with contrast in the scene. A blank field of view will cause the same accommodation regardless of light level. See quiescent accommodation.

Dark light–A subjective perception wherein a fully dark adapted visual system perceives a visual sensation that is not black but closer to a neutral gray. More appropriately described as a null condition. Primarily a result of the design of the visual architecture. The system operates as if it were AC coupled. It does not transmit an absolute black reference level. See comment in Adler's 9th edition, pg. 498.

Dartnall's Nomogram--A curve resembling a parabola when plotted on a scale of log sensitivity as a function of the frequency (as opposed to wavelength) of light. It was proposed that all photoreceptors exhibited spectral absorption functions that could be represented by this curve when it was shifted along the frequency axis

Decarboxylation– Elimination of a $-\text{COOH}$ group as CO_2 .

Decoding--1. *reading*: Linking letters and letter combinations with their corresponding sounds.

Deductive approach—The process of generating a theory, predicting results and then designing an experiment to verify that the process does indeed exhibit those results. While confirmation does not guarantee the accuracy of the theory, failure to demonstrate the predicted results demonstrates the inadequacy of the proposed theory.

Default mode—In the case of reading, the preprogrammed mode assumed in the absence of feedback from a controller indicating a failure in one of the cognitive steps following initial image scanning.

Dehydrogenation—An oxidation that releases a molecule of hydrogen. The process frequently involves the formation of a double bond between a singly bonded carbon and oxygen.

De-inactivation—A convoluted term (double negative) used by those studying the electrophysiology of the neuron based on the dual alkali-ion model. It refers to the reduction in the parameter h , that in itself describes the sodium inactivation parameter.

Delayed rectification— See time dependent rectification.

Dendrite—The name associated with the frequently ramified non-inverting input conduit of a neuron. See also podite

Desmosome—A junction like structure between the membrane walls of two adjacent cells that are not necessarily neurons. The two membranes show differences in electron density under the electron-microscope. The desmosomes (aka macula adhaerens) are generally associated with adhesion between cells (Gigula, 1975)

Deuteranomaly—Form of anomalous trichromatism for which in a green-red mixture, more than a normal amount of green is required to match a spectral yellow. (The Science of Color)

Deuteranopia—Form of dichromatism in which red and green are confused, but luminosity curve is nearly normal. (The Science of Color)

Deuterostomia—That large class of bilaterally symmetrical animals generally characterized by a notochord located along the dorsal surface of the animal

Diadromous—Animals that are born in sea water but transition to freshwater during their lives.

Dia-stereopsis—A term used in cyclopedean analyses in the clinic. Term is equivalent to diplopia in other environments.

Dichotic stimulus—The presentation of the same stimulus to the corresponding points (areas) of the two retinas.

Dichoptic—Condition where different stimuli are projected onto corresponding regions of each retina. The differences may relate to spatial, spectral or any other dimension of vision.

Dichromatism—Vision for which mixtures of two, rather than the normal three, components are necessary and sufficient to match all colors. (The Science of Color)

Difference Spectra—The difference in optical density [$\log(1/\text{transmittance})$] of the pigment layer before and after a partial or complete bleaching of the pigment, the result being independent of any stable “impurities” present in the layer. See Wyszecki & Stiles pg 588 for the details. **They caution;** “*The difference spectrum is not comparable, without careful qualifications, to spectral response curves*”. The subject of translation of the signal to the nervous system is not addressed in this formulation.

18-Processes in Animal Vision

Differential equation– (Ordinary differential equation) An equation containing the differential of a variable with respect to one independent variable. The order of the equation agrees with the highest order of the differential present. A partial differential equation contains the differentials of the variable with respect to more than one independent variable. The degree of the equation agrees with the highest exponent applied to the highest order differential.

Digitonin--A non-ionic detergent (a digitalis glycoside) resembling cholesterol. It has a strong attraction for dye molecules.

Dimer--The result of combining two molecules of the same material to obtain a new molecule with twice the original number of carbon and hydrogen atoms (sometimes with the elimination of other atoms, as in the case of carotene).

Diode--An electrical element exhibiting an exponential relationship between its current and voltage. Used in two applications depending on the value of the coefficient in the argument of the exponent. For a large coefficient, the device makes an excellent rectifier. For a small coefficient, the device is used in high accuracy signal processing applications.

Diopter–
1. A unit of ophthalmic lens power; one diopter focuses light from infinity at a distance of one meter.
2. Basic unit of accommodation and vergence. The reciprocal of the distance from the eyes to the point of interest in meters.
See also prism diopter

Dioptic stimulus– a single object seen in essentially the same way by the two eyes.

Diplopia–
1. A failure to merge the images from the two eyes when the target is within the normal region of fusion.
2. Similar images falling on non-corresponding retinal points, and therefore projecting to different visual directions; non-fused images; “double” vision.

Disease– An alteration in the state of the body or of some of its organs, interrupting or disturbing the performance of the vital functions, and causing or threatening pain and weakness; applied figuratively to the mind. Disease is the leading medical term. Disorder means much the same, with perhaps some slight reference to an irregularity of the system.

Disjunctive motions– motions where the two eyes rotate in opposite directions.

Distal--that which lies further from

DOG– Difference of Gaussians. A mathematical construct invoked in vision in the absence of a more specific theoretical model. Within loose tolerances, it can be used to fit many data sets. See Central Limit Theorem.

Dogiel cells--Displaced neurons. Cells which exhibit characteristics usually associated with cells found elsewhere, i.e., action potentials detected in a bipolar cell. May be due to poor investigative technique where excessive capacitance has been added to the cell and it has gone into oscillation.

Dominator element--An early designation used by Granit (1947) to describe putative broadband photoreceptor elements responsible for signals measured within the optic nerve. Archaic with recognition of the signal processing

occurring within the retina. See also modulator element.

Donnan potential--The potential across a semipermeable membrane caused by a difference in concentration of ions on the two sides. A more general form of the Nernst potential.

DOPA-- See L-DOPA.

Dorsal--Pertaining to the back. Synonymous with superior.

Dorsal terminal nucleus--A structure of the brain connected to the Pretectum. Part of the Precision Optical System. The interface between the afferent signal paths from the eye and the efferent signal paths to the motor neurons controlling the position of the ocular globes, apparently through the posterior and anterior rectus muscles.

Double-duty linkage-- An expression recognizing the effect of the common parameter of the correlator of the PGN, the local correlation range, on both the fusion and depth perception phenomenon of vision.

Double layer--1. (Semiconductor physics) The space charge distribution surrounding and defining the location of a junction, either electrolytic or solid state, under equilibrium conditions.

2. (Cytology) A colloquial name for the bilayer membrane forming the external wall of a biological cell. See bilayer.

3. (Electrochemistry) The space charge distribution at a metal-solution interface in an electrochemical cell (usually described under equilibrium conditions).

Drusen--1. clinically visible (>25 microns) mounds in the inner collagenous zone of Bruch's membrane.

2. Yellow-white deposits found under the macula. Drusen deposits are associated with the dry form of macular degeneration. They are thought to be an accumulation of waste materials

Duct--In a glandular context, the manifold created in a compound gland between the tubules of individual simple gland cells and the exit point of the compound gland

Duplicity theory--Used variously in vision to satisfy man's infatuation with dichotomies.

1. In the retinal aspects of vision, the Duplicity Theory proposes that there are two independent signal sensing systems. One operating at high illumination levels and one operating at low illumination levels. These two systems have been linked to the perceived morphological dichotomy between photoreceptor cells. Thus rod shaped photoreceptors have been associated with low illumination level sensing and the so-called cone shaped photoreceptors have been associated with high illumination level sensing. This work does not support either of these bilateral categorizations nor any link between them.

2. In psychophysics related to the cortex, the Duplicity Theory proposes a distinction between the perception of an event and an association of that event with other information within the cortex. In this work, these two terms are described as perception and cognition.

Dysmetria--impaired ability to estimate distance in muscular action.

E-face--Used variously in the literature. See also P-face.

1. *Generally*: The external face of the plasma membrane of a cell. The face contacting the extracellular

20-Processes in Animal Vision

matrix.

2. *Freeze-Fracture morphology*: The hydrophobic surface associated with the external leaflet of the bilayer plasma membrane. This is usually the face of the leaflet facing the other leaflet and toward the plasma of the cell.

E- A shorthand notation replacing the term *trans-* in stereochemistry. See also **Z-**

Early Receptor Potential--A loosely defined term used by different authors in distinctly different ways when discussing ERG and LERG waveforms:

1. A diphasic waveform occurring within a few **microseconds** of illumination of the photoreceptor--probably actually due to capacitive coupling between the measuring equipment and the gating circuits of the illumination equipment.
2. A monophasic waveform occurring during the first 50-100 microseconds following illumination and found in LERG's with amplifiers operating at very high sensitivity.
3. The initial transient in the ERG occurring during the first few **milliseconds** after illumination of the photoreceptor cells.

Ectopic signal generation-- The spontaneous generation of action potentials due to pathological conditions.

Edinger-Westphal nucleus--A signal processing engine identified primarily on morphological grounds based on the response to lesion in this area. It is considered a major part of the parasympathetic motor pool of the oculomotor nuclear complex. It appears to participate primarily in pupillary and accommodation functions (Glaser, pg 339).

Efferent--Directed away from a central organ or section. Carrying impulses from the central nervous system to an effector. See also afferent.

Efferescent copy--A putative signal, appearing in two contexts in the recent literature

1. A putative signal, returned to the brain from the oculomotor control system or muscles of the eye indicating the position of the eye. Such a signal assumes the oculomotor system operates open loop. The real system involves a closed loop servo system. The desired information is actually extracted from the imagery sensed by the retina and transmitted to the lateral geniculate nucleus of the thalamus.
2. A conceptual record of the perceived visual field, generally better described as the visual portion of the more global saliency map.

Efficacy--Power or capacity to produce a desired effect; effectiveness

EIM-- When discussing bilayer membranes, an excitability inducing material.

Einstein--The energy associated with the number of photons equal to Avogadro's number. One einstein is equal to 45 kcal. at 600 nm and 54 kcal at 500 nm.

Electrodics--The study of the flow of electrons between metallic and liquid solutions.

Electromyography (EMG)--A coarse investigative technique used primarily in the clinic, and of limited precision and therefore of questionable value in current research. The technique records the voltages encountered by

inserting a probe into the ocular muscles. Similar to probing the S-plane of the retina in that a variety of signals result depending on what section of the muscle is probed. Reviewed from both the clinical and research perspective by Breinin, pgs 27, 36-52 & 134-135.

Electrolysis—The study of the flow of electricity through dilute solutions and electrically symmetrical, non quantum-mechanical membranes.

Electrolytic cell--A cell containing an electrolyte wherein the conduction of electricity is accompanied by chemical action; in the general case, a reversible process

1. A cell containing an electrolyte through which an externally generated electric current is passed by a system of electrodes in order to produce an electrochemical reaction.

2. A cell containing an electrolyte in which an electrochemical reaction produces an electromotive force

Electrolytics—The field of electrochemistry involving charge transfer within liquid crystalline materials and solutions of greater than 0.1M concentration in the absence of any metallic circuit elements.

Electro-physics--Knowledge gained from the measurement of electrical responses to physical stimuli

Electroplaxes— The specialized motor end-plates of the electric organs of some fish. These electroplaxes are charged in parallel and discharged in series much like a conventional diode-ladder -based voltage multiplier circuit.

Electromyograph— **EMG**; a device for measuring the electrical activity of ocular muscles using probes entering the muscles.

Electrooculograph— **EOG**; a device for measuring the electrical activity of ocular muscles using only contact sensors external to the eye sockets.

Electro-retino-graph--**ERG**; A gross measurement, usually employing an electrode attached to a surface external to the eye.

Electrostenolytic Effect—

1. A process of chemical oxidation or reduction on the surface of a substrate that affects the local electrolytic environment. If the substrate is conductive to electronic charges, a potential may be created across the substrate.

2. A process involving reactions of oxidation and reduction at the opposite ends of an electronically conducting but high ion-resistivity path. Ref: in Marino on page 191.

Electrostenolytic metabolism— See Metabolism

Electrotonic--A term coined by du Bois Reymond to denote the distribution of potentials in a nerve or muscle polarized by weak currents from externally applied electrodes. Now widely used to refer to non-pulse signals and waveforms resulting from analog circuits within the neural system. (Hille, pg. 27)

ELM--see Exterior Limiting Membrane

Emiocytosis--The expulsion of minute particles by a cell.

Emmert's Law—Found in psychology and referring to the size of an image in space. The absolute size of an object is the product of its angular size at the aperture of an optical system times the distance from the aperture to the

22-Processes in Animal Vision

object. Under some conditions, the perceived distance may be misconstrued by the visual system.

Emmetropia--The normal condition of the eye with respect to refraction in vision. In the absence of accommodation, it offers excellent focus at infinity. Myopia is short-sightedness. Hypermetropia, or hyperopia, is far-sightedness

Emulation-- The process of assembling and operating a *physical* device or circuit having the same or similar performance characteristics as the prototype.

Endo-combining form meaning "within"

Endocrine-- A gland releasing its product into the bloodstream. See gland.

Endogenous--1. Produced or growing from within.

2. *Biology*. Originating or produced within an organism, a tissue, or a cell: *endogenous secretions*.

Endocytosis-- The taking up of material into a cell. The material may be solids (phagocytosis) or fluids (pinocytosis).

Endothermic-- Warm-blooded.

Engram--An abstract vector representing a feature extracted by a feature extraction engine of the (visual) cortex. The engram may be a member of a hierarchal family or a portion of a larger engram. To be differentiated from an analog or pulse signal vector found in the visual system prior to feature extraction.

Entopic imagery-- 1. Reproducible visible phenomena arising from within the eye.

2. Visual perceptions that are produced or influenced by the native structures of one's own eye. Generally not due to image forming photons. Commonly instigated by mechanical or electrical excitation.

Enzyme--An organic catalyst; providing a variety of functions and frequently defined in terms of its internal groups and/or the material it catalyzes. The internal groups are frequently a protein element (the apoenzyme) and a non-protein group (the prosthetic portion). Many enzymes require a cofactor or coenzyme to act as acceptors or donors of a functional group that are added or removed from the substrate.

Hydrolytic enzymes-addition or removal of the elements of water

Hydrase-addition or removal of water

Isomerase-catalyze an intramolecular rearrangement

Microsomes--microsomes (particulate bodies) within cells act as (are) enzymes

Phosphorylases-

Oxidation-reduction enzymes

Dehydrogenase-

Oxidase-

Monooxygenase

Transferring enzymes-transferring amide, amino, methyl and other groups

Transmethylation

Transoxygenation

Transporting enzymes (Binding Proteins)

mostly from White, et. al. Principles of Biochemistry, 5th Ed. McGraw-Hill

Ephaptic signal generation– Generation of false action potentials due to cross-talk between neural paths.

Ephaptic transmission– Used by some to indicate crosstalk between neurons.

Epigenesis--The creation of an animal, a phenotype, based on a specific sample of DNA, a genotype.

Epistemology– The branch of philosophy that studies the nature of knowledge, its presuppositions and foundations, and its extent and validity.

EPR–Electron paramagnetic resonance spectroscopy.

EPSP–Excitatory postsynaptic potential.

Equal area projection–A map designed to represent the areas of an original object proportionately but not necessarily conformally.

Equiluminance–Used by psychophysicists to mean a light source with equal contributions from the red and green components (usually in terms of energy).

Equivalent Circuit–An electronic circuit used to provide the same performance as another electronic circuit based on the movement of free electrons (and or holes). An equivalent circuit is in apposition to an Analogous circuit which emulates systems that do not utilize free electrons in their operation.

Erythrolab– (obsolete) A name for the long wavelength chromophore of vision, Rhodone(5). See Rhodone.

Esotropsia– Crossed eyes.

Essential tremor– A clinical term for postural tremor associated with the skeletal motor system and believed to be caused by a CNS abnormality. Not directly associated with vision or ocular tremor.

Etiology– The study of the underlying causes of medical symptoms.

Euryhaline--Having a wide tolerance to salinity variations in the exterior environment.

Exciplex– A higher level exciton complex than defined by a bi-exciton. Found in dicyano- compounds such as dicyanobenzene-naphthalene and used in infra-red photography.

Exciton– A mobile but localized non-conducting excited state; an energy packet forming a quasi-particle obeying Bose-Einstein statistics; a boson.

Exo– Indicative of a substance after a chemical change from its previous form. Associated particularly with the retinol binding proteins in this work.

Exocrine Gland– See Gland

Extrafuscal fibers– See intrafuscal fibers.

Extrastriated–A morphological designation usually used to reference all parts of the cerebral cortex not associated with area 17. However, it is sometimes used to designate all brain tissue other than area 17.

24-Processes in Animal Vision

Expanded damped sinusoid—A function describing the precise shape of the dark adaptation characteristic of human vision.

Exterior Limiting Membrane (ELM)—An apparent membrane caused by a close packing of individual structures resulting in an apparent impervious boundary in the general area of the IS; various authors place it at the midline of the IS, directly below the IS on the side nearest the outer nuclear layer, and sometimes near the OS/IS boundary.

Eye—A photodetection device consisting of at least a single photoreceptor cell enclosed in a light tight compartment with an aperture stop. There are four fundamental types of eyes;

1. The ocellus, or simple eye, of arthropoda consisting of only one (or at most a few) ommatidia, i. e., a photoreceptor cell behind a lens and enclosed in an opaque housing.
2. The Compound eye of arthropoda consisting of a large group of ommatidia forming a mosaic
3. The Mollusca eye, consisting of a large number of photoreceptors grouped into a retina enclosed into a body mounted enclosure behind a single lens element. The photoreceptor cells are usually mounted in the direct mode, in which the distal end of the cell receives the illumination.
4. The vertebrate eye, more properly chordate eye, consisting of a large number or photoreceptors grouped into a retina enclosed in a enclosure behind a single lens element where the enclosure is rotatable with respect to the animals head. The photoreceptor cells are mounted such that the proximal end of the outer segment receives the illumination.

False targets— Extraneous images of elements of a scene in object space putatively generated within the signal processing mechanisms of vision and illustrated using a Keplerian projection. Also, described as ghost images in the literature. Largely a spurious concept when the vergence angle associated with the Keplerian projection is held to less than 12 degrees.

Falsification (as an element in scientific philosophy)— Introduced by Popper (1959) from the German (1935), he argued that scientific theories can be defined by their testable, refutable or falsifiable character. The crux seems to be that falsification (demonstration of the error in at least a part) of a theory leads to a stronger and more resilient future theory. The discussion proceeds. See Lakatos (1970) and Musgrave (1976).

Faradaic impedance— The sum of the charge-transfer resistance and the Warburg impedance.

Faradaic processes— Oxidation and reduction processes occurring at charge-transfer electrodes in an electrochemical cell. See also non-faradaic processes and polarized electrode. Both conduction and displacement currents can flow at a charge-transfer electrode but only displacement currents can flow at an ideal polarized electrode.

Fascillus—Association fibers between engines of the brain.

FAZ—Foveal avascular zone. A region of the retina as viewed from the vitreous humor that describes the area believed to be free from capillaries (See Ahnelt '98). About 250 microns in diameter.

Fechner's Fraction—Ratio of differential luminance threshold to luminance. (The Science of Color)

Fechner's Law— Just noticeable difference in brightness is equal to a constant fraction of the stimulus (The Science of Color) expressed as $\Delta L/L = k \cdot \Delta B$ by Bartleson. [See Weber's Law]

FEF—*frontal eye fields*— generally within area 8 of Brodmann

Fermi-Dirac distribution law—The quantum mechanical form of the Boltzman-Maxwell distribution law.

Field of View--Not used consistently. Ophthalmologists speak of the field in terms of its half angle or semi-field angle. Most others speak of the total field angle, i.e. Social Security Act, etc.

Flicker--In vision research, usually a light alternating according to a sinusoidal or square wave manner; not wavering erratically

Focal Length (back)--the distance from the back vertex of optical system to the back focal point.

Focal Length (effective)--the distance from the second principal point to the back (or second) focal point. Also, the distance from the front (or first) focal point to the first principal point.

Focal Length (front)--the distance from the front vertex of optical system to the front focal point.

Focal Point--The point to which (paraxial) rays, parallel to the axis, converge , or appear to converge, after passing through the optical system.

1. Front (first) focal point; The focal point to which rays incident from the right are converged.
2. Back (second) focal point; The focal point to which rays incident from the left are converged.

Fornix—The reflection of the conjunctiva from the ocular globe

Fossa--A pit, groove, cavity, or depression, of greater or less depth; as, the temporal fossa on the side of the skull. See sulcus.

Fovea centralis--The region of the fovea located at the point of fixation on the retina and exhibiting the highest level of form and color discrimination. Involving about 5000 photoreceptors. No nerve cells overlay this region.

Foveal avascular zone—Used by Ahnelt (1998) to describe an approximately 250 micron (0.57 degree) diameter zone on vitreous side of retina. Fixation point varies within this zone. Historically, the zone is considered “rod free”

Foveal sparing—A common feature wherein damage to the neural path or brain causes loss of vision in one or more quadrants of the visual field but does not destroy vision related to the foveola. A result is tunnel or keyhole vision.

Free radicals— Defined variously

1. compounds with unpaired electrons that stabilize themselves by oxidizing other molecules.
2. an especially reactive atom or group of atoms that has one or more unpaired electrons.

Frontal eye field (FEF)—A generic descriptor for the portions of the frontal lobe of the cortex involved in the generation of volitional eye movements. More appropriately, the **frontal visual fields**. The field most often described consists of part of area 9 between area 6 and area 46. It is sometimes associated with area 8. A similar area is found on the opposite side of the brain. Electrical stimulation causes contralateral conjugate eye movements.

26-Processes in Animal Vision

Fronto-parallel plane– A geometric construction based on the Gaussian assumption of paraxial optics. A plane drawn through the point of fixation in object space parallel to the line drawn between the nodal points of the eyes. Assumed to match a similar plane drawn through the point of fixation on the retina. The nodal points are not defined under wide field of view conditions. The principle points should be used. The fronto-parallel plane does not project a focused image onto the retina under wide field of view conditions.

Fusion– The concept of merging the images acquired by the two eyes within the PGN of the midbrain. Haploopia.

Fusional range– The angular range (average disparity in vergence between the scene and the eyes) in which a subject can maintain a fused image acquired using both eyes.

Sensory fusion– xxx

FWHM (full width at half maximum)– An expression used to describe the width of a spectral distribution or other profile expressed as a graph. The units are usually nanometers in vision research.

Ganglia–(anatomy) A general term for a group of nerve cell bodies located outside the central nervous system, occasionally applied to certain nuclear groups within the brain or spinal cord, for example basal ganglia

Ganglion cell– (electrophysiology) A type of stage 3 signal projection neuron that encodes electrotonic signals onto a series of phasic action potentials.

(pathology) A type of interneuron that conveys information from the retinal bipolar, horizontal and amacrine cells to the brain.

G-protein–guanyl phosphate-binding proteins. Also described as guanine nucleotide-binding-proteins. A large family of proteins that are categorized by this feature rather than any chemical formula, structure or function. Can be classified into four categories based on their sensitivity to cholera and pertussis toxins according to Richelson (1995). Comprise as much as 1-2% of the brain membrane protein according to Richelson.

GABA– γ -aminobutyric acid. A material found in intimate relationship with neurons and frequently with glutamic acid. Presumed to provide electrical energy to the neuron through electromotive action.

GABAergic–An action that is inhibitory with respect to the output of a neuron. Usually associated with the response of stage 3 projection neurons generating action potentials.

GABAergic input– An inhibitory input based on the presumed release of GABA within the synapse. **See Sections 8.6.4 & 15.1.2.3.5.**

GABA receptors–Proteins that are putative receptors of GABA within a synapse. Sub-types A, B, C have been identified. This concept is not supported in this work.

Gabor packet (or patch)–The name given to small patterns used in visual testing that consist of sinusoidal intensity patterns in one or two directions. The underlying sinusoidal pattern is frequently windowed by a Gaussian or other intensity distribution in order to eliminate any sharp contrast discontinuities at the edges. The patterns are usually smaller than the diameter of the foveola. The one dimensional pattern is called a grating. The 2-dimensional version is called a plaid.

GAD– A putative glutamic acid decarboxylase enzyme. Not required in the neural system that is based on the electrostenolysis of glutamate to GABA.

Gamut of colors--Total variety of colors that can be produced by any prescribed method (The Science of Color)

Ganglia-- Used variously. Derives from ganglion, a knot or knot-like mass.

1. In vision and the morphology of the nervous systems of higher chordates, ganglia describes a single group of isolated neurons appearing along a nerve.
2. In morphology of animals with a distributed neural system, multiple ganglion where each ganglion consists of a group of isolated neurons.

All of the neurons within these structures are stage 3 neurons. The following definitions appear in the Online Medical Dictionary

1. <pathology> A mass of nerve tissue (grey matter) or a group of nerve cell bodies.
2. <anatomy> A general term for a group of nerve cell bodies located outside the central nervous system, occasionally applied to certain nuclear groups within the brain or spinal cord, for example basal ganglia.
3. <anatomy> Also refers to specific groups within the brain or spinal cord (as basal ganglia).

Ganglion cell-- The name typically given to a neuron in the retina that accepts an analog input signal and creates a phasic output signal. The output is typically described as an action potential. These cells are the encoding portion of Stage 3 (the projection stage) of the neural system.

Ganzfeld illumination--Illumination of the entire retina so that, as nearly as possible, the entire retina is illuminated at the same level. Normally achieved by observing a uniformly illuminated scene; normally the variation in the $f/\#$ of the eye with field angle has not been considered.

Gap junction-- A specific morphological region between two cells with a width of less than 10 nm. Present in two forms.

1. Basic form provides essentially total hydraulic and electrical isolation between the media on opposite sides of this cell barrier.
2. If subjected to the appropriate electrical biases, and exhibiting asymmetry in both of the bilayers, the junction becomes an "active gap junction." The active gap junction is an active electrolytic semiconductor (an Activa) and becomes the basic signaling device between two neurons.

Gap Substance--A poly-anionic matrix filling the paranode space external to the nodal recesses.

GARP-Glutamic-acid-rich-protein. An acronym for a protein rich in the amino acid, glutamic acid.

Gaussian Optics--That branch of optics that illustrates the theory in which u is substituted for $\sin u$ in Snell's Law. Effective results are achieved if the aperture and field angle are made very small. Also called paraxial optics or first order optics.

Gaze-- The period of approximately 220 ms during which the line of fixation of human eyes appears to dwell on a single point in object space. See also glimpse. During this time, the pretectum makes a number of cross calculations that result in the creation of a percept.

Genotype--A molecule of DNA defining a particular phenotype, animal. See phenotype & epigenesis.

Geranyl ring--See Cyclogeranyl ring

Gestalt School-- The psychological study of complex (primarily visual) phenomena without regard to the mechanisms and processes generating specific phenomena.

28-Processes in Animal Vision

Gestaltqualitat– (*form-quality*) The result of temporal and spatial relationships between stimuli: something which differs from (is over and above) the sum of the parts acting in isolation.

Ghost images– See false targets.

Giant axon– Used variously in the literature. Used to describe a specific axon of the third stellate nerve in *Loligo* by Young, by Cole and by Hodgkin & Huxley, et. al. during the 1930's to 1960's. Also used to describe a large axon connected to a group of neurons configured as a syncytium by Frank, et. al. (1975).

Gigaseal– Used in patch clamp electrophysiology to describe a seal between the inside of the test probe and the surrounding medium that has a resistance of at least a Giga-Ohm, therefore it is a gigaseal.

Gland– A structure capable of creating a specialized substance and excreting the substance onto a surface (exocrine type) or into the blood or lymph streams (endocrine type) Further categorized as to whether the material is passed through the cell wall (merocrine type), breaks through the wall or separates along with part of the wall (apocrine type) or holocrine type where the cell is destroyed in the process of freeing the specialized substance.

Glance– (a word most often used as a verb, occasionally used as a noun) See the preferred noun, glimpse.

Glia cells– A large group of poorly differentiated and defined cells frequently described as the glue holding neurological conduits together. Include the astrocytes, oligodendrocytes and ependymal cells. Sometimes described as providing the myelination surrounding neurons.

Glimpse– The functional interval, of about 50 ms, during which the thalamus performs a cross correlation upon the signals resulting from the tremor (motion) of the line of fixation. The output of the thalamus as a result of this calculation is an interp in vector form.

Global anterograde amnesia– Loss of ability to recognize people, places and facts.

Glutamate–A salt of glutamic acid

Glutamate-ergic– excitatory

Glutamate-ergic input–An excitatory input due to the putative release of glutamate within the synapse. See Afifi & Bergman (1998), pg 345, for a broader list.

Glutamine oxidation–A primary energy source in the α -Ketoglutarate pathway of the Krebs Cycle. Found also in a similar pathway supporting the generation of electricity in the neuron.

Glycoprotein–A protein that has a carbohydrate covalently linked to the peptide chain.

Golgi cells–

Type I--Projection neurons, cells with long axons

Type II--Interneurons, projection cells with short axons from Noback pg 32 or Dowling, pg 350

Gramicidin A– A dimer that forms a cylindrical molecule with an inside diameter of 4 nm and a length of only 25-30 Angstrom that is claimed to generate a channel through a BLM (that is typically 75 Angstrom thick).

Grotthus mechanism–An archaic putative mechanism for physically transferring a proton, a positive charge,

through a liquid crystal or other semiconductor by means of the physical transport of the ion. This action called for the physical rotation of polar ions to effect the apparent motion. This mechanism is usually accomplished by the simpler concept of hole transport.

Group translocation—transport accompanied by chemical modification of the transported substrate. See also active transport. From Cramer & Knaff, 1990.

Gyri—See association fiber.

Haidinger's brushes—Artifacts believed to be due to the dichroic properties of some of the molecules associated with any macular pigment in or on the surface of the INM.

Half-bandwidth—An expression, frequently abbreviated to $W_{1/2}$, describing the width of an absorption spectrum in units of wavenumber and expressed in units of cm^{-1} . See wavenumber, *Archaic*, See also FWHM.

Haploscopic—used to describe an optical set that presents different images to each eye. The images may fuse or if aligned properly, they may merge in a stereoscopic image.

Hallucination— Any false sensory impression, ranging from unformed light (patterns) to complex cinematic visions (sometimes described as dreaming with the eyes open). Alternately, “a symptom in which the patient claims to see something or behaves as if he sees something that the observer cannot see (Lessell).”

a visual perception reported by or causing a reaction in an individual but not observed by another investigator.

Heat etching— (as used in the freeze cleavage, or fracture, technique) The process of bringing a cryogenically frozen specimen up to a temperature of about -100 Celsius under high vacuum.

Helmholtz Layer—a region of charge concentration in the solution at a solution-semiconductor boundary under equilibrium conditions. Complementary to the Space Charge Layer on the semiconductor side of the boundary.

Helmholtz Theory—See Young-Helmholtz Theory

Henle fiber layer—The interconnection layer of the retina between the Outer Nuclear Layer (made up of the soma of photoreceptor cells) and the pedicels of the photoreceptor cells.

Herman cable—A transmission line described as a “leaky telegraph line and widely adopted in the physiological literature dating from the middle of the 19th Century. It is limited to resistors and capacitors and is not descriptive of a real transmission line of finite bandwidth which requires inductance as a primary constituent. Lacking inductance, the circuit is frequency dispersive with distance.

Hering Opponent Theory— A response oriented theory based on the hypothesis that humans only "see" six *unique* colors (black, white, red, yellow, green and blue) and assuming three photoreceptors which yield three kinds of opponent responses: white-black, red-green and yellow-blue. Previously, these colors were never defined specifically. As a result of this work, they can be assigned specific wavelengths. (See Text).

Heterarchy— A term coined by Tyler & Kontsevich to represent the opposite of a hierarchy. An arrangement of computational elements that do not exhibit a hierarchal structure, such as a star network in computers.

Heuristic approach— Relying upon ones experience and education derived from others to plan a research program. The approach frequently constitutes reliance on the conventional wisdom instead of verified facts.

Hierarchy— A grouping of elements defined in terms of their importance, power, age, etc. Usually pyramidal in

30-Processes in Animal Vision

form as in a human organization. See also heterarchy.

High wavelength colors– A term in the vernacular to describe the colors associated with the Q-channel, 532 to 655 nm. See also low wavelength and ultra-low wavelength colors.

Hillock– The morphological area between the soma and the axon. The hillock generally contains the conexus associated with the soma of the neuron. If the neuron is used in stage 3, signal propagation, the hillock also contains the matching filter between the conexus and the myelinated portion of the axon.

Histology--The study of biological tissue, generally with the aid of a light microscope. The tissue is generally divided into four classes, epithelial, muscular, nervous and connective.

Hodgkin condition– In the P/D Equation, the condition where the scale factor represented by the expression $\sigma \cdot F \cdot \tau$ divided by $1 + \sigma \cdot F \cdot \tau$ is equal to 1.000. For this condition, the P/D Equation is given by the Poisson Distribution Function.

Hole--The absence of an electron from a particular lattice site in a crystalline material. Typically indicated by the symbol, X^+ where X can be any atom or complex of atoms capable of giving up an electron. H^+ is a typical hole in a hydronium crystal.

Holo--sometimes -olo-, a combining form meaning “whole”; in enzymology used in the sense with combined with or carrying a target material. Opposite of apo-

Homeostasis--The ability or tendency of an organism or a cell to maintain internal equilibrium by adjusting its physiological processes. A vegetative process.

Homeostasis--The maintenance of static conditions in the internal environment

Homogeneous equation– A differential equation arranged so that the right hand expression is equal to zero.

Homolog (gue)–Corresponding or similar in position, value, structure, or function. See also analog.

Biology. Similar in structure and evolutionary origin, though not necessarily in function, as the flippers of a seal and the hands of a human being.

Chemistry– A series of compounds in which each member differs from the next member by a constant amount is called a homologous series, and the members are called homologs.

Horizontal cells–A generic name for neurons of the 1st lateral matrix of the signal processing stage. Given a large variety of more specific names in the recent literature. See Kaneko, A (1979) and Yang, Tauchi & Kaneko (1983).

Hormone--A substance secreted into the blood stream which influences tissues and organs so as to differentiate and elaborate new cell types and new enzymes.

Horopter– Used variously.

1. The locus of points that have zero binocular disparity is known as the horopter (the “horizon of vision”). A term attributed to Aguilonius, 1613.
2. Nonius horopter– named using the Latinized version of Nune, a Portuguese mathematician and instrument maker. First described by Wells in 1792 (pg 57).

3. A device for measuring the disparity in vergence, in multiple planes under specific conditions between the theoretical and actual vergence of the eyes. The most common are designed to measure horizontal disparity. (S & C pp 204-216)

Horseradish—*Raphanus rusticanus*. The root of *Radicula armoracia*. Used as a condiment rather than a food.

Horseradish peroxidase— An extract of horseradish frequently used in anterograde and retrograde staining of projection neurons to track their paths. Apparently travels along the non-neural, homeostasis serving portion of the neuron. Frequently used in the form of wheatgerm agglutinin-conjugated horseradish peroxidase, WGA-HRP.

HVS—Human visual system

Hyaloid canal— (alt. Canal of Cloquet) A vascular connection between the posterior of the lens capsule and the center of the optic nerve found in the embryonic state. It passes directly through the center of the viscous chamber of the eye

Hydrocarbon— Compounds containing only the two elements, carbon and hydrogen.

Hydronium—Used here to describe a form of crystalline water (not hydrated water) found at biological temperatures in the 20–50 Angstrom wide space between two membranes forming a synapse.

Hyperacuity—A term used to describe the acuity of the visual system in comparison to the expected acuity based on the assumption that the eye is a pixel based imager. By treating the visual system as a change detector, particularly with respect to spatial position, this nomenclature is not required. The acuity of the system is described by the difference in illumination as a function of position as sensed by a single photoreceptor in the presence of motion between the line of sight to the object and the line of fixation of the eye. By summing the response of multiple photoreceptors, the effective acuity relative to long lines is increased.

Hyperopic—(also hypermetropic) Farsighted

Hypertopic—(Adjective; Gk, *hyper*-over, *topis*-place) Vision at illumination levels over or beyond the normal range

Hypometropic—See myopia

Hypothalamus—(*below the thalamus*) The part of the brain that lies below the thalamus, forming the major portion of the ventral region of the diencephalon and functioning as a major interchange point of the neural system.

Hypsochromic spectral shift— A spectral shift toward shorter wavelengths. See also bathochromic spectral shift.

Imaging Sensor--Any sensor system which depends on and expects the line of sight between the scene and the sensor to remain fixed during the period of observation. The photodetection mechanism usually involves an integrating function during the observation interval to achieve maximum sensitivity. A framing sensor is usually an imaging sensor that continually repeats the observation cycle, i.e a television or motion picture camera.

Imp--Intra-membranous particle. Not shown to actually penetrate both bi-layers of a plasma membrane. Believed to be formed by synaptic vesicles deforming the plasma membrane locally.

Incised--in Gray, sharply cut

Incubation—A term that is usually inadequately described.

1. *Chemistry*— The mixing of chemicals and holding them in a controlled external environment for a

32-Processes in Animal Vision

period of time. Process frequently involves changes of the states of matter and significant changes in internal variables that are not controlled. Infrequently leads to explosions because of these changes.

2. Biochemistry/Biology– The mixing of more complex biological and biochemical materials and holding them in a controlled external environment. Subject to a much larger variety of changes of state of matter as well as states of conglomeration. Process usually involves significant changes in internal variables that are not controlled or measured adequately. Infrequently leads to genesis or mortality. Frequently leads to complex materials that are very difficult to quantify with precision.

Independence Principle–A conceptual proposal of Hodgkin and Huxley to explain the ability of positive ions to pass through a biological membrane, of unspecified structure, in opposite direction in the presence of the same electrical field potentials.

Index of Refraction– A parameter describing the speed of light at a given point in a medium relative to that in free space. Usually described as a constant throughout the medium of a lens unless more detailed knowledge is available. For a “gradient index lens,” it is common to define an “equivalent refractive index” as a first level parameter of convenience.

Inductive approach– Using a data set as a foundation for a proposed theory. The completeness of the data set and control of all ancillary parameters is critical to an adequate proposal. The inductive approach can only be verified by implementing the deductive approach. This involves additional tests seeking other related, but separate, results predicted by the theory.

Infarct, infarction– An area of tissue that undergoes necrosis as a result of obstruction of local blood supply, as by a thrombus or an embolus.

Inhibition--1. Usually used in the literature in a colloquial sense at the conceptual level to mean a throttling of a signal. Does not recognize the consequences of subtracting two signals.
2. Not used in this work

Inion--a nodal point at the rear of the head used in VEP (visual evoked potential) research as a point of physical and electrical reference.

Initial segment--An unmyelinated area associated with the axon hillock that is the location of the Activa in a neuron. It is recognized as being a specialized region of the plasma membrane. It is the degenerate form of the podite terminal of the neuron.

Inner nuclear layer–(INL) The principle layer of signal processing neurons in the retina, defined principally by the density of neuron nuclei. Contains horizontal, bipolar and amercine sublayers. See Chap. 3.

Inner Segment--The portion of the photoreceptor cell of *Chordata* associated with the secretory functions involved in forming the protein substrate of the disks found in the Outer Segment.

Instruction– A neural message not executable as a command by the PNS. Used to direct the actions of the superior colliculus and thalamic reticular nucleus. Typically found in the alarm mode, volition mode and other channels within the CNS. Usually encoded as a bit-parallel word and transmitted over a group of parallel neural paths. See Command.

Internal blur– A term in the vernacular to describe the limiting performance of the Precision Optical System of

the visual system. It relates to the tremor of the eye and the spatial range of the correlation capability of the POS. See also acuity and amblyopia.

Interp– A message in vectorial form created by the PGN/pulvinar couple (Pretectum) of the POS in response to the interpretation of a symbolic input imaged on the foveola during a single gaze. See also percept.

Interneuron--A neuron which is not used to transmit signals over long distances in the animal but to perform a variety of signal processing functions. See also Projection neuron.

Internode--A descriptor for the neural conduit between two Nodes of Ranvier. See axon segment.

Interp--A vector description of the symbol(s) imaged on the foveola issued by the pretectum following a nominal 50 ms scanning (at the microsaccades level) and cross correlation process.

Interpretation-- The function of reducing the relatively complex vector signal produced by the PERCEPTION process to a simpler vector representative of the object imaged onto the foveola. This interpretation occurs largely within the midbrain and probably involves the short term memory of the pretectum and of the cerebellum. The resulting vector signal says "it is the face of a woman with this set of auxiliary features." The vector signal is passed to Area 7 of the cortex. See also Perception and Recognition.

Intrafusal fibers-- Muscle fibers associated with the spindle of the muscle.

I. P. injection-- Generally intraperitoneal injection, injection into the peritoneal cavity containing the digestive organs. Occasionally, intraportal injection.

IPM--Inter-Photoreceptor Matrix, the fluid found in the cavity between the RPE and the layer of photoreceptor Inner Segments.

IRBP--Inter-retinal Binding Protein

Invertebrates--A loose term used to describe non-chordates

Inward current-- A conventional current entering the axoplasm of a neuron via the collector terminal of an Acell. A depolarizing current. The electron stream flows in the opposite direction.

Iodopsin--A putative chromophore of vision having a peak spectral absorption at 560 nm. This spectral peak is obtained in "difference spectra" assuming the signals generated by the chromophores of vision are manipulated in linear algebraic space in the animal eye. Appears near a psycho-physiologically observed peak in the human Luminous Efficiency Function. This peak is caused by chromatic adaptation. Depending on how it is generated, this peak near 580 nm is called a Purkinje or a Brezold-Brucke peak.

Ipsilateral-- *Biology*: Situated on, pertaining to or affecting the same side.
Vision: Affecting the same side of object space relative to the body.

Isomers--Different compounds that have the same molecular formula. It is the structure, both geometric and electrical, that differentiates the properties of the compounds.

Isoprene Rule--A guide to the understanding of how many biological molecules are constructed from simpler non-biological molecules, often before they are further modified to satisfy specific applications.

Isotopic-- (Adjective; Gk, *isos*=equal, *topis*=place) In vision, light of equal intensity, or photon flux.

34-Processes in Animal Vision

J-band--The spectral absorption band exhibited by a chromophore of the resonance hybrid type when existing in the liquid crystalline state.

Jinc--Notation for the Bessel function expression $2J_0(x)/x$ used when calculating the MTF of a blocked aperture optical system.

Jump cut-- An expression borrowed from movie-making and referring to the sudden change of the point of regard of the eyes from one scene to another scene.

K-- *upper case* A constant frequently used in photon-quantum mechanical interactions. Equal to the Boltzman constant divided by the product of Planck's Constant and the speed of light. Frequently given as 1/48 at room temperature. Equal to 1/46.34 at nominal human body temperature.

Kite, White Tailed--Elanus leucurus of the Order Falconiformes. They hover in flight between 10-20 meters above the ground with their head held still in inertial space relative to the earth while watching for the movement of prey on the ground below. When attacking, they do not dive, but slip downward feet first while maintaining their line of sight.

Konig fundamentals-- An early mathematical framework for describing the color performance of vision. Relied upon the equilateral trichromatic assumption and the linearity of the visual process. Employs normalized absorption coefficients as a basic parameter. Extended by Vos & Walraven and by Smith & Pokorny. The concept and its extensions are not supported by this work.

Koniocortex-- granular-appearing cerebral cortex especially characteristic of sensory areas.

Krebs Cycle--Also known as the Krebs tricarboxylic acid cycle. The prototypical metabolic energy cycle in animals. It involves the consumption of fatty acids through their multi-step reduction to either urea or ammonia. It is considered a multi-step catalytic process involving multiple substrates and enzymes. Steps in the process are capable of transporting electrons across membranes boundaries. (Lehninger 1970, pg. 412) One path of entry into the Krebs Cycle is via the α -Ketoglutarate pathway. This pathway employs the glutamines.

Krebs solution--An electrolyte used to maintain an external environment compatible with an excised cell. Typically a mixture of NaCl, MgSO₄, CaCl₂ and NaHCO₃. It contains no nutritional or metabolic component more complicated than dextrose or oxygen. See Bowe, Kocsis & Waxman, Proc. R. Soc. B. vol 224, pp 355-366)

L-DOPA--(laevodihydroxyphenylalanine) A pharmacological substance having major impact on the nervous system through its intervention in the electrostenolytic process. Usually administered on a global basis.

Labile-- in chemistry; unstable, metastable

Lamella-- A thin plate like structure, usually one layer of a cell wall.

Lamina Cribosa--A structural membrane at the rear of the eye penetrated by the individual neurons of the optical nerve bundle on their way to the brain. Literally, a sieve like sheet. (Howell in ARVO notes to pg I.18)

Late Receptor Potential--Labeled by Snyder & Menzel but not defined explicitly

Latency--A general concept used in neurology to describe an observed circuit delay or a servomechanism loop delay. No unique definition. Used by different investigators to define the time interval between;

the starting point of a stimulus or
the mid point of a flash stimulus

and

the inflection point indicating the start of the generator potential or
the 10% amplitude point on the rising waveform of the generator potential or
the 67% amplitude point on the rising waveform of the generator potential or
the peak amplitude point of an action potential.

Usually consists of an intrinsic delay plus some portion of the rise time associated with a waveform.

Lateral geniculate bodies--portions of the thalamus that receive neural signals from the optic nerve and distribute them to the cortex, mainly areas 17 & 18

Lateral terminal nucleus--A structure of the brain. One of three small nuclei in the Precision Optical System. The interface between the afferent signal paths from the eye and the efferent signal paths to some of the motor neurons controlling the ocular globes.

Law of innervation-- An archaic (first order) law useful in the absence of a complete understanding of the POS. It is only applicable to the low frequency characteristics of the oculomotor system. It is reviewed in detail in Breinin, where its limitations are described.

Lecithin--Choline phosphoglyceride, also known as phosphatidyl choline

Lenticular array--In optics, a two dimensional array of small lenses, each individual lens having a shape reminiscent of a lentil.

Levator Anatomy: A muscle that raises a bodily part such as an eyelid. Infrequently used as a synonym for the superior rectus oculomotor muscle.

Ligand--An ion, a molecule, or a molecular group that binds to another chemical entity to form a larger complex. See prosthetic group in the case of a conjugated protein.

Light--Electromagnetic radiation with a wavelength such that it is transmitted through the optical window in the absorption spectrum of the atmosphere; generally from 0.3 microns to a few tens of microns. Different animals perceive different portions of this spectrum as "visible light" for that species.

Lightness-- The attribute of a visual sensation according to which the area in which the visual stimulus is presented appears to emit more or less light in proportion to that emitted by a similarly illuminated area perceived as a "white" stimulus. Lightness may be referred to as relative brightness. (W&S, page 487).

Limbic system--Archaic name for a group of elements in the brain originally thought to be concerned with the olfactory process. Nominally the rhinencephalon of the midbrain. See page 34 of Hamilton.

Lipid--A water insoluble organic substance found in cells which are extractable by non-polar solvents such as ether, benzene, chloroform. [With a long (usually even numbered and never conjugated) hydrocarbon chain with a carboxyl group on the end; Lehninger, pg 189-190]

Lipoid--A fat or fat like substance; Gray

Liquid crystal--A material in a mesophase of matter existing between the liquid and crystalline states of matter.

36-Processes in Animal Vision

Frequently a temperature sensitive state. If deposited on a substrate, it will exhibit many optical features of a crystal. Mesophases include both the smectic and nematic types. The smectic is the more ordered of the two. [Adamson, A. Physical Chemistry pg 1006] The chromophores of vision are thought to be of the smectic type.

Local Electro-retinogram- LERG--An analog extracellular response obtained from a localized region of the retina by an electrical probe and representing the sum of the signals (varying in waveform and time) from many cells.

Logistic Curve--A name taken from the statistics of population growth and also known as a hyperbolic tangent given by the expression $y = 1 + \tanh x$

Low vision--A term used for myopia that is uncorrectable with lenses and due to neurological conditions, usually a failure in the precision optical system of the mid brain. Common in achromatopsia.

Low wavelength colors--A term in the vernacular to describe the colors associated with the P-channel, 437 to 532 nm. See also High wavelength and ultra-low wavelength colors.

Lumen--(also known as the *light-watt*) The monochromatic radiant flux of 1/683 W ($4.092 \cdot 10^{17}$ photons) at a frequency is $540 \cdot 10^{12}$ Hertz ($\lambda = 555.016$ nm in standard air). The equivalence was determined based on the CIE (1924) Photopic Luminous Efficiency Function, $V'(\lambda)$.

Luminance--

Photopic luminance--The product of a constant, K_M , times the integral of the radiance of a source as a function of wavelength, L (sub e & sub lambda) multiplied by the photopic visual luminous efficiency function, V (sub lambda). (W&S, page 259)

Scotopic luminance--The product of a constant, K'_M , times the integral of the radiance of a source as a function of wavelength, L (sub e & sub lambda) multiplied by the scotopic visual luminous efficiency function, V' (sub lambda). (W&S, page 259)

The constants have been established by international agreement.
(See spectral luminous efficiency function)

Luminous Efficiency Function--See Spectral Luminous Efficiency Function

Luneberg Len--A lens usually used at microwave frequencies to shape an incident radiation wavefront through the variation in the local index of refraction within the lens instead of using the shape of the external surfaces of the lens. At optical wavelengths, a glass exhibiting a variation in index of refraction with distance from the optical axis, thereby providing an additional degree of design freedom to the design engineer

Lyotropic--Lyotropic systems are formed by the dissolving of one material in a second material.

Lysosome--Membrane bounded cytoplasmic organelle containing a variety of hydrolytic enzymes that can be released into a phagosome or to the exterior.

Marker--A chemical that accumulates at a certain point in a series of reactions because of a slight difference between the normal chemical leading to the reaction and an alternate tracer chemical of similar structure to the normal chemical. The marker is the result of the tracer following the same series of reactions up to a specific point.

M-cells—Used by some authors to describe cells associated with the magnocellular pathway. By extension, used to identify the ganglion cells of the retina related to the luminance channel, the R-channel.

M-channel— One of the pathways leading from the retina through the LGN to area 17 of the cortex. Name is derived from the magnocellular pathway. By extension, synonymous with the non-foveal portion of the R-channel of this work and representing the luminance signaling channel.

M-gram—A memory-gram. Used in psychology to describe a message (vector) sent over a memory-trace (pathway) that is distinctly separate from the pathways associated with motor activity.

Macula—An area of the retina including the parafovea, fovea and foveola. Usually defined by an apparent yellowish discoloration.

Macular sparing—A condition encountered in situations where V1 is essentially destroyed but the subject can still read and fixate on objects.

MAR— Minimum angle of resolution. Used in discussing visual acuity. Equal to the width of the stroke of a character on a standard eye chart.

Matthiessen's ratio—The focal length of a lens divided by the radius of that lens. This definition does not incorporate the pupil size of the lens system. In this way, it differs from the $f/\#$ of an optical system

Macula lutea—the observed region of the retina, centered on the foveola, with a yellowish cast due to increased absorption by the INM due to the lower density of neural tissue in this region. See study by Snodderly, et. al. 1984.

Maintained response—A steady state response generally to a step input stimulus

Maxwellian optics— A colloquial name for physical optics, the study of the complete description of the performance of an optical system. In contrast to Gaussian optics, the study of a limited number of properties of such a system.

Maxwellian View—A method, similar to a Schlieran system, of using a collimating and imaging lens to create an image of the source in the aperture stop of the eye while the image of an object plane, illuminated by the collimated source, is focused on the retina of the eye. See Rodieck, pg. 273, 1973.

Maxwell's spot—A dark entopic figure seen in blue light that is thought to be caused by the macula lutea.

Medial temporal surface— MT; same as V5. Originally named for the location of V5 in the owl monkey (but not in all monkeys—including the rhesus). See Weiskrantz, 1997.

Medial terminal nucleus—A structure of the brain. One of three distinct small parts of the Precision Optical System. The interface between the afferent signal paths from the eye and the efferent signal paths to the motor neurons controlling the ocular globes, apparently the superior rectus and inferior rectus.

Meridional plane—Any plane tangent to (containing) the optical axis

Merocrine Gland—See Gland

Mesoencephalon— The middle portion of the paleo-cortex. Frequently defined to include the superior colliculus and cerebellum.

38-Processes in Animal Vision

Mesotopic—(Adjective; Gk, *mesos*-middle, *topis*-place) Informally, mesopic

Mesotopic vision—(aka **mesopic vision**) Vision utilizing the middle range of illumination between scotopic and photopic where the acuity performance and the color rendition performance are limited largely by a threshold determined by the quantum noise associated with the incident light.

Metabolism—The molecular level events involved in the synthesis, assembly, maintenance, and turnover of cells, groups of cells and components of cells in an animal. The function includes the provision of power to the neural system but not the processing and transmission of signals. Frequently subdivided into:

Electrostenolytic metabolism (introduced here)— Metabolism for the purpose of generating electrical power

Glutamate shunt metabolism— Primary mechanism of electrostenolytic metabolism.

Intermediate metabolism

Carbohydrate metabolism

Lipid metabolism

Nucleic acid (and related substances) metabolism

Porphyrin metabolism

Protein metabolism

Metabotropic— relating to or being a receptor for glutamate that when complexed with G protein triggers increased production of certain intracellular messengers . As in, metabotropic glutamate receptors

Metameres—(a.k.a. complete metameres) Incident lights in object space that are perceived as the same even though they have different sets of luminance and chrominance parameters. Chromatic metameres are perceived the same when viewed with the same light source even though they have different sets of chrominance parameters. These definitions are not compatible with the tristimulus (object-space) based definitions of the CIE.

Metarteriole— The minute capillaries at the junctions between the arterial system and the venous system.

Methine Radical-- $\cdot\text{CH}=\text{}$

Methyl Radical— $\text{CH}_3\cdot$

Methylene Radical— $\cdot\text{CH}_2\cdot$ A free radical of the *diradical* type (Morrison & Boyd, pg. 134). Able to insert itself into alkane molecules.

Meyer's Loop—The fan-like portion of the optical radiation following the LGN. It provides a spatially related timing delay to compensate for the different ganglion axon lengths with position in the retina. See its complement, Reyem's loop.

Micelle--

1. Biochemistry--A globule of lipid molecules in water where their nonpolar ends face inward and their polar tails face outward.
2. Chemistry--A colloid particle formed by an aggregate of small molecules.

Michaelis Equation--An equation of the form $y = x/c + x$ where c equals x at the point where y equals $\frac{1}{2}$ of its

maximum value. Also known as the Michaelis-Menton equation, the logistic equation and a variety of other names.

- Micro--prefix**
- a. Small: *microcircuit*.
 - b. Abnormally small: *microcephaly*.
 - c. Requiring or involving microscopy: *microsurgery*.

Midget ganglion cell– A stage 3 cell in the retina of the eye which generates action potentials continuously and modulates the time between these pulses. It is used to transmit chrominance information to the brain via the optic nerve.

Migraine headaches– An often familial symptom related to vascular related headaches. Often preceded by the constriction of the cranial arteries.

MIM–See OMIM

Missense mutation–A change in the base sequence of a gene that alters or eliminates a protein.

Mitochondria– Seat of the Tri-carboxylic-acid cycle. Manufactures a wide variety of amino acids for use by ribosomes in protein manufacture.

Modulation– See Contrast

Modulator element–An early designation used by Granit (1947) to describe three putative narrowband photoreceptor elements responsible for signals measured within the optic nerve. See also modulator element.

Monkeys–Among the most advanced mammals but the least advanced mammals of the Order Primates. Animals widely used in the research phase of vision. Found in two major Superfamilies, *Ceboida* (New World monkeys) and *Cercopithecoidea* (Old World monkeys). Functionally interchangeable with humans from the perspective of research on the signaling aspects of the visual system distal to the optical chiasm at the entry to the brain. Not completely interchangeable with regard to the foveola and the Precision Optical System controlling ocular motion. Not interchangeable with respect to research on the cortex and midbrain of the human. The degree of difference between the monkey (particularly the New World monkeys) and human brain is significant morphologically, topographically, functionally and organizationally. See Primates.

Morphology–The branch of biology that deals with the form and structure of organisms without consideration of function.

Motor neuron– A neuron that may accept either electrotonic or phasic inputs and project phasic signals to its motor end-plate where the signals are decoded and applied to the muscle through a synapse. Motor neurons of the peripheral system are divided into two types.

1. The alpha motor neuron is a heavily myelinated, fast-conducting (wide-bandwidth) neuron that terminates in the motor end-plate of a voluntary muscle (extrafusal) fiber.
2. The gamma efferent neuron is a lightly myelinated, slowly conducting (narrow-bandwidth) neuron that innervates the small muscle (intrafusal) fibers within the neuromuscular spindle receptor.

Motor unit– A motoneuron plus the muscle fibers that it innervates, is the basic functional unit of skeletomotor systems.

Muller's Law– Nerve impulses of all senses are of same kind (as defined in The Science of Color glossary); generally elucidated prior to the recognition of the electrotonic nature of some retinal neurons.

40-Processes in Animal Vision

Muller cells– An honorarium applied to macroglial cells in the retina. Largely indistinguishable from other types of macroglial cells found elsewhere such as astrocytes (in various nerve fiber layers), oligodendrocytes (in the brain) and ependymal cells (Newman & Reichenbach, 1996). Probably act as pyruvate/lactate synthesizers in support of the neural cells. Cells are largely amorphous in form and fill many voids in the retina on the neural side of the outer limiting membrane.

Murine–Member of the rodent family *muridea*

Myopia–A common eye disorder occurring in three forms, refractive, neurological and pathological myopia. Refractive myopia is the common nearsightedness where the image is focused in front of the retina. Neurological myopia is due to a failure in the precision optical system of the midbrain. (See low vision) Pathological myopia is usually due to an underlying disease that causes a physical distortion of the eyeball that is beyond the compensation range of the accommodation system.

Nanobiology–A popular name for the branch of biology concerned with subcellular structure and function.

Nasal–The side of the retina nearest to the nose

Nauplius eye–Variously used to describe a simple, more likely ocellus type, eye in *Arthropoda*. Sometimes referring to an eye formed during one of the larval stages of an animal's development.

Near point of accommodation–The closest point to the eye that a subject can focus on. The standard near point is taken as 25 cm (10 inches)

Neglect –A medical condition where the subject entirely ignores the side of his body and the side of his visual field sensed by a damaged portion of his brain, generally associated with damage to the cortex. Usually a result of a stroke in the elderly. May be due to physical damage or disease.

Nernst potential–The potential across a semipermeable membrane caused by a difference in concentration of one ionic species on the two sides. A more limited form of the Donnan potential of physical chemistry.

Nerve root–The point where a nerve enters or leaves the spinal chord of *Chordata*. A dorsal nerve root is associated with an afferent (sensory path) neuron. A ventral nerve root is associated with an efferent (motor path) neuron.

Neural network– 1. *Neurology*, A description of the topology of an engine within the CNS most easily interpreted as a Boolean network of fundamentally linear circuit elements. When overdriven, these fundamental circuit elements can provide AND, OR, NOT AND (NAND), NOT OR (NOR) and other simple logic functions. The circuits are basically self-clocking and asynchronous with respect to individual input signals. The output signals are fundamentally analog and continuous (not obviously clocked).

Neural Propagation Velocity–A group velocity incorporating significant delays due to signal regeneration along an axon. Typically 50 meters/sec in large unmyelinated neural fibers to 120 meters/sec in small myelinated neural fibers. The underlying phase velocity between regeneration points is in the 4000 meter/second region.

Neuro-facilitator– (specific) Any chemical substance that enhances the operation of a neuron by enhancing the electrotonic process occurring on the surface of the plasmalemma of a neuron. The primary reactant is glutamate, with aspartate a potential backup. Many materials can facilitate the electrotonic reaction by affecting the concentration of glutamate at the cell surface.

(global) Any material that aids or enhances the observed operation of the neural system at the elemental level. The effect may be location dependent when applied topically to a neuron. Subject to pathological limits beyond which it depresses neural operation, including by destructive means. The effect of the material may be different when applied in solution than when applied topically.

Neuro-inhibitor–(specific)Any chemical substance that inhibits the operation of a neuron by inhibiting the electrostenolytic process occurring on the surface of the plasmalemma of a neuron. The primary reaction product, GABA, is the primary inhibitor. Many materials can inhibit the electrostenolytic reaction by affecting the concentration of glutamate at the cell surface.

(global)Any material that suppresses or slows the observed operation of the neural system. The effect may be location dependent when applied topically to a neuron. Subject to pathological limits beyond which it depresses neural operation, including by destructive means. The effect of the material may be different when applied in solution than when applied topically.

Neurology–The medical science that deals with the nervous system and physiological disorders affecting it. See neuroscience. These terms are frequently used interchangeably in the vernacular.

Neuroscience– The academic science that deals with the neuron and the nervous system, and functional failures associated with it. See neurology.

Neurotransmitter– An insufficiently specific term used primarily in pharmacology and generally unrelated to signal transmission in the neural system. Signal transmission is by electrical charge transfer independent of any chemical process.

1. The common definition of a neurotransmitter is based on the presence of “specialized neuronal mechanisms for storage, release, and postsynaptic action of a particular substance.” This definition has evolved into two forms
 - A. Any substance that, when painted onto the surface of a neuron either enhances its neural response or inhibits its neural response. See neuro-facilitator or neuro-inhibitor
 - B. Any of a group of substances that are released on excitation from the axon terminal of a presynaptic neuron of the central or peripheral nervous system and travel across the synaptic cleft to either excite or inhibit the target cell. No definitive demonstration of such release, travel, or excitation within the synaptic space has appeared in the literature.

Nictating lens--An adaptation of the auxiliary eyelid in amphibian members of Chordata to provide proper image focus when changing from an atmospheric to aquatic environment. Variant of nictitating derived from medieval Latin for winking.

Nodal Planes --(For paraxial analysis of optical systems) Planes perpendicular to the optical axis at the point where the nodal points are located on that axis.

Nodal Points--(For paraxial analysis of optical systems) Two axial points of an optical system, so located that an oblique ray directed toward the first appears to emerge from the second, parallel to its original direction. For systems in air, the nodal points coincide with the principal points. For highly oblique, i. e., non-paraxial, rays, nodal points may not exist.

Node of Ranvier-- A feature of the axon of longer length neurons. Constitutes a point of amplification and is the site of an Activa and its associated circuit elements. First described by Ranvier (1878).

Noise–Most generally, interference with a desired signal.

42-Processes in Animal Vision

Typically an apparently random signal, generally due to a source unrelated to the input signal, interfering with a signal. See Quantum noise.

Frequently in psychophysics, an external (relatively low frequency relative to any internal noise) masking signal introduces with the desired signal. The mask is frequently a checkerboard pattern.

Nonbonded electron—An electron, usually of oxygen, nitrogen or sulphur that is found in the ground state and attached only to the atom while the atom is within a molecule.

Non-essential amino acids—Refers to aspartate and glutamate as nutritionally non-essential since they can be formed by (at least) chordate organisms.

Non-faradaic processes—Processes such as adsorption and desorption which take place whenever the structure of the electrical double layer changes are not described by Faraday's Laws. See faradaic processes.

Non-spherical lens—a lens of a fundamental shape other than a sphere. Usually a lens based on a conic section or a cylinder. It may be intentionally deformed slightly to improve its aberration performance. In this case, it is described as an aspherized cylindrical (or elliptical) lens.

NOT—An abbreviation for nucleus of the optical tract. An inadequately defined area in cat brain apparently between the LGN and the posterior pretectal nucleus. (Cucchiari, et. al. '93, fg 1)

Nucleus—Principle seat of glycolysis. Provides NAD and forms ATP required for the operation of the mitochondria and ribosomes.

Null—An undefined condition, not a zero, not black

Numerical Aperture—An expression of the light collecting capability of an optical system given by:
 $n. a. = nd/2p$ where n =index of refraction of the medium, d =diameter of the aperture, and p =focal length of the lens.

Nyquist frequency—The frequency of a sampling device and defined as the reciprocal of the time (or space) interval between samples. To avoid output signals being sensitive to the phase of the input signal (and therefore ambiguous), the Nyquist (ambiguity) limit is taken as a frequency equal to one-half the Nyquist frequency. For signals above the Nyquist frequency, significant frequency distortion can occur. This distortion is generally described in terms of fold-over or aliasing.

Nystagmus—This term is used variously to describe both normal and pathological conditions related to the oculomotor system.

1. A pathological condition involving an uncontrolled oscillatory movement of the axes of the eyes during which the amplitude of oscillation is tens of hundreds of times greater than the amplitude of the tremor, while the frequency of the nystagmus is tens of times lower than the frequency of the tremor. (Yarbus pg 120)
2. Pursuit nystagmus, generally not exhibited until several month post-partum in humans and probably learned, is the ability to maintain the image of a smoothly moving object on the point of fixation of the retina.
3. Optokinetic nystagmus allows the eye to track successive points in a continuously moving scene. It is characterized by a slow component in the direction of scene movement during observation and a fast

component in the opposite direction as the line of fixation jumps to a different location in the scene. This appears to be a learned capability in man.

Ocellus--1. A small simple eye, found in many invertebrates, usually consisting of a few sensory cells and a single lens.

2. One of the elements of a compound eye

Converse ocellus, one in which the distal end of the retinal cells receive the light

Inverse ocellus, one in which the proximal end of the retinal cells face the light

*** This definition does not agree with Shepherd pg. 331 ***

Occipital--pertaining to the posterior third of the chordate head

OFF-center--Traditional classification in psychophysics; actually indicative of a “negative contrast” or a lowering of stimulus level below a nominal level and not a truly “off” or black condition. (see Kulikowski, Seeing Contour & Color)

OMIM--Online Mendelian Inheritance in Man project of the NIH

Ommatidia--The individual sensor element of the compound eye, consisting of a rhabdom located behind a light collecting structure, which may or may not contain a lens. See ocellus

Ontogeny-- The development or course of development of an individual organism over time.

Oocyte --A cell from which an egg or ovum develops by meiosis; a female gametocyte

OPD (optical path difference)--The fundamental descriptor of the quality of an optical system. A complex function describing every ray that passes through an optical system from an object point. It consists of first order (Gaussian) terms, third order (Seidel) terms, fifth order (Buchdahl) terms, and higher order terms. See the Infrared Handbook, Washington, DC: Office of Naval Research 1978, pg 8-17

Operculum-- A lid or flap covering an aperture.

Ophthalmics--The correction of excessive departures from normality by the introduction of supplementary eye-lenses.

Ophthalmology-- The branch of *medicine* that deals with the anatomy, functions, pathology, and treatment of the eye.

Opsin--A 7-TMS subfamily G protein forming the substrates of the disks found in the Outer Segments associated with the photoreceptor cells.

Optic disk--The area on the surface of the retina where the optic nerves leave the eye. Also known as the papilla or the “blind spot.”

Optical Analysis--Frequently carried out in four degrees of completeness. **[check these terms]**

1. First Order Analysis, frequently spoken of as Gaussian Optics and limited to the paraxial condition.
2. Third Order Analysis, concerned with spherical aberration and defining the Petzval surface of the optical system.
3. Fifth Order Analysis, concerned with coma, astigmatism and chromatic aberration.
4. Complete Analysis, which entails a complete ray trace of the optical system, both paraxial and

44-Processes in Animal Vision

off axis rays, and a full description of the image surface, image distortions, magnifications, etc.

Optics--

1. Dioptrics; optical elements based on refraction, lenses
2. Catoptrics; optical elements based on reflection, mirrors and waveguides
3. Catadioptrics; optical systems employing both refraction and reflection

Optic nerve-- The second cranial nerve. Generally considered part of the peripheral nervous system.

Optic tectum-- A general descriptor for the anterior top of the thalamus in *Chordata* that is involved in the visual process.

Optokinetic reflex--Archaic, see Optokinetic response

Optokinetic response--(OKR)--The rotational response of the eyes due to signals derived from the retina as well as other auditory and somatosensory inputs.

Ora serrata--The outer (terminal) margin of the peripheral retina (See Hogan & Alvarado, 1971)

Ordinate--Distance from the horizontal axis in a two-dimensional plot.

Orthodromic--In the normal direction of signal flow in the nervous system

Osmosis-- Diffusion of fluid through a semipermeable membrane until there is an equal concentration of fluid on both sides of the membrane

Outer nuclear layer--(ONL) The principle layer of photoreceptor neuron nuclei in the retina, defined principally by the density of the nuclei. The layer and the nuclei are largely inert with respect to signaling. See Chap. 3.

Outward current-- The conventional current that flows out of any plasma conduit of a neuron through areas of type 2 BLM due to the electrostenolytic process occurring on the surface of that BLM. A polarizing (or hyperpolarizing) current. Generally described as a Sodium current in the vernacular.

Overvoltage-- Used with multiple meanings

1. Hydrogen overvoltage; the difference between the theoretical and the actual potentials at which detectable hydrogen evolution takes place at an electrode when the concentration of hydrogen, $[H^+] = 1M$. The value is different for each metal.
2. The voltage in an electrochemical cell relative to the standard potential at which the reduction current equals the oxidation current. This current value is known as the exchange current.

Oxidation-- The addition of oxygen, the loss of hydrogen or the loss of electrons from a molecule.

Oxime--A compound formed of an aldehyde reacting with hydroxylamine of the form $C=N-OH$. The process is one of reductive amination. Similar to one of the forms of the putative rhodopsin, $C=N$ -opsin. The other form would presumably be an aldimine, $C-NH-OH$, previously described as a Schiff-base or a protonated Schiff-base.

P-cells--Used by some authors to describe cells exciting the neurons of the parvocellular pathway. Not sufficiently

explicit to separate the cells associated with the P-channel and the Q-channel of the optic nerve. See P-channel.

P-channel—Used in two different contexts.

1. (In the literature) One of the pathways leading from the retina through the LGN to area 17 of the cortex. Name is derived from the parvocellular pathway.

2. (In this work) The signaling channel generated in the horizontal cells of the retina and representing the difference between the S-channel and M-channel photoreceptor signals.

P-face—Used variously in the literature. See also E-face.

1. *Generally*: The internal face of the plasma membrane of a cell. The face contacting the plasma of the cell.

2. *Freeze-Fracture morphology*: The hydrophobic surface of the internal leaflet of the bilayer plasma membrane. This is usually the face of the leaflet facing the other leaflet and toward the external medium surrounding the cell.

Palinopsia—Persistent after images and trails.

Pallial eyes—Eyes located on the mantle. As opposed to cephalic eyes located on the head.

Panum's area—A description of the area in X,Y coordinates in object space at the point of fixation associated with the limits of fusion in normal vision. More precisely, a projection of the maximum effective dimensions of the associative correlator of the perigeniculate nucleus.

Panum's limit—Used variously in the literature. Generally, the edge of Panum's area as defined at the associative correlator of the PGN.

Papilla—see optic disk

Paradoxical pupil—Sometimes found in Achromatopsia. The iris tends to open with increasing light level.

Paraxial Ray—A ray which makes a very small angle with the optical axis and lies close to the axis throughout the distance from object to image.

Parasol ganglion cell—

Pedicle— (ped-i-kal) The termination(s) associated with the extreme end of an axon. The terminations of neurites will be called stalks or boutons in this work.

Percept— An accumulation of interps, in vector form, that are presented to the higher cognitive centers. It may relate to a message conveyed by a written sentence or clause. Alternately, it may represent a recognized object. See also interp.

Paresis— Partially-paralyzed extraocular muscle.

Parietal eye—An eye located on the parietal bone of the head

Parietal-Occipital-Temporal lobe junction area, POT— A major hub of signal interchange in the visual system. Signals are received and exchanged between a broad range of signal processing engines.

Pectal—(Latin for Breast area)

46-Processes in Animal Vision

Pedicel—From Botany, the stalk of a flower. In vision, sometimes used to describe the terminal ending of the axon. (See pedicle).

Pedicle—Corruption of the word pedicel, now generally used to describe a complex terminal ending of the axon.

Peduncle—A stalk-like bundle of myelinated nerve fibers connecting different parts of the brain. Alternately, the originating or terminating structure associated with a commissure. See also brachium.

Percept— The vector created by the assembly of individual interps generated by the pretectum in response to the scanning and cross correlation process performed by the Precision Optical System.

Perception— The function of analyzing the image projected onto the *foveola* by the midbrain. It is a primary function of the Precision Optical System (POS). The POS has historically been referred to as the auxiliary optical system by anatomists. The function is performed primarily in image space. The output of the process is a vector that is largely independent of image space and is representative of the graphical *features* of the object scene. It says "the image contains the following strokes interconnected in the following way <LIST>. The color within each enclosed series of strokes is defined as <LIST>.

Perfuse—To pass a liquid through the interior of a cell or part of a cell. See also superfuse

PERG—Pattern electroretinograph, a frequency response function obtained by varying the contrast of a checkerboard or sine wave pattern while changing the pattern pitch in steps. Results are strongly dependent on the specific spectral wavelengths employed to achieve the contrast.

Perigeniculate nucleus— (PGN) One of a pair of elements of the thalamus concerned with the precision processing of signals from the foveola. Performs the initial steps of image interpretation in conjunction with the posterior pulvinar.

Perikaryon—A general description of the cell body of a neuron, containing the nucleus and organelles. In most cases also containing the active element, the Activa.

Peripheral nervous system—The systems primarily concerned with the sensory organs and the control of the skeletal muscles.

Preprohormone—(*preliminary* from Wikipedia) A preprohormone is the precursor molecule to a prohormone, which is in turn the precursor to a peptide hormone. It consists of the amino acid chain that is created by the hormone secreting portion of the cell, before any changes have been made to it. It contains the hormone itself, signal peptides and some other amino acids. Before the hormone is released from the cell, the signal peptides and other amino acids will be removed.

Phagocytosis—The process of engulfing material by a cell in the process of digesting or further processing it. A form of endocytosis. See also pinocytosis.

Phasic—Poorly defined but generally an adjective relating to a transient process; as opposed to tonic. In some spectral work, used to describe the shape of the response waveform (particularly the number of times the waveform reverses polarity, hence monophasic, biphasic and triphasic)

Phenotype— **a.** The observable physical or biochemical characteristics of an organism, as determined by both genetic makeup and environmental influences.

- b. The expression of a specific trait, such as stature or blood type, based on genetic and environmental influences.
- c. An animal resulting from epigenesis based on a specific genotype of DNA.

Pheromones—Molecules that transmit signals between members of the same species (conspecifics) are called pheromones.

Phoria— (clinical) A description of the state of deviation of the eye (inward, outward, upward, downward or cyclorotatory in nature) in the fusion free state (typically either with one eye occluded or with prismatic disassociation). A latent strabismus revealed only when the eyes are disassociated (when no fusible stimuli are in view).

Esophoria— An inward lateral deviation of the eye in the fusion-free state.

Exophoria— An outward lateral deviation of the eye in the fusion-free state.

Orthophoria— Lack of deviation of the eye in the fusion-free state.

Phosphene—1. Perceived visual responses not formed by imaged light through the aperture of the eye.

2. The dark circular spot in the visual field caused by mechanical pressure on the ocular globe on the side directly [only an approximation] opposite the spot. (See Adler's)

3. Perceived flash (unstructured image vector) from a surgically implanted electrode stimulating the visual cortex. They appear as white spots on "black."

Phosphoglycerides—Polar lipids found almost exclusively in cell membranes. Consist of a polar head containing an atom of phosphorous and two non-polar hydrocarbon tails.

Phospholipids—See phosphoglycerides.

Photochromatic interval—The difference in intensity between the absolute (achromatic) intensity threshold and the photochromatic threshold under photopic intensity (illumination) conditions, generally described as a function of wavelength. Beyond 655 nm, this interval is considered equal to zero.

Photochromatic threshold—The intensity of a spectral light source (frequently described in luminance terms) required to elicit a chromatic sensation. Compare to the absolute intensity (frequently described as the luminance) threshold.

Photopic—(an adjective; Gk *photos*-light & *topis*-place) used in two main situations.

1. Primarily to describe the spectral characteristic of the long wavelength trichromats, primarily large chordates (including humans) that cannot sense in the ultraviolet because of the absorption of their lens, at light intensity levels. where their visual systems are dynamic range limited.

2. Secondarily to describe the light intensity range that is associated with the dynamic range limited operation of the human visual system. Typically "daylight" conditions existing prior to twilight..

Photopic Vision—Vision at moderate and high levels of luminance (in humans)

Photochromatic interval—The difference in threshold sensitivity of the chrominance and luminance channels in human vision. The interval is a function of spectral content in the test irradiance and possibly additional secondary processes within the visual system. The interval contains a large transient component.

48-Processes in Animal Vision

Photochromatic threshold—A threshold for chromatic perception in the visual system. It is highly dependent on the spatial location and size of the source as well as the temporal aspects of the source and the state of adaptation of the eye.

Phylogeny—The evolutionary history of a kind of organism

Physiology—The biological study of the functions of living organisms and their parts

Sub-disciplines according to Dowben:

1. Physiological chemistry (or more recently Biochemistry).
2. Systems physiology--study of functional integration.
3. General physiology--concentration at a cellular level based on molecular structure and in terms of chemical and physical principles.

Pinocytosis—The uptake of fluids into a cell by invagination

Pitt's Law—The differential wavelength discrimination in the color-defective patient is *best* where the intrinsic saturation is poorest.

Planck's Law of Radiation—The law and equation defining the spectral radiation from a perfect blackbody. Usually plotted with respect to wavelength, temperature being a parameter.

Plant—In control theory, the spatially dynamic portion of a servomechanism as opposed to the control portion.

Pleiotropy—The ability of a single allele to have more than one distinguishable effect. The most familiar example is the allele responsible for color pattern in Siamese cats

PNP--

1. (Electrolytic semiconductor chemistry-) The descriptors used to define the types of semiconductor material forming the Activa, the active three terminal electrolytic semiconductor device analogous to the transistor. Adapted from its use in solid state semiconductor physics.
2. (Morphology) The paranode-node-paranode region describing a Node of Ranvier. Can also be defined as the pre-node/node/post node region defining the active region of the Node of Ranvier.

Podite or Poditic terminal—The neurite terminal of the Activa providing signal inversion between the Poda and the Axon. Also known as the basilar dendrite (but more properly the basilar neurite) in some literature.

Polarization—Used variously within the biological sciences.

<cytology> Used in place of the term orientation to describe the preferred direction of molecules, particularly proteins (of unspecified electrical polarization) found within a cell.

Polarized electrode—Electrodes at which no charge transfer across the metal-solution interface can occur, regardless of the potential imposed on the electrode from an outside source of voltage (Mohilner). The calomel electrode approaches this condition.

Polyene Dyes—Organic chemicals characterized by a conjugated chain of methine groups terminated by alkyl or other groups which do not influence the electronic excitation of of the dye. The molecule is normally in E (trans) configuration. (Zollinger 1991)

Polymethine Dyes--Organic chemicals characterized by a conjugated chain of methine groups terminated by an electron donor D on one end and an electron acceptor A on the other. The molecule is normally in E (trans) configuration. (Zollinger 1991)

Pooling--Used in neural modeling to describe the decoding of a stream of action potentials by integration, and potentially to describe the summation of such integrated signals.

Porphyropsin--Synonymous with Rhodonein(7) in its liquid crystalline form and exhibiting a peak anisotropic spectral absorption at 532 nm. *Archaic*: A name in the literature for the visual pigment based on a protein, opsin, and a chromophore based on vitamin A₂ and hence retinene₂

Positive visual phenomena--A perception that adds to the conventionally imaged scene as opposed to a scotoma or other negative visual phenomenon.

Posterior--The hinder part of an organism

Postsynaptic--Generally referring to elements proximal to a sensory synapse.

Potassium channel--The vernacular name for the electrical channel generated by the electrostenolytic process located on type 2 portions of the axolemma, as well as type 2 portions of other lemmas associated with the neural conduits. The name has commonly been used previously in the literature to describe the putative channel through only the axolemma and used by potassium ions or potassium ions complexed with other materials.

Potassium ion current--In the vernacular, a current proposed by Hodgkin & Huxley to account for the falling phase of an action potential, or other repolarizing process associated with the axoplasm of a neuron. This current is actually the conventional current moving moving out of the axoplasm into the surrounding INM or the electron-based flow of charge moving through the axolemma into the axoplasm region from the INM in response to the reduction of the axoplasm potential from its quiescent value. It is caused by the electrostenolytic mechanism fueled by the conversion of glutamic acid to GABA. See Outward current.

Poynting vector--A vector indicating the direction of travel of radiation. It is orthogonal to both the electric and magnetic vectors of the radiation.

Precision Optical Servomechanism System--The closed loop servomechanism responsible for controlling the line of fixation of the visual system and extracting the information presented to the eyes as an optical image.

Precision Optical System--Also known historically as the Auxiliary Optical System. A set of functional parts of the brain acting as the interface between the afferent signals from the eye and the efferent signals passing over the motor neurons to the muscles controlling the line of fixation by steering the ocular globes (and selected head and body muscle).

Presbyopia--The condition of degrading performance of the visual system due to a gradual hardening of the lens of the eye and subsequent inability of the lens muscles to deform the lens sufficiently to accomplish accommodations.

Presynaptic--Generally referring to elements distal to a sensory synapse, typically a presynaptic neuron is providing the signal to the postsynaptic neuron

Preteectum--The posterior part of the thalamus in more advanced chordates. Frequently equated to the area including the pulvinar in primates. Now recognized as a complex shell containing many individual elements critical to vision and hearing. One element functions as a supervisor of much of the activity within the brain. In animals with a foveola, one element is known as the perigeniculate nucleus. It provides the signal extraction

50-Processes in Animal Vision

function and controls the pointing of the line of fixation associated with the Precision Optical Servomechanism System. See also perigeniculate nucleus and pulvinar.

Primates—The highest Order in the Class *Mammalia* in the Phylum *Chordata*. Consists of the Superfamilies *Homoioidea* (man and the higher, anthropoid, apes), *Ceboida* (New World monkeys) and *Cercopithecoidea* (Old World monkeys). All of these animals have visual systems distal to the optic chiasm that are similar. There are significant differences proximal to the optic chiasm. While the rhesus monkey (*Cercopithecoidea macacus*) is widely used in visual research, only the *Pongidae* family of *Homoioidea* are sufficiently similar to man to be interchangeable at the functional and topographic level of the cortex and mid brain. *Pongidae* includes the gibbon, orangutan, chimpanzee, and the gorilla. Recent information suggests only the chimpanzee approaches the inter- and percept forming capacity of the human.

Primitives— A synonym for features in a scene. Usually used to focus on a specific (but frequently conceptual and open ended) list of features.

Principal Planes (Surfaces)—(The Principal Planes are planes only in the paraxial region; at any finite distance from the axis they are figures of rotation, frequently approximating spherical surfaces.) If each ray of a bundle, incident on an optical system parallel to the axis, is extended to meet the backward extension of the same ray after it has passed through the system, the locus of the intersections of all the rays is called a principal plane. The first principal plane is formed by rays incident from the right. The second principal plane is formed by rays incident from the left.

Principal ray—The ray that passes through the middle of the aperture stop from an extra-axial object point is called the principal ray of an oblique beam.

Principle of Electrical Neutrality— Used in two forms

1. Diffusion based Principle of Electrical Neutrality— Based on reaction chemistry and the Nernst (Equilibrium) potential. Requires a symmetrical homogeneous membrane semipermeable to the ions in the electrolytes on each side of the membrane. Does not apply to biological bilayer membranes, BLMs

2. Electrostatics based Principle of Electrical Neutrality— Based on Gauss's Law of Electrostatics (integral form of one of Maxwell's Laws); *the surface integral of the normal component of the electric flux density vector, D , over any closed surface equals the charge enclosed, Q* (using the rationalized mks system of units). Two corollaries of this principle are:

A. *The total net charge **within** any enclosed conductive or semi-conductive system must be zero.* Applies generally to all aspects of biological science.

B. Any excess net charge inserted within a conductive or semi-conductive system will be distributed along the outer surface of such conductive or semi-conductive medium in accordance with the laws of electrical charge repulsion.

Prism diopter— A unit of ophthalmic prism power, one prism diopter deviates light from infinity by one cm at 1 meter; 1.745 prism diopters equal 1 degree.

Process—1. A series of actions, changes, or functions bringing about a result: *the process of digestion; the process of obtaining a driver's license.*

2. A series of operations performed in the making or treatment of a product: *a manufacturing process; leather dyed during the tanning process.*

3. *Biology*. An outgrowth of tissue; a projecting part: *a bony process*

Projection neuron--A neuron used to transmit nervous signals over long distances in the animal.
See also Interneuron.

Proof of Principle-- Scientific confirmation that a previously unproven experimental therapy actually confers a therapeutic effect in animal models. Proof of principle provides the first measurable evidence that an experimental therapy might also work in humans

propioceptors--Sensory cells related to the physical state of the organism, particularly the pressure sensitive neuro-receptor cells

Prosopagnosia--The inability to recognize, i.e. comprehend a subtle connection, between a perceived image, such as a car, and the fact that the car belongs to the subject--or the style or brand of the car.

Prosthetic group--The non-amino acid portion of a conjugated protein. See ligand in the case of non-protein conjugated molecule.

Protanomaly--Form of anomalous trichromatism for which, in a red-green mixture, more than the normal amount of red is required to match a particular yellow (The Science of Color)

Protanopia--Form of dichromatism in which red and bluish-green are confused, and relative luminosity of red is much lower than for normal observer (The Science of Color)

Proteome Project-- A project to identify and characterize all proteins found in man. Has been subdivided by major organ.

Protostomia--That large class of bilaterally symmetrical animals generally characterized by a notochord located along the ventral surface of the animal

Proximal--that which lies nearer to

Proximal accommodation--initial accommodation assumed based on knowledge of the distance to the target. Nominally the accommodation stored in the saliency map of the subjects environment and available as an initial condition. The existence of this effect has been questioned. (S & C pg 82)

Proximal convergence-- See proximal vergence

Proximal vergence-- "knowledge of nearness," frequently described as prior knowledge of nearness. Presumably based on values stored in the saliency map.

Pseudopupil--A dark circular area observed on the surface of a compound eye that is seen to move with the angle of observation. The diameter of this pseudopupil is an indication of the diameter and acceptance angle of the photoreceptor cell behind the lenslets of that eye. It is also an indication of the quality of the light baffling provided within the optical system of that eye.

P.s.p--Used variously by authors to indicate the pre-synaptic potential or post-synaptic potential

Psychophysics--Knowledge concerning the response of an animal, primarily aural or mechanical, to the physical stimulus acting upon it.

52-Processes in Animal Vision

Ptosis—A drooping eye lid that partially blocks the pupil and introduces vignetting.

Pulvinar—Defined variously

1. *Anatomy*: A prominence on the posterior part of each lobe of the thalamus of the human brain.
2. A label used in the primates to describe a major portion of the anterior portion of the thalamus.
3. *Morphology*: A major part of the pretectum common to all chordates. The pretectum is defined in this context as containing the pulvinar and the perigeniculate nucleus for that lobe of the thalamus. Possibly uniquely developed in the *Pongidae* and *Hominidae* (man) families of *Homoioidea* (See primates).
4. *Neuroscience*: Apparently the most significant part of the pretectum or optic tectum in these families. It is a major element in the initial extraction of information from the image projected onto the foveola.

Puncta adhaerentia--Tiny holes, spots or points sticking to a surface. Used by Raviola & Raviola.

Pupil, Entrance--The image of the aperture stop formed by the optical elements (if any) between the aperture stop and the object. The image of the aperture stop as “seen” from the object. The entrance pupil appears to lie 0.5 mm. in front of the actual aperture stop formed by the iris.

Purkinje cell--The only recognized type of output neuron of the cerebellar cortex. It accepts electrotonic input signals and produces action potentials. Appears to be functionally identical to the ganglion cells of the PNS and the Pyramid cells of the neocortex.

Purkinje Effect--

Purkinje image tracker--A device that tracks an image reflected from the surfaces of the lens group of the eye. The first Purkinje image is reflected from the first surface of the cornea. The fourth Purkinje image is reflected from the second (or rear) surface of the lens.

Purkinje Shift--Defined by this author (1985) as the unique characteristic of the perceived spectral sensitivity wherein the peak sensitivity moves, as the light level is reduced, from a peak near 580 nm. to a peak near 530 nm. without ever exhibiting a peak in the region of 550 nm. The minimum in the graph of the minimum discernable wavelength versus wavelength also shifts in this manner. Other authors have indicated different values for the peak wavelengths involved.

Purple Line--The construction line in the C.I.E. (1931) Chromaticity Diagram drawn arbitrarily between points considered to be at the extremes of the visible spectral locus. Usually shown as drawn between the x,y coordinates associated with 380 nm. point and the x,y coordinates associated with the 700 nm. point on that diagram.

Purpura--Latin for purple and the name of a mollusc that yields a purple dye.

Pursuit--The process of trying to track a moving object across the visual field. Appears to be accomplished using two different algorithmic modes, fast and slow pursuit.

Putative--Generally regarded as such; supposed **or** proposed.

Pyramid cell– An encoding (stage 3) neuron frequently associated with the motor system. Pyramid cells originating in the mid-brain of humans may have an axon longer than three feet (Noback, 1967).

Pyridoxal– A generic name for several materials

1. a B vitamin that is essential for metabolism of amino acids and starch. Vitamin B₆.
2. Pyridoxal 5'-phosphate (PLP)
3. Pyridoxal 5'-phosphate-dependent amino acid racemases of broad substrate specificity catalyze transamination as a side-reaction.
4. In many situations, the body must convert vitamin B₆ to Pyridoxal-5-phosphate (P5P) before it can be used.
5. Pyridoxal, C₈H₉NO₃, molar mass: 167.18 g/mol. Aldehyde from Vitamin B₆

Quadrigenina– (or corpora quadrigemina) The pair of superior colliculi and inferior colliculi on the dorsal surface of the brainstem (Noback, 1967 pg 9)

Quantum efficiency–The ratio of the number of electrons excited in the initial stage of a process to the number of incident photons. Compare to quantum yield.

Quantum noise– A noise associated with the statistical properties of a random variation in a variable. Usually described in terms of the square root of the mean value (Gaussian statistics) of the disturbance but more accurately described by the square root of the mean plus one. (Poisson statistics)

Quantum yield–the ratio of the number of events, creating of excited or free electrons (or number of chemical reactions) measured at a given point and resulting from irradiation, to the number of incident photons. See also quantum efficiency.

Quiescent accommodation– The state of accommodation, beyond that level provided by anatomical accommodation, assumed by the living accommodation system under any illumination conditions **but** in the absence of distinct within the field of view of the foveola. Commonly described inappropriately as dark accommodation in the vernacular.

Ranvier, Node of-- See Node of Ranvier

Ray, Chief--A ray directed toward the center of the entrance pupil of the optical system.

Ray, Principal--Strictly, a ray directed toward the first principal point, but commonly used to refer to the Chief Ray.

Rayleigh equation--Actually a shorthand notation according to Rubin and Walls; used as a basis for the Nagel Anomaloscope; "a" amount of red plus "b" amount of green equals "c" amount of yellow.

RDS– Random dot stereogram

Receptors–Used in two distinctly different contexts.

1. Photoreceptors that absorb photons (quantum-mechanically in vision) and produce an electrical signal.
2. Biochemical receptors that receive a variety of biochemicals at sites on cell plasma membranes and are coupled to a variety of biochemical effectors.

Recognition– The function of placing a vector received by Area 7 of the cortex from the interpretation facility of the midbrain in proper context by comparing it to previously stored features of the saliency map (in vector space). The term "map" is used here to describe a general database of largely unknown content and arrangement used by

54-Processes in Animal Vision

the cortex and shared with all sensory information [15.2.1 through 15.2.5]. The result of this process is an even simpler vector that says "it is grandma. She is smiling, six feet away and turning to the left." In the absence of recognition based on the historical saliency map, a tentative new entry is made in the saliency map and the POS is generally requested to study the image in more detail and provide more information for perception, interpretation and recognition before adding a permanent entry to the saliency map.

Recruitment—A coarse term describing the typical number of individual muscle fibers innervated by a given axon. Usually with a value of several hundred for neurons supporting the low frequency operation of the oculomotor muscles and about five to ten for the tremor related (twitch) muscle fibers.

Reduction—The removal of oxygen, the addition of hydrogen, or the gain of electrons in a molecule.

Resonance—Used in three distinct manners.

1. A condition where a single molecule can assume more than one electronic state while maintaining the same structural arrangement.
2. The property of a single molecule that causes it to vibrate mechanically at a specific frequency related to the wavelength of light.
3. A property of a liquid crystalline structure, related to its slow wave structure, that causes it to be electrically excitable by photons of a particular wavelength striking the crystal perpendicularly to its surface.

Resonant Dyes—Dyes consisting of two polar atoms separated by a conjugated chain, usually of carbon atoms, frequently of the vinylene type. These dyes exhibit two distinctly different structures depending on the state of the electronic charge associated with the dye. These dyes differ only in the way the electrons are disposed, *not* in the location or configuration of the atoms. See the Resonance Theory of Dyes.

Retinal—The simple aldehyde of Vitamin A. Peak isotropic spectral absorption at ~330 nm.

Retinal disparity—The geometric angular difference at the eyes between any object in the visual field and the point of fixation. Separable into horizontal (lateral) and vertical components.

Retinene—The simple aldehyde of Vitamin A (also known as retinal)

Retinula—The photoreceptor cell(s) at the base of an ommatidium, forming the rhabdom.

Retinochrome—non-signal related but possibly photosensitive pigments frequently found in the interstitial spaces between rhabdom(ere)

Retonic Acid—Vitamin A acid.

Retinoids—Definition has and is still evolving. First used in the 1960's informally for the natural forms of retinol. Formally defined in 1976 by Sporn et. al. to broaden the term beyond the vision and nutrition aspects to include potential biologic and mechanistic relationships between metabolites of retinol and steroids. The IUPAC-IUB (1982) Joint Commission on Biochemical Nomenclature stated that: "Retinoids are a class of compounds consisting of four isoprenoid units joined in a head -to-tail manner." In 1994, Sporn & Roberts (1985) suggested the much broader definition of a Retinoid as any substance that: "can elicit specific biologic responses by binding to and activating a specific receptor or set of receptors, with the program for the biologic response of the target

cell residing in the retinoid receptor rather than in the retinoid ligand itself.

Retinol--Vitamin A. Peak isotropic spectral absorption at ~370 nm. No significant absorption in the visible spectrum

Retinotopic--Exhibiting a topographic organization showing a geometrical relationship to the retinal surface. Such an organization is not directly related to the geometry of object space over large areas. See also visuotopic

Reyem's loop--The fluted champagne glass like arrangement of the axons leaving the ganglion cells of the retina as they converge on the lamina cribosa. Action potentials travel relatively slowly over these unmyelinated sections of axons. Their length introduces a variable time delay that provides a conversion of a spatial encoding to an equivalent temporal encoding. See its complement, Meyer's loop.

RBP--Retinoid-Binding Protein, a generic descriptor. Archaic: Retinol-Binding Protein. The material exists in a variety of forms at different locations within the body. Some of the forms are still speculative.

LRBP--putative form found in the lacteals of the lymph system and in the liver.

CRALBP-- form found in the RPE and believed to transport chromophores from pigment granules to the cell wall at the IPM interface.

CRBP--form found in the RPE and believed to transport chromophores from the blood interface to storage within pigment granules.

IRBP--form found in the IPM and used to transport chromophores from the RPE interface to the surface of the disks

PRBP-- form found in blood plasma and used to transport retinol from the liver to the RPE interface, in conjunction with TTR

SRBP--Alternate, and more specific label for PRBP. The RBP is probably one of the globulin proteins which makes up 38% of the total protein in plasma.

RGC--Retinal ganglion cells

Reverse genetics--The determination of the relevant genetic mutation based on the prior observation of the medical symptom or syndrome.

RSC--reverse saturation current. A fundamental electrical parameter of a diode indicative of its current carrying capacity as a function of voltage.

Rhabdom--The sensory assembly in the compound eye, consisting of a cylindrical structure illuminated from the end, frequently exhibiting a ciliary internal structure consisting of the rhabdomere (Outer Segments) of 1-15 (individual) photoreceptor cells (Stavenga, pg 30 & 283). Also used to describe a similar assembly in the complex eye of *Mollusca*. There are two types, the open and closed rhabdoms. Looking along the line of incident radiation, the open rhabdom (primarily in *Mollusca*) exhibits a series of small areas of chromophoric material that are arranged in a circle and isolated from each other. The closed rhabdom (primarily in *Arthropoda*) has larger areas of chromophoric material that are interleaved.

Rhabdomere--A dense microvillous structure carrying the photosensitive pigments associated with a photoreceptor cell in *Arthropoda* and *Mollusca*. Frequently radiating, sometimes bilaterally, from a central structure.

Rhesus monkey--(*Cercopithecoidea macacus*) An "old world monkey" widely used in visual research. Not sufficiently similar to man to be used in detailed topological and topographical studies of the cortex. See monkey.

Rhinencephalon--See Limbic System.

56-Processes in Animal Vision

Rhodonine()--A family of visual band chromophores prepared from Vitamin A aldehyde (retinene) through the addition of a second auxochrome using a single bond at carbon position 5, 7, 9 or 11 (using the Kramer notation for retinoids). The numeric in the parenthesis indicates the number of vinylene residues between the auxochromes; 2 for the UV chromophore, 3 for the Blue, 4 for the Yellow and 5 for the Red chromophore.

Rhodopsin--A conceptual compound proposed as the principle chromophore of vision with a peak isotropic spectral absorption at 500 nm. First proposed by Boll in 1876 as the photosensitive element of the rod pigment. Further elucidated by Kuhne during the following year. Investigated intensely by Wald and associates in the 1930-50's. They postulated a large molecule consisting of the 11-cis form of retinene combined with the protein Opsin. It has been proposed that the junction involves the epsilon nitrogen of the lysine group (lys-296) of Opsin in a protonated Schiff-base linkage. Never demonstrated. The peak absorption at 500 nm. is actually obtained in two situations. By smoothing the composite absorption function known as the luminous efficiency function or by measuring the isotropic absorption of a wide variety of retinoids in dilute solution. Neither situation records the absorption characteristic of a visual chromophore.

Ribosomes-- Seat of protein synthesis within the cell. Uses amino acids provided by the mitochondria.

Ricco's Law-- For small areas of the retina, a constant (psychophysical) effect is achieved for a constant product of area and illumination.

Riddoch Syndrome--See Blind sight.

Ringer solution--A man made aqueous solution of the chlorides of sodium, potassium, and calcium that is isotonic to animal tissue (but species specific for accurate scientific work) and is used topically as a physiological saline and, in experiments, to bathe animal tissues. Unless specifically modified by an investigator, it contains no nutritional or metabolic components.

Rivalry-- The commonly observed situation (under laboratory conditions) where the visual system will continue to change from one perception of a dichoptic scene to another because of the difference between the two images provided.

Rods--1. A morphological descriptor terminating a continuum used in vision research. The continuum extends from a cone shaped structure on one end to a rod shaped structure on the other. This continuum was first used to describe the outer segment of the photoreceptor cell. However, this proved unworkable and it was later applied to the shape of the inner segment without regard to the shape of the outer segment. This approach was also unworkable.

2. A term previously used to describe the broad spectral photoreceptor of the eye responsible for the scotopic spectral characteristic of vision. Subsequently it was found that there are "blue" sensitive, "green" sensitive and "red" sensitive rods; and none of them exhibit a spectral absorption that correlates with the scotopic spectral characteristic of the human eye.

3. The term is archaic . It is not used in this work in a scientific sense.

Rostral--Anterior

S-glutamate-- glutamate specified using a "right-hand rule" of chemistry. Similar to the notation L-glutamate. Both S and L denote the "sinister" left-handed convention, but in slightly different contexts.

S-Plane--An early name for the region of the retina (more recently described as the inner nuclear layer) where bipolar waveforms were first found that exhibited a hyperpolarization at certain wavelengths and a depolarization at others. Now further differentiated into the Outer lateral, Outer Plexiform, Inner nuclear, Inner plexiform, and Inner lateral layers.

S-potential--A sustained response found in the layers between the photoreceptor and ganglion layers, name generally associated with Svaetichin and with Tomita but may be from Motokawa. The S-potentials frequently exhibit chromatic characteristics.

Saccades--Motions of the eyes independent of the head. These motions can be subdivided into three classifications, large, small and microsaccades. Microsaccades are the manifestation of the tremor mechanism. Some writers use the terms fast and slow which correspond to large and small respectively because of the impulse nature of the oculomotor mechanism.

1. Large saccades; a sharp rotation of the optic axes characterized by an almost identical movement in both eyes and a high velocity. The angle of rotation ranges between 2-5 minutes of arc to over 20 degrees. The maximum velocity reached in a 20 degree saccade can be 450 degrees/sec. The time of a large saccades ranges from 0.01 sec to 0.07 sec. (Yarbus, pg 146). More recent authors give a maximum angle of up to 90 degrees (beginning from an offset), a rate of over 600 degrees/sec. and a maximum duration of 0.260 sec. (Baloh, et. al.).

2. Small saccades; the observable motion of the eyes as they analyze a scene such as a face. The line of sight jumps from one feature in the scene to another. The maximum angle is below that of the large saccades but the angular rate is similar.

3. Flick, the small saccadic motions of the eye, less than 1 degree, when reading text or studying similar fine details. Used to reposition the eye from one letter to another.

4. Microsaccades, the very fine motion of the eyes during the collection of detailed information by the foveola. This motion has a frequency spectrum from 30 up to 150 Hz. The amplitude of the motion is usually 20-40 arc seconds in object space (one or two photoreceptor diameters in image space). See also tremor.

Saccadic latency-- The interval between the change in a test stimulus and the initial movement of the eyes to realign the line of fixation to the new location.

Sagittal--like or related to an arrow

Sagittal plane--

1. *Zoology* A longitudinal plane that divides the body of a bilaterally symmetrical animal into right and left sections
2. *Optics* A plane perpendicular to the meridional (a tangential) plane and containing the chief ray.

Saliency engine--A higher level mechanism in perception that provides the addresses of pieces of perceived information that must be considered as a group to achieve cognition. The various vectors, relating to the perceived information, when grouped act as individual bytes in the overall cognition vector describing the recognized event.

Saliency Map-- The general database employed by the cortex as a archive of all sensory information collected during the life of the subject. Highly associative. Not generally re-writable except under instruction from the controller following significant cognitive processes calling for such a change.

58-Processes in Animal Vision

Saliency spreadsheet--A putative collection of high level cognition vectors (or series of addresses to lower level perception vectors) that constitute the basis of cognition. The vectors are encoded and exhibit no direct relationship with the geometry of object space. See Saliency map.

Saltatory--Proceeding by leaps rather than by smooth transitions

Saponification--The hydrolysis of glycerides. The hydrolysis yields salts of the carboxylic acids. Almost certainly a destructive process when related to isolation of vision chromophores

Scanning Sensor--Any sensor system which senses differences in the signal presented to the sensing element as a continuous function of time. If physical motion of the line of sight is involved, the sensed signal may represent spatial changes in the scene.

Scene element disparity-- Distance, in three dimensional coordinates, between a point in object space and the point of fixation within that object space. Sometimes separated into longitudinal and lateral components. The lateral component is sometimes separated into horizontal and vertical components. See **retinal disparity**.

Schematic--A structural or procedural diagram, especially of an electrical or mechanical system.

Schematic Eye--A simplified model of the optical system of the eye; consisting of only two principle points and two principle planes. Only useful for the on-axis, small field angle case.

Schiff-base--A reversible reaction between an aldehyde and the alpha-amino group of an amino acid releasing water and resulting in the replacement of the double bonded oxygen with a double bonded nitrogen of the amino acid. A very labile product. Also known as an aldimine. An alternate form involves a single bond between the nitrogen and carbon 15 of the retinoid. It is defined as a secondary amine. These forms are characterized by their ability to shift from an acid to a base depending on the ph of their environment. (Stavenga, pg 115--Davson pg 243-244) (-C=N-), prefix azo-. This is a characteristic of the indicator family of chemicals. A third form consists of a double bond between the nitrogen and the carbon but with an extra proton attached to the nitrogen. This is described as a protonated Schiff-base. It shows a bathochromic shift in its absorption but not enough to match the absorption of any visual chromophores. (Summary by Stavenga & Schwemer in Ali)

Schwann cells-- The name given for one class of glia found within the PNS. Similar cells within the CNS are called astrocytes. Appear to provide additional lactate for use by the neurons at the remote locations of Nodes of Ranvier.

Scission--To cut, frequently along an intensity level or a chromatic contour in psychophysics

Sclera--The outer covering of the eyes to which the muscles are attached.

Scotoma--An area of less than nominal perception of vision within the visual field, surrounded by an area of less depressed or of normal vision. The scotoma need not involve the photoreceptors or the physiological optics.

Scotopic--(Adjective; Gk, *scotia*-darkness, *topis* place)

Scotopic Vision--Vision at very low levels of luminance (in humans) that is characterized by visual acuity that is limited by internal threshold conditions. Typically at light levels below twilight and characterized by the nominal loss of color vision.

Second breakdown—A term in the vernacular of transistor electronics referring to a breakdown in performance due to avalanche multiplication of the current within the collector region of the transistor. Usually leads to the thermal destruction of high power transistors used as regulators.

Self-screening-- Or correction for self-screening. An archaic concept found in the vision literature based on an approximation associated with the absorption of light by low molar concentration materials in true solutions. Its purpose was to avoid using a very simple equation derived with the Calculus. It ignored the fact that activated molecules became transparent. Generally not appropriate for research in the actual visual process. See Section 5.2.3.3.1 or Wyszecki & Stiles, 2nd. pg 588-589.

Semantics

1. *Linguistics*. The study or science of meaning in language forms.
2. *Logic*. The study of relationships between signs and symbols and what they represent. In this sense, also called *semasiology*.

Sensillum— A hair

Serif—A small decoration(s) added to the characters of a type face to enhance its legibility and general attractiveness. San serif is the trade terminology for “no serif.”

Shaker (*Drosophila Shaker* or *Shaker mRNA*)— A modified gene of *Drosophila* that ostensibly modifies the operation of activation and inactivation gates in neural lemmas. It has been isolated and inserted into other species in the laboratory. (Hoshi, 1990)

Sholl Diagram—A formalized tree structure (using only orthogonal lines) to describe the lengths of individual dendritic segments ramifying from a single soma. Used in Rapp, et. al. 1992.

Sigmoidal—*Anatomy*, curved in two directions; shaped like the letter S or the letter C. Generally an S shaped curve in the vision literature. In the absence of added noise, a smooth transition (no discontinuity) between a sigmoidal curve and a baseline is not compatible with a first order physical system.

Signal transduction—

1. (with respect to the hormonal system) An intracellular cascade of biochemical event that follow the interaction between extracellular growth factors and their membrane receptors, ending in the switch of nuclear mechanisms controlling the proper biological responses. (Battistini, et. al. 1993 in Papa & Tager)
2. (with respect to the sensory mechanisms of the neural system) The transfer of acoustic energy, electromagnetic energy or tactile motion by quantum-mechanical sensors into free electrons that can be further processed by the neural system.

“Silent substitution”—Not a concept supported in this work. Used widely in colorimetry to account for the unaccounted. See Flitcroft for an explanation and background, *Vision Res.* vol. 29, no. 3, pp. 349-360, (1989) Also used in spectrometry to substitute a stimulus at one narrow band wavelength with a second having the same stimulus capability with respect to one spectral channel while having a different stimulus capability with regard to another spectral channel. (Kulikowski, et. al. pg 175-177) Very difficult to insure adequate results due to the logarithmic signal processing with regard to the R-channel (luminance). Method frequently impacts the perceived chrominance in ways not accounted for by the investigator.

Simulation— The process of preparing and plotting the performance of an *equation* or assembling and running a *computer program* designed to describe the performance characteristics of a prototype.

Sinc function—An expression occasionally used to define the $(\sin \alpha)/\alpha$ function, one basis for the MTF function.

60-Processes in Animal Vision

Sine qua non– An essential element, condition or prerequisite

Single Lens Compound Eye–A transitional type, found in some insects, between a superposition type of compound eye and the simple eye of animals.

Singular value decomposition–A powerful tool in matrix algebra for studying the properties of a set of equations near a singularity. <http://kwon3d.com/theory/jkinem/svd.html> provides a quick overview. A more detailed and complicated discussion is in <http://public.lanl.gov/mewall/kluwer2002.html> . The latter discussion includes PCA, Principal Component Analysis.

Sink–In electronics, an absorber of electrical energy. In electronic circuits, a negative terminal of a power supply.

Smectic– The name given to a structural phase (molecular organization) of the liquid crystalline state of matter. The molecules are arranged side by side in a two dimensional film. The films may be stacked in layers.

Smith Chart– A graphical presentation plotting the reactance and resistance of a circuit parametrically as a function of frequency.

Snowy vision– An aura characterized by the appearance of fine randomly flashing dots scattered widely over the full field of view of the subject. Their visibility is highly dependent on the contrast of the scene. The dots appear predominantly as darker dots on any uniform background. This is also the case in pitch darkness due to the AC coupling used in the visual system.

Sodium channel– The vernacular name for the electrical channel from the axoplasm to the INM via the Activa and the podaplasm of a neuron. The name has commonly been used previously in the literature to describe the putative channel through the axolemma used by sodium ions or sodium ions complexed with other materials.

Sodium ion current– In the vernacular, a current proposed by Hodgkin & Huxley to account for the rising phase or positive going phase of an action potential, or other depolarizing process associated with the axoplasm of a neuron. This current is actually the conventional current moving from the podaplasm to the axoplasm of the electron-based current moving from the axoplasm to the podaplasm via the Activa of a neuron. See Inward current.

Solution– A mixture (normally in liquid form) of two or more constituents that cannot be separated by filtration or settling and which can be formed with the constituents in any proportion (down to molecular sizes). See also suspension and gel. Not susceptible to changes in temperature or pH.

Soma–The portion of a cell that contains the nucleus and other metabolic elements and in the case of the neuron, encircles portions of the neurites and axon of the neuron.

Somatosensory–Of or related to the sensors of the skin.

Source–In electronics, a supplier of electrical energy. In electronic circuits, a positive terminal of a power supply.

Space clamping–In loss analogy to voltage clamping, the concept of insuring the electrical uniformity of a piece of axolemma by the process of limiting the region of axolemma explored using electrical barriers.

Spectra–See Absorption spectra, Difference spectra, Spectral absorption curves and Spectral response curves

Spectral absorption curves--A graphical presentation based on spectrophotometric measurements on material extracted from a retina after a standardized but poorly understood separation process. The tests are designed to provide in-vitro measurements of chromophore like material that is no longer in the liquid crystalline state and which has been subjected to detergents, surfactants, and various complex sodium based salts. The resultant absorption curves are usually due to a (unknown) mixture of materials (chromophores, retinachromes and other materials), frequently exhibiting a peak near 500 nm. which is most likely the intrinsic (as opposed to the resonant) spectral peak of the dominant constituent.

Spectral Luminous Efficiency Functions--The functions describing the perceived (psychophysical) spectral response of the subject under one of two standardized conditions.

1. Photopic luminous efficiency function. Occurs in two forms,
 - $R(\lambda)$, the precise form which agrees with the theoretical model of the visual process and is obtained in practice using a spectral filter width of 10 nm or less.
 - $V(\lambda)$, a smoothed version of the theoretical function using a 30 nm spectral width window that is represented by the CIE 1924 Standard Observer.
2. Scotopic luminous efficiency function. Occurs in two forms,
 - $R'(\lambda)$, the precise form which agrees with the theoretical model of the visual process and is obtained in practice using a spectral filter width of 10 nm or less.
 - $V'(\lambda)$, a smoothed version of the theoretical function using a 30 nm spectral width window that is represented by the CIE 1951 Standard Observer.

Spectral Opponency-- In neurophysiology, the neural mechanism that codes for hue contrast in the insect brain. In this work, synonymous with function of the horizontal cells of the human retina and similar differencing cells throughout *Arthropoda* and *Mollusca*, not just in insects.

- Spectral response curves**--
1. The basic graphical presentation of the *electrophysical* response of any single type of complete photoreceptor mechanism to a varying monochromatic stimulation.
 2. . The basic graphical presentation of the *electrophysical* response of any neuron cell in the retina, typically one of the amacrine type, to a varying monochromatic stimulation
 3. The basic graphical presentation of the *psychophysical* response of any overall retina, generally as a function of location on the retina, to a varying monochromatic stimulation.

Speed of Sound-- in air, 343 meters/sec. In fresh water, 1435 m/sec. In salt water, 1500 m/sec. In steel, 5100 m/sec.

Spherule--term frequently used to describe the terminal of an axon, particularly of a photoreceptor cell axon. See pedicel.

Sphingomyelin-- a phospholipid material quite closely related to phosphatidyl choline, PC (while it contains phosphocholine as its "head," it differs stereo-chemically from PC). This material is found primarily in brain and nerve tissue.

Spines--Fine structures protruding from the limbs of a neuritic arborization. See Stuart, et. al. Some sources suggest the spines are mobile and may be a mechanism supporting the development of memory. See Yuste. A

62-Processes in Animal Vision

similar feature, known as filopodia when extending from the axon and myopodia when extending from muscle tissue, is found in the synapse related to the neuromotor system. See Rowell.

Stellate ganglion– A ganglion with the individual neurons radiating from the cluster in a starlike pattern.

Stenohaline– Referring to an animal that remains in a marine environment throughout its life.

Stereochemistry–The study of the physical alignment of a molecule relative to its various internal groups. There are at least two sets of nomenclature in use. The terms *syn-*, *cis-*, *trans-* & *anti-* all play a role in one of these sets when describing a molecule at a detailed level.

Stereopsis–The process of extracting distance information from visual images. The process is implemented through two mechanisms. The most commonly discussed mechanism is limited to short distances. It involves the determination of the parallax angle between the images formed by a binocular system and calculating the distance to the scene element by geometry. The second method is suitable for determining larger distances. It involves introducing motion between the line of sight of the visual sensor and the scene and determining the different apparent rates of motion of scene elements. From these calculations, relative distances can be deduced. The precision of this method can be quite high. This method is most easily employed while moving in an automobile or an airplane. It is observed most clearly in the motions of the head of the cobra snake before striking..

Stereopsis–Used variously over time.

1. An older concept: The process of merging the two images, acquired by the eyes from different points in space, into a useful image by eliminating the parallax and obtaining distance cues. See Hubel (1988)
2. A higher precision concept separating binocular vision from stereopsis: The mechanism within the POS that merges the two images from the foveola of the two eyes. The mechanism results in the phenomena of fusion and depth perception. These phenomena are degraded by vertical disparity.

Tyler takes a narrow view and claims stereopsis is observed under and is independent of the conditions of both fusion and diplopia. (S & C pg 200) Ogle differed and defined the following:

Patent stereopsis– Stereopsis within a range of up to 10 minutes of disparity, roughly aligned with the range of fusion.

Qualitative stereopsis– Between 10 and 15 minutes of disparity, where subject still perceives relative depth position but without veridical relationship.

Stereospecific reactions–

1. Reactions that only occur when specific stereographic relationships are obtained between a reactant and a substrate.
2. Reactions that result in a specific stereoisomer depending on the substrate used to support the reaction.

Stereotaxy– Obtaining measurements of the surface of a structure in three dimensions.

Strabismus– An anomaly of binocular vision in which the visual axis (line of fixation) of one eye fails to intersect the object of interest. Hence, a pathological failure of the two eyes to converge on a given target in the visual field. Found in horizontal, vertical and torsional situations. Strabismus is classified according to the direction of

misalignment. When one eye is looking straight ahead, the other eye may turn inward toward the nose (esotropia or convergent), outward toward the ear (exotropia or divergent), downward (hypotropia), or upward (hypertropia).

Strehl ratio—Two common variants that are often confused.

1. Strehl definition—The peak value of the diffraction pattern of an aberrated point image divided by the peak value of an aberration free point image for the same system.

2. Strehl resolution—The volume under a two-dimensional MTF of an optical system divided by the equivalent volume of a perfect (aberration free) system with the same aperture (if computed in angular space) or $F/\#$ if at a focal plane.

Substantia nigra—A layer of deeply pigmented gray matter situated in the midbrain and containing the cell bodies of a tract of dopamine-producing nerve cells whose secretion tends to be deficient in Parkinson's disease

Substrate—Used variously.

1. Biology, the molecule on which an enzyme exerts catalytic action.
2. Surface chemistry, the surface upon which reactants accumulate and react.

Sucrose gap chamber—A three chamber test cell used by Bowe, Kocsis & Waxman to isolate and superfuse distinct parts of a neuron during *in-vitro* electrophysiological testing.

Sulcus—Small fissure or furrow on the surface of the brain

Superior colliculus—See Tectum

Superfuse—To surround a cell with a liquid, frequently disturbing the coatings on the surface of the cell. See also perfuse

Superposition Eye—A compound eye wherein the ommatidia are not optically isolated. Anatomically, these eyes are characterized by the presence of an un-pigmented space separating the optical array from a much deeper-lying retina of rhabdoms. (Stavenga, pg 50)

Supervisory circuit—A circuit paralleling a data circuit(s) that defines the accuracy and possibly the integrity of the signals in the associated data circuit

Suprathreshold—Used generically to define a luminance level significantly above threshold. Frequently used to describe a state where the absolute noise level (relative to a given integration area) is higher than at the threshold level (irresardless of the change in average photon flux level).

Suspension—A mixture (usually in liquid form) that can be separated into its individual constituents by filtering, settling, a change in pH or temperature, or through spontaneous aggregation of one or more of the constituents. Usually exhibits scattering of light due to the presence of large aggregates with a size similar to the wavelength of the light.

Sympathetic nervous system—That portion of the nervous system responding to the will of the individual. Related primarily to the peripheral neuromotor system but including aspects of the oculomotor system.

Synapse—From the Greek, meaning to come face to face with or to join. A specialized site of functional interaction between morphologically defined neurons. The area in the immediate vicinity of the synapse is critical to the operation of this feature.

64-Processes in Animal Vision

Synaptic gap—The narrowest region between the axon and neurite of two neurons. Generally under 100 Angstrom wide and filled with hydronium in a liquid crystalline state, thereby forming the base of an Active. The area within the gap is usually filled with an orderly array of unit synapses with a spacing of about 100 Angstrom.. Each unit synapse is approximately 200 Angstrom in diameter.

Syncytium—(sin-sish'-e-um) A multinucleate mass of protoplasm resulting from a fusion of cells or from a failed subdivision of cells.

Syndrome--1. A group of symptoms that collectively indicate or characterize a disease, a psychological disorder, or another abnormal condition.

2. a. A complex of symptoms indicating the existence of an undesirable condition or quality. b. A distinctive or characteristic pattern of behavior

Tapetum--A layer of cells located behind the retina, relative to the direction of the incident light, in many animals. In many cases, this layer exhibits a high coefficient of reflectance. In some cases, the reflectance is variable with illumination level or other parameters. Also known as argentea.

Taxonomy— The orderly classification of plants and animals according to their presumed natural relationships

Tectum—The roof of the midbrain consisting of the paired superior and inferior colliculi in mammals. A portion of the midbrain focused on the initial extraction of visual signals and the generation of precision motor responses.

Tegmentum— The neural pathway immediately dorsal to the combined pons and medulla of the brainstem (Noback, 1967, pg 4)

Teleology--1. *Philosophy.* The study of design or purpose in natural phenomena.

2. The use of ultimate purpose or design as a means of explaining natural phenomena

Teleostat-- “Bony Fish” of the Superorder Teleostei, Class Osteichthyes, Phylum Chordate

Temporal--The side of the retina farthest from the nose

Tetartanopia--Rare form of dichromatism in which blue and yellow are confused, but luminosity is approximately normal (The Science of Color)

Tetrachromats--Animals which employ photoreceptors containing four different color chromophores, known to include some insects, reptiles and fish; and able to sense the “red”, “green”, “blue” and “ultraviolet”.

Tetrodotoxin—(TTX) A guanidinium toxin from the ovaries of the globe fish (puffer fish), *Spheroides rubripes*. Used in pharmacological studies of the neural system.

Thalamus--1. *Archaic Anatomy:* A large ovoid mass of gray matter situated in the posterior part of the forebrain that relays sensory impulses to the cerebral cortex.

2. *Anatomy:* Either of two large, ovoid masses, consisting chiefly of grey substance, situated one on each side of and forming part of the lateral wall of the third ventricle. Each is divided into two major parts: dorsal and ventral, each of which contains many nuclei.

3. *Colloquial*: The inner chamber. Part of a very complex area between the top of the spinal cord and the proliferation of the cerebral cortex. Easily looked upon as a mere switching point but clearly performing significant signal manipulation within its numerous individual engines.

4. *Neuroscience*: The primary control center, and highest level signal integration and coordination center for the visual and other sensory systems of the organism.

Thevenin's Theorem—A useful theorem in electrical engineering that demonstrates the equivalence of a simple series circuit of two elements with an equivalent parallel circuit of two different elements.

Timbre (pronounced "tambur") 1. The quality of a sound that distinguishes it from other sounds of the same pitch and volume. 2. *Music*. The distinctive tone of an instrument or a singing voice.

Time-dependent rectification— or *delayed rectification*. The effect where the resistance of the membrane as measured with steady currents varies as the magnitude of the current is varied, but following a sudden change in this magnitude the new steady state value for the resistance is not achieved immediately (Taylor, pg 224).

Tocopherol— (commonly known as Vitamin E) A compound containing a hydroxyl-bearing ring system and a single isoprenoid side chain.

Tonic—**a.** *As used in Physiology*. Of, relating to, or producing tone or tonicity in muscles or tissue: *a tonic reflex*.
b. Medicine. Characterized by continuous tension or contraction of muscles

Topography—The study of the location and arrangement of the parts of a structure without regard to their interconnection. See topology.

Topology --**1.** The study of the relationships between different elements of a structure
2. *Medicine*. The anatomical structure of a specific area or part of the body.
3. *Electronics*. The description of an electrical circuit in terms of its elements and their interconnections.

Trabecular meshwork—The truss work between the ciliary muscle and the lens of the physiological optics.

Traffic analysis— A term used in military intelligence and applicable to uncovering the interconnections found within the neural system. Generally, the observation of signals emanating from or arriving at a given location and relating them to other terminal locations.

Transamination—Exchange of NH_3 and O among reactants, particularly those associated with the Krebs cycle.

Transducin—A G-protein proposed in the literature to be activated by rhodopsin in conjunction with rhodopsin kinase. [Crouch 1996] It is a material found in the glutamate cascade theory of photodetection

Transduction—See Signal transduction.

Transistor— A three terminal solid state semiconducting device that achieves electrical gain (amplification) when biased properly. Announced on 30 June, 1948 by Bardeen, Brattain & Shockley. See also Activa.

Translation—Creation of a free electron within the signal channel of a dendrite connected to the neuron located within the IS of the photoreceptor cell as a result of the de-excitation of an excited electron in an adjacent chromophoric layer of the OS

Translucent—Transmitting light but causing sufficient diffusion to prevent perception of distinct images

66-Processes in Animal Vision

Trans-metameres--Any two surfaces that cause the same (P,Q) values to be perceived and interpreted by the cortex when illuminated by the same source, are defined as trans-metameres in object color space.

Tremor-- The arc-second to arc-minute level motions of the eyes of *Chordata* and some higher members of *Mollusca* designed to provide an analytical capability to the visual system. Also described as physiological tremor or oculomotor tremor. This tremor is not related to the term "essential tremor" as applied to the postural system. The amplitude of the tremor is the most important parameter. It is reported to be 20-40 arc seconds in Man (corresponding to one or two photoreceptor diameters in the fovea). The frequency in Man is difficult to measure, the data ranges from 30-90 Hertz with reports to 150 Hertz. The tremor can be factored vectorially into vertical and horizontal components. The waveforms of the components are indicative of the POS servo system analyzing the object at the center of the foveola. See also saccades.

Trichromats--Animals which employ photoreceptors containing three different color chromophores; known to include two separate classes, those able to see in the "red", "green" and "blue" and those able to see in the "green", "blue" and "ultraviolet".

Tritanopia--Form of dichromatism in which blue and yellow are confused and relative luminosity of blue is much lower than for normal vision (The Science of Color)

Troland--A measure used primarily in psychophysical experiments. It is the product of the illumination in candles per square meter times the area of an artificial pupil with an area of one square millimeter. It is frequently erroneously described as the retinal illumination. However, it does not include the square of the F/# of the optical system required to properly calculate the illumination on the retinal surface.

Troxler's Fading-- (Used without definition by Kremers, Stepian, Scholl & Saito 2003)

TTR-- Plasma transthyretin, also known as plasma prealbumin. Used in the transport of retinol from the liver to the RPE of the retina.

TTX--See tetrodotoxin

Tubule--In the glandular context, the pocket like structure formed by the glandular cell wall and opening on the external surface of the cell or a group of cells.

Tunnel mechanism-- A quantum mechanical phenomenon where the wave function of a conduction band electron on one side of an insulator extends to the other side. The electron can disappear and reappear on the other side of the insulator in a mechanism called tunneling.

TvC--Threshold versus (generally external) contrast.

Two-exciton excitation--Analogous to two-photon excitation in two-photon microscopy (see below). The process where two excitons are used to accumulate energy within a quantum-mechanical material before the summed energy is transferred to a second material.

Two pathway theory--The concept that there are only two primary signaling pathways in the cortex radiating from the primary visual cortex, V1. The concept is not supported in this work. See Duplicity Theory.

Two-photon microscopy--Actually a method of exciting a material that is subject to fluorescence. The material is

illuminated by a laser source of one-half the wavelength needed to photo-excite the molecule. Energy summation within the excited molecule leads to fluorescence that can be photographed. Very useful in recording very fine detail such as the arborization of a neuron. See Yuste. Also Berns @ UCI.

Ultra- prefix

1. Beyond; on the other side of: *ultraviolet*.
2. Beyond the range, scope, or limit of: *ultrasonic*.
not specific as to which side of a range; see micro--

Ultra-low wavelength colors– A term in the vernacular to describe the colors associated with the O-channel, 400 to 437 nm. See also low wavelength and high wavelength colors.

Uncrossed Disparate– A descriptor for a scene element located outside the Vieth-Muller circle. It has a smaller target vergence than the point of fixation. Equivalent to the term divergent when discussing relative disparity. See also crossed disparate.

Unit synapse– See Synaptic cleft.

Univariance Principle–*Archaic* Each visual pigment can only signal the rate at which it is effectively catching quanta; it cannot also signal the wavelength associated with the quanta caught (Naka & Rushton, 1966 pg 538). This is only partially true with respect to the L-channel of vision. See **Section 11.1.1**.

Uvea–The vascular tunic of the eye, generally synonymous with the choroid. Sometimes used to describe the choroid, ciliary body and iris as a group. Named for the similar visual pattern of the posterior iris to the uva grape (of latin origin). Enclosed by the sclera.

Vector– A coded multidimensional signal incorporating multiple values derived from multiple sensory or cognitive sources (possibly over a time interval).

Ventral–synonymous with inferior

Ventricle–A small cavity, especially in the heart or the brain

VEP–*Visual Evoked Potential*; A gross measurement using electrodes external to the eye, frequently using a location on the scalp as a voltage or current reference point

Vergence– The disjunctive rotation of the eyes to obtain a fused image of an object within the stereoscopic field of view of vision.

Target vergence– the angle between the lines joining the center of rotation of each eye with the target stimulus.

Eye vergence– the angle between the fixation lines of the two eyes at a given time.

Accommodative vergence– vergence angle assumed by the eyes in response to a well-illuminated target in object space. Performance degrades under reduced illumination. (S & C pg 32)

Dark vergence– (see Tonic vergence).

Morbid vergence– vergence angle following death or under heavy sedation

Tonic vergence– vergence angle assumed with the eyes open but in the dark. The quiescent state.

Disparity error – the difference between target vergence and eye vergence under operational conditions. In closed-loop operation, the residual error between target and eye vergence.

Accommodative vergence–(S & C pg 101 & 114)

Proximal vergence– initial vergence assumed based on knowledge of the distance to the target.

Nominally the vergence stored in the saliency map of the subjects environment and available as

68-Processes in Animal Vision

an initial condition.

Veridical– 1. Coinciding with fact or reality; genuine or real (Used in psychophysics).
2. Used infrequently to describe the condition where, if the distance of an object at zero disparity is perceived at its true distance, then the change in distance for a given disparity is also correctly perceived. (S&C 238)

Vermis– median lobe of the cerebellum Believed to be involved in the interpretation of image information extracted by the pulvinar within the POS. If correct, it can be described as a trainable long term memory and comparator for the interpretation of primitive graphic patterns associated with higher level recognition within the cerebral cortex..

Version– The conjunctive rotation of the eyes, generally used to cause the line of fixation to pass through the location of an object in the field of view.

Vesicles–Small, generally spherical bodies found in greatest density near the terminal ends of neural conduits. Appear to play both an electrical and structural role. Electrically, they appear to be termini of reticulum running the length of the conduits as they branch at their ends. Structurally, they appear to play a role in establishing or maintaining the spacings involved in creating synapses or arrays of synapses within one larger synapse.

Vibrissal shaft– A hair

Villus–A minute projection from an exocrine gland. Generally proteinous; generally a hair.

Vinylene residue--A minimal conjugated carbon chain consisting of two carbons, (C--C==).

Visuotopic–Showing a topographic organization that is directly relatable to the corresponding geometry of object space. See also retinotopic.

Vitamin A--IUPAC-IUB (1982) states: “The term vitamin A should be used as the generic descriptor for retinoids exhibiting qualitatively the biological activity of retinol.” More generally, it is known as a fat soluble vitamin described chemically as retinol. Retinol is a lipid and can also be described as a fatty acid. It contains a long carbon chain ending in a carboxyl group. Depending on application, it can be described as:

1. Nutrition--A coenzyme
2. Physiology--A hormone
3. Dye Chemistry--The prototype of a group of retinoids
4. Vision--A chromogen of the chromophores of vision

There are three subtypes of the basic Vitamin A:

Vitamin A ₁ , the classic form described by retinol.	Found in saltwater based animals
Vitamin A ₂ , 3,4-dehydroretinol	Found in freshwater based animals
Vitamin A ₃ , 3-hydroxyretinol	Found in Diptera (flies) of <i>Arthropoda</i>

In nutrition, Vitamin A works as a *coenzyme* (biological catalyst) in conjunction with a protein moiety (*apoenzyme*) to form a *holoenzyme*.

In vision, Vitamin A (the retinoid) is adsorbed as a liquid crystal to a protein substrate (opsin), via hydrogen bonding, to form the historically conceptual material rhodopsin.

Vitreous humor–The gel-like material within the ocular cavity between the lens and retina. See Aqueous humor.

Von Kries adaptation–See adaptation. Von Kries adaptation uses differential adaptation among the spectral channels to achieve color constancy.

Voxel– The location of a cortical response, in Talairach coordinates to a visual stimulus, registered by fMRI techniques.

Young-Helmholtz Theory–The most prevalent name for the "Trichromatic theory" of color vision; Young first hypothesized the three photoreceptors to be red, yellow and blue (1801) but proposed red, green and blue a year later.

Warburg impedance– The impedance associated with the movement of ions within an electrolyte near the metal-electrolyte interface.

Wavenumber– The value given by the reciprocal of wavelength expressed in centimeters.

Weber's Law– Just noticeable increment of stimulus is a constant fraction of stimulus; based on work in the tactile sensations (The Science of Color) expressed as $\Delta L/L=k$ by Bartleson. [See Fechner's Law]

Warm-blooded– Endothermic

WGA-HRP– See Horseradish peroxidase

WKB–Wentzel-Kramers-Brillouin method– A phase integral method of approximation used in complex structural analysis. It makes an assumption that allows the separation of variables. It is considerably faster than competing finite element or finite difference computations.

Witterion–An amino acid in solution normally existing in a dipolar configuration but subject to the pH of the solution.

Xanthophylls–carbohydrates or oxygen containing hydrocarbons related to the carotenes. See Carotenoides

Young's Modulus–A fundamentally linear concept equal to the ratio of the tensile strain to the associated linear stress. In any isotropic solid, the modulus is a function of both the shear modulus and the bulk modulus.

Z- A shorthand notation replacing the term *cis-* in stereochemistry. See also **E-**.

Zebra pattern–In physiological optics a Moire pattern seen when using an interferometric technique to project narrow lines on the retina. Largely the result of interference between the projected lines and the photoreceptor array and the vascular structures of the retina.

Zoological classifications–The XV International Congress for Zoology adopted the following hierarchy.

Kingdom
 Sub-kingdom
 Phylum
 Subphylum
 Class

70-Processes in Animal Vision

Subclass
Superorder
Order
Suborder
Infraorder
Family
Subfamily
Tribe
Genus
Subgenus
Species
Subspecies