Word	Definition
12th Cranial Nerve innervation of tongue	Tongue muscles are innervated by axons of the hypoglossal nerve (XII).
1st Cranial Nerve	The most rostral cranial nerve: the olfactory nerve, consisting of axons of primary sensory neurons located in the olfactory part of the nasal epithelium that synapse with dendrites in the olfactory bulb on the same side.
4 Striatal-Pallidal Divisions	Larry Swanson has distinguished four striatal divisions, each projecting to separate pallidal structures, which in turn project to diencephalic and midbrain structures. In addition to the dorsal striatum and dorsal pallidum (globus pallidus), he describes a ventral striatum and pallidum, a medial striatum and pallidum (septal nuclei and nucleus of the diagonal band), and a "caudorostral striatum and pallidum" (striatal amygdala and the bed nucleus of the stria terminalis). Thus, these four divisions consist of dorsal somatic components (dorsal striatum and globus pallidus) and ventral limbic components.
5th Cranial Nerve	The most rostral cranial nerve of the hindbrain. It has three main branches, which gives it the name "trigeminal nerve." Its axons carry somatosensory information from the face and oral cavity to the trigeminal nuclei, which extend from the rostral hindbrain to the most rostral spinal cord. The 5th nerve includes a motor component from the masticatory nucleus of the rostral hindbrain. It controls the muscles of mastication (chewing).
5th Cranial Nerve innervation of tongue	Trigeminal nerve innervation of the tongue is necessary for somatosensory inputs that convey touch and pressure information.
7th Cranial Nerve innervation of tongue	In addition to carrying axons from the facial motor nucleus to facial muscles, and axons innervating salivatory glands, the 7th nerve innervates taste buds of the anterior tongue, in front of the vallate (circumvallate) papillae.
8th Cranial Nerve	The auditory-vestibular nerve, which enters the lateral part of the rostral hindbrain.
9th Cranial Nerve innervation of tongue	The glossopharyngeal nerve (IX) innervates the taste receptors of the tongue behind, and including, the circumvallate papillae,
Absolute Connectivity	Connectivity only between neighboring neurons in a structure.
Accessory Olfactory Bulb	A caudo-dorsal portion of the olfactory bulb that receives inputs from the vomeronasal organ

	(Jacobson's Organ) at the base of the nasal cavity, rather than from the olfactory epithelium. The structure is connected by a duct that opens in the roof of the mouth in many species. The vomeronasal organ responds to pheromones.
Accessory Optic Tract	Axons that leave the main portion of the optic tract and innervate small terminal nuclei, the nuclei of the accessory optic tract (dorsal, lateral, and medial). The neurons of these nuclei are activated by simultaneous and matching movements of all objects and contours in large parts of the visual field. The directions of movement correspond to the head movements to which the semicircular canals of the vestibular system are sensitive.
Accessory Optic Tract (AOT)	Optic tract axons that deviate from the course of the main optic tract and terminate in small cell groups in the midbrain. In rodents, these axons are found in three distinct groups. In other species there are 1-3 groups. The AOT axons carry information about movement throughout large receptive fields, as occurs during head movements.
Acetylcholine Inhibition (during sleep)	See "Cortical Neuromodulation during sleep."In the midbrain reticular formation, e.g., in the cholinergic cells of the midbrain locomotor area's pedunculo-pontine nucleus, acetylcholine inputs result in hyperpolarization (inhibition) of the neurons. Such inhibition can result from catecholamine activity. The neuromodulators ACh and NE are important in regulating changes in sleep stages.
Affective Tags	A shorthand descriptive term for a function of the amygdala, the formation of learned associations between perceived objects (including other organisms) and various emotional and autonomic responses to those objects, i.e., various feelings.
Agonistic Behaviors	Term used in ethology to refer to fighting, either aggressive or defensive in nature. It also includes various displays related to aggressive interactions among animals.
Agranular Cortex	Neocortical areas that have little or no layer 4. The most agranular area is area 4—the primary motor cortex. In the paralimbic cortex, areas can be granular or agranular.
Akinesia, hypokinesia, bradykinesia	Movement disorders often associated with pathologies of the corpus striatum and related structures. Akinesia is a lack of movement, as in an inability to initiate a new movement (which occurs in

	severe Parkinson's Disease). Hypokinesia is a greatly reduced amount of movement. Bradykinesia is abnormal slowness in the execution of movements.
Alar Plate	The dorsal part of the lateral wall of the neural tube, dorsal to the sulcus limitans in the ventricular surface. Most secondary sensory neurons are formed in the alar plate.
Alimentary Tract	The tube that forms during gastrulation in the developing embryo. It develops into the passage through the body that extends from the mouth through to the anus.
Allocentric Direction	A direction (in the horizontal plane) specified with reference to something stationary in the external environment, e.g., the earth's magnetic field or a visually detected landmark.
Allocortex	Cortex of the endbrain other than neocortex.
Alzheimer's Disease	A degenerative brain disease that causes gradually increasing dementia and memory losses. It is a common cause of dementia in older people. One cell group that usually degenerates is in the basal forebrain: the basal nucleus of Meynart. Neurofibrillary tangles (abnormal intracellular increases in the cytoskeletal protein tau) form within neurons in various parts of the cortex. Also, as cells die there is an increase in "senile plaques" formed by amyloid deposits. The disease rarely occurs in young people.
Amygdala	A structure of the limbic endbrain located in the temporal part of the cerebral hemisphere. It is a kind of "caudal outpost" of the ventral striatum. It is mostly a subcortical structure but it has a cortical nucleus that reaches the surface of the brain and receives projections from the olfactory bulb, mostly from the accessory bulb. It consists of a collection of cell groups or nuclei, some of which are derived from the embryonic striatum and others are derived from the pallium. The term means "almond"--in the human brain it has an almond shape, located near the anterior tip of the temporal lobe, in front of one end of the hippocampus. The amygdala is important in emotional, affective and visceral responses to objects, many of which are learned.
Amygdala	The amygdala (meaning the "almond") is an important structure of the limbic system located next to the temporal end of the hippocampus. It can be considered as a caudal extension of the ventral

	striatum but with several components derived from the embryonic pallium. The amygdala is subcortical except for its cortical nucleus.
Ansa Lenticularis	Literally the hook of the lenticular nucleus, the ansa lenticularis is a group of axons from the internal segment of the globus pallidus that passes through and around the edge of the internal capsule where it is becoming the cerebral peduncle, and courses rostrally into the ventral thalamus, ending in VL and VA, especially in the VA.
Anterior Commissure	A large bundle of axons, ventral to the anterior part of the corpus callosum, that interconnect structures on the two sides of the brain. It is located anterior to the diencephalon; the axons cross just below the septal area in the dorsal part of the basal forebrain. Many of the AC fibers pass from one olfactory bulb to the other; others interconnect the anterior portions of the temporal lobes.
Anterior Perforated Space (or anterior perforated substance)	The area at the base of the brain in humans anterior to the optic tract and caudomedial to the lateral olfactory tract which is penetrated by many blood vessels, branches of the anterior and middle cerebral arteries. These vessels supply the basal forebrain, corpus striatum and internal capsule. The area includes the olfactory tubercle.
Anterior Pituitary	The glandular part of the pituitary. This part is also called the adenohypophysis. It is connected with the hypothalamus by the bloodstream through specialized capillaries.
Antermedial Nucleus of the Thalamus (AM)	Receives inputs from the mammillary bodies and from the subiculum, and projects to anterior cingulate gyrus regions (infraradiata, frontal polar). It also projects in rats to visual area 18b, and also to perirhinal and adjacent subicular and entorhinal cortex.
Anterodorsal Nucleus of the Thalamus (AD)	The AD receives inputs from the mammillary body and from the hippocampus (subiculum), and projects to posterior parts of the cingulate gyrus—the retrosplenial cortex—and also to the subiculum.
Anterograde transport	Active (energy requiring) movement of an organelle or molecule down axons, usually from the cell body to axonal endings. Uses kinesin, a protein that acts as a molecular motor.
Anteroventral Nucleus of the Thalamus (AV)	Similar to AD in its inputs and projections (but the AV projects more to the presubiculum and less to more ventral parts of the subiculum).

Antidromic stimulation	Stimulation of axons that results in action potentials that travel in a direction opposite to the normal (physiological) direction. When such action potentials reach the cell body of the axon, the waveform contains no indication of a synaptic trigger, and thus a physiologist can discriminate antidromic activation of a neuron from synaptic activation.
Apoptosis	Cell "suicide" in which the cell dies from factors generated from within the cell, e.g., in response to a shortage or lack of trophic substances. Apoptosis is sometimes called programmed cell death, in contrast to necrosis that occurs due to traumatic injury.
Appetitive Behavior	Behavior that involves seeking for stimuli that trigger consummatory behavior. Appetitive behavior is the initial behavior triggered by high levels of a motivation. Appetitive behavior can lead to an instinctive action pattern that is part of a "fixed action pattern" (instinctive motivation and related actions).
Aqueduct of Sylvius	The narrowed ventricle that passes through the midbrain.
Arachnoid Space	Synonymous with "subarachnoid space"
Arbor Maturation	The final period of development of an axon when the end arbors undergo changes in synapse distribution and appearance.
Arborization	The formation of tree-like branching by a growing axon, or the branching structure formed by such a process. Such structures are where synapses are made by an axon, usually on neuronal dendrites and cell bodies.
Archetypal Embryonic Stage	An embryonic stage that resembles a proposed ancestral state from which later evolving forms are derived.
Archistriatum	An older term for the avian arcopallium, a structure of the caudal endbrain that is like the mammalian amygdala in its orgins and in some of its major connections.
Arcopallium (in a songbird)	A structure of a bird's caudal endbrain that is the avian equivalent of the amygdala in mammals. It includes nucleus robustus, which has descending projections that control singing.
Arcuate Fasciculus	Transcortical association pathway in primates that interconnects posterior portions of the superior temporal gyrus to inferior and mid-lateral prefrontal areas. In the human brain, axons from Wernicke's area to Broca's area follow the arcuate fasciculus.
Arcuate Nucleus	A small hypothalamic cell group located in the

	caudoventral hypothalamus near the pituitary stalk. Arcuate nucleus neurons are of multiple types. Projections influence the pituitary through the vascular system (see "Median Eminence"), and also reach multiple structures of the limbic system. Some cells of the nucleus are involved in the regulation of feeding.
Area Postrema	A region of the caudal hindbrain just rostral to the obex, where specialized ependymal cells are located. The region is one of the circumventricular organs, which lack a blood-brain barrier. Cells of the area postrema act as receptors that detect toxins in the bloodstream. Such detection triggers the vomiting reflex.
Area Prostriata	A little-studied visual cortical area located in the paralimbic region between visual neocortex and the posterior cingulate and parahippocampal areas. It receives thalamic input from the lateral-dorsal nucleus (LD) and the anterior nuclei, and projects to retrosplenial and parahippocampal cortical areas, and to more rostral cingulate areas with motor functions.
Area X in songbirds	The region of the striatum in songbirds that is critical for the learning of song patterns. Area X projects to the thalamus (nucleus DLM), which projects to the nidopallial structure LMAN, which projects to nucleus robustus of the arcopallium. The robustus has descending outputs that control singing.
Areas TF, TH, and TL	Areas of the posterior parahippocampal gyrus that are often distinguished in large primates. They receive projections from visual, auditory, or somatosensory association areas or multimodal areas, and are connected to entorhinal and other parahippocampal areas.
Ascending Reticular Activating System (ARAS)	Neurons of the brainstem reticular formation, especially in the midbrain, with widespread ascending projections which, when stimulated, cause arousal of the entire forebrain according to various measures (EEG recordings from hemispheric surface or scalp, various signs of sympathetic nervous system arousal). Thus the ARAS is a brain-state changing system. Many of the neurons are cholinergic.
Association Cortex	Parts of the neocortex of mammals that are outside the primary sensory areas of the visual, auditory and somatosensory systems. Multimodal areas of the association cortex have many long-axon connections with other association areas.

Association Cortex in relation to Papez' Circuit	Visual association areas and multimodal association areas of the parietal cortex are interconnected with paralimbic areas, especially the retrosplenial cortex of the posterior cingulate gyrus. These areas project to entorhinal cortex and to pre- and post-subiculum, and thereby to the hippocampus.
Asymmetric Cell Division	Mitosis in the CNS that results in one post-mitotic cell and one cell that remains in the cell cycle. The post-mitotic cell migrates towards its final location.
Auditory Pattern selectivity	Many neurons of auditory cortical areas are selectively responsive to temporal patterns of auditory stimuli, e.g., frequency modulation of tones. Areas have been found that appear to respond to more complex aspects of auditory patterns like the vocalizations of conspecifics.
Autonomic Nervous System	The visceral nervous system. It controls smooth muscles and glands throughout the body *via* the sympathetic and parasympathetic systems.
Axon Bifurcation	A point along an axon where it branches.
Axonal Competition	During development, and continuing into adulthood in the PNS and in some regions of the CNS, axons that reach the same regions may show competitive interactions, competing for a limited amount of terminal space, which may mean a limited number of postsynaptic sites, or competing for a limited quantity of trophic substance. The competition is among axons with the same or similar membrane molecules that determine their specificity of termination.
Axonal Spreading	In response to removal of competing axons, the remaining axons may spread their terminals out over a larger than normal territory. The total number of terminal may be the same after the spreading out.
Azimuthal Positions	Positions around the organism describable as angular deviations from the straight ahead position. These are positions in the horizontal plane that passes through the head.
Ballistic Movement	A ballistic movement is a movement carried out without guidance once it has started. In neurology, it often refers to sudden flinging movements, usually of a limb.
Basal Forebrain	The region of the brain located rostral to the hypothalamus, including various cell groups of the ventral striatum.
Basal Forebrain	The ventrally located striatal and pallidal areas found rostral to the anterior hypothalamus. Structures included are all parts of the ventral striatum and

	ventral pallidum: the olfactory tubercle, the basal nucleus of Meynart, the diagonal band of Broca, nucleus accumbens, the bed nucleus of the stria terminalis. Often the septal nuclei are included as well.
Basal Ganglia or Basal Nuclei	Subcortical structures of the endbrain: The term "basal ganglia" refers to the corpus striatum and pallidal structures (both dorsal and ventral portions) and the amygdala. The septal nuclei may also be included.
Basal Nucleus of the Amygdala (and vision)	The basal nucleus receives visual and other sensory information from the lateral nucleus of the amygdala and from association areas of neocortex. It projects to the various visual association areas of the inferotemporal cortex and to prefrontal areas.
Basal Plate	The ventral part of the lateral wall of the neural tube, ventral to the sulcus limitans. Somatic motor neurons form in the basal plate (as well as many interneurons).
Basic Action Patterns	Patterns of movement in animal behavior that are largely inherited, and are important in survival and reproduction in almost all species. Such patterns include locomotion towards or away from objects or other animals, and grasping of objects in feeding and other activities.
Basic Behaviors	Behavioral patterns present in one form or another in all animals because they are necessary for survival and reproduction.
Basolateral Nuclei of the Amygdala	The basal and lateral nuclei of the amygdala develop from the embryonic pallium. The lateral nucleus receives visual and auditory system inputs from thalamus and from neocortex. The basal nucleus, especially its lateral part, receives inputs from the lateral nucleus, also from association cortex, and projects to auditory and visual cortical areas of the temporal lobe as well as to prefrontal cortex. These nuclei of the amygdala also project to its central nucleus, and thereby to basal forebrain structures and to hypothalamus.
Bed Nucleus of the Stria Terminalis (BST) and gender identity	Cell group in the basal forebrain that receives a strong projection from the amygdala (*via* axons of the stria terminalis). The central section of this nucleus (BSTc) is larger in males than in females, with almost twice as many somatostatin-containing neurons. Transgender male-to-female individuals have a female-like BSTc.

Betz Cells	The very large layer 5 pyramidal cells of the motor cortex (Brodmann's area 4). The Betz cell axons project to the spinal cord. (Vladimir Betz described them in a paper published in 1874.)
Bilateral Pyramidotomy	Transection, by a surgical knife cut, of the pyramidal tract on both sides of the hindbrain.
Bimodal Cells	Neurons that can be activated by inputs of two different sensory modalities
Blastula	When the morula develops a fluid-filled center, it is called a blastula.
Boutons	French for "buttons"—the enlargements of axons, often at the terminal ends. They usually contain synaptic vesicles, and include the presynaptic side of synapses, often more than one.
Brachium Conjunctivum	Axons of the superior cerebellar peduncle, which carry information from the deep nuclei of the cerebellum (mostly the dentate nucleus) to the midbrain and 'tweenbrain. In the midbrain, the target is mainly the red nucleus. In the 'tweenbrain, the major target is the ventrolateral nucleus.
Brachium of the Inferior Colliculus (BIC)	The "arm" of the inferior colliculus, the brachium of IC contains axons that come from cells of the IC and terminate in the medial geniculate body (nucleus or group of nuclei) of the thalamus.
Branchial Arches	The embryonic arches that form the gills in fishes. They are also called pharyngeal arches, and are a major subset of the visceral arches. In vertebrates various structures of the head and neck develop from these arches, with innervation of the muscles from the hindbrain's branchial motor column: trigeminal motor nucleus (controls mastication), facial nucleus (controls facial expressions), and nucleus ambiguus (controls swallowing and vocalization).
Branchial Motor Column	Nuclei of the hindbrain containing motor neurons that innervate muscles that developed from the embryonic branchial arches. These include the masticatory nucleus (trigeminal motor nucleus), the facial nucleus (7^{th} nerve nucleus), and nucleus ambiguus (innervating muscles of swallowing and vocalization *via* the 9^{th} and 10^{th} cranial nerves).
Buffalo Fish - Vagal lobe	[The brain of the buffalo fish and its vagal lobe are illustrated and described in Schneider chapter 4.]
Bursting Patterns	Brief rapid firings of action potentials
CA1	A portion of the hippocampus located adjacent to the subiculum. CA stands for Cornu Ammonis, or the horn of Ammon. The CA1 cells receive inputs from

	collaterals of CA3 axons (the Schaffer collaterals).
CA3	A portion of the hippocampus located near the dentate gyrus, which forms the end of the hippocampus that is topologically farthest from the neocortex. CA3 cell dendrites receive inputs from the dentate gyrus.
Calcarine Fissure	A deep sulcus in the medial surface of the occipital lobe of primates, in the middle of area 17 (primary visual cortex). In monkey and human, the upper visual field is represented below the fissure, and the lower field above.
Carotid Body	A small group of chemoreceptive cells and associated cells located close to the fork in the carotid artery. These cells detect blood oxygenation and carbon dioxide levels. The information reaches the nucleus of the solitary tract in the hindbrain through the glossopharyngeal nerve (cranial nerve 9).
Catecholamine	A monoamine derived from the amino acid tyrosine, a catecholamine has an amine side chain attached to a catechol (a benzene ring with two hydroxyl groups attached). The most abundant catecholamines are epinephrine (adrenaline), norepinephrine (noradrenaline) and dopamine. The latter two are the catecholamine neurotransmitters of the brain.
Catfish -	[The brain and the body of a catfish are pictured and described in Schneider chapter 4.]
Caudal Ganglionic Eminence	See Class 11 vocabulary for "Lateral Ganglionic Eminence" and "Medial Ganglionic Eminence."The caudal part of the thick layer of proliferative cells in the striatal location of a mammalian embryo does not show the separation of a lateral and a medial ganglionic eminence that is seen rostrally. The caudal ganglionic eminence gives rise not only to caudal parts of the striatum and some cells of the amygdala but also to cells that migrate into the caudal neocortex where they differentiate into GABA-ergic interneurons. (See chapter 12, figure 12-10.)
Central Canal	The ventricle in the center of the spinal cord.
Central Gray Area	An area surrounding the aqueduct of Sylvius in the midbrain. Activity of central gray cells influences motivational states, especially fear and aversion, but regions of the central gray can also initiate aggression and predatory attack, or sexual behavior. Stimulation of the CGA can cause feelings of pain and extreme discomfort, but stimulation of certain parts of it can also cause reduction of pain and tension. The CGA is

	one of Nauta's "limbic midbrain areas."
Central Nucleus of the Amygdala	A subdivision of the amygdala that is derived from the embryonic striatum, the central nucleus receives inputs from the other components of the amygdala and projects *via* the stria terminalis to the basal forebrain and the hypothalamus.
Central Oscillator	When neurons are rhythmically activated without corresponding rhythms of input driving this activity, then we assume that they are driven by central oscillators.
Central Pattern Controllers	Neuronal groups above the midbrain that can activate central pattern initiators of the midbrain. Examples: the hypothalamic locomotor area; neurons of the hypothalamus that can activate predatory attack behavior.
Central Pattern Generators	Networks of interconnected neurons of the hindbrain and spinal cord that generate patterns of somatic movements that are largely inherited.
Central Pattern Initiators	Brainstem, especially midbrain, neuronal groups where activity can activate central pattern generators of more caudal parts of the CNS. Example: the midbrain locomotor area.
Centrifugal Axons	Axons from a central CNS structure that connect with structures close to the receptors, and thus can affect the inputs to the CNS. In the olfactory bulbs, centrifugal axons coming from olfactory cortex connect with interneurons of the bulbs—the granule cells and the periglomerular cells. By this means the brain can modulate the amount of lateral inhibition.
Cerebellar Channel / Spinocerebellar Tract	A group of axons of secondary sensory neurons that form synapses in the cerebellar cortex. (In the spinal cord there is a dorsal spinocerebellar tract that ascends ipsilaterally and a ventral spinocerebellar tract that ascends contralaterally.)
Cerebellum	The word cerebellum means "little brain." The vertebrate cerebellum develops in the roof of the rostral hindbrain.
Cerebral Peduncle	The bundle of axons from and to the endbrain in the diencephalon and midbrain. The term peduncle (literally "little foot" in Latin) is used in biology for a stalk-like structure. The cerebral peduncle in a brain dissection is like a stalk holding up the "flower" of the endbrain, the cerebral cortex.
Cerebrospinal Fluid (CSF)	The fluid that fills the ventricles of the CNS. It also reaches the subarachnoid space that surrounds the entire brain and spinal cord.

Cervical Flexure	A similar bend develops at about the same time, and in the same direction, in the junction region between the hindbrain and the cervical spinal cord.
Chaining of Reflexes	When one reflex results in stimulation that triggers another reflex, which then results in another stimulus that triggers a third reflex, *et cetera*, it is called a reflex chain.
Chemoarchitecture	The distribution of specific chemical substances in brain tissue, studied in histological sections where at least one substance is marked.
Chemoattraction	Growth of axons towards a source of a diffusing substance.
Chemoreception	Sensory responses to specific chemical substances. Chemoreception is a property of the gustatory and olfactory systems. There are other chemoreptors in the body as well.
Chemorepulsion	Blocking of axon growth by a chemical barrier, or growth of the axon away from a source of a diffusing substance.
Chemotropism	Chemical effects on direction of growth of cell processes (like axons)
Cholera toxin subunit B	A subunit of the cholera toxin is relatively non-toxic, and is useful as an axon tracer in experimental neuroanatomy. It is taken up by cell bodies and transported down the axon to the terminals. When an immunohistochemical method is used to make the locations of the tracer visible, the labeled axons appear in great detail, with the axons and their terminals visible as in a Golgi stain. The method works best when the numbers of labeled axons are not very large, i.e., for relatively sparse projections.
Chordate	A member of the phylum *Chordata*, which includes all animals with a CNS located dorsal to the alimentary tract, above a notochord during development.
Chorionic Gonadotropin	A hormone produced by the placenta from the earliest period of pregnancy, it binds to receptors in the ovaries and in the placenta as well as other tissues, stimulating many of the processes of gestation. One of its subunits is very similar to thyroid stimulating hormone, and it can bind to thyroid receptors resulting in stimulation of thyroid function during pregnancy.
Choroid Plexus	Modified ependymal cells (a kind of glial cell that lines the ventricles) that secrete cerebrospinal fluid. The choroid plexus is formed by proliferation of these

	cells, forming strands of tissue that protrude into the lateral ventricles, into the top of the third ventricle, and into the fourth ventricle.
Cingulate Gyrus and motor functions	The cingulate gyrus is located just above the corpus callosum. It contains a number of separable regions. Its structure indicates its transitional nature, between neocortex on one side and limbic cortex (hippocampus) on the other. The anterior cingulate includes motor areas that appear to form interfaces between motivational systems, cognitive areas and motor outputs of the neocortex, but these areas also have direct projections to the spinal cord.
Circumvallate Papillae	A row of raised areas at the back of the tongue that includes taste buds innervated by the 9th cranial nerve and ducts of lingual salivary glands. Inputs from touch stimulation behind these papillae triggers swallowing.
Clarke's Column	See "dorsal spinocerebellar tract."
Claustrum	A thin sheet of neurons that overlies the putamen and is separated from it by a fiber layer. Superficial to the claustrum is the cortex of the insula in primates. The claustrum receives inputs from visual, auditory and somatosensory cortical areas and is also connected to motor cortex. Functions of the claustrum are not known.
Claustrum	A thin sheet of neurons within the white matter overlying the insular cortex, which overlies the putamen in mammals. Different portions of the claustrum are interconnected with different parts of the neocortex, e.g., the caudodorsal claustrum receives retinotopically organized inputs from multiple visual cortical areas and projects back to these areas. Other parts of the claustrum are similarly interconnected with other sensory cortex. The white matter on either side of the claustrum is the external capsule nearest the putamen and the extreme capsule nearest the deep layers of neocortex.
CNS Fasciculi	Plural of "fasciculus"—a bundle of axons in the brain or spinal cord, identifiable with neuroanatomical techniques. Fasciculi are particular tracts in the CNS.
CNS Tract	Axons running next to each other in the central nervous system in a bundle that can be identified in histological sections.
Cochlear Duct	The third fluid-filled portion of the cochlea, filled with endolymph, is separated from the vestibular duct by Reissner's membrane. The cochlear duct is

	separated from the scala tympani by the Organ of Corti.
Cochlear Nuclei	Secondary sensory neurons receiving inputs through the 8th cranial nerve from the cochlea. The nuclei include the dorsal cochlear nucleus and the anteroventral and posteroventral cochlear nuclei.
Cochlear Nuclei	The secondary sensory cell groups of the auditory system, located in the alar plate region of the rostral hindbrain. There are two main cell groups, the dorsal and the ventral cochlear nuclei. The ventral cochlear nucleus can be subdivided into the anteroventral and posteroventral cochlear nuclei.
Cognitive Abilities	Behavioral abilities that cannot be explained in terms of reflexes or fixed action patterns. They include anticipation, prediction or planning, at least of the immediate future.
Collapsin	Molecules in the brain have been called collapsins if, when encountered by a growing axon, they result in collapse of the growth cone and retraction of the axon for a short distance before the growth cone re-forms. This has been described for members of the semaphorin family of growth factors.
Collateral Sprouting	When there is a partial loss of axons connected to a part of the CNS, the remaining, undamaged, axons often grow (sprout) new collaterals that form synapses that replace the lost synapses.
Common Chemical Sense	Responses of free nerve endings in the skin to chemical stimulants that are potentially harmful. More primitive than taste and olfactory senses, the common chemical sense can cause sneezing, arrest of breathing, tear secretion, and sensations of pain or irritation.
Concerted Evolution	When evolutionary enlargements of brain structures in a group of animals are similar to the enlargement of the entire brain.
Conduction Time	Frequently, conduction time refers to the delay between stimulus and response. In a reflex, this delay depends on rate of conduction of action potentials along axons, synaptic delays, and times for spatial and temporal summation within neurons.
Consummatory Behavior	A behavioral action that is the goal of an instinctive motivation. For example, eating is the consummatory behavior resulting from hunger motivation.
Contact Attraction	Growth of axons along a particular surface due to molecules in that surface, or adherence to a surface because of molecules in that surface.

Contact Repulsion	Movement away from a surface containing certain molecules.
Contralateral	On the opposite side
Corpus Callosum (males *vs*. females)	The axons that interconnect the two hemispheres of the endbrain, most of them in the corpus callosum but also in the anterior commissure, are more numerous in females than in males. (Findings from imaging studies have resulted in the claim that these difference do not hold for homosexual men and women.)
Corpus Striatum	Developing from the subpallium of the endbrain, below the lateral ventricle in each hemisphere, the corpus striatum ("striped body") includes both dorsal and ventral portions, with multiple subdivisions. In brain dissections of mammalian brains, the stripes correspond to bundles of myelinated axons passing to and from the overlying neocortex.
Correlation Center	A brain structure that receives inputs from multiple sources and has outputs of specific types, e.g., outputs that control specific movements. Important midbrain correlation centers are the superior colliculus, the red nucleus, the midbrain locomotor area, and the central gray area. [The term is descriptive only, based on functions, and is not a standard neuroanatomical term.]
Correlation Centers	Neuronal structures where sensory information is analysed and reaches neurons with axons that connect with motor system structures.
Cortical Neuromodulation during sleep	During slow-wave sleep, the levels of neuromodulators acetylcholine, norepinephrine and serotonin (ACh, NE, and 5HT) decrease to less than half the waking levels. The changes in acetylcholine are postulated to result in a greater flow of information from hippocampus to neocortex, due to changes in presynaptic inhibition. In REM sleep, the levels of NE and 5HT decrease even further, but levels of ACh increase to levels above the waking state levels, so, it is assumed, that information flow from hippocampus to neocortex drops considerably.
Cortical Nucleus (of the Amygdala)	A component of the amygdala derived from the embryonic pallium which reaches the brain surface. Its surface layer receives direct projections from the accessory olfactory bulb. In some species this connection is critical for normal mating behavior.
Cortical Plate	Neocortical cells that have migrated from the ventricular and subventricular zones to a subpial location form a dense layer of undifferentiated cells

	below the marginal zone. This is the cortical plate. Cells of the deepest layers 5 and 6 begin differentiating first.
Corticoid structures	Structures with some resemblances to cortex but which are not usually classified as cortex. These include the septal area (septal nuclei) and parts of the amygdala.
Corticomedial Nuclei of the Amygdala	The cortical nucleus and the adjacent medial nucleus of the amygdala develop from the embryonic pallium and striatum, respectively. Sensory inputs come from olfactory, gustatory, visceral sensory and pain systems. There are reciprocal connections with the hypothalamus whereby the autonomic nervous system is influenced. There are also projections to the central nucleus and thereby to basal forebrain structures as well as to the hypothalamus.
Corticospinal Tract	Axons from the neocortex to the spinal cord in mammals. They originate in somatosensory cortical areas and in motor and premotor cortical areas, pass through the white matter of the cerebral hemisphere and through the internal capsule (traversing the corpus striatum), through the cerebral peduncle, then through the pons and the pyramidal tract of the ventromedial hindbrain. The axons decussate at the caudal end of the hindbrain, and descend to all levels of the spinal gray matter. In the spinal cord, the corticospinal axons are found in the lateral columns of some species (including primates) and in the ventralmost part of the dorsal columns in other species (including rodents).
Cranial Nerve	A peripheral nerve attached to the CNS above the spinal cord, inside the cranium. Cranial nerves, like spinal nerves, are made up of axons that carry sensory information to secondary sensory neurons in the CNS and/or axons from motor neurons of the CNS.
Cranio-Sacral System	The parasympathetic division of the autonomic nervous system. Its preganglionic motor neurons are found in a number of nuclei of the midbrain and hindbrain—each of them small in frontal sections—and in the sacral segments of the spinal cord.
Cribriform Plate	The bone that separates the nasal cavity from the olfactory bulbs in mammals. Axons of olfactory receptor cells pass through tiny openings in the cribriform plate and reach the olfactory bulbs just inside the brain case.
Crus Cerebri	The *Crus Cerebri* is a term for the fibers of the

	cerebral peduncle at the base of the midbrain. Also known as the *basis pedunculi*.
Cynodont	Cynodonts were a group of reptilian species, often called mammal-like reptiles. Some of these animals evolved into the early mammals.
Cytoarchitecture	The structural arrangement of cells. Arrangements include grouping of neuronal cell bodies into cell groups or nuclei; lamination of specific functional or structural cell types.
Deafferentation Depression	Depressed neuronal function caused by a major loss of inputs, usually inputs from excitatory axons.
Decerebrate	An animal which has suffered loss of the cerebrum bilaterally by experimental surgery. A high decerebrate animal has lost all connections of the cerebral hemispheres including cortex and corpus striatum. Other types of decerebration involve lower transections of the neuraxis, e.g., behind the diencephalon (as by forebrain removal) or even behind the midbrain.
Decussation	The site where an axonal pathway crosses to the opposite side of the CNS. (The term is not generally used for axons that simply connect with the same structure on the opposite side; such axons form a "commissure.")
Deep Nuclei of Cerebellum	The output structures of the cerebellum, located below the cerebellar cortex within the cerebellar white matter. There are 3-4 deep nuclei on each side. The most medial deep nucleus is the fastigial nucleus, which receives projections of the large cerebellar Purkinje cells (P cells) of the most medial cerebellum (the vermis). The most lateral deep nucleus is the dentate nucleus, which receives projections from P cells of most of the cerebellar hemispheres. In between are the interposed nuclei (the emboliform and globose nuclei), receiving projections from the medial part of the hemispheres. In some species these latter two nuclei are not separable, so the term nucleus interpositus is used. (Major connections: fastigial nucleus to structures of axial muscle control; interposed nucleus to structures of limb control; dentate nucleus to motor cortex *via* projections to the ventrolateral nucleus of the thalamus, involved in motor planning.)
Denervation Supersensitivity	After a loss of neuronal function caused by diaschisis, the neurons that have lost many inputs become more sensitive to remaining inputs of the same type as the

	lost ones. Recovery of function is the result. The increased sensitivity results from an increase in synaptic receptors that bind to the neurotransmitter of the degenerating axons. The supersensitivity can go too far, so that reflexes can become overactive—a condition called reflex spasticity.
Dentate Gurus	The part of the hippocampus at the extreme caudomedial and caudal margin of the hemisphere (extending into the temporal lobe in large-brained mammals). It is a one-cell-layer cortex that encloses the distal end of Ammon's Horn—the CA4 region. The dentate gyrus neurons receive their major input from axons of the perforant path—axons from the entorhinal cortex that penetrate the pial surface of the dentate gyrus after passing through the subicular region.
Dentate Gyrus Neurogenesis	The birth of new neurons of the dentate gyrus of the hippocampal formation, either in the embryo or in the adult. Neurogenesis in the dentate is ongoing in mature animals. The rate in young adult rats has been estimated to be 6% of the total number of dentate granule cells per month (Cameron and McKay, Journal of Comparative Neurology, 2001). The rate is increased by activity and by environmental enrichment.
Dentate Nucleus	The most lateral of the deep nuclei of the cerebellum. It receives projections from the cerebellar hemispheres and is important for coordinated movement of the extremities, especially the hands. It projects to the small-celled, rostral part of the red nucleus and to the ventrolateral thalamic nucleus (VL). [VL projects to motor cortex.]
Dermatome	The area of the body surface innervated by a single pair of dorsal roots (of one spinal segment, involving one spinal nerve on either side).
Descending Nucleus of the Trigeminal Nerve	The primary sensory axons of the fifth cranial nerve terminate on secondary sensory neurons of the brainstem found in the alar plate from the rostral hindbrain to the cervical spinal cord. The rostral-most nucleus containing these neurons is the principle or main sensory nucleus, and the more caudal neurons are in the descending nucleus.
Diabetes Insipidus	Very frequent urination (polyuria) and constant thirst and drinking (polydipsia) that can be caused by insufficient ADH secretion or by insensitivity of the kidneys to ADH. Similar symptoms can occasionally

	result from a drug side effect. (Similar symptoms are caused by acute onset of diabetes mellitus, caused in this case by the body's response to blood acidity resulting from processes of metabolism of fat and protein when the body lacks insulin and cannot metabolise glucose.)
Diaschisis	A loss of function of one region of the brain caused by damage in another part that is connected with it. The loss is usually not permanent. It is caused by deafferentation depression (see below). The word is from the Greek language, meaning a division (separation).
Diencephalon	The 'tweenbrain, which includes the epithalamus, thalamus, subthalamus and hypothalamus of adult vertebrates
Differential Adhesion	The strength of cell-cell adhesion has major effects of axonal growth and on cell sorting during morphogenesis. Very strong adhesion will cause the growing axon to stop advancing. Weaker adhesion of surfaces can guide axonal growth, as filopodia adhere, pull the growth cone, and then break contact. The duration of the adhesion varies with the strength of the adhesion, and thus, differential adhesion can result in guidance of growth along a particular path. In the case of mixing of different cells, sorting will occur as a result of differential cell-cell adhesion.
Diffusion Tensor Imaging (DTI)	A method for tracing fiber bundles in live brains using magnetic resonance imaging that detects the axis of maximal water movement, which is movement up and down axons more than in any other direction. Using a computer algorithm, a small region of interest is selected and the computer can follow fiber bundles entering or leaving that region to other regions where the bundles appear to originate or terminate. See chapter 2 and figure 2-20. (Adjustments of parameters can result in different results, and the resolution of the method is far less than that of light microscopy, but with guidance from information from experimental tracing studies of monkeys, DTI is able to yield useful information about pathways in normal and pathological human brains.)
Disconnection Syndrome	The behavioral effect of a brain lesion (a deficit) caused by a disruption of an axonal pathway that results in a disconnection of one structure from other structures. Example: a lesion of corpus callosum

	fibers results in loss of interconnections between the left and right hemispheres, and the disconnection causes a split-brain syndrome. A specific example of such a syndrome is the effect of a loss of the left striate cortex plus a transection of the caudal part of the corpus callosum (the splenium), a combination that makes it impossible for a person to read words. The visual input reaches only the right hemisphere, and the visual information cannot reach the speech areas of the left hemisphere. The prestriate areas on the right and left are normally interconnected by callosal axons that cross in the splenium.
Diurnal Rhythms	Activity that occurs daily (in a regular cycle).
Dopamine (DA)	The catecholamine neurotransmitter of the brain used by neurons of the ventral tegmental area and the substantia nigra in mammals. The axons of these neurons project widely in the CNS. They are important for the type of arousal involved in reward (and, subjectively, in feelings of pleasure). Dopamine receptors are of multiple types.
Dorsal Association Tract, frog endbrain	In the frog brain, the dorsal association tract interconnects the dorsal pallium with the medial pallium (the homolog of the hippocampus). Many fibers of this tract are found close to the pial surface. Some axons from the thalamus are found there also, with terminations in both the dorsal and the medial pallium.
Dorsal Cochlear Nucleus	See "cochlear nuclei".
Dorsal Column	The fiber columns located dorsomedially in the spinal cord. The ascending axons of the dorsal columns are axons of primary sensory neurons of dorsal root ganglia. They terminate in the dorsal column nuclei located at the rostral end of the spinal cord and caudal end of the hindbrain.
Dorsal Column Nuclei	Groups of secondary sensory neurons located in the rostral end of the spinal cord's dorsal columns. Some anatomists describe their location as the caudal end of the hindbrain. They receive inputs from primary sensory axons of the dorsal roots of the spinal cord that ascend in the dorsal columns. The medial nucleus of the dorsal columns is called nucleus gracilis (slender nucleus); it relays information about touch, pressure and proprioception from the lower trunk, legs (rear legs), and anogenital region. The more lateral nucleus is the nucleus cuneatus (wedge-shaped nucleus); it relays somatosensory and proprioceptive

	information from the upper trunk, arms (front limbs), and neck. Both nuclei project axons to the contralateral thalamus (with branches to some midbrain and hindbrain regions) *via* the medial lemniscus, decussating before turning rostralward.
Dorsal Lateral Geniculate Nucleus (LGd)	The dorsal nucleus of the lateral geniculate body (LGB) is the major recipient of retinal projections in the thalamus.
Dorsal Motor Nuclei	The "dorsal motor nuclei of the vagus nervc," one on either side of the hindbrain's medulla oblongata, are major nuclei of the parasympathetic nervous system. Their axons form the vagus nerves, which innervate smooth muscles and glands of the thoracic and abdominal cavities. The axons form synapses on neurons of parasympathetic ganglia, which are located very close to the organs or smooth muscles being innervated.
Dorsal Pallium	The dorsal pallium of non-mammalian vertebrates, which forms what is called the dorsal cortex of reptiles, is similar in connections to parahippocampal areas in mammals, but in mammals, much of it has evolved into the neocortex.
Dorsal root	One of two branches of each spinal nerve attached to the spinal cord. The dorsal branch—the dorsal root—contains axons of primary sensory neurons that synapse in the CNS on secondary sensory neurons. The peripheral axons of dorsal roots extend to receptors in the periphery (skin, joints, muscle, visceral organs). (The ventral root in vertebrates contains axons from motor neurons that extend to muscles, plus axons from the lateral horn to autonomic ganglia.)
Dorsal Spinocerebellar Tract	Axons from Clark's column in the spinal cord (nucleus dorsalis, located in the medial part of Rexed's layer 6). Clark's column neurons receive proprioceptive information from the joints of the lower parts of the body. The axons of the secondary sensory neurons ascend in the lateral column on the ipsilateral side to the cerebellar cortex.
Dorsal Terminal Nucleus (DTN) of the Accessory Optic Tract	A small clump of neurons located just caudal to the main optic tract, caudolateral to the nucleus of the optic tract (NOT) in the pretectal area. Neurons are activated by visual stimuli resulting from lateral deviations of the head—as are neurons in the NOT.
Dorsal Ventricular Ridge (DVR)	A major subcortical structure of the endbrain of birds and reptiles. The neurons of the DVR have

	connections that are similar to connections of parts of the mammalian neocortex. The DVR receives unimodal sensory inputs from thalamic nuclei that receive projections from dorsal midbrain areas.
Dorsalateral Placodes	Local thickenings of the epithelium of the embryonic head that form the peripheral portions of the auditory, vestibular, lateral line, and trigeminal systems.
Dorsolateral Cortex	In reptiles, the dorsal cortex receives sensory projections from the thalamus. The dorsolateral part of this cortex receives visual input from a retino-recipient cell group in the thalamus, the DLO (dorsolateral optic nucleus). The pathway is similar to the pathway from the dorsal nucleus of the lateral geniculate body to the primary visual cortex in mammals.
Drive State	The behavioral state caused by a high level of a particular instinctive motivation (drive).
Drive *vs*. Reward	Reward occurs when an animal obtains the stimuli it seeks as a consequence of a particular biological drive. Thus, the "drive" is the state of arousal of a particular motivation (e.g., hunger). The "reward" is the sensory pleasure resulting from reaching the goal of the drive and carrying out the consummatory action (e.g., eating of food). The term "reinforcement" is associated with reward, and refers to the learning that often results—the change in behavior that increases the likelihood of the behavior being repeated.
Dura mater	The outermost layer of the meniges—the coverings of the central nervous system. Meaning of words: tough, or hard, mother.
Dynamic Zone in neocortex	In a superficial strip of layer 2-3 of mouse neocortex, GABA-ergic interneuron dendrites show rapid remodeling according to results using imaging of the live brain using a multiphoton microscope system. This has been reported by Elly Nedivi (in BCS at MIT) working with Wei-Chung Allen Lee and a group of other collaborators at MIT. In their 2008 paper, they state: "Remodeling occurs primarily at the periphery of dendritic fields with addition and retraction of new branch tips." Other investigators have found physiological evidence for the involvement of GABA-containing interneurons in cortical plasticity accompanying learning.
Early Amygdalar Lesion	A lesion of the amygdala that occurs very early in life, e.g., prenatally or perinatally.

Ectoderm	The surface layer of the early embryo of a bilaterally symmetric animal, including the chordates. It forms the epidermis, the nervous system, and pigment cells. It also forms tooth enamel, the lining of the mouth, nostrils and anus, the sweat glands, hair and nails.
Ectosylvian Cortex	The ectosylvian cortex of the cat surrounds the pseudosylvian sulcus. It is bordered by the suprasylvian sulcus posteriorly, dorsally, and anterodorsally. The ectosylvian cortical areas are bordered ventrally by the perirhinal cortex dorsal to the rhinal sulcus.
Ectotherm [Sometimes "exotherm" is used, but this is not the proper term.]	An animal that cannot maintain a constant body temperature so its temperature fluctuates with the environmental temperature. To enable body processes, temperature can be raised by ectothermic animals by vigorous muscular activity or by finding warmer places, or it can be lowered by avoidance of direct sunlight.
Egocentric Direction	A direction specified with respect to the organism's body or head.
Emotional Expression	A behavioral change that expresses to conspecifics a motivational state or reaction. Many emotional expressions are innate responses, common to all members of a species.
Endbulb of Held	A type of large terminal, with multiple synapses, of auditory nerve axons that end on bushy cells in the ventral cochlear nucleus. In birds, these types of terminals are found on cells of the magnocellular nucleus.
Endocrine System	The glands of the body that secrete hormones into the bloodstream with widespread effects on other tissues. The major glands are controlled by secretions of the pituitary organs, which are controlled by the brain through the hypothalamus. Hormones are also secreted by various organs as feedback signals to the brain (e.g., hormones from the stomach that affect hunger and feeding). The endocrine system is important in homeostasis of the body's internal environment.
Endoderm	The innermost layer of the early embryo. It forms the linings of the two main tubes of the body—the digestive tract (alimentary canal) except for the mouth and anus, and the respiratory tract. Tissues derived from these two systems are also endodermal, including the thymus . thyroid and parathyroid glands, and parts of the auditory system.

Endogenous activity	Activity generated from within, without an external stimulus.
Endotherm	An animal with endothermal control maintains fairly constant body temperature at levels that enable optimal function of tissues. Mammals and birds are endotherms—commonly called warm-blooded animals.
Enkephalin	A pentapeptide (5 amino acid peptide) that binds to opioid receptors, involved in regulating the processing of pain stimuli. (In this function the enkephalins (leu-enkephalon and met-enkephalon) are like the endorphins and dynorphins.) Enkephalins occur as neuromodulators in GABA-ergic neurons of the dorsal striatum, neurons that project to the external segment of the globus pallidus.
Enteric Nervous System	In the wall of the intestinal tract, throughout its length, there are large numbers of neurons in interconnected networks that contain sensory, motor and interneuronal elements. Many different neurotransmitters are involved. This "enteric nervous system" is largely autonomous in its functions but it is influenced by inputs from the parasympathetic and sympathetic systems. The enteric nervous system is an important part of the autonomic nervous system.
Entopallium	The part of the nidopallium in birds that receives visual inputs from nucleus rotundus of the thalamus (a tectorecipient structure).
Entorhinal Cortex	Limbic cortex of the piriform lobe located caudal to most of the olfactory cortex. The rostral margins of the entorhinal cortex receive direct olfactory input. The entorhinal cortex is reciprocally connected to structures of the hippocampal formation, and is also closely connected to neocortical association areas *via* paralimbic cortical areas (chapters 26-28). In the human brain, the entorhinal cortex provides what is believed to be the major input to the hippocampus.
Entrain	Refers to entrainment of a rhythm so the oscillation matches the rhythm of an external stimulus. In animal behavior, there is normally an entrainment of the innate circadian rhythm so it matches the 24-hr day-night rhythm.
Ependyma	The one-cell thick neural tube has been called the neuroependyma, as all the cells reach the ventricle. However, with the differentiation of various cell types of the CNS, both neuronal and glial, the ependymal cells are those that line the ventricle as a

	thin layer of glial cells. Cerebrospinal fluid is made by modified ependymal cells, especially in regions where ependymal cells proliferate into extensions that protrude into the ventricular fluid. These ependymal cells are called the choroid plexus.
Ephrin	Ephrins are membrane-bound ligands for Eph receptors, which are also membrane bound. Eph molecules are receptor protein-tyrosine kinases (RTKs). Because of the presence of these molecules in neurons, cell-cell contacts during axonal growth can affect axon guidance. Retinal neurons and their axons contain specific Eph receptors, and cells of the midbrain tectum contain the ephrin ligands, some of which are distributed in gradients of concentration across one of the tectal axes.
Epigenetic Factors	Influences on development in addition to genetic factors. Epigenetic factors in brain development include effects of axonal connections, of neuronal activity, of specific sensory inputs, and of learning.
Epithalamus	Subdivision of the diencephalon closest to the midbrain. In an adult vertebrate it is located above the caudal parts of the thalamus. It includes the habenular nuclei and the pretectal nuclei. (Some anatomists include only the habenular nuclei in epithalamus, considering the pretectal nuclei to be part of a more caudal segment. Others have considered the pretectal cell groups to be part of the midbrain.)
Error Correction	Loss of connections made by axons that do not form in the proper topographic positions in a mapped representation. This is often due to degeneration of axons or axon collaterals, which may be a result of cell loss in the source structure.
Estrogens	The female steroid hormones found in all vertebrates. Their synthesis involves a series of steps beginning with cholesterol; the step before an estrogen is an androgen (male hormone), e.g., estradiol is synthesized from testosterone by aromatase (estrogen synthetase).
Expansion of Midbrain	Enlargements of the midbrain in chordate evolution, or enlargements of its components. (As the forebrain differentiated and expanded in evolution, the midbrain also showed some expansion because it received inputs from the forebrain; such connections were the only way the forebrain could control the somatic movements of the animal. As the adaptive

	functions of the midbrain for visually elicited escape movements and orienting movements increased in evolution, there was an expansion of the size of the midbrain tectum.)
External Capsule	Cortical white matter sheet overlying the putamen, below the claustrum.
External Granular Layer	Neocortical layer 2, composed of small neurons of various shapes, including many small pyramidal cells as well as stellate cells.
External Pyramidal Layer	Neocortical layer 3, composed of pyramidal cells that tend to be larger than those found in layer 2, but not as large as those in layer 5. Axons from layer three pyramidal cells make transcortical connections in addition to local, intracolumnar connections.
Extrapyramidal Motor System	The various structures of the brain that control somatic movements other than the neocortical areas that give rise to the pyramidal tract (motor and premotor areas and somatosensory areas). The largest structures are the corpus striatum and the cerebellum, but many other structures are involved. See chapters 14 and 15.
Extrastriate Visual Cortex	Visual receptive neocortical areas located outside the striate area. Multiple areas have been mapped. Most of them show a complete topographic representation of the visual field (hemifield on the opposite side). A greater number of extrastriate visual areas is found in mammals with larger brains.
Extreme Capsule	Cortical white matter sheet overlying the claustrum.
Facial Motor Nucleus	The group of hindbrain motor neurons, located in the branchial motor column, with axons that control facial muscles. The axons are in the 7^{th} cranial nerve.
Facial Nerve	The facial nerve is cranial nerve 7. It includes axons of motor neurons that innervate facial muscles, and axons of primary sensory neurons carrying taste information from the distal parts of the tongue. Axons of the parasympathetic division of the autonomic nervous system are also contained in the facial nerve.
Fastigial Nucleus	The most medial of the 3-4 deep nuclei of the cerebellum.
Fastigiospinal Tract	A group of axons originating in the most medial of the cerebellar deep nuclei—the fastigial nucleus. Whereas other axons from this nucleus project to the vestibular nuclei and to other brainstem locations, the fastigiospinal tract fibers, after crossing to the contralateral side, descend to, and terminate in, the

	upper cervical spinal cord.
Feedback Circuitry	Circuits that do not just go from the stimulus end to the response end, but include pathways that go back to earlier points in the pathway. Such loops in the flow of information are feedback loops.
Fiber architecture	The arrangement of axons into layers, tracts (bundles) and columns. These arrangements tend to be different in different regions of the brain.
Fibroblast	The most common cell type in connective tissue, fibroblasts move to sites of injury, and secrete collagen and extra-cellular matrix molecules.
Field L	The area in the endbrain of birds where the auditory projections from the thalamus terminate. Field L is located in the medial part of the nidopallium, a large region below the lateral ventricle of the endbrain.
Filopodia	Filamentous processes that extend from cells during some stages of embryogenesis. These processes contain the contractile protein actin. The cell membrane at the tip of a filopodium contains cell adhesion molecules. Contraction of filopodia can cause movement of cells or parts of cells.
Fimbria	The fimbria, short for "fimbria fornicis" meaning the fringe of the fornix, is the initial part of the fornix bundle of axons. These axons come from the white matter of the hippocampus—the alveus (next to the ventricle)—and collect at the medial margin of the hippocampus where they are called the fibria. They occupy part of the ventricular wall. Where these axons are beyond the hippocampal cell bodies they are called the fornix.
First Endbrain Expansion	In chordate evolution, the earliest expansion of an endbrain occurred very early with the development of olfactory inputs.
Fixed Action Patterns	Patterns of instinctive behavior that include inherited motivations and motor output patterns. Although they are "fixed" in the genes, they are often subject to modification, especially on the sensory side. A fixed action pattern (FAP) includes appetitive behavior (seeking of certain stimuli), a specific motivational arousal state, and an instinctive movement pattern or "fixed motor pattern."
Flexure of the CNS	A bend in the developing neural tube.
Flocculus	The egg-shaped lateral protrusion of the vestibular part of the cerebellar cortex, located at the caudolateral margin of the structure.
Floor Plate	The ependymal cells of the most ventral neural tube.

	It forms at the place where the forming notochord contacts the neural plate, and some cells of the embryonic notochord become part of the floor plate of the neural tube. The floor plate cells separate the left and right basal plates.
Fluorescent tracers	A substance that fluoresces at a specific wavelength of light when illuminated with light of a different wavelength. Such substances can be used as axon tracers by neuroanatomists if they are transported retrogradely or anterogradely, or both.
Fourth Ventricle	The widened ventricle under the roof plate of the hindbrain.
Frequency Coding	The code for sound frequencies is based on rhythmic firing of auditory nerve axons that matches low sound frequencies, and on differential firing of axons from different parts of the cochlea for higher frequencies.
Frequency modulation of sounds	Temporally varying frequencies of tones. Such stimuli are used in the study of the specificity of neuronal firing patterns in the auditory cortex.
Frog Midbrain Tectum Lamina	Frogs have well developed optic tecta with multiple layers defined by fiber and cell arrangements. Axons from the retina with different functional characteristics are found in different superficial layers of the tectum.
Frontal Eye Spot	The light sensitive region near the anterior end of the CNS of amphioxus (Branchiostoma): It contains neurons, receptor cells, and pigmented cells.
Fronto-occipital Fasciculus	In monkeys the fronto-occipital fasciculus interconnects medial pre-striate, posterior parietal and posterior cingulate gyrus with dorsolateral frontal cortex including frontal eye fields and premotor cortex. (The term has had a complex history. For the human brain, radiologists sometimes distinguish superior and inferior fronto-occipital fasciculi, but Pandya and collaborators have not supported this.)
Galvanotropism	Guidance of axon growth by minute electrical currents. It is debated whether such electric currents play important roles except for rare instances in a few species.
Ganglionic Neuron of the autonomic nervous system	Neuron in one of the peripheral ganglia of the autonomic nervous system. Such neurons have axons that innervate smooth muscle or gland cells.
Gap Junction	A junction between two cells that is characterized by close apposition of cell membranes with molecular channels that allow free passage of ions and other small molecules between cells. Electrical activity in

	the membrane of one cell influences the other cell without any special neurotransmitters or receptor molecules. In evolution, gap junctions constitute electrical synapses that appeared earlier than chemical synapses.
GAP-43	The growth associated protein known as GAP-43 is named for its apparent migration rate in gels, although its actual molecular weight is less. It is a cytoplasmic protein that can attach to membranes, and is found most abundantly in neurons and their axons during growth when the axon has filopodia and growth cones. It is down-regulated after the growth period. However, this protein appears to be at higher levels whenever growth is occurring even in mature animals, and it is found at higher levels in some regions of the adult brain than in others, e.g., in the association layers of multimodal neocortical areas.
Gastrula	After the blastula forms an invagination that leads to the development of a channel to the other side (the precursor of the alimentary tract), it becomes a gastrula. The whole process is called gastrulation.
Genetic Factors	Influences of specific genes on development.
Geniculostriate Pathway	The axons from the lateral geniculate body (dorsal nucleus of LGB) through the internal capsule and neocortical white matter to the striate cortex in the occipital lobe. Also called the optic radiations.
Genu of the Corpus Callosum	The genu is the most anterior part of the corpus callosum, called the "knee" of the callosum because of its shape at the anterior end.
Globus Pallidus	The subcortical endbrain structure that receives the major outputs of the dorsal striatum (caudate nucleus and putamen) other than the projection to the substantia nigra. Globus pallidus neurons project to the ventral-anterior and ventral-lateral nuclei of the thalamus (which project to motor cortical areas), to the subthalamus, and to midbrain structures including the midbrain locomotor area. [Discussed in chapter 30.]
Globus Pallidus	The globus pallidus is the dorsal pallidum, the major output structure of the dorsal striatum. It consists of an external (laterodorsal) segment and an internal (medioventral) segment. These interconnected segments receive projections from different striatal neurons and have different connections. The external segment is interconnected with the subthalamic nucleus and also projects to the substantia nigra. The

	internal segment projects to the ventral thalamus (primarily the VA) and to the caudal midbrain (part of the locomotor area).
Glomerulus	A cluster of blood vessels or nerve endings. Vascular glomeruli are found in the kidneys. The olfactory glomeruli are found near the surface of the olfactory bulbs: they are onion-shaped clusters of end-arborizations of axons from the olfactory epithelium that form terminations on dendritic arborizations of mitral cells of the olfactory bulb. Dendritic arbors of tufted cells are also found in these glomeruli.
Golgi stain	A histological stain that results in the complete or nearly complete filling of scattered neurons and glial cells in blocks of brain tissue with a black color. The staining works by impregnation of fixed nervous tissue with potassium dichromate and silver nitrate. Cells that stain are filled by silver chromate precipitate. The method was first developed by Camillo Golgi in 1873, but it became more well known when it was used extensively by the neuroanatomist Santiago Ramon y Cajal.
Granular Cortex	Sometimes called koniocortex, the granular areas have a prominent layer 4. The primary sensory cortical areas are granular cortex: the primary visual cortex, the primary auditory cortex, and the primary somatosensory cortex.
Granule Cell	A small interneuron of the CNS. The granule cells of the olfactory bulbs, which do not fire action potentials, interconnect nearby mitral cells, resulting in lateral inhibition.
Growth Cone	The motile tip of a growing axon. Growth cones of dendrites have also been observed.
Growth Factor	A protein, usually a member of a family of related growth factors, that when present increases proliferation of cells or growth of cell processes (like axons) and/or causes changes in the direction of growth of cell processes, either up or down a gradient of the factor. Examples: nerve growth factor (NGF), brain-derived neurotrophic factor (BDNF), fibroblast growth factor (FGF).
Growth of Layer 3 in Infants	Layer three of neocortex—the outer layer of pyramidal cells—is the source of many transcortically projecting axons, and it also receives connections from such axons. This layer was found by Poliakov to increase in thickness postnatally in several multimodal regions of association cortex, an increase

	that is most marked up to age 7 but continues even past age 12.
Growth Potency	The tendency for an axon to grow more terminals in a terminal region. Its growth potency tends to decrease after it begins to arborize, as it forms more and more terminals, often dropping to zero or near zero.
Guidepost Cells	Non-neuronal cells that guide growing axons (in some cases) by serving as temporary anchoring points along their growth trajectory.
Gustatory Nucleus	The rostral portion of the nucleus of the solitary tract in the hindbrain. It receives gustatory inputs from the tongue and throat via cranial nerves 7, 9 and 10.
Habenular Nuclei	Cell groups of the epithalamus, composed of medial and lateral components. Major inputs from anterior parts of the hypothalamus and from the septal area *via* the stria medullaris reveal these nuclei to be part of the limbic system. They are connected with the pineal gland, and project to the interpeduncular nuclei and other midline cell groups (via the habenulo-interpeducular tract), thereby modulating movement and brain states.
Head Direction Cells (HD cells)	Neurons with activity that encodes direction. Usually, allocentric direction is represented. Brainstem cells that encode changes in head direction are also sometimes called HD cells. The changes are used to alter the activity of HD cells in the mammillary bodies and in anterior thalamic nuclei and in the anterior part of the lateral nucleus.
Head of the Caudate	The most anterior part of the caudate nucleus, which is the largest part—anterior to the rostral end of the thalamus and dorsal to the basal forebrain.
Hemiballism	Hemiballism is a movement disorder usually caused by lesions that affect the corpus striatum and its satellites. One cause is a (rarely occurring) lesion of the subthalamic nucleus on one side, causing sudden flinging movements on the opposite side of the body, usually movements of one or both limbs. The movements seem to occur randomly but they occur much more when the person is active, indicating a voluntary component. Various lesions other than a lesion of the subthalamic nucleus can cause the movement disorder, which is often difficult to distinguish from non-Huntington's chorea, so many neurologists group chorea and ballism together.
Heteromodal Fields	Areas of the neocortex that represent multiple sensory modalities because they receive inputs from unimodal

	regions of association cortex of more than one modality. Synonymous with multimodal areas.
Higher Vocal Center (HVC)	Cell group in a songbird's caudal nidopallium that is important for the control of singing. The HVC projects to the arcopallium, which projects to midbrain auditory structures and to the portion of the hypoglossal nucleus that innervates the syrinx in the throat.
Hindbrain Expansion	In the course of vertebrate evolution, various sensory systems developed in the head region with inputs into the caudal brainstem—the hindbrain. Examples are gustatory (taste), vestibular, auditory, and electrosensory inputs. Analysis of these inputs by CNS neuronal structures evolved, requiring enlargement of specialized secondary sensory cell groups and further neuronal structures connected to these cell groups. This was a major factor that resulted in enlargement of the hindbrain.
Hippocampal Commissure	Fibers that interconnect the right and left hippocampi. Also called the fornix commissure. The hippocampal commissure fibers are located just below the fibers of the posterior corpus callosum.
Hippocampal Formation	The hippocampal formation consists, first of all, of Ammon's Horn and subiculum plus the Dentate Gyrus, which are cortical areas with only one cell layer at the medial and caudal margins of the cerebral hemisphere's pallium. In addition, the nearby parahippocampal cortical areas (presubiculum, parasubiculum, entorhinal cortex) are included in the hippocampal formation. The hippocampal formation of mammals evolved from the medial pallium and adjacent cortical areas in non-mammalian vertebrates.
Hippocampal Rudiment	In mammals, the hippocampus is very small just above the corpus callosum at the ventral margin of the cingulate gyrus. This part of the hippocampus is called the hippocampal rudiment. It can be followed forward around the genu of the callosum to a point where it merges with the septal area. At the opposite end of the gyrus fornicatus (limbic lobe) the hippocampus is much larger.
Hippocampocentric cortical regions	Centered on, i.e., having connections to, the parahippocampal areas and hippocampus. The hippocampocentric paralimbic regions project to those areas and are interconnected with neocortical regions concerned with places and retaining memories of specific places.

Hippocampus	The hippocampus, a structure known to be of major importance in spatial memory and other aspects of episodic or declarative memory formation, is located at the medial margin of the cerebral hemisphere anteriorly, dorsally and posteriorly, but the structure is tiny in mammals except in the occipito-temporal region. The word hippocampus means a seahorse, named for its appearance in dissections of the human brain. It is called archicortex—a cortex with only one cell layer.
Homeobox (Hox) Genes	Genes that encode for transcription factors that contain a characteristic series of amino acids—the homeobox. These genes, first discovered in fruit flies, are highly conserved across widely different species from insects to mammals. Their locations along a chromosome correspond to the order in which they are expressed in segments along the anterior-posterior axis of the body.
Homeostatic Mechanism	A mechanism that causes some parameter (e.g. body temperature) to remain within a certain limited range of values.
Homotypical Isocortex	Most of the neocortex in humans is homotypical isocortex. It includes all the association cortical areas—including the unimodal cortical areas that receive most of their transcortical input from a primary sensory area or from other unimodal association areas, or areas that are multimodal (heteromodal) association areas. Homotypic areas are all fairly similar in laminar structure.
Horizontal section	A slice of the brain cut at right angles to coronal and to sagittal sections
HRP histochemistry	Horseradish peroxidase is a plant enzyme that when injected into a brain region is taken up by axonal endings and cells and transported in both retrograde and anterograde directions. Histochemical methods can be used to visualize the distribution of the HRP in cell bodies and in axons using histological sections studied with light microscopy.
Huntington's Chorea	Huntington’s Disease (HD) is a degenerative brain disease that is genetic in origin. The Huntingtin gene Htt is abnormal, producing a mutant Huntingtin protein (mHtt). Symptoms commonly have a mid-life onset. They include cognitive decline and other mental disorders of a psychiatric nature, and movement problems. The abnormal, dance-like writhing movements of HD are called Huntington’s

	Chorea. These movements are involuntary, and they increase with the severity of the disease. Abnormalities occur in neurons throughout the brain, but certain areas are more severely affected, like the dorsal striatum and the substantia nigra.
Hyperkinesia	An excessive amount of movement, either of normal movements or of abnormal movements as in tremors.
Hyperpallium	The dorsalmost surface layers of the avian endbrain, derived from the pallium. Some of it is above a lateral ventricle, as in the case of the neocortex of mammals. It was called the hyperstriatum in the older literature.
Hypocretin or Orexin	A neuropeptide located in certain neurons of the lateral hypothalamus that project widely to various other brain regions. These projections are important in regulation of sleep, arousal and also appetite and lipid metabolism. Defects in this peptide can cause a form of narcolepsy.
Hypoglossal Nucleus	The motor neuronal cell group that controls tongue movements. The axons form cranial nerve XII.
Hypophyseal Artery	The superior and inferior hypophyseal arteries are found adjacent to the pituitary. These arteries give rise to capillaries that branch within the neural part of the pituitary where they pick up hormones. The arteries empty into portal veins that empty into a nearby venous sinus, or into another capillary bed in the glandular pituitary, which finally joins with a venous sinus.
Hypothalamic Locomotor Area (HLA)	A region of the caudal hypothalamus which when activated results in locomotion. It has strong connections to the midbrain locomotor area, and receives inputs from the ventral striatum and other limbic endbrain structures, and from other parts of the hypothalamus.
Hypothalamus	A subdivision of the diencephalon located at the base of the adult brain just below the subthalamus. It is a major controller of the autonomic nervous system and of the endocrine system *via* the attached pituitary organ. Its cells are important controllers of motivational states and of locomotor initiation.
Idiodendritic	Having distinct dendrites that are different in different brain structures. Such neurons are specialized in their functions, e.g., processing information for a particular sensory modality.
Idiotypic Cortex	Neocortical areas that are the most specialized in structure: the primary sensory areas and the primary

	motor cortex.
Iguana Midbrain Tectum Lamina	The Iguana is a reptile with an elaborately laminated midbrain tectum.
Immunohistochemistry	The localization of specific proteins in sections of tissues by using antibodies to those proteins. In the usual procedure, an antibody is conjugated to a peroxidase enzyme or to a fluorophore to enable visualization using a histochemical procedure or fluorescence microscopy.
Impedance (Middle Ear)	When two materials offer different impedances to sound energy transfer, more sound is reflected (not transferred) at the boundary. When impedances can be matched, the transfer of energy is optimized. This kind of matching between conduction of sound in air and in fluids is accomplished by the middle ear bones, attached to each other in lever arrangements. The improved impedance matching makes it possible for mammals to detect sound at much higher frequencies than reptiles or birds.
Implicit Learning	Similar in meaning to "procedural learning." Learning without much awareness of the changes in behavior that are occurring.
Inferior Colliculus (IC)	The caudal bump (little hill) at the surface of the midbrain on either side. It receives auditory information and projects to the thalamus and a few other places.
Inferior Fasciculus of the AOT	Retinofugal axons traveling caudally below the cerebral peduncle at the lateral margin of the hypothalamus. They terminate in the medial terminal nucleus of the AOT, just medial to the substantia nigra. In many non-mammals, these axons are called the basal optic root.
Inferior Longitudinal Fasciculus	Transcortical association fibers that interconnect prestriate and posterior parietal areas with inferior temporal cortex.
Inferior Olive	A pre-cerebellar cell group of the ventral hindbrain caudal to the pons. It forms an olive shaped bump on the ventral surface of the human hindbrain located caudal to auditory system structures. It receives diverse inputs important in motor control and projects to the cerebellar cortex by means of "climbing fibers" –which wrap like vines around Purkinje cell dendrites. Action potentials of climbing fibers excite the Purkinje cells through multiple excitatory synapses per axon.
Inferior Olive	A pre-cerebellar cell group near the ventral surface of

	the hindbrain caudal to the trapezoid body. It receives diverse inputs, many of them sensory. Its large axons end in the climbing fibers of the cerebellar cortex—the main excitatory input to the Purkinje cells. The inferior olive causes an olive shaped bump on the ventrolateral surface of the human hindbrain.
Initial Focalization	During development of an axon, the losing of rudimentary widespread branches and the augmentation of branches in one small region.
Innate Releasing Mechanisms	An ethological term for inherited brain mechanisms that respond selectively to particular stimulus configurations and can trigger particular movements depending on the motivational state.
Insectivores	The order *Insectivora* included many small, primitive mammals that ate mostly insects. Now, taxonomists do not use this classification because diverse mammalian species eat insects and some of them need to be classified in different groupings. Insect-eating mammals in an order containing several families of insect eaters include hedgehogs, moles and shrews.
Inside-Out Pattern	The pattern of neuronal migration in the neocortex in which layer 6 cells migrate first, followed by layer 5 cells, followed by layer 4 cells, etc. Thus, later-born cells migrate past the earlier born cells in the cortical plate.
Insular Neocortex	Cortical areas that are hidden within the Sylvian fissure and overlie the putamen. Much of the insular cortex is paralimbic in nature (adjacent to the olfactory cortex), with particularly close connections to and from the amygdala. Anteriorly it includes the gustatory neocortical area, which extends into the prefrontal cortex in the upper bank of the fissure (the frontal operculum). Some of the olfactory cortex is also included at the anteroventral margin of the insula—the "limen insulae" or threshold of the insula (see figure 19-10).
Integrative action	Action of the central nervous system that results in coordination of disparate functional activities.
Intensity Coding	In auditory nerve axons, different intensities are coded by different rates of firing of action potentials, and also by differences in the number of axons firing, since these axons have different thresholds.
Intermediate Layer	In the embryonic CNS, the intermediate layer is a layer of migrating cells and of developing axons.

Internal Capsule	Axons to and from neocortex as they course through the corpus striatum.
Internal Granular Layer	Layer four of the neocortex, containing small stellate cells. This layer is particularly prominent in primary sensory areas. It is the main recipient of most thalamocortical axons in mammals. Its cells are excitatory interneurons with axons that ascend into supragranular layers 2 and 3.
Internal Model	The neocortical representation of the world outside the organism in neuronal activity that constitutes an ongoing simulation of the perceived world. The model is constantly being updated by sensory input. It makes possible anticipation of sensory inputs and planning of actions.
Internal Pyramidal Layer	Layer 5 of the neocortex. It is the output layer of the cortex, as its pyramidal cells give rise to projections to various subcortical targets. These cells throughout the cortex project to the dorsal striatum and to the pons. In many areas, especially those of the sensory and posterior association areas, some layer 5 pyramidal cells project to the superior colliculus as well as to the subthalamus and the midbrain reticular formation. Layer 5 cells of central neocortical areas (motor and somatosensory areas) also project more caudally, to the hindbrain and spinal cord.
Interneuron	Broadly defined, an interneuron is any neuron in the nervous system that is not a primary or secondary sensory neuron and not a motor neuron. The term is often used more specifically for interneurons with short axons.
Interpenduncular Fossa	The recessed surface of the midbrain at its base between the cerebral peduncles. It extends from the anterior border of the pons to the mammillary bodies. Its penetration by many blood vessels, branches of the posterior cerebral artery, gives this region the name “posterior perforated substance.”
Intersegmental Reflex	A reflex arc of the spinal cord (carrying information from the sensory to the motor side) that involves connections in more than one spinal segment.
Interventricular Foramen	The confluence of the forebrain ventricles. It interconnects the lateral ventricles and the third ventricle. Also called the Foramen of Monro.
Intralaminar Nuclei	The intralaminar and midline nuclei of the thalamus constitute the more ancient thalamic cell groups. These nuclei have reciprocal connections with the midbrain reticular formation, and they project to the

	corpus striatum and to the neocortex. The projections to neocortex are more widespread than are the projections from more recently evolved thalamic cell groups.
Ipsilateral	On the same side.
Isodendritic	The dendritic pattern of brainstem reticular formation neurons is isodendritic, with few dendrites per neuron, all similar to each other ("iso" means same). The structure of reticular formation neurons resembles that of motor neurons. Like motor neurons, the reticular formation neurons receive very diverse inputs.
Jacobson's Organ	A sensory structure located at the base of the nasal cavity. It is connected by a duct opening in the roof of the mouth in many species. It responds to pheromones in the liquids of the mouth. The receptors are primary sensory neurons with axons that connect with the accessory olfactory bulb.
Juxtallocortex	A term sometimes used for transitional cortex located in-between the 6-layered neocortex and the allocortex—the various limbic cortical areas that have fewer than six cell layers. Paralimbic cortex is a similar, more commonly used, term.
Koniocortex	Neocortical areas that have a very thick granular layer 4 (the granular cortical areas)
Lamellar Body	A structure in the epithalamic region of amphioxus. Includes a light-sensitive region.
Lamellipodia	Plural form of "lamellipodium." Some growth cones are dominated by lamellipodia and have few filopodia.
Laminar Focalization	Growth of more branches of an axon in one layer with loss of branches in other layers of the tissue.
Late Amygdalar Lesion	A lesion of the amygdala that occurs later in life, e.g., after maturity is reached.
Lateral Apertures	Small openings in the roof plate of the fourth ventricle, one on each side under the lateral edges of the cerebellum. CSF flows through these apertures from the ventricle to the subarachnoid space that surrounds the entire CNS. The lateral apertures are also known as the foramena of Luschka.
Lateral Brainstem Pathways	Axons that course longitudinally through the lateral parts of the hindbrain, including the rubrospinal and lateral reticulospinal tracts.
Lateral Forebrain Bundle	The group of axons that carries outputs of the endbrain pallium and subpallium to more caudal structures. In mammals, the lateral forebrain bundle

	contains the axons from the neocortex that project to 'tweenbrain, midbrain, hindbrain and spinal cord. The bundle of axons is given different names at different levels of the neuraxis. [See chapter 12.]
Lateral Ganglionic Eminence	A prominent zone of cell proliferation in the mammalian embryo, found next to the ventricle in the location of the future corpus striatum.
Lateral Horn	In a section of the spinal cord between the first thoracic and the second or third lumbar segment, the gray matter shows not only a dorsal horn and a ventral horn, but also a small lateral horn or cell column. The neurons of the lateral horn (extending from T1 to L2-3) are preganglionic motor neurons of the sympathetic nervous system. They project to the paravertebral and prevertebral ganglia.
Lateral Hypothalamus	The more lateral division of the hypothalamus that contains the rostral-to-caudal running axons of the medial forebrain bundle. It contains neurons of several different groups scattered among the axons.
Lateral Inhibition	When each neuron in an array of neurons inhibits its neighbors, this lateral inhibition results in a sharpening of contrast between more active and less active regions.
Lateral Lemniscus	A band of myelinated axons of the auditory system located at the brainstem surface that originate in cell groups of the trapezoid body and terminate mainly in the nuclei of the lateral lemniscus and in the inferior colliculus.
Lateral Nucleus of the Amygdala	A part of the amygdala derived from the embryonic pallium, the lateral nucleus receives visual, auditory and somatosensory inputs and projects not only to other amygdalar regions but also to the ventral prefrontal cortex.
Lateral Nucleus of the Amygdala (and audition)	The lateral nucleus of the amygdala receives multiple sensory inputs from the association areas of the neocortex: auditory, visual, somatosensory. It also receives inputs carrying taste and visceral sensory information from gustatory neocortex. It receives direct projections carrying auditory input from the medial geniculate nucleus of the thalamus, a projection that is larger in more primitive mammals. Similar afferent projections from lateral-posterior thalamus carry visual information. The lateral nucleus projects to the central nucleus as well as to other areas through its projections to basal and medial nuclei of the amygdala.

Lateral Olfactory Tract	See "olfactory tract" defined for chapter 18.
Lateral Pallium	The embryonic lateral pallium forms the olfactory cortex.
Lateral Posterior Nucleus (LP)	A caudal portion of the lateral group of thalamic nuclei in mammals, the LP is found dorsal and medial to the LGd. It receives dense projections from the superior colliculus. This is the region of the thalamus that expands into the large pulvinar nucleus in primates.
Lateral Posterior Nucleus (LP)	A particular portion of the lateral group of nuclei of the mammalian thalamus. It is located adjacent to the dorsal nucleus of the lateral geniculate body. The LP receives a strong projection from the superficial layers of the superior colliculus (layers that receive direct retinal input), and a sparse projection from the retina. It projects to neocortical areas adjacent and lateral to the primary visual cortical area (e.g., area 18).
Lateral Superior Olive	A cell group in the ventral part of the rostral hindbrain that receives inputs from the ventral cochlear nucleus. The lateral superior olive neurons receive inputs from both right and left sides, and are sensitive to right-left differences in amplitude of a sound reaching the two ears.
Lateral Tegmental System (Axons)	Ascending axons of the auditory system that arise in rostral hindbrain reticular formation and/or the nuclei of the lateral lemniscus and terminate in the posterior nuclear group (Po) of the caudolateral thalamus and in the medial nucleus of the medial geniculate body. These thalamic cell groups contain many multimodal neurons.
Lateral Terminal Nucleus of the Accessory Optic Tract	A small group of neurons located at the lateral edge of the midbrain just ventral to the axons from the inferior colliculus (the brachium of the IC) as they near their terminal sites in the medial geniculate body of the thalamus.
Lateral Ventricles (left and right)	The CSF-filled ventricles of the cerebral hemispheres.
Lateral Ventricular Angle Region	A zone of cell proliferation in the mammalian embryo, found next to the ventricle in the subpallial region just lateral to the lateral ganglionic eminence and continuous with the zone of mitotic cells of the neocortex. Some migrating neurons from this region reach the adjoining neocortex; others migrate to the amygdala and claustrum.
Lateral-dorsal nucleus	The most anterior parts of the lateral thalamic nucleus

(Anterior Lateral Thalamus)	is called the lateral-dorsal nucleus (LD). It receives input from the pretectal area. It is adjacent to the anterior nuclei of the thalamus, in particular the anterodorsal nucleus. Input from the cortex represents head-direction in the local environment.
Laterodorsal Nucleus (LD) in relation to Papez' Circuit	See "Pretectal Nuclei in relation to Papez' Circuit.
Lemniscus	A ribbon or band of axons in the CNS. The term is used for pathways ascending to the brain carrying sensory information from the spinal cord, usually fairly compact groups of myelinated axons. It is also applied to pathways ascending to the forebrain from the hindbrain (the trigeminal lemniscus). Examples: the medial lemniscus, the spinothalamic tract, the spinoreticular pathway, spinocerebellar tracts. There is also a "lateral lemniscus" within the auditory pathways of the brainstem.
Lentiform Nucleus	The dorsal striatal and pallidal structures located lateral to the internal capsule fibers are together called the lentiform nucleus. In the human brain and in the brains of other large mammals, it includes the putamen and the external and internal segments of the globus pallidus.
Limbic Associated Membrane Protein (LAMP)	The gene for LAMP is expressed in paralimbic and limbic cortical and subcortical areas. Its expression as a cell-surface glycoprotein determines the developmental fate of the areas where it is found. It was the first example of a specific genetic factor that separates different cortical regions in development. (Discovered by Pat Levitt and co-workers)
Limbic Endbrain	The structures of the telencephalon which are closely connected with the hypothalamus. These structures include structures of the olfactory system. Limbic endbrain structures are located at the margins (the limbus) of the cerebral hemispheres and do not include the neocortex in mammals.
Limbic Midbrain Structures	The central gray area (periaqueductal gray) and the ventral tegmental area. These structures are closely connected with the hypothalamus. They also receive inputs from limbic endbrain structures.
Limbic System Arousal	Stimulation of limbic system structures in the midbrain (central gray area, ventral tegmental area) causes sympathetic nervous system arousal and other effects of the ascending reticular activating system. In addition, limbic arousal results in motivational

	changes and rewarding effects (especially from VTA) or punishing effects (from parts of CGA). This arousal can be caused not only by electrical or chemical stimulation but also by key stimuli that trigger instinctive behaviors (e.g., tastes, smells, sexual contacts), or stimuli associated with learned responses (e.g., calling of your name). The effects do not show much habituation.
Limbic Telencephalon	Endbrain structures strongly connected to hypothalamus. Limbic system structures of the endbrain include both cortical and subcortical structures. The cortical structures include olfactory and entorhinal cortex, parahippocampal cortex and the hippocampus. The subcortical structures include the amygdala, the septal nuclei, and the various structures of the ventral striatum and ventral pallidum.
Line of Gennari	A layer of transverse intracortical fibers located within layer 4 is particularly prominent in area 17 (striate cortex; area V1), and can be seen with the naked eye during human brain dissections. This layer of fibers in visual cortex is called the Line of Gennari, or the Stria or Band of Gennari, after the Italian medical student who first called attention to it. It is the stria (band, stripe) that gives the striate cortex its name.
LMAN	The lateral magnocellular nucleus of the anterior nidopallium in birds. LMAN is important in the learning of song, which it controls by its projections to the nucleus robustus of the arcopallium.
Local Reflex Channel	Information in a local reflex channel flows from primary sensory neurons to secondary sensory neurons in one segment of the CNS, and from there to motor neurons of the same segment either directly or involving one or more additional synapses. Example: a segmental reflex of the spinal cord.
Locus Coeruleus	A small group of noradrenergic neurons located in the rostral hindbrain, in the periventricular gray area ventral to the cerebellum. These neurons are project to most structures of the CNS (but not to the dorsal striatum), and are the main source of norepinephrine (noradrenaline) in the forebrain.
Long Term Depression (LTD)	When electrical stimulation of axons has particular properties, different from those that cause LTP, synaptic depression may result. For example, high frequency stimulating pulses can cause potentiation

	whereas after a train of very low frequency pulses, e.g., one per second, depression can occur at the same synapses.
Long Term Potentiation (LTP)	Enhanced amplitude of excitatory postsynaptic potentials in certain neurons after activity of specific afferent axons. The activity is usually a rapid firing of axons contacting the neuron. The enhancement persists for at least a few minutes, usually more than an hour, and as long as many days or even weeks. LTP has been studied intensively in hippocampal formation connections.
LP projections to neocortex: Type 1 Axon	In the hamster, the lateral-posterior nucleus (LP), with inputs from the superior colliculus, sends axons to several peristriate cortical areas such as area 18a. When the axons reach a terminal area, they turn toward the pial surface, leaving the white matter, with dense terminations in layers 4 and 1 and less dense terminations in layer 6, and some in layers 5, 3 and 2.
LP projections to neocortex: Type 2 Axon	In the hamster, the thalamic nucleus LP and/or the adjacent deeper lying posterior nucleus gives rise to a second type of axon. This second type courses tangentially in the superficial part of the white matter and deeper parts of layer 6 throughout the posterior cortex, encompassing somatosensory, auditory and visual areas and areas in between. Terminations in layer 6 appear to be very widespread. However, detailed information on this type of axon is lacking.
Macrosmatic	Adjective describing a vertebrate animal, usually a mammal, with a relatively large olfactory system, including large olfactory bulbs.
Magnocellular Red Nucleus	The caudal, large-celled portion of the red nucleus. Source of the rubrospinal tract.
Map Compression	After brain damage that destroys part of a topographic representation in the CNS of a sensory surface, e.g., the map of the retina in the midbrain tectum, the entire map can become reorganized in the remaining tissue. Thus, the map is compressed. This happens after lesions very early in life in mammals, but it happens even in adult fish and amphibians. (It has also been reported in some reptiles.)
Map Expansion	In the example of the retinotectal projection described above, if the damage is a partial lesion of the retina, the map of the remaining retina will become spread out over the entire optic tectum (as seen from the surface). This happens only after very early damage in mammals, but it can happen in adult fish and

	amphibians.
Marginal Layer	In the embryonic CNS, the marginal layer is the most superficial layer, covered by pial cells. It contains few neurons but many cell processes (radial glia processes attached to the pial surface., dendrites, axons).
Mauthner Cells	A pair of very large neurons of the middle hindbrain of amphibians or fishes with axons that cross the midline and extend to motor neurons that activate escape movements. The axons have both chemical and electrical synapses.
Medial Brainstem Pathways	Groups of axons that course rostrocaudally through the medial parts of the hindbrain. These pathways include the tectospinal, vestibulospinal and other axons of the medial longitudinal fasciculus, fastigiospinal (from cerebellum) and reticulospinal tracts.
Medial Forebrain Bundle	The group of axons that carries outputs of the limbic endbrain structures to the hypothalamus and limbic midbrain areas. Ascending axons also follow this bundle.
Medial Ganglionic Eminence	A prominent zone of cell proliferation in the mammalian embryo, found next to the ventricle in the location of the future globus pallidus (output structure of the dorsal striatum).
Medial Geniculate Body (MGB)	Thalamic nucleus of the auditory system. It can be subdivided into several distinct parts (subnuclei).
Medial Geniculate Nucleus (MGN)	Also called the medial geniculate body (MGB), it is the major recipient of ascending auditory pathways in the mammalian thalamus.
Medial lemniscus	Ascending axons from the dorsal column nuclei to the ventral-posterior nucleus of the thalamus.
Medial Longditudinal Fasciculus	A bundle of axons, one on each side of the medial brainstem, that extends from the midbrain through the hindbrain and reaches the cervical levels of the spinal cord. Many of its fibers originate in the vestibular nuclei. Its connections with the three oculomotor nuclei on each side coordinate the movements of the eyes, and movements of the eyes with movements of the head.
Medial Magnocellular portion of the Mediodorsal Nucleus of the Thalamus (MDm)	The MD of the thalamus project to the prefrontal neocortex. MDm projects to the most ventral, including the orbital, parts of the prefrontal cortex. MDm receives inputs from the hypothalamus and from limbic endbrain structures including olfactory cortex.

Medial Pallium	The medial pallium of the vertebrate embryo develops into the hippocampus or hippocampal homologues.
Medial Pallium in a Bullfrog	The homolog of the mammalian hippocampus, the bullfrog's medial pallium is the thickest part of the pallium of the dorsal endbrain. It receives inputs from the adjacent dorsal pallium, the septum, olfactory regions, and the anterior thalamus.
Medial Pallium in a Marsupial	The hippocampal formation of marsupials is not separated dorsally from neocortical areas by a corpus callosum, but its structure is similar to what is found in other mammals.
Medial Pallium in a sharks and teleosts	The medial pallium in fish, amphibians and reptiles is the homolog of the mammalian hippocampus. In many species, it is not dominated by olfactory input. It has inputs from adjacent stuctures, the dorsal pallium on one side and the septal nuclei on the other, and from more caudal structures including the thalamic region.
Medial Superior Olive	A cell group in the ventral part of the rostral hindbrain that receives inputs from the ventral cochlear nucleus. The medial superior olive neurons receive inputs from both right and left sides, and are sensitive to the spatial position of the sound source (in the horizontal plane).
Medial Terminal Nucleus of the Accessory Optic Tract	The most ventral terminal nucleus of the AOT, located in the ventral midbrain between the ventral tegmental area and the substantia nigra.
Median Aperture	A small opening in the roof plate of the fourth ventricle in the region of the obex. The obex is at the caudal-most end of the hindbrain's widened roof plate. The opening is also known as the foramen of Magendie. CSF flows from the fourth ventricle into the subarachnoid space through this opening as well as through the lateral apertures.
Median Eminence	The most ventral region of the hypothalamus in the vicinity of the pituitary stalk. Axons of neurons in this region terminate on capillaries in the proximal part of the neuropituitary stalk and secrete hormonal factors that move through a portal vein to another capillary bed in the anterior (glandular) pituitary. There the hormonal factors cause the release of pituitary hormones into the general circulation. Hence, the substances produced in the median eminence are called releasing hormones.
Mediodorsal Nucleus of	The thalamic nucleus which projects to neocortex in

the Thalamus (MD)	front of the motor areas—the prefrontal cortex. The medial division of MD receives inputs from olfactory cortex, as well as other inputs.
Medulla oblongata	The caudal hindbrain, just above the spinal cord. The words mean the elongated core, or contents, of the bony enclosure (of the spinal column). The spinal cord, in these terms, is the medulla spinalis.
Mesencephalic Flexure (Cephalic flexure)	Early in development of the neural tube, it bends towards the ventral side, i.e., when seen from the dorsal surface the bend is convex upwards, with the dorsal surface of the midbrain in the convexity.
Mesencephalon	The midbrain
Mesoderm	The middle layer of the early embryo of a bilaterally symmetric animal. In chordates, it forms the notochord, the bones of the skeleton, muscle, connective and a few other tissues.
Meyer's Loop	Axons of the optic radiations found in the white matter of the neocortex of the temporal lobe. The "loop" forms during the development of the temporal lobe. These axons represent the upper part of the visual field (on the opposite side).
Microsmatic	Adjective describing a vertebrate animal, usually a mammal, with a relatively small olfactory system, including small olfactory bulbs. Microsmatic animals are less sensitive to odors that are the microsmatic animals.
Midbrain Expansion	Expansions of the midbrain occurred in vertebrate evolution because the midbrain had evolved neuronal groups where activity initiated movements important for survival and reproduction. These included locomotion, orienting and grasping movements. Sensory pathways to the midbrain evolved for control of these movements. Increases in the circuits of these sensorimotor interfaces resulted in enlargement of midbrain structures.
Midbrain Extrapyramidal Area	Neurons located medial to the main structure of the midbrain locomotor area (the pedunculopontine tegmental nucleus), less involved in locomotor control and more involved in other movements including turning of head and body.
Midbrain Locomotor Area (MLA)	A region of the caudolateral midbrain below the inferior colliculus. Activation causes locomotor movements. Most notably it receives inputs from pallidal structures (output structures of the striatum), from the hypothalamus, and from the superior colliculus, and also from the subthalamus and

	substantia nigra.
Midbrain Tectum	The midbrain roof. In many species, it is a layered structure over the midbrain ventricle. It is often called the optic tectum because the most superficial layers are dominated by inputs from the retina.
Middle Longitudinal Fasciculus	Transcortical association fibers that interconnect posterior parietal cortex with auditory and multimodal association areas of the superior and middle temporal gyri. The fasciculus also includes fibers that interconnect different parts of the temporal lobe association cortex.
Mitral Cell	The major secondary sensory neuron of the olfactory bulbs. The mitral cell axons form the lateral olfactory tract.
Molecular Layer	Layer one, the most superficial layer, of the cortex. It contains few neurons but many branches of dendrites of deeper-lying pyramidal cells, and axons that synapse with those branches. Axons from thalamus as well as axons from other cortical areas make axodendritic synapses in this layer.
Monoamine Systems	Systems of widely projecting axons using monoamine neurotransmitters. The monoamines are serotonin (5-hydroxytryptamine) and the catecholamines norepinephrine and dopamine.
Monocular Crescent	The most temporal part of the visual field of each eye—the part which does not overlap with the visual field of the opposite eye.
Monocular Deprivation	Elimination of patterned optic input to one of the two eyes, e.g., by lid suture.
Mooneye - what does it teach us?	The fresh water mooneye has a brain that is useful in comparative neuroanatomy for comparision with the brains of other fish in which the relative sizes of various structures differs.
Mormyrid Fish and Electroreceptors	The mormyrids are a family of African fishes that live in murky waters and depend heavily on detecting objects and prey around them by using their electrosensory abilities. Mormyrids have relatively large brains dominated by a very large cerebellum that is involved in decoding electrosensory signals. (Some mormyrids are called elephant fish because of their long snouts.) The electroreceptors are found in the lateral line, consisting of a row of receptor organs located along each side of the body.
Morula	The raspberry-like clump of dividing cells after fertilization of the egg.
Mosaic Evolution	When certain brain structures show evolutionary

	enlargements in a group of animals disproportionately when compared to the enlargement of the entire brain.
Mossy Fibers	The mossy fibers are the small axons that extend from neurons of the dentate gyrus to the neurons of CA3 of the hippocampus. (There are also mossy fibers that carry inputs into the cerebellum.)
Motivational States	Brain states controlled by limbic system structures, especially the hypothalamus.
Motor Acuity	A measure of the degree of dexterity of movements. The term is used by analogy with sensory acuity. More commonly, one refers to digital dexterity rather than the more general term "motor acuity".
Motor Neuron	A CNS neuron with an axon that synapses with muscle cells. Any CNS neuron with an axon that goes out of the CNS. If the axon connects with peripheral autonomic ganglion cells, it is called a preganglionic motor neuron.
Motor Neuron Pools	Groups of spinal or hindbrain motor neurons that can activate a particular somatic movement.
Motor System Hierarchy	The entire network of neurons of the CNS that control somatic movements, extending from the neocortex to motor neurons of the hindbrain and spinal cord.
Multiform Layer	Layer 6 of the neocortex. It receives some input from the thalamus, and strong input from intracolumnar axons from the overlying layer 5. It contains cells of various shapes, and projects to the thalamus, also to other neocortical areas and to the claustrum.
Multimodal Association Area	In sensory areas of the neocortex, the multimodal association areas receive major inputs from unimodal areas of two or more modalities. In addition, multimodal association cortex receives inputs from lateral thalamic cell groups. In primates, the pulvinar nucleus of the thalamus is the major source of such inputs to the posterior multimodal association areas.
Multimodal Association Areas	Neocortical areas that receive a mixture of sensory inputs so that single neurons may respond to a least two different modalities. The multimodal areas receive sensory inputs from unimodal association areas and from the thalamus (MD and Pulvinar), and are interconnected with each other as well as with paralimbic cortex.
Myelin	The ensheathment of axons by membranes of glial cells that speeds the conduction of action potentials. In the PNS, the glial cells that form myelin are

	Schwann cells. In the CNS, myelin is formed by the membrane protrusions of oligodendrocytes. The myelin is not continuous along an axon, as regularly spaced short nodes of axonal membrane are left unsheathed. This results in the action potential jumping from node to node. Where there is myelin the depolarization spreads decrementally and very rapidly, whereas at each node the depolarization is complete.
Myeloarchitecture	Fiber architecture using histological stains for the myelin sheath around axonal membranes.
Myelogenesis	The initial appearance of myelin in a brain region. Myelogenesis can be determined by histological stains. More sensitive methods of detection of myelin have used antibodies to myelin-specific proteins. Most sensitive examination of myelin formation around axons has involved electron microscopy.
Myoid Cell	Cell that is like the more specialized cells in muscle tissue in its ability to contract. Myoid cells in Cnidarians and sponges may also have a special sensitivity to sensory stimulation.
Myotome	The muscle fibers innervated by a single pair of ventral roots (of one spinal segment, involving one spinal nerve on either side).
Nauta method	A method of staining degenerating axons in the CNS: The fixed tissue is impregnated with silver nitrate, then a reduction step results in deposition of silver in the axons. Prior to silver impregnation, an oxidation step results in suppression of the staining of normal axons, so the degenerating axons become more visible. Nauta methods were modified at MIT by Robert Fink and Lennart Heimer so they became more sensitive, staining even the terminal boutons in most axonal systems if the degeneration time was right.
Neocortical Areas	Distinct regions or areas of the neocortex that can be distinguished by their cytoarchitecture and/or fiber architecture or chemical contents. The nature of inputs and outputs is frequently different for different cortical areas. In more recent research, some of these areas have been found to have distinct genetic determinants.
Neocortical Function	Looked at broadly, major neocortical functions include high resolution perception and fine motor control, and cognitive abilities that include anticipation of inputs and planning of actions.

Neolemniscus	A term that can be misleading; it is sometimes used for the dorsal column-medial lemniscus pathway in mammals although it is not really “new” in mammals—but it becomes larger than in amphibians and reptiles. It carries somatosensory information from the spinal cord to the thalamus. Its conduction rates are faster than those of the spinoreticular and spinothalamic tracts.
Neopallium	The neocortex of mammals. The “new mantle.” (The word neocortex means “new bark.”)
Netrin	“Netrins are a class of proteins involved in axon guidance. They are named after the Sanskrit word "netr", which means "one who guides." … Netrins are chemotropic; a growing axon will either move towards or away from a higher concentration of netrin.” [From a Wikipedia entry.]
Neural Crest Cells	Neural plate cells at the lips of the neural groove do not become incorporated into the neural tube. They become neural crest cells, and form the elements of the peripheral nervous system including glial cells (Schwann cells) and also pigment cells that migrate into the embryonic skin (the melanocytes). In the head region the neural crest cells form cartilage, bone and smooth muscle (that includes some smooth muscle of the heart vessels, the aorta and the pulmonary arteries).
Neural Groove	The neural plate develops an invagination along the back of the chordate embryo, caused by inductive influences from the underlying notochord. The result is the neural groove.
Neural Plate	Differentiation of the primitive ectoderm above the forming notochord is characterized by a thickening of the ectodermal cells, forming the neural plate.
Neural Tube	The initial form of the embryonic CNS. The neural tube forms from an invagination of the surface ectoderm along the back of all chordates, a process induced by molecular influences of the underlying notochord.
Neural Tube	The tube, initially one-cell thick, formed by an invagination of neural plate cells above the notochord. It develops into the central nervous system.
Neuraxis	The orientation of the rostro-caudal axis of the central nervous system. Early in development this axis bends in specific places (the flexures).
Neuroblast	An embryonic neuron, not yet differentiating into an

	adult form.
Neuroethology	Scientific studies of the neural basis of natural behavior patterns of animals. These behaviors, similar in all members of a species, are inherited (instinctive) but can be influenced by learning.
Neurohypophysis	The neural portion of the pituitary organ; the posterior pituitary.
Neuroid Cell	Cell that has some properties of neurons in more specialized neural tissue. This includes conduction of membrane potentials along cell processes that resemble axons.
Neuromere	A segment of the developing CNS. Segments have been defined by anatomical structures, some of which are transient, and by gene expression patterns. Rhombomeres are examples of neuromeres.
Neuromodulator	A neuromodulator substance is not a neurotransmitter but it can alter the synaptic actions of an axon.
Neuropil Segment	Since the dendrites of reticular formation neurons tend to lie in planes parallel to frontal sections, it has been postulated that this indicates some kind of functionally different segments of the neuropil (the tissue in between neuronal cell bodies, where dendrite and axons connect).
Neurotrophins	A particular family of growth factors important in the development of both PNS and CNS. They are also important in some types of neuronal plasticity in the mature nervous system. They bind to trk receptors in cell membranes, which results in many of their effects. Some of the effects result from uptake of the neurotrophin molecules and their transport to the cell body.
Neurula	The gastrula becomes a neurula when it forms the precursors of a nervous system. See "neurulation."
Neurulation	The earliest appearance of the central nervous system that results from induction of changes in ectodermal cells by molecules diffusing from the notochord. It begins with a thickening of the cells, forming the neural plate. The neural plate invaginates to form the neural groove above the notochord, which leads to the formation of the neural tube and the neural crest cells.
Nidopallium	The "nested pallium" in birds, a large region located below the endbrain ventricle. Connections from visual, auditory and somatosensory systems show the nidopallium to be similar in function to parts of the neocortex in mammals (especially more lateral parts).

Nidopallium	The "nested pallium"—the large region in the endbrain of a bird located below the lateral ventricle. Sensory afferents to the nidopallium include visual (centrolaterally), auditory (caudomedially), somatosensory (anteriorly).
Nigrostriatal Tract	The pathway from the substantia nigra—mainly from the pars compacta—to the dorsal striatum. The axons release dopamine at their terminals when activated.
Nigrotectal Tract	The axons that come from the pars reticulata of the substantia nigra and terminate in the superior colliculus. The axons are GABA-ergic, and therefore inhibitory. (Hence, the dorsal striatum influences the colliculus by inhibiting and inhibitory pathway.)
Nigrothalamic Tract	Axons from the pars reticulata of the substantia nigra to the dorsal thalamus. These axons are GABA-ergic, and end in the VM and VA (ventromedial thalamic nucleus and the ventral anterior nucleus). VM has widespread projections to the neocortex, especially to central sensorimotor areas, and the VA projects to premotor areas.
Nissl stain	A histological stain using analine dye that binds selectively to Nissl bodies in neuronal cell bodies. The Nissl bodies are ribosomal RNA associated with the rough endoplasmic reticulum in neuronal cell bodies and the proximal parts of dendrites.
Nodulus	The medial portions of the vestibular part of the cerebellar cortex, located at the caudal margin of the structure, which in large animals becomes overhung by the remainder of the cerebellar cortex.
Non-limbic Arousal	Midbrain stimulation outside the limbic areas, in the reticular formation, causes sympathetic nervous system arousal with widespread changes in the forebrain, but without strong rewarding or punishing effects. Also, the effects tend to habituate with repetition of the stimulus. This arousal can be caused not only by electrical or chemical stimulation but also by novel sensory stimuli.
Norepinepherine (NE)	The catecholamine neurotransmitter, also called noradrenaline, of the sympathetic-nervous-system ganglia. NE is also the neurotransmitter of a widely projecting axon system in the CNS. A major locus of the cell bodies is the locus coeruleus of the rostral hindbrain.
Notochord	A cartilaginous rod derived from the embryonic mesoderm that runs along the back of all developing chordate animals. Above the notochord, the neural

	tube (CNS) forms. The vertebral arches and intervertebral disks form around the notochord in vertebrate development.
Nuclear Translocation	The movement of the cell nucleus through the elongated cell. Migration of neurons in many regions of the developing CNS occurs by nuclear translocation, when the embryonic neuron is attached to both the pial surface and the ventricular surface, and the cell body moves from a position next to the ventricle towards a position closer to the pia. At some point the attachments to ventricular and pial surfaces are lost and the cell forms dendrites and an axon.
Nuclei	Plural of "nucleus"—a group of CNS neuronal cell bodies that can be distinguished from surrounding cells in a cell-stained histological section.
Nucleus Accumbens	In mammals, the nucleus accumbens is the largest part of the ventral striatum, with major inputs from other limbic system structures including the amygdala, hippocampus and hypothalamus. Known to be important in control of mood and emotion.
Nucleus Ambiguus	The caudal-most motor nucleus of the branchial motor column. It is difficult to identify in cell-stained sections, hence its name (which is spelled almost the same as ambiguous). The motor neurons of the ambiguus nucleus innervate muscles of swallowing and vocalization (of the pharynx and larynx), *via* axons in cranial nerves 9 and 10. Additional axons from nucleus ambiguus contribute to the spinal accessory nerve (cranial nerve 11), joining axons that originate in a branchial motor nucleus within the cervical spinal cord (and ascend into the cranium before exiting as a cranial nerve).
Nucleus Ambiguus	A branchial motor nucleus of the hindbrain that innervates muscles of swallowing and vocalization. The nucleus forms a long column of neurons, small in cross section and therefore difficult to distinguish in Nissl-stained sections. Axons from this nucleus pass through the 9^{th} and 10^{th} cranial nerves primarily to the pharynx and larynx.
Nucleus Basalis	The basal nucleus of Meynert is located in the basal forebrain, anterior to the optic chiasm, and extends caudally in the substantia innominate (between the amygdala and hypothalamus). It contains large cholinergic neurons that project very widely to the neocortex (see chapter 17 on brain states).
Nucleus Basalis of	A group of acetylcholine-containing neurons in the

Meynert (nucleus basalis)	basal forebrain. These neurons project diffusely to most or all of the neocortex.
Nucleus Bulbocavernosis (Bulbospongiosus)	The cell group in the spinal cord that innervates the muscle in the genital area that causes vascular engorgement during sexual excitement. This nucleus is considerably more prominent in males than in females, a fact initially reported for rats.
Nucleus Centralis Lateralis (CL)	A cell group of the paleothalamus, known structurally as the midline and intralaminar nuclei. CL is one of the intralaminar cell groups, located just lateral to the mediodorsal thalamic nucleus in mammals.
Nucleus Laminaris	Auditory cell group in the dorsal hindbrain of birds near the cochlear nuclei. The neurons are arranged in a line, with dorsal dendrites that receive axonal connections from the ipsilateral magnocellular cochlear nucleus and ventral dendrites that receive axonal connections from the contralateral magnocellular cochlear nucleus. The cells respond most strongly to coincidence of inputs from the two sides. Responses are maximal for sounds coming from specific azimuthal positions.
Nucleus of the Diagonal Band	The nucleus of the diagonal band of Broca is a basal forebrain cell group containing cholinergic, GABA-ergic and glutamatergic neurons. It is seen as an elongated structure in the ventromedial corner of a section of the endbrain, with a horizontal limb and a vertical limb. The vertical limb extends towards the medial septal nucleus. Like the cholinergic cells in the medial septal nucleus and in the basal nucleus of Meynart, axons from the diagonal band have widespread projections to neocortex and to hippocampus. The hippocampal theta rhythm seems to be driven by these axons.
Nucleus of the Lateral Olfactory Tract (nLOT)	A rostral extension of the olfactory part of the amygdala which projects to the basolateral amygdala and to the ventral striatum, and is reciprocally connected to the main olfactory bulb (not the accessory bulb).
Nucleus of the Optic Tract (NOT or nOT)	Neurons embedded in the optic tract fibers as they course over and through the pretectal area just rostral to the superior colliculus. The neurons of NOT are activated by movement of a large part of the visual field of an eye in temporal to nasal direction, and are inhibited by movement in the nasal to temporal direction. The neurons are sensitive to any changes in horizontal head direction.

Nucleus of the Solitary Tract	The column of secondary sensory neurons in the hindbrain (the visceral sensory column) that receives inputs from the visceral organs and from primary sensory neurons of the gustatory system. The rostral part of the nucleus of the solitary tract is often called the gustatory nucleus.
Nucleus Ovoidalis	The nucleus of the avian thalamus that receives auditory projections from the midbrain's torus semicircularis (comparable to the mammalian inferior colliculus).
Nucleus Robustus	The cell group of a songbird's arcopallium that controls singing by direct projections to the portion of the hypoglossal nucleus that innervates the syrinx in the throat. The robust nucleus also projects to midbrain auditory structures.
Nucleus Rotundus	A cell group of the dorsal thalamus in birds and reptiles that receives visual input from the optic tectum of the midbrain and projects to part of the dorsal ventricular ridge (nidopallium of birds).
Obex	The point at which the roof plate of the hindbrain narrows and the spinal canal appears. In this region major decussations occur: the decussations of the medial lemniscus axons and of corticospinal axons.
Object Identity	Sensory characteristics that distinguish any material object including a living organism, so it is considered as a single entity.
Octaval System	In mammals, the auditory and vestibular systems. The peripheral structures give rise to the two portions of the 8^{th} cranial nerve: the auditory and vestibular portions.
Octopus cell, globular bushy cell, multipolar cell, spherical bushy cell	Distinct cell types of the ventral cochlear nucleus, each with different responses to inputs from auditory nerve axons.
Ocular Dominance Columns	Columns of neocortical cells in area 17 that receive geniculocortical input that originated in one or the other eye. When made visible by a neuroanatomical tracing method and seen from the surface, the ocular dominance columns form a pattern of stripes, like the stripes of a zebra's coat.
Olfactocentric cortical regions	Centered on, i.e., having connections to, the olfactory cortex, ventral striatum, or amygdala. The olfactocentric paralimbic regions project to those structures and are interconnected with neocortical regions that store information on object values.
Olfactory Bulb	A protrusion of the endbrain anteriorly that is a pallial structure that receives inputs from primary sensory

	axons arising from the primary sensory neurons of the nasal epithelium. The outputs from the olfactory bulbs come mainly from mitral cells, which have axons that project widely to the most superficial layers of the olfactory cortex.
Olfactory Bulb	The most rostral structure of the vertebrate endbrain, where axons from the olfactory receptor cells of the olfactory epithelium terminate. These axons form cranial nerve 1.
Olfactory Cortex	The cortex that receives direct projections from the olfactory bulbs. The projection axons are from secondary sensory neurons of the bulbs—mostly mitral cells. In most vertebrates, olfactory cortex can be seen most easily in a ventral view of the forebrain.
Olfactory Cortex	The cortex of the endbrain that the mitral cells of the olfactory bulb projects to. The largest part of the olfactory cortex is called the piriform cortex, or the cortex of the piriform lobe.
Olfactory Filaments	A name for the tiny, unmyelinated axons of the primary sensory neurons of the olfactory epithelium that connect to the olfactory bulb.
Olfactory Tract	Axons of secondary sensory neurons of the olfactory bulb. Often called the lateral olfactory tract, this tract forms a visible white band, rostro-caudally oriented, just behind the olfactory bulb. It also contains axons from endbrain structures that connect to cells in the olfactory bulb. (The latter are called centrifugal axons.)
Olfactory Tubercle	The ventral-most part of the ventral striatum, reaching the ventral surface of the basal forebrain. Its surface layers receive input from the olfactory bulb.
Olfactory Tubercle	A structure located at the surface of the basal forebrain rostral to the optic chiasm. Axons from the olfactory bulb terminate in its most superficial layer. It is part of the ventral striatum.
Ontogeny	Development of an organism or biological entity.
Optic Radiations	The axons from the lateral geniculate body (dorsal nucleus of LGB) through the internal capsule and neocortical white matter to the striate cortex in the occipital lobe. Also called the geniculostriate pathway.
Optic Tract	The axons from the retina after they pass through the optic chiasm become the optic tract.
Order of Differentiation (in Mammalian Neocortex)	When cells of the cortical plate differentiate into mature neurons, the differentiation follows an inside-out order, repeating the order of cell migration. Thus,

	in the first 5 postnatal days, Syrian hamster brains show a differentiation of layers 5 and 6 in the visual cortex whereas the more superficial layers retain the appearance of the undifferentiated cortical plate.
Organ of Corti	The Structural complex running down the center of the cochlear tube that contains the auditory receptor cells—the hair cells—and the endings of 8^{th} nerve axons. Sound vibrations in the cochlear fluid result in shearing forces on the hair cells, which are placed between the basilar and tectorial membranes.
Origins of the Corpus Striatum	The most primitive part of the corpus striatum is postulated to be the olfactory recipient portions in the ventral striatum. It linked the olfactory system to motor systems; this link probably became a plastic one very early in evolution. Striatal complexity increased greatly with the addition of non-olfactory inputs, which led to the differentiation of the dorsal striatum.
Orthodromic	In the right direction, i.e., in the direction that nerve impulses normally travel.
Ossicles	The tiny bones of the middle ear in mammals.
Otic Placodes	Local thickenings of the epithelium of the embryonic head that form the peripheral portions of the auditory and vestibular systems.
Oval Window	The oval-shaped membrane where the stapes of the middle ear in mammals attaches. The membrane separates the air-filled middle ear cavity from the upper part of the fluid-filled cochlea.
Oxytocin	A hormone produced by neurons in the supraoptic and paraventricular nuclei of the hypothalamus and released into the bloodstream by their axonal endings in the posterior (neural) pituitary. The hormone's best known functions are the stimulation of contractions of the uterus during the birth process and of milk release in response to nipple stimulation during nursing.
Pallial Amygdala	Portions of the amygdala that develop from the embryonic pallium (lateral and ventral pallium): the cortical, lateral and basal nuclei of the amygdala. The projections from these structures are glutamatergic.
Pallium	The pallium (Latin for cloak) of the developing endbrain is the layered structure at the surface, most of it above a ventricle. It develops into various types of cortex and also some nuclear structures below parts of the cortex.
Pallium and Subpallium	The pallium includes all the cortical areas that

	developed above, and also dorsolateral and dorsomedial to the lateral ventricle of the cerebral hemisphere. Subpallial regions are non-cortical areas that developed from the ventral, ventrolateral and ventromedial parts of the endbrain neural tube. They are located mainly below the lateral ventricle.
Parabrachial Nucleus	Cell group of the rostral hindbrain (at the border with the midbrain) with input from the nucleus of the solitary tract. Part of the nucleus receives taste inputs. Projections from this nucleus to the forebrain go to the ventral posteromedial thalamus, the hypothalamus and the amygdala. The parabrachial nucleus gets its name from its location next to the brachium conjunctivum—axons of the superior cerebellar peduncle, which project to the midbrain and 'tweenbrain.
Parafascicular Nucleus	The caudal-most cell group of the intralaminar nuclei of the thalamus. This nucleus is enlarged in large primates, forming the centrum medianum or centromedian nucleus. This nucleus together with the other intralaminar nuclei of the thalamus are very important for maintaining arousal and attentiveness.
Parahippocampal Gyrus	Sometimes called the hippocampal gyrus, this gyrus in monkeys, apes and humans includes several cortical areas near the hippocampus, including entorhinal cortex, presubiculum, and several other areas (e.g., retrosplenial and perirhinal areas). In other species, other areas are named, such as the postsubiculum in rodents (the dorsal part of the subiculum). The subiculum is sometimes included in the parahippocampal gyrus but it is more properly a part of the hippocampus itself.
Paralimbic Areas	Cortical areas located next to neocortex on one side and to limbic areas on the other. Paralimbic areas are interconnected with association areas of the neocortex, especially with multimodal areas, and they also have reciprocal connections with limbic system structures. The cingulate gyrus and retrosplenial areas are paralimbic, with close interconnections with the hippocampus and entorhinal cortex.
Parasympathic Nervous System	The cranio-sacral portion of the autonomic nervous system. Its preganglionic motor neurons are located in small cell groups within the midbrain and hindbrain and within the sacral part of the spinal cord. This system's functions are very specific and are most active during periods of reduced activity.

	Examples are slowing of the heart rate and secretions from gland cells.
Paraventricular Hypothalamic Nucleus (PVH)	A cell group of the medial part of the anterodorsal hypothalamus, involved in various regulatory functions. Large neurons of PVH produce oxytocin and vasopressin, released into the bloodstream by axons that end in the posterior pituitary. Small neurons of PVH produce various peptides that influence the secretions of the anterior pituitary. Axons also project to various CNS regions including the spinal cord.
Paraventricular Nucleus	Cell group located in the anterodorsal hypothalamus near the ventricle (on both sides). Some of the neurons are neurosecretory, sending axons to the neural portion of the pituitary where they release ADH or oxytocin. Other neurons in these nuclei receive input from the suprachiasmatic nuclei, and have axons that descend to the lateral horn at spinal levels T1 and T2.
Paravertebral Ganglion	A compact group of peripheral motor neurons of the sympathetic nervous system. There is an interconnected chain of paravertebral ganglia on either side of the spinal cord, outside the column of vertebrae. The most rostral of these ganglia is the superior cervical ganglion located in the neck. The ganglia receive axonal connections from the pre-ganglionic motor neurons of the sympathetic nervous system, located in the lateral horns of the spinal gray matter from T1 down to L2-3 (first thoracic segment to second or third lumbar segment). Axons from these sympathetic ganglia innervate smooth muscles and glands.
Parcellation	In brain evolution, the formation of distinct regions of the brain with separate inputs from a single region with overlapping inputs.
Parcellation by Competition	Progressive separation of two or more projections to a structure during evolution or development, beginning with overlap of the different projections and ending with a segregation.
Parcellation of Thalamus	A process by which distinct cell groups of the thalamus with different inputs are postulated to evolve. The thalamic cell groups appear to have evolved from fewer cell groups with a greater mixing of inputs.
Parietal Eye	Also known as the pineal eye, the parietal eye is a single eye-like region that responds to light, which

	times the production of melatonin.
Parietal Multimodal Association Areas	Posterior parietal lobe cortex that receives inputs from unimodal association cortex of at least two and often three different sensory modalities (somatosensory, visual, auditory). The region abuts similar cortical areas in the temporal lobe. Thalamic inputs come from parts of the pulvinar nucleus. These multimodal areas are also interconnected with paralimbic cortex. All these connections are reciprocated. (Functions of this region are discussed in chapters 33 and 34.)
Pars Compacta of the substantia nigra	The dorsal part of the nigra, which contains a concentration of dopamine-containing neurons which project to the dorsal striatum.
Pars Reticulata of the substantia nigra	The larger ventral part of the nigra, which contains many GABA-ergic neurons that project to the superior colliculus, to the midbrain locomotor area, and to the VA and VM of the thalamus. The pars reticulata also contains some dopamine neurons that project to the superior colliculus.
Parvocellular Red Nucleus	The rostral, small-celled portion of the red nucleus. Many of its axons ascend to thalamic ventrolateral and ventral anterior nuclei (VL and VA), which project to motor cortical areas.
Passerine birds	The largest order of birds, all adapted for perching with three toes extending forwards and one backward. Passerines are small to medium sized birds, including the songbirds.
Perforant Pathway	The path followed by axons from the entorhinal cortex into the hippocampus. These axons penetrate the pial surface of the subiculum, entering the dentate gyrus where many of them terminate.
Periamygdalar Cortex	The portions of the piriform cortex in the temporal region that overlie the amygdala but are not part of the amygdala.
Periaqueductal Gray Area	Synonymous with Central Gray Area
Periglomerular Cell	Small interneurons of the olfactory bulbs with processes that enter glomeruli and participate in synaptic complexes there. The periglomerular cells interconnect adjacent glomeruli.
Period Gene	The period gene (per) discovered in Drosophila has a transcript, the per protein, that changes in quantity in a rhythmic pattern. The rhythm is about 24 hours (circadian). The oscillating level of per underlies the circadian activity rhythm. Homologs of the gene are important in circadian rhythms in mammals.

Peripheral and central domains of an axonal growth cone	Thin filopodial processes filled with actin filaments, and thin sheets of membrane enclosing an actin meshwork (referred to as lamellipodia) constitute the peripheral domains of a growth cone. The central domain is closer to the trunk of the axon, and contains microtubules and various cytoskeletal proteins with anchoring functions.
Peripheral ganglion	Any group of neurons located outside the central nervous system (CNS). Peripheral ganglia in vertebrate animals include the ganglia of the autonomic nervous system. Examples: the ciliary ganglion behind the eye, the cardiac ganglion.
Persistent Electrical Activity	Electrical activity in the CNS that continues for some time after it first occurs. This activity is not a permanent change but it can function as a kind of short-term memory, and may be useful to the organism as working memory.
Phylogeny	The history of the evolution of groups of animals (species and groups of species).
Pia mater	The innermost layer of the three layers of meninges, the connective tissue that covers the central nervous system (dura mater, arachnoid, and pia mater). Pial cells are the outermost covering of the central nervous system, constituting a one-cell-thick sheet of cells to which the endfeet of astrocytes adhere.
Pial Surface	The surface of the CNS is covered by flattened cells called pial cells, generally only one-cell thick, so the pia forms a very thin membrane. Attached to it on the CNS side are the endfeet of astrocytes. Pial cells also cover blood vessels that penetrate the CNS.
Piloerection	Standing up of body hair, usually in response to cold temperatures. Piloerection results in better insulation in animals with fur.
Pineal Eye	Photoreceptor cells located in a structure on top of the head in many reptiles, amphibians, and fish. These cells connect to the pineal gland and influence melatonin secretion.
Pineal Eye	Synonymous with parietal eye.
Pineal Gland	A small endocrine gland located on the midline above and attached to the epithalamus. The pineal produces and secretes melatonin, normally varying in a 24-hr cycle. Important in circadian rhythms and reproduction.
Pineal Organ	The pineal gland. It forms in the roof of the third ventricle, and functions as an endocrine organ, producing melatonin. (Melatonin secretion is greater

	during the sleep phase of the daily activity rhythm.)
Pioneer axon	One of the first axons to grow in the formation of a nerve or axon tract. Pioneer axons can extend independent of the presence of neighboring axons.
Piriform Cortex	The pear-shaped cortex: a name for the olfactory cortical areas. The pear shape is seen in ventral views of the brains of smooth-brained mammals, like small rodents. The pear shape actually includes both olfactory cortex and adjacent non-neocortical areas.
Pit Viper and Infrared Radiation	Pit vipers are snakes that can detect and locate warm-blooded prey animals using infrared radiation. The infrared receptors are located at the bottom of a small pit located below each eye. Rattlesnakes are pit vipers.
Plexus	A network of interlaced nerve fibers of the peripheral nervous system. The term may also refer to a network of blood vessels.
PN Bridge	A segment of peripheral nerve that has been taken from some part of the body, e.g., leg, and implanted in the CNS so it forms a bridge over a site of damage where axons have been severed. The purpose is to provide a growth-friendly pathway in which CNS axons can regenerate.
Polychorinated Biphenols (PCBs)	Compounds that are recognized as persistent environmental pollutants; their production has been banned in the USA. They have been widely used commercially in both structures (e.g., electrical transformers) and fluids. They are carcinogens, and are also known to bind to thyroid hormone receptors and disrupt normal thyroid function. (In these harmful properties the PCBs are like dioxin.)
Polymorphic layer of cells	In the CNS, a cortical layer where the cells are of multiple shapes, and sometimes multiple sizes.
Polysynaptic Pathways (hypothalamus)	Pathways from the hypothalamus have widespread effects including effects on distant parts of the CNS. This involves very few long pathways. Most are interrupted by multiple synapses.
Pons	The “bridge” at the base of the rostral hindbrain that includes the cells that receive inputs from the cerebral hemispheres and some brainstem structures and project axons to the cerebellar cortex. The term can also refer to the entire rostral portion of the hindbrain at the level of the pons, but excluding the cerebellum.
Pontine Flexure	A third flexure, or bend, appears in between the mesencephalic and cervical flexures, in the pontine region, where the bend is in the opposite direction—

	concave upward. At about the same time (5th embryonic week in humans) the roof plate of the hindbrain widens.
Pontine Taste Area	The taste-receptive portion of the parabrachial nucleus.
Population Size Matching	Matching of the populations of the source of an axon population and the synaptic targets of that population, resulting from death of extra cells that lose out in the competition for a sufficient amount of trophic factor.
Posterior Pituitary	The neural part of the pituitary. This part is also called the neurohypophysis.
Posterior Pretectal Nucleus	One of the cell groups of the pretectal area. The posterior pretectal nucleus is densely innervated by optic-tract axons. The nucleus is located just ventral to the superficial optic tract but is traversed by deeper lying optic-tract axons.
Posterior Suprasylvian Sulcus	In the cerebral hemisphere of a cat, the lateral sulcus is the sulcus nearest to the medial and caudal margin. It separates the suprasylvian gyrus from the lateral gyrus. The suprsylvian sulcus separates the suprasylvian gyrus from the ectosylvian auditory cortical areas. This gyrus and sulcus form inverted U shapes, so they can be subdivided into posterior, middle and anterior portions. The suprasylvian sulcus surrounds the auditory regions on three sides.
Posterior Tuberculum	A structure in the caudoventral diencephalon of many vertebrates (amphibians, cartilaginous fishes, ray-finned fishes) that contains dopamine cells. In some of these animals there is no midbrain area that contains dopamine cells. Cell groups of the posterior tuberculum receive sensory inputs (ascending gustatory, lateral line) and inputs from optic tectum, and they project to the endbrain.
Post-Orbital Bar	The post-orbital bar is bone at the caudolateral margin of the orbit that has evolved in some vertebrates including many mammals. The strength it gives to the orbit prevents distortion of the eyes during chewing. A post-orbital bar was lost in the earliest mammals, apparently because of reduction in eye size and importance together with increased reliance on olfaction and audition.
Postsubiculum	A dorsal portion of the subiculum in rodents that receives visual inputs from several neocortical areas as well as from the thalamus, particularly visual inputs.
Precommissural Fornix	The fornix fibers come from the hippocampus

	following an arched trajectory over the diencephalon. At the anterior part of the curve, the axons pass ventrally through the septal region. Entering the septal region, the fornix fibers have two major components. The caudal component forms a compact column near the midline that passes caudal to the anterior commissure before turning caudally into the hypothalamus. This is the post-commissural fornix. The other component—the precommissural fornix—is less compact as the fibers distribute through the septal nuclei where many of them terminate. Others terminate more ventrally in basal forebrain structures, especially in nucleus accumbens—a major part of the ventral striatum.
Prefrontal Cortex	Neocortical areas located anterior to the motor cortical areas.
Prefrontal Multimodal Association Areas	Frontal lobe neocortical areas that receive three major kinds of input: 1) projections from other association areas, including multimodal cortex of the parietal and temporal regions and other prefrontal regions (and also from homotopic areas in the opposite hemisphere), 2) projections from paralimbic areas, and 3) projections from the mediodorsal nucleus of the thalamus. These projections are generally reciprocated. (Functions of this region of the brain are discussed in chapters 33 and 34.)
Pre-ganglionic motor neuron	A neuron in the CNS with an axon that connects with neurons in a peripheral ganglion of the autonomic nervous system.
Prestriate Areas	Visual cortical areas just outside the striate cortex, always including areas 18 and 19 of Brodmann. Sometimes all the unimodal visual association areas (extra-striate visual areas) are included.
Presynaptic facilitation	Increased excitatory effects of a synaptic terminal that occurs when the terminal receives axo-axonal synapses that when activated cause hyperpolarization of the membrane of the terminal. When a hyperpolarized terminal is depolarized by the arrival of an action potential, a greater amount of neurotransmitter is released—hence it's effects are facilitated.
Presynaptic inhibition and pain reduction	Axo-axonal synaptic contacts, if their activation results in depolarizations of the membrane of small unmyelinated dorsal root axons, can reduce the excitatory effects of the dorsal root inputs to secondary sensory neurons. This happens in the

	spinal cord when certain descending axons from the brainstem are activated. These descending axons originate in cells in the nucleus raphe magnus of the caudal hindbrain (using serotonin as the neurotransmitter). The raphe magnus neurons can be activated by stimulation of the central gray area of the midbrain.
Pretectal Area	The region just rostral to the midbrain tectum (mammalian superior colliculus) that is part of the epithalamus. The area is traversed by optic-tract axons, which form synaptic terminals in several pretectal cell groups (chapters 20 and 21).
Pretectal Nuclei in relation to Papez' Circuit	Although the pretectal nuclei are not considered part of Papez' Circuit, they appear to provide an important input to this circuit. The Nucleus of the Optic Tract (NOT)—one of the pretectal nuclei—responds to lateral movements of the retinal image, movements that can result from shifts in head position. This information is relayed to part of the laterodorsal nucleus (LD), which projects to parahippocampal areas (retrosplenial cortex and postsubiculum in rodents). The LD also receives allocentric directional information from the hippocampus. (Thus, the combination of inputs to at least part of LD resemble inputs to the mammillary bodies.)
Prevertebral Ganglion	A sympathetic nervous system ganglion with connections like those of the paravertebral ganglia, but located more anteriorly in the body, ventral to the vertebrae. The celiac ganglion (solar ganglion or plexus) is the largest and most rostral of the prevertebral ganglia; the others are the superior and inferior mesenteric ganglia. The ganglionic neurons innervate the digestive tract of the abdominal cavity and the various abdominal and pelvic organs.
Primary Fields of the Nuclear Zones	Poliakov's term for primary sensory and motor cortical areas, equivalent to Mesulam's idiotypic cortex.
Primary sensory neurons	Neurons with cell bodies outside the CNS—in the peripheral nervous system—and axons that synapse within the central nervous system. They carry sensory information into the CNS.
Procedural Learning	Habit formation by reinforcement learning, often over many repetitions.
Proportional Connectivity	Connectivity between neurons that is 100%, so every neuron is connected to every other neuron in a structure, like the neocortex. Axons increase

	exponentially as number of neurons increases linearly.
Propriospinal Fibers	Axons that originate in the spinal cord and terminate in the spinal cord.
Prosencephalon	The forebrain, including endbrain (telencephalon) and 'tweenbrain (diencephalon)
Prosimians	In addition to the tarsiers, living prosimians include the members of a separate suborder of primates that includes lemurs, lorises, and bushbabies.
Pruning Lesion	Damage that destroys part but not all of an axon's end arbor or arbors.
Pulvinar Nucleus	The enlarged posterior part of the lateral nuclei in the primates. The name means a cushion or pillow. A ventral part of it (the inferior pulvinar) receives input from the visual layers of the superior colliculus and sparse projections from the retina. Other parts receive auditory or somatosensory inputs, or are multimodal. The pulvinar projects to posterior association areas of the neocortex (chapter 33).
Pupillary Eye Reflex	The narrowing of the pupils in response to brightening of the light reaching the eyes. The reflex pathway goes from retina to the pretectal area to the parasympathetic preganglionic motor neurons of the 3rd nerve complex (the Edinger-Westphal nucleus) to the ciliary ganglion behind the eye. The axons of this ganglion innervate the iris.
Pyramidal Cell Axon Collaterals and Dendritic Arbors	The initial part of the axon of neocortical pyramidal cells gives rise to numerous collateral branches. The lateral spread of these collaterals of the large pyramidal cells is about 3000 microns in the cat. The lateral spread of the dendrites of these same neurons is about 500 microns. Many synapses of axon collaterals excite nearby pyramidal cells; others connect with inhibitory interneurons.
Pyramidal Cells	Pyramidal cells are the most prominent cell type in the neocortex. They are excitatory, glutamatergic neurons that are the main cell type in layers 3, and 5. Pyramidal cells are also common in layers 2 and 6. A pyramidal cell has an apical dendrite that extends towards the pial surface. This dendrite, studded with dendritic spines except near the cell body, gives off multiple, multibranched oblique dendrites; in layer one there are many thin lateral dendritic branches. At the base of the cell, there is a fan-shaped distribution of basal dendrites.
Pyramidal Tract	Corticospinal tract axons coursing through the

	hindbrain caudal to the pons form, on each side, a compact, pyramidal shaped bundle located ventrally next to the midline.
Quadrate and articular bones	Small jawbones in reptiles that underwent changes in the cynodonts (mammal-like reptiles), acquiring functions in hearing. In the transition to mammals, the articular bone became the malleus of the middle ear, and the quadrate became the incus.
Radial Fascicles	Small bundles of axons within the neocortex oriented at right angles to the surface. These bundles are thickest in the deepest layer, and contain many fewer axons in the supragranular layers. They contain thalamocortical axons and transcortical U fibers, both afferent and efferent, and also include intracolumnar axons. The bundles appear to be associated with anatomical columns. Their thickness and spacing in the human brain becomes adult like by age 12 yr.
Radial Glial Cell	A radially elongated astrocyte, usually with a cell body near the ventricle and a process that extends to the pial surface. Such radial glial cells serve as scaffolds for migrating neurons in the cerebral cortex and some other regions of the developing brain.
Raphe Nuclei	Cell groups located at the midline of the midbrain and hindbrain with axons that release serotonin. The axons distribute very widely in the CNS.
Rat Midbrain Tectum Lamina	The rat's midbrain tectum has a laminar pattern that is more distinct in fiber stains than in Nissl stains for cell bodies. The tectal laminae are generally more distinct and elaborate in more visual species.
Ray-finned Fish Midbrain Tectum Lamina	The ray-finned fishes are one of two major groups of fishes, the other group being the lobe-finned fishes. The ray-finned fishes are the largest group of fishes, making up half of all living vertebrates. These fishes have well developed optic tecta with multiple layers (laminae)—defined by cell and fiber arrangements seen in histological sections, and by dendritic and axonal arborizations. The layers are more elaborate in some groups than in others, e.g., in the teleosts.
Reciprocal Inhibition	When motor neurons that excite a flexor muscle are activated, there are innate pathways that simultaneously inhibit extensor motor neurons that innervate opposing muscles.
Reciprocal synapses	A synapse between two neurons is polarized, with synaptic vesicles containing neurotransmitter on one side. Reciprocal synapses are sometimes observed, with two adjacent synapses polarized in opposite

	directions.
Red Nucleus	A cell group of the midbrain tegmentum (surrounded by reticular formation of the ventral midbrain). It has a pink color when seen in human brain dissections. The caudal part of the nucleus has larger cells—hence it is called the magnocellular part. This part gives rise to the rubrospinal tract, which decussates in the midbrain and terminates mainly in the spinal enlargements. It plays important roles in limb movements, especially in animals without a large neocortex.
Reflex Spasticity	Hyperactive spinal reflexes that can occur after recovery from diaschisis following degeneration of many descending axons from brain to spinal cord. The hyperactivity appears to be a consequence of compensatory mechanisms of recovery from diaschisis: collateral sprouting and denervation supersensitivity. These processes result in functional recovery from the depression of neuronal responsiveness cause by loss of afferents, but the recovery can "overshoot" and cause the spasticity.
Reinforcement Learning	Modification of Stimulus-Response connections that results from sensory feedback that is either positive or negative (rewarding or punishing). Reward is said to "reinforce" the actions that preceded the reward by making their occurrence more probable, or less probable in the case of negative consequences.
Releasing Hormones	Peptides made in hypothalamic cells in the median eminence region. These peptides are released by axons into capillaries, and they move through the bloodstream into the glandular pituitary where they cause release of pituitary hormones into the bloodstream.
Reticular Activating System	Neurons of the brainstem reticular formation with widespread connections to more rostral structures that include the thalamus. Activity of this system of neurons thereby activates the neocortex, as indicated by low voltage fast activity in electroencephalographic recordings.
Reticular Formation	Neurons of the brainstem that have a non-specialized appearance, with inputs of a mixed nature. Their axons may be quite specifically involved in one function, or they may be distributed more diffusely (non-specifically). Reticular formation cells are difficult to divide into specialized groups by cytoarchitecture alone.

Reticulospinal Tract	Axons that come from neurons of the brainstem reticular formation—mostly from the hindbrain—and travel caudally in the ventral columns of the spinal cord to destinations in the spinal cord. Many of these axons are involved in whole-body movement patterns which are inherited.
Reticulospinal Tract(s)	Axonal pathways from the brainstem reticular formation to the spinal cord. The largest such tract comes from the large neurons of the medial hindbrain, and is important for control of organized whole-body movement patterns.
Retinal Maps	Shorthand for topographically organized retinal projections in various optic-tract terminal areas. Within these areas, each position receives terminals of axons from one small part of the retina, with the entire pattern in each structure forming a map of the retinal surface.
Retrograde transport	Active (energy requiring) movement of an organelle or molecule down axons, usually from axonal endings, towards the cell body. Uses dynein, a protein that acts as a molecular motor.
Reverberating Circuits	Pathways in the brain that are self-re-exciting so their activity is maintained for some time. It has been proposed that such circuits underlie short-term memories.
Rexed Layers	The cytological organization of the spinal gray matter was described by Bror Rexed as 9 layers, with the first layer at the dorsal-most edge of the dorsal horn and the ventral-most layers (8 and 9) containing the somatic motor neurons. He named the small region surrounding the central canal (ventricle) as a 10^{th} layer.
Rhinal Fissure	A sulcus, or in some species just a shallow groove, that separates the olfactory cortex on the ventromedial side from the neocortex and transitional areas on the dorsolateral side.
Rhinencephalon	The “nose brain.” Since experimental axon tracing experiments have shown that the olfactory bulbs have a more restricted distribution in many vertebrates than was once believed, much of what used to be called the rhinencephalon is now included in the limbic system but not in the narrower designation of olfactory system.
Rhombencephalon	The hindbrain, which is made up of a rostral part that includes the pons and cerebellum, and a caudal part also known as the medulla oblongata. From the Latin

	rhombus, and the Greek *enkephalon* (in the head)—referring to the shape of the roof plate in this part of the CNS.
Rhombic Lip	Transient embryonic structure of the alar plate in the rostral hindbrain. It contains proliferating cells many of which migrate into the roof plate to form the cerebellum, and others migrate ventrally into basal plate regions where they form pre-cerebellar cell groups (neurons that project to the cerebellum), e.g., the pontine gray matter and the inferior olive.
Rhombomere	A segment of the developing hindbrain. There are 7 of these rhombencephalic segments.
Roof Plate	The ependymal cells of the most dorsal neural tube that form the connection between the left and right alar plates.
Round Window	The oval-shaped membrane, similar in size to the oval window, that separates the lower part of the fluid-filled cochlea from the middle ear cavity. Its presence lowers impedance of the cochlear fluids to sound vibrations.
Routine Maintenance - Hindbrain	The functions of the hindbrain that are largely unconscious, including the control of breathing and heart rate, coordination of movements, postural control, control of various innate patterns of movement that include reflexes and the motor components of fixed action patterns, and maintenance of arousal states of the brain.
Rubrospinal Tract	A bundle of CNS axons from cells of the midbrain's red nucleus—nucleus ruber—to the spinal cord on the opposite side. The axons decussate in the midbrain near their cells of origin.
Rubrospinal Tract	The axonal pathway from the large-celled caudal part of the red nucleus of the midbrain (nucleus ruber). The axons cross to the opposite side and descend through the lateral hindbrain reticular formation and through the lateral column of the spinal cord, terminating in the spinal enlargements. Activation results in limb movements such as grasping by the hands.
Salivatory Nuclei	Preganglionic motor neurons of the parasympathetic nervous system found in small groups (in the visceral motor column) in the hindbrain. The axons from these nuclei, using acetylcholine as the neurotransmitter, innervate small ganglia (the otic ganglion and the pterygopalatine ganglion) which send axons to the parotic glands, the submandibular

	and sublingual glands, many smaller salivatory glands, and also to the lacrimal gland and mucosal glands of the nose, palate and throat.
Sauropsids	Reptiles and birds.
Scala Tympani	The chamber of the fluid-filled cochlea (filled with perilymph) that is attached to the scala vestibuli only at the cochlear apex—farthest from the oval and round windows.
Scala Vestibuli	The chamber of the fluid-filled cochlea that is continuous with the fluid of the vestibular canals. Throughout the length of the cochlea the Organ of Corti sepaates the scala vestibuli from the scala tympani.
Schaffer Collaterals	Axons from hippocampal CA3 neurons extend into the fimbria and have collaterals—called the Schaffer Collaterals—within the hippocampus that extend to the neurons of CA1. These collateral axon branches are named for the Hungarian psychiatrist and neuropathologist who described them, Károly Schaffer.
Schizocortex	A term that has been used for a group of paralimbic cortical regions closely linked to the hippocampal formation.
Schizophrenia	A major form of mental disorder that includes a variety of types. It is a brain disorder that most commonly begins after puberty, especially in the early twenties, with decreasing ability to distinguish the real outside world from various fantasies. Hallucinations are common, visual or auditory, and the person feels that these are real perceptions. Paranoid reactions to events, especially social events, may occur, or other delusions and disordered thinking. In chronic schizophrenia, the person's affects often become "flat" and she or he appears to be totally cut off from the real world. This cutting off, or splitting, from reality is what the word schizophrenia means (divided or split-off mind).
Second Endbrain Expansion	A second expansion of the endbrain occurred in early vertebrates after the evolution of non-olfactory inputs, many of which came from the midbrain via the 'tweenbrain.
Secondary Fields of the Nuclear Zone	Poliakov's term for neocortical regions surrounding the primary fields. These fields are equivalent to the parts of Mesulam's unimodal association areas that are closest to the idiotypic areas. More distant unimodal areas are included by Poliakov in the

	tertiary fields.
Secondary Optic Radiations	Fibers from the visual cortex that terminate in brainstem structures (thalamus, pretectal area, superior colliculus)
Secondary Sensory Neuron	A neuron within the central nervous system that receives synaptic inputs from primary sensory neurons (that are located outside the CNS)
Segregation of Modalities	Separation of the terminal arbors of axons of different sensory modalities so they occupy different brain regions. Overlap of axons of different modalities has been observed early in development, in some brain regions, followed by segregation later in development. Such a process of segregation resulting in a parcellation of brain tissue into separated regions is postulated to have occurred in the thalamus and in cortical areas over the course of evolution of the CNS.
Selective Adhesion	By means of specific cell adhesion molecules, cells or parts of cells may adhere much more to some surfaces than to others. This kind of selective adhesion is important in the guidance of growing axons. It is also important in cell sorting.
Self-Assembling Protein	A manufactured protein which, when placed in water solution, will form a solid or gel when it contacts a salt solution like cerebrospinal fluid or some other bodily fluid.
Semaphorins	A family of molecules that strongly affect the direction of growth of particular axon populations.
Sensorimotor Amalgam Hypothesis	The hypothesis that the motor cortex and primary somatosensory cortex arose in evolution from a single somatosensory area. These two regions appear to overlap nearly completely in the Virginia Opossum.
Sensory Acuity	A measure of spatial sensory discrimination that represents the smallest separation of adjacent stimuli that can be detected under specific conditions, or the smallest point that can be seen as different from the background under those conditions. It is correlated with the sharpness of vision or the fineness of touch sensitivity.
Sensory Placode	A thickened region of the embryonic ectoderm of the head from which sensory organs, including primary sensory neurons, develop.
Septum	The septal nuclei of the endbrain are in the septum that separates the lateral ventricles just rostral to the interventricular foramen. The septal cells are part of the limbic endbrain, projecting to the hippocampus,

	to ventral striatal structures, and to hypothalamus and epithalamus. The septal nuclei can be considered as part of the basal forebrain and ventral striatum.
Serial synapses	One synapse is observed from an axon onto a small neuronal process. On the opposite side of the small postsynaptic process (probably a small dendrite) the process is on the presynaptic side of another synapse onto a third neuron. One can speculate that activity in the middle process has gating influences on the action of the first synapse on the third neuron.
Serotonin	5-hydroxy-tryptamine. The neurotransmitter of a system of axons that come from cells of the raphe nuclei of the brainstem and distribute very widely throughout the brain, and more specifically to parts of the spinal cord.
Sexual Dimorphism	Physical differences between males and females of a species that usually appear during sexual maturation (puberty). Sexually dimorphic traits are often correlated with differences in behavior, which implies differences in the brain. Some sexually dimorphic CNS structures have been described.
Sexually Dimorphic Nucleus	Any cell group in the central nervous system that is significantly different in males and females.
Shepherd's Crook Cell	A neuron in the optic tectum of the midbrain of a chicken. The initial part of the axon forms a bend that looks like the crook at the top of a shepherd's staff. This part of the axon develops very early in embryogenesis, when the cell is still an elongated radial cell attached to the ventricular and pial surfaces and the cell body is near the ventricle. Studies with the Golgi stain have demonstrated the progressive translocation of the cell body to the position of axon origin, as the axon elongates and later as dendrites begin to form. Thus, this type of cell migrates by nuclear translocation.
Silent Synapses	Synapses of axons that do not normally excite the postsynaptic neurons, but may be "unmasked" under certain conditions.
Simians	An infraorder of primates that includes humans, old world monkeys and the great apes. In modern taxonomy, tarsiers and tarsier-like primates are prosimians in the same suborder but in separate infraorders.
Small World Architecture	Absolute connectivity plus a limited number of longer range connections. Modelers depict these longer connections as random.

Solitary Chemosensory Cells	Cells with similarities to gustatory receptor cells of taste buds. They are scattered mainly in surface layers of the respiratory and digestive tracts of mammals and also in the surface epithelium of acquatic animals. Inputs from these cells reach the CNS largely through the 5th cranial nerve and through dorsal roots. Functions are not as well understood as are the functions of taste and olfaction.
Somatic Motor Column	The nuclei of the brainstem that contain motor neurons controlling the extrinsic eye muscles (oculomotor and trochlear nuclei in the midbrain, and the abducens nucleus of the rostral hindbrain, with axons in cranial nerves 3, 4, and 6, respectively) and the motor neurons that control the tongue (hypoglossal nucleus, with axons in cranial nerve 12).
Somatic Sensory Columns	Rostro-caudal columns of secondary sensory neurons. In the hindbrain, these columns are designated as special somatic sensory (auditory, vestibular), general somatic sensory (trigeminal), and visceral sensory (including gustatory).
Somatic System of the CNS	The various structures of the CNS that control the movements of the body using striated muscles.
Somatotopy	Topographic organization of brain representations of somatosensory surfaces.
Somites	Segments of the developing mesoderm. In the embryo they form on either side of the body. Somites are the transient segments of tissues that give rise to skeletal muscle, tendons and cartilage, endothelial cells (lining the blood vessels) and cells of the dermis.
Somnolent	Sleepy or drowsy.
Sonic Hedgehog Protein (SHH)	A molecule that diffuses from the embryonic notochord and induces the formation of the neural plate and tube, and then acts as a "ventralizing factor" in the differentiation of the basal plate neurons.
Spatial Summation	When EPSPs are initiated simultaneously (or nearly so) at different places on a neuron, the resulting depolarizations at the axon hillock are additive, so the likelihood of firing an action potential is increased.
Spherical Bushy Cell	A type of cell in the ventral cochlear nucleus that is characterised by primary-like responses to auditory nerve axons. The auditory nerve axon endings are called endbulbs of Held after their discoverer Hans Held (1893) who studied them in cats.
Spinal Enlargements	The thicker regions of the spinal cord located in the cervical region and in the lumbar regions. The larger cord in these two regions is due to the larger number

	of neurons present, a result of innervation of the limbs.
Spinal Nerve	A nerve at one spinal segment that divides into a dorsal and a ventral root before reaching the spinal cord. Such a nerve is found in between adjacent spinal vertebra.
Spinal Shock	The loss of function of the spinal cord caudal to the site of a transection. Spinal reflexes are lost for a period of time. The degree of functional loss and the duration of the loss is proportional to the quantity of descending axons destroyed by the transection.
Spindle Cells	Neurons with a spindle-shaped cell body—wider in the middle and tapering at both ends. Spindle cells are found especially in layer 6 of the neocortex.
Spino-hypothalamic Pathway	Axons from neurons in the dorsal horn of the spinal cord reach the hypothalamus. The neurons respond to pain inputs.
Spinoreticular Pathway	Axons that ascend, mostly on the same side, to the brain from secondary sensory neurons of the dorsal horn of the spinal cord. These axons terminate mainly in the reticular formation of the brainstem. The longest axons, which are a minority of these axons, reach various cell groups of the 'tweenbrain.
Spinothalamic Pathway	Axons of secondary sensory neurons of the dorsal horn of the spinal cord that decussate ventral to the central canal and reach the ventral part of the lateral column before turning rostrally to ascend to the hindbrain, midbrain and diencephalon. No more than about 20% of these axons reach the thalamus. This pathway is sometimes called the "paleolemniscus" (old ribbon).
Splenium	The caudal end of the corpus callosum.
Spontaneous Activity in Retina	Action potentials in retinal ganglion cells that occur without any stimulation by light. Waves of spontaneous activity move from one side of the retina to the other in prenatal cats. This activity plays an important role in the development of precision in axon termination patterns formed by the optic-tract axons.
S-R Model	The model that explains all behavior as the consequence of stimuli that elicit responses. This model is a more general form of the model proposed by the reflexologists of the 19th century (who included Ivan Sechenov and his student Ivan Pavlov).
Stages of Origins of Vision (suggested)	The most primitive vision: detection of light, or of different intensities of light…Evolution of bilateral

	projections to the predecessors of the hypothalamus…Evolution of ability to separate light coming from the left or the right, and differences in light intensity on the two sides…Evolution of predominantly crossed projections to 'tweenbrain and midbrain…Ability to detect images using a lens, with evolution of topographic projections of the optic tract…Evolution of visual pathways to the endbrain: (This may have begun to evolve after stage 2.)
Startle Reflex	Response to a sudden unexpected stimulus. More specifically, the acoustic startle reflex is triggered by a sudden loud noise. The intensity of the response decreases with repetitions of the stimulus (habituation). The motor components of the response begin with eyeblink, followed by facial tension, neck flexion, arm flexion, and leg flexion. The latter responses occur only with more intense sounds.
Stellate Cells	Smaller than most pyramidal cells, the stellate, or star-shaped, neurons of the neocortex are short-axon interneurons. They make up most of the small neurons of layer 4, where they are excitatory interneurons that connect to cells in the more superficial layers. Additional neocortical stellate cells with various dendritic and local axon distributions are inhibitory interneurons (GABA-ergic). The dendrites are non-spiney.
Stereotropism	Guidance of the direction of axon growth by surfaces of other cells and the contours of those surfaces.
Stria Terminalis (ST)	The group of axons that constitute a major output of the amygdala. These axons follow a course in the mammalian endbrain that is mostly parallel to the course of the fornix fibers from the hippocampus. The ST axons project especially to basal forebrain structures and to the hypothalamus.
Stria Terminalis (ST)	A major output of the amygdala. The axons of ST arise in the central nucleus of the amygdala, running parallel to the fornix fibers from the hippocampus into the basal forebrain where they terminate in structures of the ventral striatum, including the bed nucleus of the stria terminalis. The ST axons turn caudally into the hypothalamus, where many of them terminate in the shell of the ventromedial hypothalamic nucleus. Some continue caudally into the midbrain limbic areas.
Striatal Amygdala	Portions of the amygdala that develop from the embryonic striatal region: the central nucleus and the

	medial nucleus of the amygdala. The projections from these structures are GABA-ergic.
Striate Visual Cortex	The primary visual cortex of the occipital lobe, known to electrophysiologists as V1 (visual area 1). The area is named for its distinct laminar appearance in the human brain. The "stripe of Gennari" can be seen even in unstained brain material as a band of myelinated axons within layer 4. In each hemisphere, the opposite hemifield is represented in V1 in a precise topographic manner…Also called area 17 of Brodmann, a homologous area is found in all mammals, so it is assumed to have been present in the earliest mammals. It may have been preceded by a more primitive visual area represented in mammals by area "prostriata" located in the posterior cingulate region adjacent to and connected with parahippocampal areas; this area receives visual input from thalamic nucleus LD (lateralis dorsalis), which receives a projection from the pretectal area.
Striatonigral Tract	The pathway from the dorsal striatum (caudate nucleus and putamen) to the substantia nigra in the midbrain. The axons are GABA-ergic, and hence inhibitory.
Subarachnoid Space	The CSF-filled space beneath the arachnoid membrane that is found underneath the outermost meningeal layer—the dura mater. It contains many spider-web like strands of arachnoid membrane that connect the arachnoid membrane under the dura with the pial membrane (the innermost meningeal layer).
Subepithelial Network	Multiple interconnected neuronal cells located beneath the surface layer of the body of an animal. Such a network allows the transmission of excitation from one local area to other parts of the body.
Subparaventricular Nucleus	Hypothalamic cell group that receives projections from the suprachiasmatic nucleus. It projects to the more dorsal paraventricular hypothalamic nucleus *via* the dorsomedial hypothalamic nucleus. Therefore, it is important for a daily rhythm of secretions of ADH/vasopressin and of melatonin.
Substance P	An eleven amino acid peptide that acts as a neurotransmitter or neuromodulator in the CNS. It is released by C fibers of the dorsal roots and trigeminal nerve, causing pain sensations. It has many other functions in the brain. In the corpus striatum, it is found together with GABA (and usually dynorphin as well) in neurons that project to the internal segment

	of the globus pallidus and to the substantia nigra. Substance P binds to the neurokinin-1 receptor (NK1).
Substantia Nigra	Named for black pigment (melanin) present in its dopamine-containing neurons, especially in human brains, the substantia nigra (SN) is located in the ventral midbrain just dorsal to the cerebral peduncle. It is the major source of dopamine-containing axons projecting to the dorsal striatum, and it receives a direct projection from the striatum (inhibitory in nature). The nigra also projects to the superior colliculus, and is reciprocally connected to the midbrain locomotor area. The SN can be subdivided into a pars compacta and a pars reticulata (with somewhat different connections), and its medial-most portion has connections with limbic system structures. [Discussed in chapter 30.]
Substantia Nigra (SN)	Structure of the ventral midbrain that is closely connected to the corpus striatum, especially the dorsal striatum, as well as other structures important in movement control. The name comes from a black pigment, melanin, in the dopaminergic neurons in the human brain. The SN is the source of dopamine axons in the dorsal striatum, important for normal function including habit learning. A loss of DA cells in the nigra occurs in Parkinson's Disease.
Subthalamic Nucleus	A well-defined nucleus within the subthalamus, the subthalamic nucleus receives major input from the external segment of the globus pallidus and projects back to the same structure. The GPe projection is inhibitory but the projections of the subthalamic nucleus are all excitatory—to both segments of the globus pallidus and to the substantia nigra.
Subthalamus	A subdivision of the adult 'tweenbrain (diencephalon), located below the thalamus and above the hypothalamus. This division is called the ventral thalamus during embryogenesis.
Subventricular Zone	A layer of proliferating cells in developing neocortex adjacent to the ventricular layer. Many cells that migrate from this zone differentiate into glial cells (oligodendrocytes and astrocytes) but many neurons are also produced. There is evidence that a slow rate of neurogenesis as well as gliogenesis continues in this zone in adult brains.
Sulcus Limitans	A groove in the lateral walls of the ventricle of the embryonic spinal cord, hindbrain and midbrain. It

	separates the alar plate from the basal plate of the thickening walls of the neural tube.
Superficial Grey Layer	The most superficial cell layer of the mammalian superior colliculus, this layer is located superficial to the optic tract. Its cells receive dense projections from the retina *via* the optic tract, and from the visual cortex. These cells project not only to deeper tectal layers but also to the thalamic nucleus LP and to the external layer of the ventral nucleus of the lateral geniculate body.
Superior Cervical Ganglia	The most rostral ganglion of the sympathetic chain of ganglia (one on either side of the spinal column) is called the superior cervical ganglion (SCG). The neurons of these ganglia have axons that provide the sympathetic innervation of smooth muscle and glands of the head region.
Superior Colliculus (SC)	The rostral bump (little hill) at the surface of the midbrain on either side in a mammal. Its surface layers receive input directly from the retina. The SC is often called the midbrain tectum or the optic tectum, although the latter term usually refers to the homologous structure in non-mammals.
Superior Fasciculus of the AOT	Retinofugal axons found in a small bundle between the dorsal and lateral terminal nuclei of the accessory optic tract
Superior Longitudinal Fasciculus	Transcortical association pathway in primates that interconnects posterior parietal areas with superior and middle portions of prefrontal cortex. This fasciculus has three major components. Axons carrying information about egocentric location of visually detected objects follow this pathway to the frontal eye fields.
Superior Olive	A collection of cell groups that receives projections from the ventral cochlear nuclei on both sides of the hindbrain. It forms an olive-shaped bump on the ventral surface of the hindbrain rostral to the inferior olive.
Supernumerary Limbs	Additional (abnormal) limbs that develop because of transplants or because of genetic anomalies.
Suprachiasmatic Nucleus	A small cell group of the CNS located just above the optic chiasm. Neurons there receive direct input from retinal ganglion cells. Some of these neurons have an endogenous circadian cycle of activity.
Suprachiasmatic Nucleus (SCN) in homosexual males	The SCN is well known for its role as a “biological clock” that has circadian changes in activity which is normally synchronized by the 24-hr day-night cycle.

	It has a number of sub-regions that indicate an incompletely understood complexity of functions. Its possible role in influencing sexual preference has been indicated by the discovery that it is larger in homosexual men than in non-homosexual men, a difference that can be explained by an increased number of vasopressin-containing neurons. These neurons normally diminish in number during development, but diminish much less in the gay men.
Supraoptic Nucleus	Cell group located in the hypothalamus, just above the lateral part of the optic chiasm (on both sides). The large neurons are neurosecretory, making either vasopressin (anti-diuretic hormone, ADH) or oxytocin. These hormones are transported in vesicles down axons that terminate on capillaries within the neural portion of the pituitary (called the neurohypophysis, or posterior pituitary), where the hormones are secreted into the bloodstream. The supraoptic cells also make some releasing hormones that reach the glandular pituitary.
Sylvian Fissure	The deep fissure in primate brains that separates the temporal lobe cortex from the frontal and parietal lobe cortex. Hidden in the fissure is the insular cortex, which overlies the putamen.
Symmetric Cell Division	Mitosis in the CNS that results in two cells that each remain in the cell cycle. The cell divides along a line approximately at right angles to the ventricular surface.
Sympathetic Ganglion	A clump of neurons in the peripheral nervous system that is innervated by axons from the lateral horn neurons of the spinal cord—the preganglionic motor neurons of the sympathetic nervous system. The neurons use acetylcholine as the neurotransmitter. These clumps of neurons are the paravertebral ganglia on either side of each spinal vertebra; they form an interconnected chain of ganglia with inputs coming through the ventral roots from the first thoracic to the second of third lumbar level (T1 to L2-3). The postganglionic motor neurons of these ganglia use norepinephrine as the neurotransmitter.
Sympathetic Nervous System	The thoracico-lumbar portion of the autonomic nervous system. Its preganglionic motor neurons are located in a column of cells on either side of the spinal cord. The columns form the lateral horns seen in sections of the thoracic and upper lumbar cord. The system acts less specifically than the parasympathetic

	system, as all parts of it tend to be activated together. This is especially the case during periods of "fight or flight." Sympathetic arousal is increased by adrenalin secreted from the adrenal glands.
Syrinx	The vocal organ of birds, located at the base of the trachea and at the beginning of each of the two bronchial tubes. Sounds are produced by vibrations of the walls of the trachea and bronchi. Separate sounds can be produced simultaneously by separate control of the two sides. The syrinx is more complex in songbirds than in other birds. It is lacking in vultures.
Tectospinal Tract	Large neurons in the deep layers of the superior colliculus of mammals, and in the homologous structure in non-mammalian vertebrates (the optic tectum) project their axons across the midline before descending near the midline to the ventromedial portions of the cervical spinal cord. The pathway functions in elicitation of head-turning movements. Eye movements result from activity of a similar pathway reaching the areas of oculomotor nuclei of the midbrain and rostral hindbrain.
Tectospinal Tract	The axonal pathway from the deep layers of the midbrain tectum (superior colliculus) that crosses the midline of the midbrain and descends as far as the cervical spinal cord. The axons synapse in the medial hindbrain reticular formation as well as on interneurons of the spinal cord. Activation results in turning of head and eyes and associated postural adjustments (orienting movements).
Tectum	A tectum is a structure that forms a "roof" over the ventricle, at least in the embryo. Used alone, the word usually refers to the optic tectum of the midbrain, or superior colliculus in mammals.
Tegmentum	Structures of the midbrain located below the tectum (superior colliculus), forming the floor of the midbrain above the cerebral peduncles.
Telencephalon	The endbrain, which includes the cerebral hemispheres, basal forebrain and olfactory bulb. The hemispheres include cortical structures and basal ganglia (corpus striatum and amygdala)
Teleost Fish	A ray-finned fish that is a member of a large, advanced group of bony fishes. It includes about 30,000 species.
Teleost Fish Midbrain Tectum Lamina	The teleosts are the largest group of ray-finned fishes. They have large optic tecta showing differentiation of

	multiple layers (laminae).
Telodendria	End branches, usually referring to axon telodendria—the terminal arbors at the ends of many axons.
Temporal Summation	When excitatory postsynaptic potentials (EPSPs) are elicited by successive incoming action potentials that are very close together in time, they overlap and the depolarizations are additive. This summation increases the likelihood that the threshold for firing an action potential will be reached at the axon hillock.
Terminal Field	The region or area over which the synapsing terminals of a group of axons are distributed. Also, the term is sometimes used for a single axon.
Tertiary Fields of the Nuclear Zone	Poliakov's term for neocortical regions located further from the primary fields than the secondary fields. They coincide with Mesulam's heteromodal association areas plus adjacent unimodal areas that do not abut idiotypic cortex.
Testosterone	The male steroid hormone found in mammals, birds, reptiles and other vertebrates. It is found at much higher levels in males than in females. It is secreted primarily by the testes, but in much lower amounts by the adrenal glands.
Thalamus	A subdivision of the diencephalon, in mammals the largest subdivision. The word means an inner chamber. Most neural routes for inputs to cortical structures of the endbrain other than olfactory cortex include a synapse in the thalamus. In adult vertebrates, the thalamus is located above the subthalamus and below the epithalamus.
Third Endbrain Expansion	A third major expansion of the endbrain occurred much later in vertebrates with the evolution of various cognitive functions.
Third Ventricle	The narrow ventricle at the midline of the 'tweenbrain (diencephalon).
Thoracolumbar System	The sympathetic division of the autonomic nervous system. Its preganglionic motor neurons are found in the spinal cord's lateral horns at all thoracic levels and at the most rostral 2 or 3 lumbar levels. Thus, it can be called a thoracic-lumbar, or thoracolumbar, system.
Topographic Matching of Inputs in the Midbrain Tectum	The retinal inputs to the midbrain tectum terminate with an orderly topography in the most superficial layers. Auditory inputs into the intermediate layers are strongest when the sounds originate in the same parts of space represented in the nearest neurons of the superficial layers. Somatosensory inputs into the

	deeper layers are also topographically organized. The neurons respond best at the touch of whiskers that protrude into the parts of the visual field represented in the overlying superficial layers.
Topographic Organization of the Cochlear Nucleus	In both dorsal and ventral cochlear nuclei, higher pitched sounds activate more dorsally placed neurons, and lower pitched sounds activate more ventrally placed neurons.
Torus Semicircularis	The major midbrain cell group of the auditory pathway in non-mammalian vertebrates, similar to the inferior colliculus of mammals. This structure receives lateral line inputs in animals with mechanosensory or electrosensory lateral line systems.
Transcortical Auditory Pathways	Transcortical pathways from auditory cortex can be followed in different major directions. In monkeys, one route leads from unimodal association areas just caudal to primary auditory cortex to posterior parietal areas (both unimodal and multimodal), and thence to dorsolateral prefrontal cortex including the frontal eye fields. A second route leads from unimodal association areas rostral to primary auditory cortex, and thence to more anterior temporal cortex and to the amygdala, and to ventral prefrontal cortical areas…There are also pathways leading to parahippocampal cortical areas, and thence to entorhinal cortex and hippocampus. These pathways, however, are not commonly studied or discussed… These three pathways have functions like three major transcortical pathways of the visual system (concerned with object location, object identification, and allocentric location and heading of the organism.
Transcortical Fibers	Any axons that project from one cortical region to another. Besides the long association bundles, there are short U-fibers interconnecting nearby regions. Even more local axons that project across cortical columns or within columns may be called transcortical fibers.
Transcortical Pathways	Axonal pathways originating in a cortical area and terminating in other cortical areas.
Transcortical Visual Pathways: three major functions	Function 1: object localization (egocentric). This pathway is often called the “dorsal stream” by neuroscientists, concerned with “where is it?” information The striate cortex projects to prestriate and posterior parietal areas; from these areas there are major pathways to dorsal parts of prefrontal corex,

	including the frontal eye fields.Function 2: object identification. This pathway is often called the "ventral stream" and is concerned with "what is it?" information. The striate area projects to prestriate areas, which project to ventral portions of the temporal lobe neocortex (inferotemporal cortex). These areas project to the amygdala and to the ventral parts of prefrontal cortex.Function 3: allocentric localization of the animal's position in the environment, and the direction faced by the organism in that environment. The pathways involved, concerned with "where am I? and "where am I heading?" information, go to parahippocampal areas, which are interconnected with the hippocampus (medial pallium).
Trans-pedundular Tract	Retinofugal axons that course in one or several small bundles over the surface of the cerebral peduncle between the lateral and medial terminal nuclei of the AOT.
Trapezoid Body	Transversely oriented axons located in the ventral part of the hindbrain just caudal to the pons that come mostly from the ventral cochlear nucleus. Many of these axons cross the midline and terminate on cells of the superior olivary nucleus on the opposite side. Others terminate on cells of this nucleus on the same side. Similar connections are made with nearby cells of the nuclei of the trapezoid body.
Trigeminal Lemniscus	Axons of neurons of the hindbrain trigeminal nuclei that decussate and ascend to the thalamus. Many of these axons have some branches that terminate in other structures, especially in the midbrain tectum. Some of the axons do not reach the thalamus.
Trigeminal Nuclei	The secondary sensory neurons of the hindbrain that receive input from the trigeminal ganglion of the 5^{th} cranial nerve.
Trigeminal Nuclei	The secondary sensory neurons that receive inputs from the face and oral cavity *via* the three branches of the trigeminal nerve. The brainstem trigeminal nuclei include the main sensory nucleus and the descending nucleus of the trigeminal nerve. The latter can be divided into three portions (oralis, interpolaris, and caudalis); the caudal division is within the cervical spinal cord and is important for pain and temperature sensations.
Trigeminoreticular Pathway	Axons of neurons of the hindbrain trigeminal nuclei that ascend ipsilaterally with terminations in the

	reticular formation of the hindbrain and midbrain. A minority of the axons reach the 'tweenbrain, with terminations mostly in the subthalamus and older parts of the thalamus.
Tritiated Proline	The amino acid proline when it contains ^{3}H (tritium) is called tritiated proline. The radioactivity of tritium can be used to follow the fate of ^{3}H-proline in histological sections. The sections are mounted on slides and coated with a photographic emulsion (in darkness). The radioactivity exposes the emulsion when the sections are stored in darkness. Later development of the emulsion reveals the locations of the tritium-labeled proline.
Tritiated Thymidine	Thymidine, or thymine deoxyriboside, is one of the four deoxyribosides that make up DNA. When thymidine-H^3 is injected into developing animals, cells undergoing DNA synthesis take up some of the labeled material and incorporate it into the nuclear DNA. The locations of the tritium-labeled cells can be determined much later in life by the procedure of autoradiography, in which the radioactivity of the tritium exposes a photographic emulsion which is then developed.
Trophic	Increasing the amount or rate of cell or axonal growth, or preventing cells from dying. Increasing the growth vigor of developing axons.
Tropic	Affecting the direction of growth of cell processes, like axons.
TTX	The abbreviation for tetrodotoxin, a neurotoxin from the pufferfish (and other fish of the same order). TTX blocks action potentials by binding to voltage gated sodium channels in axonal membranes.
Tufted Cells	Neurons in the olfactory bulb that, like mitral cells, are secondary sensory neurons, with dendrites that enter olfactory glomeruli and synapse with axons of receptor neurons of the olfactory epithelium and with dendrites of periglomerular cells. Tufted cells are like mitral cells but smaller with more limited dendritic spread. Their axons enter the lateral olfactory tract.
Umami	Pleasant and savory: one of the basic tastes. The other basic tastes are sweet, salty, sour, and bitter.
Uncinate Fasciculus	Transcortical association pathway in primates that interconnects the anterior temporal cortical regions with orbital and frontal polar portions of the prefrontal association cortex.
Uncus	The term uncus means a hook. In anatomy of the

	human brain, the uncus refers to the medial bulge at the anterior end of the parahippocampal gyrus. (The medial surface there has a hook shape.) It includes a portion of the olfactory cortex—the periamygdaloid portion. The amygdala is covered by the cortex of the uncus.
Unilateral Amygdalectomy	Total or near-total lesion or removal of the amygdala on one side only.
Unimodal Association Area	Neocortical area that receives all or nearly all of its transcortical input from ideotypic cortex or from other unimodal areas.
Unimodal Association Area	In sensory areas of the neocortex, a unimodal association area is any one of the areas which receive transcortical inputs from a primary sensory area. Such areas also receive input from the lateral group of nuclei in the dorsal thalamus (LD, LP, Pulvinar, Po).
Vagus Nerve	The vagus nerve is cranial nerve 10, and includes both efferent and afferent axons. The name means "wandering" nerve because it is very long, distributing fibers to the throat, the thorax and the abdomen. Afferent axons include those from taste receptors of the throat. Efferent axons of the parasympathetic nervous system follow the vagus nerve into the thoracic and abdominal cavities. Included are fibers that result in slowing of the heartbeat. Afferent axons carry sensory inputs from various visceral organs to the hindbrain.
Valences	A descriptive term that can be used for positive or negative subjective values of objects (including other organisms) learned by an animal through encounters with those objects. Such subjective valences represent the positive or negative nature of affective tags.
Vasopressin (Anti-Diuretic Hormone or ADH)	A hormone that causes water retention by acting on the kidneys and also causes vascular constriction resulting in increased blood pressure.
Venous Sinus	A channel that acts as a vein, carrying venous blood into the venous system. A sinus is different from a vein in its lack of the same structures in its walls. For example, there are venous sinuses formed by channels in the dura mater.
Ventral Cochlear Nucleus	See "cochlear nuclei".
Ventral horn	The ventral part of the spinal gray matter. It contains the motor neurons that extend to striated muscle cells.
Ventral Lateral Geniculate Nucleus	The ventral nucleus of the LGB is the recipient of retinal projections in the subthalamus, adjacent to the

(LGv)	dorsal nucleus of the LGB.
Ventral Pallidum	Like the globus pallidus for the dorsal striatum, the ventral pallidum contains the output structures of the ventral striatal structures (mostly nucleus accumbens and olfactory tubercle). The ventral pallidal neurons are in the substantia innominata (between amygdala and hypothalamus) and in the preoptic area. [Discussed in chapter 30.]
Ventral pallium	The embryonic ventral pallium forms various olfactory structures of ventral and medial portions of the cerebral hemisphere, from olfactory bulb rostrally to portions of the amygdala caudally. However, most of the olfactory cortex (piriform cortex) is derived from the lateral pallium.
Ventral Posterior Nucleus (of the Thalamus)	The thalamic nucleus that receives somatosensory projections from spinal cord and from the trigeminal nuclei and also, in its most medial portion, from gustatory nuclei (rostral nucleus of the solitary tract and the parabrachial nucleus)
Ventral Striatum	The ventral parts of the corpus striatum, the major subcortical structure of the endbrain. The ventral striatal structures include the olfactory tubercle which reaches the ventral surface of the basal forebrain rostral to the optic chiasm and receives input at its surface from the olfactory bulb. The tubercle and other structures of the ventral striatum are strongly connected to limbic forebrain structures and to the hypothalamus.
Ventral striatum	The subcortical structures of the basal forebrain including the olfactory tubercle and the nucleus accumbens. These structures are part of the limbic system, receiving strong projections from limbic endbrain structures like the hippocampus and the amygdala. The ventral striatum is the most ancient part of the striatum. See also "ventral pallidum." [Discussed in chapter 30.]
Ventral Tegmental Area	A region near the midline of the ventral midbrain, located between the left and right substantia nigra. It is a limbic midbrain area, and like the CGA is strongly connected with the hypothalamus. It is an important source of dopamine-containing axons which are associated with pleasure and reward.
Ventral Tegmental Area (VTA)	The region in the ventral midbrain of mammals medial to the substantia nigra and extending across the midline. The VTA neurons are the source of dopaminergic axons that project to ventral striatum

	and other limbic structures, and to most of the neocortex.
Ventricular Layer	In the embryonic CNS, the ventricular layer is a layer that includes many mitotic cells. In regions generating particularly large numbers of neurons, a subventricular layer of dividing cells develops. After mitoses cease, the remaining cells lining the ventricle are called ependymal cells.
Ventricular Surface	The surface formed by cells that separate the ventricular fluid—the cerebrospinal fluid—from other CNS cells (neuronal and glial cells). The cells at the ventricular surface are the ependymal cells.
Ventrobasal Nucleus	The cell group of the ventral thalamus in mammals that receives somatosensory projections. It is also called the ventral posterior nucleus.
Vermis	The medial parts of the cerebellar cortex, coordinating movements of the axial musculature. It projects to the fastigial nucleus, the most medial of the deep nuclei of the cerebellum.
Vestibular Canals	The three semicircular canals in the temporal bone, arranged in three different planes. Movement of fluid in these canals during head movement is detected by the vestibular receptors.
Vestibular Nuclei	The secondary sensory neuron groups in the rostral hindbrain, other than those located in the cerebellum, that are innervated by primary sensory axons from the vestibular organ.
Vestibulocular Reflex	The counter-rotation of the eyes in response to turning of the head.
Vestibulospinal Tract	Fibers that originate in the vestibular nuclei of the hindbrain and project to the spinal cord. The lateral vestibulospinal tract originates in large neurons of the lateral vestibular nucleus (Deiter's nucleus), and descends ipsilaterally in the ventral part of the lateral funiculus (column). The axons terminate at all levels of the cord, mainly in layers 7 and 8, in the ventral horn, some directly on motor neurons. Additional vestibulospinal fibers descend in the ventral funiculi bilaterally from the medial vestibular nucleus, terminating on motor neurons of the cervical cord that control neck muscles.
Vestibulospinal Tract(s)	The lateral vestibulospinal tract is a descending pathway from the large cells of the lateral vestibular nucleus (Deiter's nucleus) with inputs from the vestibular apparatus and from the fastigial nucleus of the cerebellum. It is an uncrossed pathway that

	follows the ventral part of the lateral column and also the ventral column and terminates in layers 8 and 9 of the spinal gray, with effects primarily on antigravity muscles (extensors).... The medial vestibulospinal tract descends from the medial and descending vestibular nuclei. It is a caudal extension of the medial longitudinal fasciculus that controls eye muscles; it descends to cervical levels of the spinal cord where it influences neck muscles.
Visceral control	Control of activities of the internal organs by the nervous system. Control that originates in the central nervous system acts through the peripheral ganglia of the autonomic nervous system.
Visceral Motor Column	The parasympathetic preganglionic motor neurons of the brainstem. The most rostral group is the parasympathetic portions of the oculomotor nucleus in the midbrain. In the hindbrain, the visceral motor column includes both the salivatory nuclei and the dorsal motor nucleus of the vagus nerve.
Visceral Sensory Column	The secondary sensory neurons of the nucleus of the solitary tract in the hindbrain. The rostral portion is called the gustatory nucleus; the more caudal portions of the nucleus receives sensory information from the organs of the thoracic and abdominal cavities.
Wulst	From the German word for bulge, the term usually refers to the hyperpallial region of birds that receives visual information from a nucleus of the thalamus that is directly connected to the retina. There is also a somatosensory Wulst and a motor Wulst. The visual Wulst is a homolog of the mammalian primary visual cortex.
Xenograft	A graft of tissue taken from one species and implanted in another species.
Zona Incerta (ZI)	Neurons of the subthalamic region (the embryonic ventral thalamus of vertebrates) that are not included in the subthalamic nucleus or the ventral nucleus of the lateral geniculate body. ZI neurons receive many connections from various parts of neocortex and from much of the midbrain. The ZI projects to striatal output structures (pallidal structures) and to midbrain structures including the midbrain locomotor area, the red nucleus, the superior colliculus and central gray area (and to other structures). It projections to the neocortex and the striatum mostly indirectly, since it projects to the midline and intralaminar nuclei of the thalamus (sometimes called the non-specific

	thalamus).