Somatic Afferent

Related terms:

Cranial Nerves, Eicosanoid Receptor, Neurotransmitters, Nociceptor, Axon, Visceral Afferent, Dysautonomia, Reflex

View all Topics

Introduction

Alexander de Lahunta DVM, PhD, DACVIM, DACVP, Eric Glass MS, DVM, DACVIM (Neurology), in Veterinary Neuroanatomy and Clinical Neurology (Third Edition), 2009

Somatic Afferent

The somatic afferent system has its dendritic zone on or near the surface of the body derived from the somatopleura, where it receives the various stimuli from the external environment.

General Somatic Afferent

The general somatic afferent (GSA) system comprises the neurons distributed primarily by the fifth cranial nerve to the surface of the head and all the spinal nerves to the surface of body and limbs that are sensitive to touch, temperature, and noxious stimuli.

Special Somatic Afferent

The special somatic afferent (SSA) system involves specialized dendritic zone receptor organs limited to one area deep to the body surface but stimulated by changes in the external environment. These include light to the eyeball (cranial nerve II) and air waves indirectly to the membranous labyrinth of the inner ear (cranial nerve VIII, cochlear division).

The Biological Basis for Mind Body Interactions

Richard Bandler, ... Kevin A. Keay, in Progress in Brain Research, 2000

Spinal and medullary afferents to different PAG columns

Somatic and visceral afferents are major sources of 'primary' afferent drive onto the PAG and anatomical studies of the patterns of termination of these afferents indicate a respect for PAG columnar boundaries.

Lateral column of PAG.

The lateral column receives inputs from the contralateral lumbar and cervical enlargements, as well as the spinal trigeminal nucleus. These inputs are topographically organized: the lumbar enlargement projects to the most caudal part of the lateral column; the cervical enlargement and spinal trigeminal nucleus project to progressively more rostral parts of the lateral column (Wiberg et al., 1987; Yzierski, 1988; Blomqvist and Craig, 1991; Bandler and Shipley, 1994; Keay et al., 1997). The upper cervical spinal cord also provides a major input to the lateral column with approximately 50% of all lateral column-projecting spinal neurons located within segments C1-C4. As illustrated in Fig. 4, spinal afferents to the lateral column arise predominantly, contralaterally from the lateral spinal nucleus, superficial dorsal horn (lamina I) and deep dorsal horn (laminae IV and V) (Keay et al., 1997).

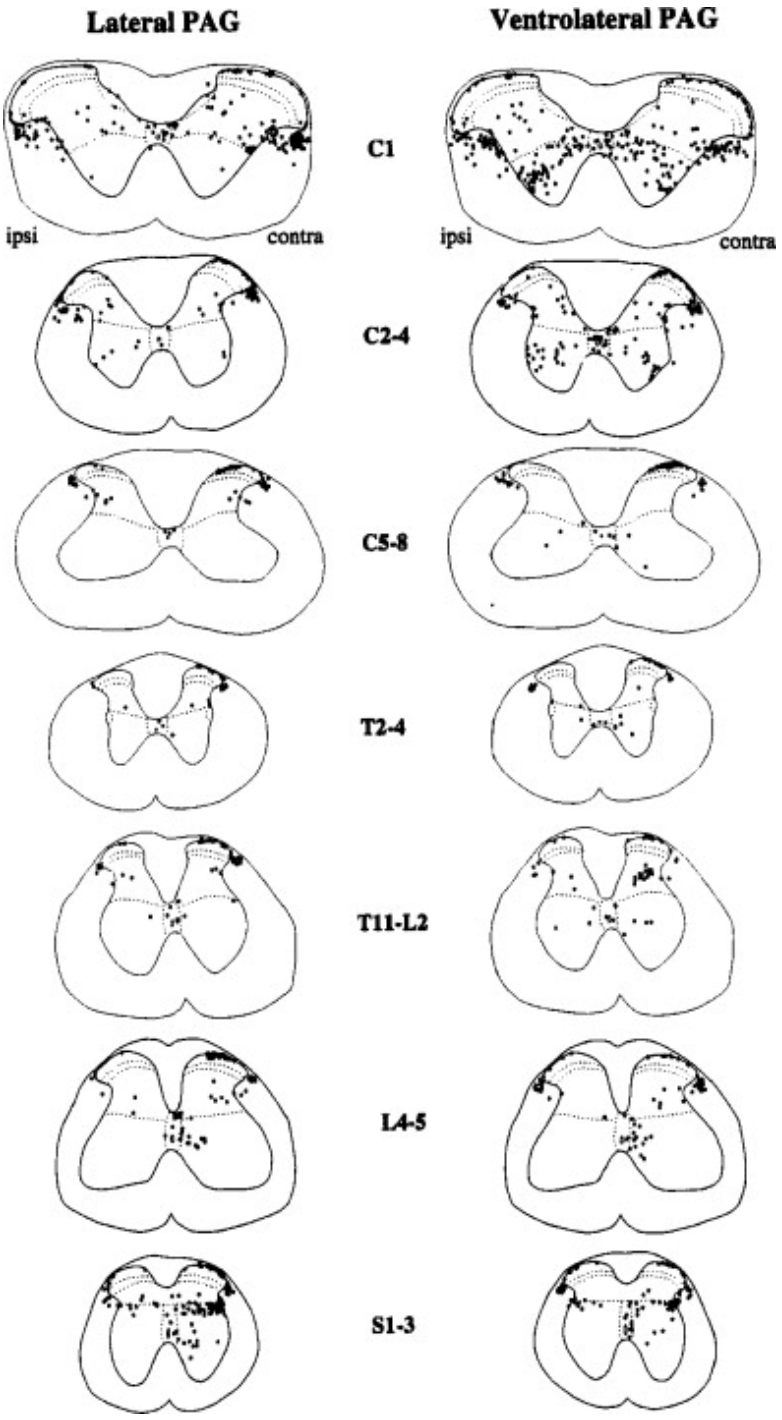

Fig. 4. Comparison of the distribution of labeled neurons in seven segmental regions following injection of retrograde tracer (cholera toxin subunit B) in the lateral column of the PAG (left) or the ventrolateral column of the PAG (right).Reproduced from Fig. 4 (Keay et al., 1997).Copyright © 1997

Ventrolateral column of PAG.

In contrast to the general topographical organization of spinal afferents to the lateral column, afferents arising from multiple spinal segmental levels (upper cervical, cervical and lumbosacral enlargements, thoracic cord) terminate convergently within the ventrolateral column (Keay et al., 1997). Further, the ventrolateral column receives a major input from the general, visceral afferent-recipient part of the nucleus

of the solitary tract (NTS) (Herbert and Saper, 1992; Clement et al., 1998). The C1 segment contains approximately 30% of the total number of spinal neurons projecting to the ventrolateral column, with segments C2 to C4 contributing an additional 20% of all ventrolateral column-projecting spinal neurons. Below C4, neurons which project to the ventrolateral column are distributed in a similar laminar pattern to those which project to the lateral column. However, within the upper cervical region projections to the ventrolateral column arise bilaterally from the dorsal horn, and large numbers of ventrolateral column-projecting neurons are located uniquely within laminae VII and VIII (see Fig. 4).

Functional considerations.

As discussed previously, excitation of the lateral column of the PAG evokes coping strategies characterized by an active engagement with the external environment. In this context, the topographically organized, lateral spinal nucleus, lamina I and deep dorsal horn projections to the lateral column provide routes via which touch or cutaneous pain arising from a specific body region could trigger distinct, stereotyped active coping responses. For example, a response to a threat or stress arising from in front of an animal – triggered by afferents from the face (spinal trigeminal) and forelimbs (cervical enlargement) which target specifically the rostral half of the lateral column – is a strategy of confrontation and if provoked, attack. In response to threat or stress felt at the rear of the animal, input from hindlimbs (lumbar enlargement) which project specifically to the caudal half of the lateral column would trigger a reaction of flight.

In contrast to the above, excitation of the ventrolateral column triggers a passive coping reaction, which is the characteristic mode of response to social defeat or inescapable stress, e.g. the blood loss and deep pain associated with traumatic injury. This suggests that spinal and NTS neurons that project to the ventrolateral column are likely to be excited by nociceptive signals carried by muscle, joint and/or visceral afferent fibers, a picture that fits with the fos findings reviewed previously. Upper cervical afferents (C1-C4) to the ventrolateral column are very substantial and it is interesting to note that these projections arise from laminae known to receive convergent inputs (from lower spinal segments) of noxious visceral and noxious deep somatic origin (Bolton and Tracey, 1992; Foreman, Chapter 15, this volume), as well as primary afferents arising from deep neck muscles and the trigeminal innervated regions of the head (Abrahams et al., 1979, 1984; Pfaller and Arvidsson, 1988). Thus, upper cervical regions projecting to the ventrolateral column are already a site of convergence of deep noxious signals arising from the entire body.

Neither the dorsomedial nor dorsolateral columns of the PAG receive any comparable direct spinal or NTS innervation.

> Read full chapter

Physiology

David Williams, ... Dawn Adamson, in Basic Science in Obstetrics and Gynaecology (Fourth Edition), 2010

Somatic nervous system

Somatic afferent neurones enter the spinal cord via the dorsal roots or cranial nerves, and efferent neurones leave via the ventral roots or the motor cranial nerves.

The simplest reflex is a monosynaptic reflex of which the only example is the stretch reflex. When a muscle is stretched, the spindles within the muscles are stimulated, which causes a discharge in the afferent neurone. The afferent neurone stimulates the efferent motor neurone at a single synapse in the spinal cord; impulses pass down the motor neurone to the muscle, which then contracts.

Motor system

Most reflexes are polysynaptic with several (often hundreds) of synapses between the sensory receptor and the effector cell. Many different afferent neurones may synapse with each efferent neurone. Thus the motor neurone also receives synapses from nerves originating in the cerebral cortex which allow voluntary control of movement. The motor system is conventionally divided into lower motor neurones, spinal and cranial nerves which directly innervate muscles, and upper motor neurones, those of the brain and spinal cord that innervate lower motor neurones. Lesions of lower motor neurones cause a flaccid paralysis with wasting. Lesions of upper motor neurones often cause a spastic paralysis without initial wasting.

The major innervation from the cortex to somatic muscular cells in humans is via the pyramidal system (Figs 10.25–10.27). Nerves which have their cell bodies in the specialized motor area of the cerebral cortex descend via the internal capsule. About 80% cross the midline in the pyramidal decussation to form the lateral corticospinal tract. The remaining 20% descend the anterior corticospinal tract and cross just before their termination at the spinal lower motor neurone. Current evidence indicates that there are several other areas in the brain which can generate voluntary muscular movement apart from the precentral gyrus, the specialized area where movement of each part of the body is spatially located.

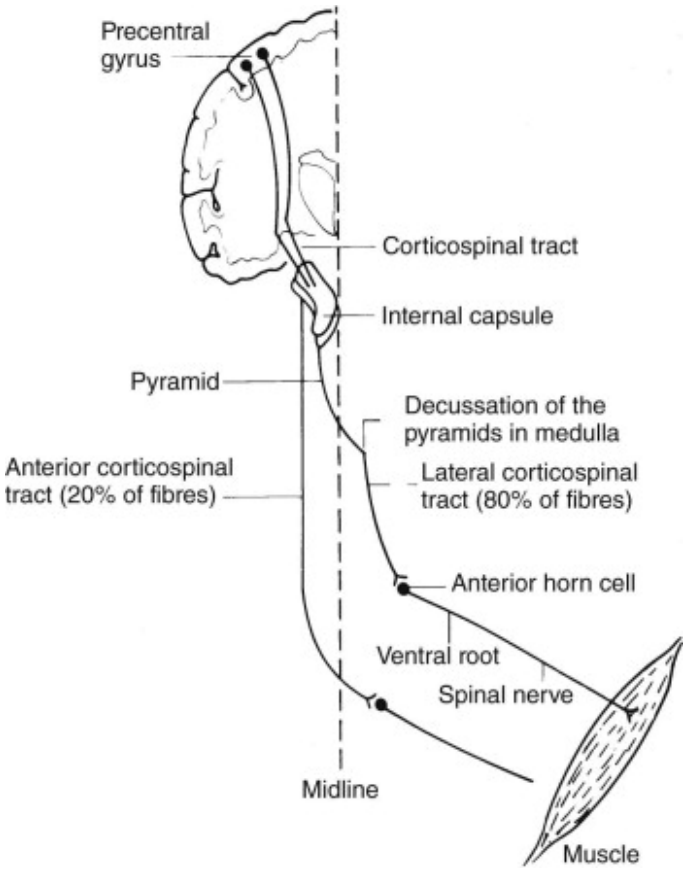

Figure 10.25 •. The corticospinal tracts.(Reproduced with permission from Ganong W. Review of medical physiology. Lange Medical, Los Altos, CA.)

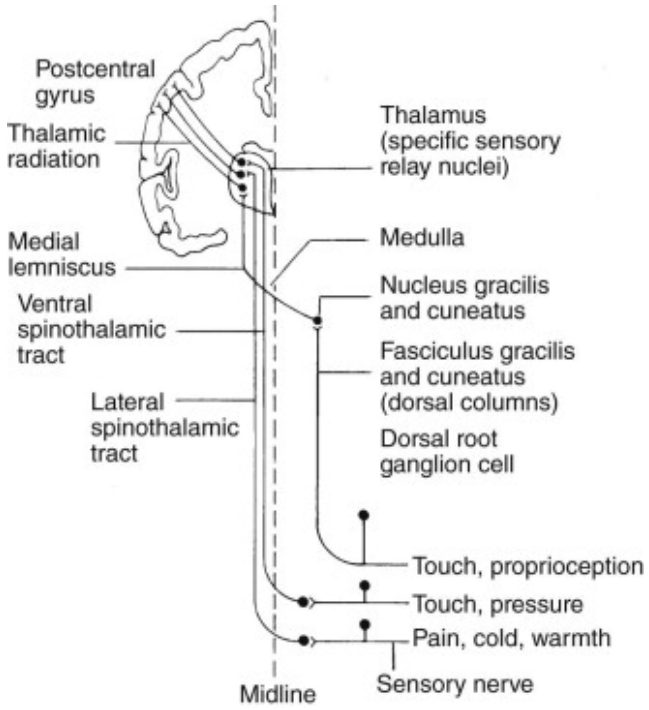

Figure 10.26 •. Touch, pressure, pain and proprioception from the trunk and limbs.-(Reproduced with permission from Ganong W. Review of medical physiology. Lange Medical, Los Altos, CA.)

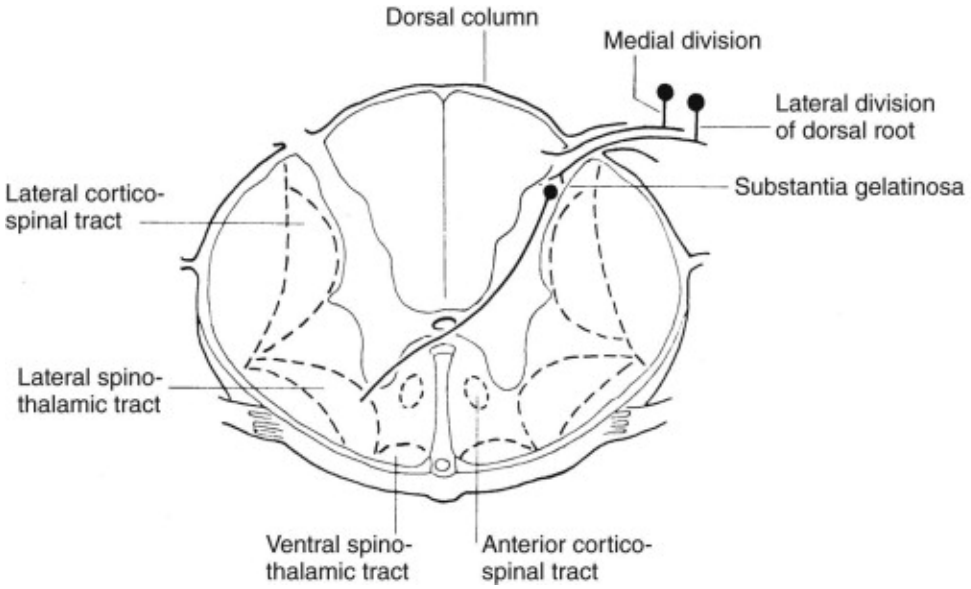

Figure 10.27 •. Major spinal pathways.(Reproduced with permission from Ganong W. Review of medical physiology. Lange Medical, Los Altos, CA.)

The pyramidal tracts are probably responsible for skilled, fine movement. In addition, the lower motor neurone receives innervation from many other sources. The stretch receptors, acting at a local spinal segmental level, have already been mentioned. The action of these stretch receptors is modulated both by local nervous influences (efferent system), which in turn are affected by descending fibres from the cerebrum. The lower motor neurone itself is also innervated from the cerebrum via extrapyramidal tracts, responsible for gross movements and posture, and by fibres from the cerebellum, which are concerned with coordination and control.

Sensory system

Sensation can be divided into the modalities of the special sensory organs – vision, hearing, taste and smell – and the more generalized sensations of pain, touch, temperature and joint position sense. The specialized sensory organs are outside the scope of this book. The organization and cerebral representation of generalized sensation require further consideration.

Primary afferent fibres from specific receptors enter the spinal cord via the dorsal root. They have their cell bodies in the dorsal root ganglion. Those fibres that come from receptors for proprioception and fine touch ascend in the dorsal columns to the medulla (Figs 10.26, 10.27). There they synapse with second-order neurones in the cuneate and gracile nuclei. The second-order neurones cross the midline, at the level of the medulla, and ascend via the medial lemniscus to the thalamus. Neurones project from the thalamus to at least two areas on the cortex. The most precise localization is at somatic sensory area I in the postcentral gyrus. Here each part of the body is specifically represented, and within each area are columns of cells which react to specific sensory modalities (e.g. proprioception and fine touch).

A second sensory area, somatic sensory area II, is in the wall of the Sylvian fissure. Here representation of the body is not so complete, nor so specific.

Fibres from pain and temperature receptors and some other touch receptors also enter the spinal cord via the dorsal root, but synapse with nerves in the substantia gelatinosa of the dorsal horn. Fibres from these neurones cross the midline immediately (cf. spinothalamic tracts) and then ascend in the anterolateral system of the spinal cord (lateral columns) (Figs 10.26, 10.27). Touch ascends the ventral spinothalamic tract; pain and temperature ascend the lateral spinothalamic tract. These fibres also project to the thalamus and then synapse with other neurones passing to somatic sensory areas I and II. However, the sensations carried by the anterolateral system are not so exclusively represented in the cerebral cortex as those carried by the spinothalamic tracts. Experimental ablation, or observations on patients with spontaneously occurring lesions, show that proprioception and fine touch (spinothalamic tract) are most affected by cortical lesions. Temperature sensation is less affected and pain sensation (lateral columns) is barely affected at all.

The 'gate' theory accounts for the observation that individuals' perception of pain varies enormously both between individuals and within individuals on different occasions. Many external and internal influences, such as hypnosis, acupuncture and analgesic drugs, can affect pain perception, and probably do so by influencing transmission of impulses from pain receptors at many sites within the central nervous system. One site that has been extensively investigated is in the substantia gelatinosa of the spinal cord (Fig. 10.27), where pain afferent neurones synapse with fibres that will ascend in the lateral columns. Transmission here can be inhibited by stimulation of other fibres, mediating touch or proprioception in the adjacent spinothalamic tract. Stimulation of these fibres has been used clinically in the relief of pain. The fibres may be stimulated either in the skin (as in the treatment of trigeminal neuralgia using an electrical stimulator) or by implantation of chronic stimulators in the dorsal columns.

> Read full chapter

Preparation of the Patient for Awake Intubation

Carlos A. Artime, Antonio Sanchez, in Benumof and Hagberg's Airway Management, 2013

1 Anatomy

The somatic and visceral afferent sensory fibers of the oropharynx are supplied by a plexus derived from the vagus (CN X), facial (CN VII), and glossopharyngeal (CN IX) nerves. The glossopharyngeal nerve (GPN) emerges from the skull through the jugular foramen and passes anteriorly between the internal jugular and carotid vessels, traveling along the lateral wall of the pharynx. It supplies sensory innervation to the posterior third of the tongue via the lingual branch and to the vallecula, the anterior surface of the epiglottis, the posterior and lateral walls of the pharynx, and the tonsillar pillars. Its only motor innervation in the pharynx is to the stylopharyngeus muscle, one of the muscles of deglutition.

In most patients, topicalization of the mucosa of the oropharynx is sufficient to allow instrumentation of the airway. In some, however, the gag reflex is so pronounced that topicalization alone may be insufficient for AI. The afferent limb of the gag reflex arises from stimulation of deep pressure receptors found in the posterior third of the tongue, which cannot be reached by the diffusion of local anesthetics through the mucosa. There are various measures for minimizing this problem: instructing the patient to breathe in a nonstop panting fashion, avoiding pressure on the base of the tongue by performing a nasal intubation, administering opioids, and performing blockade of the GPN. The GPN block is easy to perform and is highly effective in abolishing the gag reflex and decreasing the hemodynamic response to laryngoscopy, including awake laryngoscopy. Several different approaches have been described.

> Read full chapter

Glossopharyngeal Nerve

Paul Rea, in Clinical Anatomy of the Cranial Nerves, 2014

General Somatic Afferent

The general somatic afferent, or general sensory fibers, conveys general sensory information from the skin of the external ear, inside of the tympanic membrane, the upper portion of the pharynx as well as general sensation from the posterior one-third of the tongue.

The fibers from the skin of the external ear initially travel with the vagus nerve (auricular branch (Arnold's nerve)). From the inner aspect of the tympanic membrane, the fibers for general sensation travel in the tympanic nerve. The fibers for general

sensation from the upper part of the pharynx and posterior one-third of the tongue pass via the pharyngeal branch of the glossopharyngeal nerve.

From these branches, they then pass centrally to the medulla entering the spinal nucleus of the trigeminal nerve, projecting contralaterally to the ventral postero-medial nucleus of the thalamus. From there, the fibers from the external ear, tympanic membrane, pharynx, and tongue then terminate in the sensory cortex for interpretation and processing of the information conveyed.

> Read full chapter

Head

Paul Rea MBChB, MSc, PhD, MIMI, RMIP, FHEA, FRSA, in Essential Clinically Applied Anatomy of the Peripheral Nervous System in the Head and Neck, 2016

General Somatic Afferent

The general somatic afferent or general sensory fibers convey general sensory information from the skin of the external ear, inside of the tympanic membrane, the upper portion of the pharynx, and general sensation from the posterior one-third of the tongue.

The fibers from the skin of the external ear initially travel with the vagus nerve (auricular branch (Arnold's nerve)). From the inner aspect of the tympanic membrane, the fibers for general sensation travel in the tympanic nerve (see above). The fibers for general sensation from the upper part of the pharynx and posterior one-third of the tongue pass via the pharyngeal branch of the glossopharyngeal nerve.

From these branches, they then pass centrally to the medulla entering the spinal nucleus of the trigeminal nerve, projecting contralaterally to the ventral postero-medial nucleus of the thalamus. From there, the fibers from the external ear, tympanic membrane, pharynx, and tongue then terminate in the sensory cortex for interpretation and processing of the information conveyed.

The ganglia of the glossopharyngeal nerve can be summarized as follows:

Superior ganglion—This ganglion is very small and is sometimes viewed as a broken off part of the inferior ganglion. It is found within the groove of where the glossopharyngeal nerve passes in the jugular foramen. It contains the visceral sensory fibers from the pharynx, parotid gland, carotid body, and sinus as well as the middle ear.

Inferior ganglion—The inferior ganglion conveys information related to special and general sensation from the mucous membrane of the posterior one-third of the tongue. Its peripheral fibers also come from the oropharynx and soft palate conveying general sensory fibers. The inferior ganglion is the bigger of the two ganglia related to the glossopharyngeal nerve and is found on the lower border of the petrous temporal bone in a notch. The inferior ganglion also communicates with the facial and vagus nerves, as well as with the sympathetic trunk.

> Read full chapter

The Glossopharyngeal Nerve—Cranial Nerve IX

Steven D. Waldman MD, JD, in Pain Review, 2009

The general sensory somatic afferent fibers carry pain, temperature, and touch information from the skin of the external ear, internal surface of the tympanic membrane, the walls of the upper pharynx, and the posterior third of the tongue. Sensory fibers from the skin of the external ear initially travel with the auricular branch of the vagus nerve with those fibers innervating the middle ear combining as part of the tympanic nerve. Pain, temperature, and touch information from the upper pharynx and posterior third of the tongue ascend via the pharyngeal branches of the glossopharyngeal nerve. The cell bodies for these peripheral portions of the glossopharyngeal nerve are located in the superior or inferior glossopharyngeal ganglia that reside within the jugular foramen. Leaving the glossopharyngeal ganglia, these general sensory neurons then pass superiorly through the jugular foramen to enter the brainstem at the level of the medulla where they descend in the spinal trigeminal tract and synapse in the caudal spinal nucleus of the trigeminal nerve. Ascending secondary neurons originating from the spinal nucleus of the trigeminal nerve project to the contralateral ventral posteromedial nucleus of the thalamus via the ventral trigeminothalamic tract. Tertiary neurons from the ventral posteromedial nucleus of the thalamus project via the posterior limb of the internal capsule to the sensory cortex of the post-central gyrus.

> Read full chapter

Diencephalon and internal capsule

J.L. Wilkinson OBE, MD, FRCS, in Neuroanatomy for Medical Students (Second Edition), 1992

Afferent connexions

1. . Visceral and somatic afferents. General visceral afferents arrive from the vagal sensory nucleus, gustatory afferents from the nucleus solitarius, and somatic afferents from the nipples and genitalia. Retinal afferents, concerned with light intensity, programme a 'biological clock'. There is an input from the olfactory cortex to the medial forebrain bundle.
2. Limbic system, thalamus and cortex. The hippocampus, in the floor of the inferior horn of the lateral ventricle is connected by the *fornix* to the mamillary body, with collaterals to other hypothalamic nuclei. The amygdaloid nucleus, in the roof of the inferior horn, has efferents forming the stria terminalis which reach the anterior hypothalamic and septal regions. Both these tracts, the fornix and the stria curve round the thalamus (*Figs* 8.1, 8.10, *see Fig.* 10.2). The *medial forebrain bundle* brings afferents from the septal region. The *mamillothalamic tract* connects the hypothalamus to the anterior thalamic nucleus, which has reciprocal links with the cingulate gyrus. These are all part of the limbic system, forming a bording zone (limbus) between the diencephalon and telencephalon.The prefrontal cortex transmits emotional, affective information through the dorsal medial thalamic nucleus to the hypothalamus via a periventricular system of fibres on the medial surface of the thalamus.
3. **Pineal gland**: a reciprocal relationship (*see* p. 178).
4. **Direct physical and chemical receptors**. Circulating blood is constantly monitored by hypothalamic cells that function as thermoreceptors, osmoreceptors or chemoreceptors.

> Read full chapter

The Somatosensory System I

S. Warren, ... R.P. Yezierski, in Fundamental Neuroscience for Basic and Clinical Applications (Fifth Edition), 2018

Primary Afferent Fibers

As initially described in Chapter 9, somatic afferent fibers consist of (1) a **peripheral process** extending from the posterior root ganglion either to contact peripheral mechanoreceptors or to end as free nerve endings, (2) a **central process** extend-

ing from the posterior root ganglion into the central nervous system, and (3) a **pseudounipolar cell body** in the posterior root ganglion. The peripheral distribution of the afferent nerves arising from each spinal level delineates the segmental pattern of dermatomes. In clinical testing, these ribbon-like strips of skin are associated primarily with fibers and pathways that convey pain and thermal information; they are considered in Chapter 18.

Peripheral nerves are classified by two schemes. One is based on their contribution to a compound action potential (A, B, and C waves) recorded from an entire mixed peripheral nerve (e.g., sciatic nerve) after electrical stimulation of that nerve. The other scheme specific to cutaneous fibers (e.g., lateral antebrachial cutaneous nerve, sural nerve) is based on fiber diameter, myelin thickness, and conduction velocity (classes I, II, III, and IV) (Table 17.3; Fig. 17.4). The two schemes are related because conduction velocity determines a fiber's contribution to the compound action potential. Discriminative touch, vibratory sense, and position sense are transmitted by group Ia, Ib, and II fibers (Tables 17.1 and 17.2). The compound action potential and conduction velocity of nerve fibers is often used as a diagnostic test in the evaluation of peripheral nerve disease, for instance, multiple sclerosis and peripheral neuropathies.

Table 17.3. Peripheral Sensory and Motor Fibers: Groups, Diameters, and Conduction Velocities

Electrophysiologic Classification of Peripheral Nerves	Classification of Afferent Fibers ONLY (Class/Group)	Fiber Diameter (-µm)	Conduction Velocity (m/s)	Receptor Supplied
Sensory Fiber Type				
A□	Ia and Ib	13-20	80-120	Primary muscle spindles, Golgi tendon organ
A□	II	6-12	35-75	Secondary muscle spindles, skin mechanoreceptors
A□	III	1-5	5-30	Skin mechanoreceptors, thermal receptors, and nociceptors
C	IV	0.2-1.5	0.5-2	Skin mechanoreceptors, thermal receptors, and nociceptors
Motor Fiber Type				
A□	N/A	12-20	72-120	Extrafusal skeletal muscle fibers
A□	N/A	2-8	12-48	Intrafusal muscle fibers
B	N/A	1-3	6-18	Preganglionic autonomic fibers
C	N/A	0.2-2	0.5-2	Postganglionic autonomic fibers

N/A, not applicable.

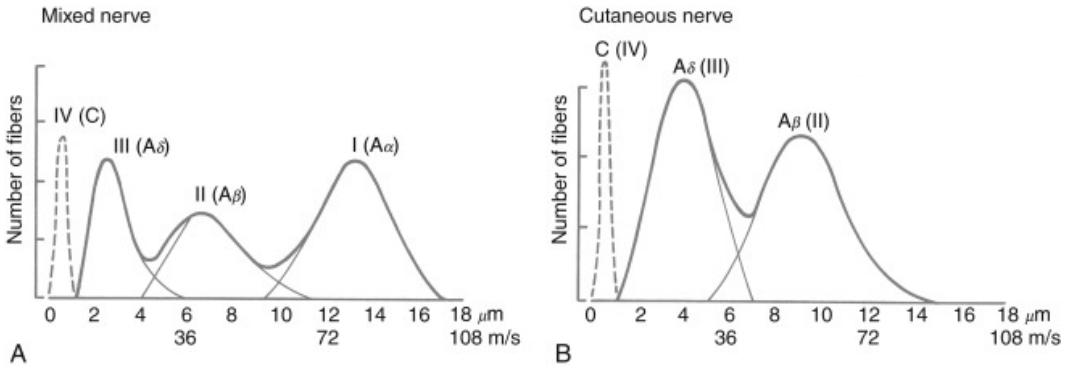

Fig. 17.4. Compound action potential evoked in a mixed nerve (**A**) and a cutaneous nerve (**B**) in response to electrical stimulation. Note the increase in the number of small-diameter fibers and the absence of the A□ fibers in the cutaneous nerve (**B**).

> Read full chapter

Somatosensory System

JON H. KAAS, in The Human Nervous System (Second Edition), 2004

Anterior Pulvinar, Medial Pulvinar, and Lateral Posterior Nucleus

Other thalamic structures without direct inputs from second-order somatic afferents can be considered part of the somatosensory system on the basis of connections with somatosensory cortex. These include the anterior (oral) pulvinar with widespread projections to anterior parietal cortex, posterior parietal cortex, and somatosensory cortex of the lateral fissure (Cusick and Gould, 1990; Krubitzer and Kaas, 1992); the medial pulvinar with connections with posterior parietal cortex and the temporal lobe (see Mesulam, 1981); and the lateral posterior nucleus with projections to posterior parietal cortex (see Kaas and Pons, 1988). In humans, degeneration has been noted in the anterior pulvinar after damage to parietal cortex of the lateral fissure, while LP degenerates after lesions of posterior parietal cortex (Van Buren and Borke, 1972). The roles of these nuclei in the processing of somatosensory information are unknown, but the lack of direct sensory input and the widespread cortical connections suggest modulatory and integrative functions.

> Read full chapter