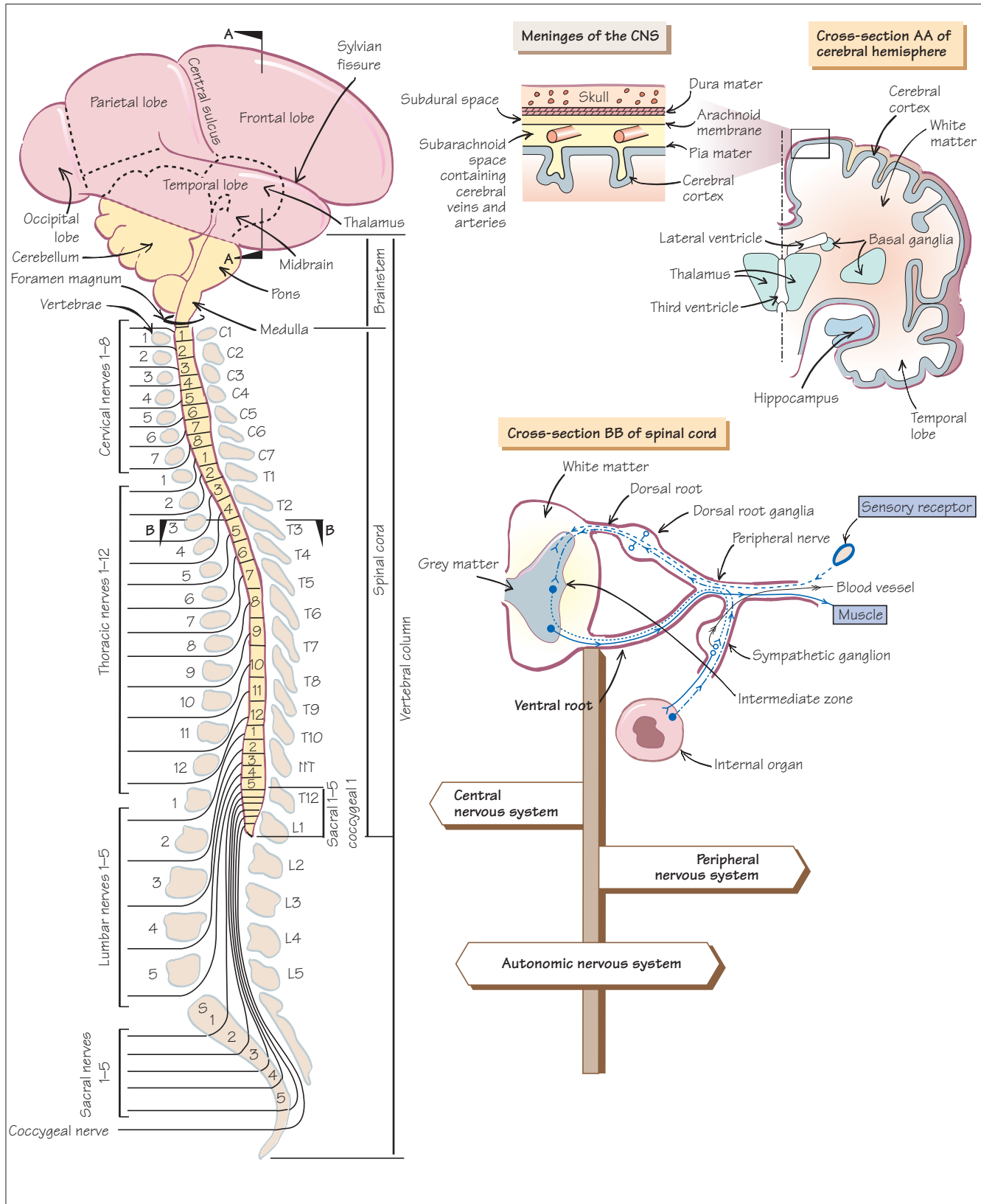


1 The organization of the nervous system



An overview

The nervous system can be divided into three major parts: the **peripheral** (PNS), **central** (CNS) and **autonomic** (ANS) **nervous system**. The PNS is defined as those nerves that lie outside the brain, brainstem or spinal cord, while the CNS embraces those cells that lie within these structures.

Peripheral nervous system

The PNS consists of nerve trunks made up of both afferent fibres or axons conducting sensory information to the spinal cord and brainstem, and efferent fibres transmitting impulses primarily to the muscles. Damage to an individual nerve leads to weakness of the muscles it innervates and sensory loss in the area from which it conveys sensory information. The peripheral nerves occasionally form a dense network or plexus adjacent to the spinal cord (e.g. brachial plexus in the upper limb). The peripheral nerves connect with the spinal cord through foramina between the bones (or **vertebrae**) of the spine (or **vertebral column**), or with the brain through foramina in the skull.

Spinal cord

The **spinal cord** begins at the **foramen magnum**, which is the site in the base of the skull where the lower part of the brainstem (medulla) ends. The spinal cord terminates in the adult at the first lumbar vertebra, and gives rise to 30 pairs (or 31 if the coccygeal nerves are included) of spinal nerves, which exit the spinal cord between the vertebral bones of the spine. The first eight spinal nerves originate from the **cervical spinal cord** with the first pair exiting above the first cervical vertebra and the next 12 spinal nerves originate from the **thoracic or dorsal spinal cord**. The remaining 10 pairs of spinal nerves originate from the lower cord, five from the **lumbar** and five from the **sacral** regions.

The spinal nerves consist of an **anterior or ventral root** that innervates the skeletal muscles, while the **posterior or dorsal root** carries sensation to the spinal cord from the skin that shared a common embryological origin during development with that part of the spinal cord (see Chapter 2). In the case of the dorsal root fibres, they have their cell bodies in the **dorsal root ganglia** which lie just outside the spinal canal.

The spinal cord itself consists of **white matter**, which is that part of it containing the nerve fibres that form the **ascending and descending pathways of the spinal cord**, while the **grey matter** is located in the centre of the spinal cord and contains the cell bodies of the neurones (see Chapter 12).

Brainstem, cranial nerves and cerebellum

The spinal cord gives way to the **brainstem** which lies at the base of the

brain and is composed of the **medulla, pons and midbrain** (or **mesencephalon** as it is sometimes called, although this is strictly a term that should be reserved for this region of the brain in embryonic development) and contains discrete collections of neurones or nuclei for 10 of the 12 cranial nerves (see Chapter 14). The brainstem and the **cerebellum** constitute the structures of the posterior fossa. The cerebellum is connected to the brainstem via three pairs of cerebellar peduncles, and is involved in the coordination of movement (see Chapter 39).

Cerebral hemispheres

The **cerebral hemispheres** are composed of **four major lobes: occipital, parietal, temporal and frontal**. On the medial part of the temporal lobe are a series of structures, including the **hippocampus**, that form the limbic system (see Chapter 46).

The outer layer of the cerebral hemisphere is termed the **cerebral cortex**, and contains neurones that are organized in both horizontal layers and vertical columns (see Chapter 15). The cerebral cortex is interconnected over long distances via pathways that run subcortically. These pathways, together with those that connect the cerebral cortex to the spinal cord, brainstem and nuclei deep within the cerebral hemisphere, constitute the **white matter of the cerebral hemisphere**. These deep nuclei include structures such as the **basal ganglia** (see Chapters 40 and 41) and the **thalamus**.

Meninges

The CNS is enclosed within the skull and vertebral column and separating these structures are a series of membranes known as the **meninges**. The **pia mater** is separated from the delicate **arachnoid membrane** by the subarachnoid space, which in turn is separated from the **dura mater** by the subdural space (see Chapter 18).

Autonomic nervous system

The **ANS** has both a central and peripheral component and is concerned with the innervation of internal and glandular organs (see Chapter 16): it has an important role in the control of the endocrine and homeostatic systems of the body (see Chapter 17). The peripheral component of the ANS is defined in terms of the **enteric, sympathetic and parasympathetic systems** (see Chapter 16).

The efferent fibres of the ANS originate either from the **intermediate zone** (or **lateral column**) of the spinal cord or specific cranial nerve and sacral nuclei, and synapse in a **ganglion**, the site of which is different for the sympathetic and parasympathetic systems. The afferent fibres from the organs innervated by the ANS pass via the dorsal root to the spinal cord.