

## **HBB – central nervous system**

### **1**

**Cerebral hemispheres:** left and right hemispheres are the largest part of the CNS and are located at the superior part of the brain. Functional areas include the frontal lobe (for motor control and contains the primary motor cortex), parietal lobe (somatosensory and contains the primary somatosensory cortex), temporal lobe (hearing) and occipital lobe (sight).

**Thalamus:** the two egg-like structures inferior to the cerebral hemispheres and acts as a gateway to the cortex.

**Hypothalamus:** inferior to the thalamus and controls thirst, appetite, body temperature and blood pressure.

**Brainstem:** inferior to the diencephalon and is made up of 3 parts (midbrain, pons and medulla oblongata). It connects the spinal cord to higher brain centres and it contains groups of special nuclei that control vital functions (breathing, heartbeat, blood pressure via vasoconstriction and swallowing).

**Cerebellum:** located at the posterior and inferior part of the brain and is involved in balance control, movement coordination and learning of movements.

### **2**

**Meninges:** Three connective tissue membranes that lie just external to the CNS organs. They cover and protect the CNS, protect blood vessels and enclose venous sinuses, contain cerebrospinal fluid, and form partitions in the skull.

**Dura mater:** 'Tough Mother'. A two layered sheet of fibrous connective tissue. The superficial layer is attached to the surface of the skull (periosteum) (not found around the spinal cord). The deeper meningeal layer forms the true external covering of the brain and continues caudally in the vertebral canal as the spinal dura mater. The two layers are fused together except in certain areas where they separate to enclose dural venous sinuses that absorb CSF via the arachnoid villi and direct it into the internal jugular veins of the neck. Dura mater forms partitions that subdivide the cranial cavity and limit excessive movement of the brain within the skull (e.g. falx cerebri, falx cerebelli, tentorium cerebelli).

**Arachnoid mater:** 'Spider Mother'. A loose covering that never dips into the sulci at the cerebral surface. Knoblike projections of the arachnoid mater called arachnoid villi protrude superiorly through the dura mater and into the superior sagittal sinus (the gap between the 2 dura mater layers).

**Pia mater:** 'Gentle mother'. Composed of a delicate connective tissue and is richly invested with tiny blood vessels. Clings tightly to the brain like cellophane wrap.

**Subdural space:** gap between dura mater and arachnoid mater. Contains a film of fluid.

**Subarachnoid space:** gap between arachnoid mater and pia mater. Weblike extensions span this space and secure the arachnoid mater to the underlying pia mater. Contains CSF and the largest blood vessels serving the brain.

### 3

**Grey matter:** areas containing cell bodies and unmyelinated fibres. These areas include the cerebral cortex, nuclei (like basal nuclei found deep in the cerebrum), horns (found in the deep part of the spinal cord) or ganglia (bundles of cell bodies in the PNS).

**White matter:** areas containing mostly axons and their covering myelin sheaths. These areas include tracts (white matter in brain), columns (found in the superficial part of the spinal cord), pathways, fasciculi (bundles of axons), lemnisci.

### 4

**Spinal cord:** Extends from the foramen magnum of the skull to the level of the first or second lumbar vertebra, just inferior to the ribs. The spinal cord typically ends between L1 and L2, but the dural and arachnoid membranes extend to the level of S2, well beyond the end of the spinal cord.

**Spinal cord regions:** take their name from the regions of the vertebral column they are within; cervical, thoracic, lumbar, sacral and coccygeal.

**Cervical enlargement:** enlargement in the cervical region of the spinal cord due to additional cell bodies present in the anterior and posterior horns that serve the upper limb.

**Lumbar enlargement:** enlargement in the lumbosacral region of the spinal cord due to additional cell bodies present in the anterior and posterior horns that serve the lower limb.

### 5

**Dorsal horns:** run the entire length of the spinal cord. Consist entirely of interneurons. Contains synapses with somatic sensory neurons and visceral sensory neurons. The cell bodies of sensory neurons are found in an enlarged region of the dorsal root called the dorsal root ganglion. After entering the spinal cord, the axons of these neurons may take a number of routes. Some enter the dorsal white matter of the cord directly and travel to synapse at higher cord or brain levels. Others synapse with interneurons in the dorsal horns of the spinal cord grey matter at their entry level.

**Ventral horns:** run the entire length of the spinal cord. Have some interneurons, but mainly house cell bodies of somatic motor neurons. The amount of ventral grey matter present at a given level of the spinal cord reflects the amount of skeletal muscle innervated at that level. As a result, the ventral horns are largest in the limb-innervating cervical and lumbar regions of the spinal cord and are responsible for the cord enlargements seen in those regions.

**Lateral horns:** present in the thoracic and superior lumbar segments of the spinal cord. These neurons are autonomic (sympathetic division only – the parasympathetic neurons come off the brain stem in the cranial region and some are located in the sacral region) motor neurons that serve visceral organs. Their axons leave the cord via the ventral root along with those of the somatic motor neurons.

**Ascending tracts:** Located in the white matter of the spinal cord. Messages are taken up to higher centres. Ascending pathways conduct sensory impulses upward, typically through chains of three successive neurons (first, second and third order neurons) to various areas of the brain. First order takes info from body to spinal cord. 1<sup>st</sup> and 2<sup>nd</sup> order neurons synapse in spinal cord. 2<sup>nd</sup> order take info from dorsal horn of spinal cord to the thalamus or cerebellum. 3<sup>rd</sup> order neurons synapse with 2<sup>nd</sup> order in thalamus (not cerebellum) and take info to the somatosensory cortex of the cerebrum.

**Descending tracts:** Located in the white matter of the spinal cord. Messages are taken down to the cord from the brain or within the cord to lower levels (motor outputs). Motor pathways involve two neurons, upper and lower neurons. Upper motor neurons originate from the motor cortex or the subcortical motor nuclei and travel down the spinal cord where they synapse with lower motor neurons which then travel out of the spinal cord. Most descending pathways cross to the opposite side of the body (decussate).

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### Ascending pathways:

**Dorsal column-medial lemniscus:** Transmits info for discriminative touch, pressure and proprioception. These pathways are formed by the paired tracts of the dorsal white column of the spinal cord – fasciculus cuneatus or fasciculus gracilis (1<sup>st</sup> order), and then the medial lemniscus (2<sup>nd</sup> order). The medial lemniscus arises in the medulla and terminates in the thalamus. From the thalamus, impulses are forwarded to specific areas of the somatosensory cortex (3<sup>rd</sup> order). (see pic12.34 on p472)

**Spinothalamic:** Transmits info about pain, temperature and coarse touch, sensations that we are aware of but have difficulty localizing precisely on the body surface. These pathways are largely formed by the lateral and ventral spinothalamic tracts. Their fibres cross over in the spinal cord. Pain/temperature/etc receptors synapse in the dorsal horn (1<sup>st</sup> order). Info then travels up the lateral and ventral spinothalamic tracts (2<sup>nd</sup> order). Synapse in thalamus with 3<sup>rd</sup> order neuron that takes info to the primary somatosensory cortex. (see pic12.34 on p472)

### **Descending pathways:**

**Corticospinal:** Controls skeletal muscle, specifically fast and fine (or skilled) movements. The direct pathways originate mainly with the pyramidal neurons located in the precentral gyri. These neurons send impulses through the brain stem via the large pyramidal (corticospinal) tracts. The axons descend without synapsing from the pyramidal neurons to the spinal cord (upper motor neuron). In the spinal cord they either synapse with interneurons or with ventral horn motor neurons. Stimulation of the ventral horn neurons activates the skeletal muscles with which they are associated.

## **7**

### **Protective features of CNS:**

**Axial skeleton:** strong bones act as a shield to prevent physical trauma

**Meninges:** Cover and protect the CNS, protect blood vessels and enclose the venous sinuses, contain cerebrospinal fluid, and form partitions in the skull.

**Cerebrospinal fluid:** forms a liquid cushion that gives buoyancy to the CNS structures and prevents the delicate brain from crushing under its own weight. CSF also protects the brain and spinal cord from blows and other trauma. CSF also helps nourish the brain.

**Blood-brain barrier:** Helps maintain a stable environment for the brain because the brain depends highly on a constant internal environment. Blood borne substances in the brain's capillaries must pass through three layers before they reach the neurons; the endothelium of the capillary wall, a relatively thick basal lamina surrounding the external face of each capillary, and the bulbous "feet" of the astrocytes clinging to the capillaries. The actual blood brain barrier is the tight junctions between the endothelial cells. This barrier is selective. However the barrier is ineffective against fats, fatty acids, oxygen, carbon dioxide, and other fat-soluble molecules that diffuse easily through all plasma membranes (e.g. alcohol, nicotine and anaesthetics).