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Major Neuroanatomical Brain Regions Reference Sheet

Cerebral Cortex and Its Lobes

The **cerebral cortex** is the outer grey matter layer of the brain, highly folded into gyri (ridges) and sulci (grooves). It is divided by deep fissures into several **lobes**, traditionally four visible lobes per hemisphere (frontal, parietal, temporal, occipital), plus two hidden/medial lobes (insular and limbic). These lobes are continuous with each other and interconnected via white matter pathways. Below is an overview of each lobe's location, landmarks, and general functions:

- **Frontal Lobe:** The largest lobe, forming the most anterior portion of the hemisphere. Bounded posteriorly by the **central sulcus** (separating it from the parietal lobe) and inferiorly by the **lateral sulcus (Sylvian fissure)** (separating it from the temporal lobe). The frontal lobe extends from the frontal pole back to the central sulcus. Key landmarks include the **precentral gyrus** (primary motor cortex) and superior/middle/inferior frontal gyri (the inferior frontal gyrus contains **Broca's area** for speech in the dominant hemisphere). The frontal lobe has lateral, medial, and inferior (orbital) surfaces [1]. **Function:** It houses the primary and premotor cortices (voluntary movement control) and the prefrontal cortex (executive functions, decision-making, personality). For example, the precentral gyrus contains the primary motor cortex (Brodmann area 4) controlling contralateral movements, and the inferolateral frontal lobe contains Broca's speech area (left hemisphere in most people). The prefrontal regions are crucial for intellectual tasks, social behavior, and emotional regulation.

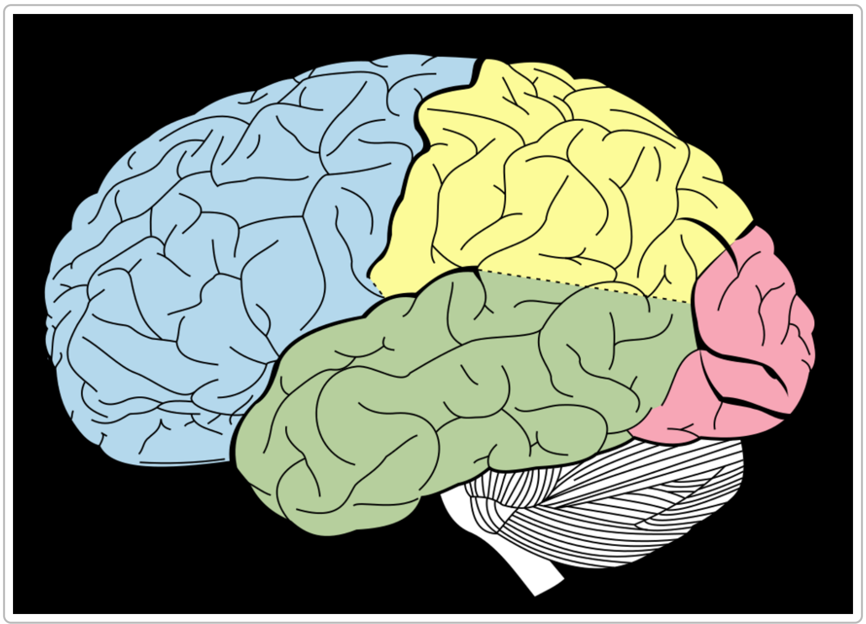
- **Parietal Lobe:** Located behind the frontal lobe, under the parietal bone. Anteriorly it begins at the central sulcus (border with frontal lobe), and posteriorly it extends to an imaginary line between the **parieto-occipital sulcus** (on the medial surface) and the preoccipital notch (on the lateral surface) which separates it from the occipital lobe [2] [3]. Inferiorly, it borders the temporal lobe at the lateral fissure [2]. The parietal lobe includes the **postcentral gyrus** (directly behind the central sulcus), which is the primary somatosensory cortex processing touch, pain, temperature, and proprioceptive input from the body [4]. Posterior to the postcentral gyrus, the parietal lobe is divided into the **superior and inferior parietal lobules** by the intraparietal sulcus [5]. **Function:** The parietal lobe integrates sensory information to form spatial awareness and navigation. The postcentral gyrus receives somatic sensory data (Brodmann areas 1, 2, 3) [4]. The superior parietal lobule contributes to sensorimotor integration (e.g. understanding where the body is in space), while the inferior parietal lobule (which includes language-related regions like the supramarginal and angular gyri) is involved in functions such as language processing and auditory integration [6].

- **Temporal Lobe:** Located on the side of the brain, under the temporal bone, occupying the middle cranial fossa [7]. It is demarcated from the frontal and parietal lobes by the lateral sulcus above it [7]. Posteriorly, it is separated from the occipital lobe by an arbitrary line from the parieto-occipital sulcus to the preoccipital notch [8]. The temporal lobe extends downward to the ventral surface of the brain. Key surface features are the **superior, middle, and inferior temporal gyri** on its lateral aspect [9], separated by the superior and inferior temporal sulci. Deep in the lateral fissure on the superior aspect lies the **transverse temporal gyri of Heschl** (primary auditory cortex, Brodmann area 41) which receive auditory information [10] [11]. The posterior part of the superior temporal gyrus (Wernicke's area in the dominant hemisphere) is important for language comprehension [12]. The inferomedial part of the temporal lobe includes the **parahippocampal gyrus** and **hippocampus** (part of the limbic system, discussed later). **Function:** The temporal lobe is the primary center for **auditory processing** (hearing) and is also critical for **language** (comprehension of speech in Wernicke's area) [12]. It contributes to **memory** formation via the medial temporal structures (hippocampus) and emotion (amygdala located deep in the anterior temporal lobe). In addition, the middle and inferior temporal gyri are involved in higher-order visual processing – e.g. perception of visual motion (middle gyrus) and object/face recognition in the fusiform gyrus (part of inferior temporal gyrus) [13].

- **Occipital Lobe:** The smallest and most posterior lobe, situated underneath the occipital bone at the back of the head [14]. It is separated from the parietal lobe by the **parieto-occipital sulcus** on the medial surface (and by an imaginary line laterally) [15], and from the temporal lobe by the lateral parietotemporal line (running from the parieto-occipital sulcus to the preoccipital notch) [15]. The occipital lobe lies above the tentorium cerebelli (the extension of dura mater over the cerebellum) [16]. The lateral surface of the occipital lobe is less clearly demarcated but may have superior, middle, and inferior occipital gyri (with variable anatomy) [17]. The medial surface features the prominent **calcarine sulcus**, which runs roughly horizontally and divides the occipital lobe's medial aspect into the **cuneus** (above the sulcus) and **lingual gyrus** (below the sulcus) [18]. **Function:** The occipital lobe is the primary **visual processing center** of the brain. The **primary visual cortex** (Brodmann area 17) lies along the banks of the calcarine sulcus and receives visual input from the eyes via the thalamus, enabling basic vision (perception of visual stimuli) [18] [19]. The surrounding **visual association cortex** (Brodmann areas 18 and 19, also called extrastriate cortex) occupies the rest of the occipital lobe and interprets visual information (such as recognizing shapes, colors, and motion) [19].

- **Insular Lobe (Insula):** The insula is sometimes called the "fifth lobe." It is a hidden region of cortex **buried deep within the lateral sulcus**, covered by the opercula of the frontal, parietal, and temporal lobes [20]. To see it, one must pry open or remove the opercular portions of those lobes (hence the Latin name *insula* meaning "island" of cortex) [20]. The insula has several short gyri anteriorly and a long gyrus posteriorly, and is separated from the frontal/parietal opercula by the circular sulcus. **Function:** The insula has diverse roles, primarily in **visceral sensory processing and integrative autonomic functions**. It is considered the primary gustatory cortex (processing taste) and is crucial for **interoception** – the sense of the body's internal state (e.g. visceral pain, gut feelings). The insula also participates in limbic functions such as emotion and homeostasis; in fact, it is often included as part of the limbic system circuit, connecting to structures that mediate cravings, addictive behaviors, and emotions [21] [22].

- **Limbic "Lobe" (Cingulate and Parahippocampal Gyri):** The limbic lobe is not an anatomically separate lobe with clear boundaries, but rather a ring of cortex on the medial side of the hemisphere encircling the corpus callosum and diencephalon [23]. It includes the **cingulate gyrus** and **parahippocampal gyrus** (as well as the olfactory cortex and uncus). The **cingulate gyrus** arches over the corpus callosum on each side, from beneath the frontal lobe (subcallosal area) curving above the corpus callosum and extending back toward the splenium (rear) of the corpus callosum, then down to meet the parahippocampal gyrus. It is separated from the rest of the frontal/parietal cortex by the **cingulate sulcus**. The **parahippocampal gyrus** is located on the ventromedial surface of the temporal lobe, forming a ridge that runs along the hippocampus (to which it is connected) [24]. At its anterior end is the **uncus**, a hook-like region that overlies the amygdala. **Function:** The limbic cortical areas are part of the limbic system, involved in **emotion, motivation, memory, and olfaction**. The cingulate cortex in particular is linked to emotion formation and processing, pain perception, and attention. It has been associated with the affective component of pain (e.g. emotional suffering due to pain). The parahippocampal gyrus plays an important role in **memory encoding and retrieval**, serving as a pathway for communication between the cerebral cortex and the **hippocampus**. Overall, the limbic "lobe" acts as a bridge between higher cortical areas and deeper limbic structures (like the hippocampus and amygdala), influencing endocrine and autonomic responses to emotional stimuli [23] [22].



Major lobes of the brain (lateral view). The frontal lobe (blue) is anterior; parietal lobe (yellow) superior-posterior; temporal lobe (green) inferior; occipital lobe (pink) posterior. The cerebellum is shown in white striping.

Key Subcortical Structures

Beneath the cerebral cortex lies the **subcortical regions** of the brain, which include the diencephalon, basal ganglia, limbic structures (such as the hippocampus and amygdala), and other deep nuclei [25]. These structures are composed of gray matter "islands" embedded within the brain's white matter and serve as crucial hubs for relaying information and controlling complex functions (memory, emotion, hormone regulation, etc.). Below are the major subcortical structures and their features:

- **Thalamus:** The thalami (one on each side) are paired ovoid gray matter masses located at the center of the brain, **deep in the diencephalon (forebrain)** just above the brainstem and midline around the third ventricle. Each thalamus sits lateral to the third ventricle and forms its walls. The two thalami often touch at a midline adhesion (interthalamic adhesion). **Function:** The thalamus is often described as the brain's **central relay station**. Almost all sensory information (except smell) passing from the periphery to the cortex stops in specific thalamic nuclei, which filter and forward the signals to the appropriate cortical areas. For example, visual signals go to the lateral geniculate nucleus of the thalamus before the visual cortex. The thalamus also relays motor information from the cerebellum and basal ganglia to the motor cortex. In essence, it **integrates and relays sensory and motor information** between lower centers and the cerebral cortex [26]. In addition, the thalamus has roles in maintaining consciousness and alertness by interacting with the cortex and brainstem.

- **Hypothalamus:** The hypothalamus is a smaller but critically important structure that lies **below the thalamus** (hence “hypo”), forming the floor and inferolateral walls of the third ventricle. It extends from the area just behind the optic chiasm (anteriorly) to the mammillary bodies (posteriorly). Despite its small size (about the size of an almond), the hypothalamus is the main control center for the body’s **homeostatic functions**. **Function:** It regulates fundamental life-sustaining drives and autonomic functions. This includes controlling body temperature, hunger and thirst, sleep-wake cycles, and aspects of emotion and behavior. The hypothalamus is the key interface between the nervous system and the endocrine system: it produces hormones and controls the adjacent **pituitary gland**, thereby influencing growth, metabolism, and reproduction. It also governs the **autonomic nervous system**, adjusting heart rate, blood pressure, digestion, and sweating in response to the body’s needs. For example, when body temperature rises, the hypothalamus triggers sweating and blood vessel dilation to cool down. It also plays a role in generating physical responses to emotions (via connections with the limbic system), such as changes in heart rate when afraid. Overall, the hypothalamus maintains the internal balance (homeostasis) of the body and orchestrates behaviors essential for survival (feeding, fleeing, fighting, and mating).

- **Basal Ganglia (Basal Nuclei):** The basal ganglia are a group of deep **interconnected nuclei** in the forebrain (telencephalon) and midbrain that are involved in the control of movement. Anatomically, the main components of the basal ganglia are the **caudate nucleus**, **putamen**, and **globus pallidus** (the putamen and globus pallidus together form the lentiform nucleus) within the cerebrum, as well as two functionally related structures: the **subthalamic nucleus** (in the diencephalon) and the **substantia nigra** (in the midbrain). The caudate and putamen are also referred to together as the **striatum**, which is separated by the internal capsule but remains functionally linked. **Location:** The basal ganglia are situated lateral to the thalamus, deep to the cortical lobes. For instance, the C-shaped caudate nucleus follows the lateral ventricle curve, and the lentiform nucleus sits lateral to the caudate and thalamus, with the internal capsule running between them. **Function:** The basal ganglia are part of the- **Basal Ganglia (Basal Nuclei):** The basal ganglia are a group of deep **interconnected nuclei** in the forebrain (telencephalon) and midbrain that are involved in the control of movement. Anatomically, the main components of the basal ganglia are the **caudate nucleus**, **putamen**, and **globus pallidus** (the putamen and globus pallidus together form the lentiform nucleus) within the cerebrum, as well as two functionally related structures: the **subthalamic nucleus** (in the diencephalon) and the **substantia nigra** (in the midbrain). (The caudate and putamen are also referred together as the **striatum**, separated by the internal capsule but functionally linked.) **Location:** The basal ganglia are situated lateral to the thalamus and deep to the cortical lobes. For example, the curved caudate nucleus lies along the lateral ventricle, while the lentiform nucleus (putamen + globus pallidus) lies further lateral, with the internal capsule white matter tract running between the caudate/thalamus medially and the lentiform nucleus laterally. **Function:** The basal ganglia are part of the **extrapyramidal motor system** and primarily modulate and refine motor commands. They do not directly initiate movement but influence the output of the motor cortex via the thalamus. Simplified, the basal ganglia facilitate desired movements and inhibit unwanted movements. They operate through multiple pathways: a direct pathway that **promotes the initiation of voluntary movement**, and an indirect pathway that **suppresses inappropriate movements**. Imbalances in these pathways can lead to movement disorders; for instance, Parkinson’s disease (characterized by difficulty initiating movement and resting tremor) is caused by degeneration of the substantia nigra, disrupting basal ganglia output. In addition to motor functions, the basal ganglia also have roles in procedural learning, habit formation, and reward circuits.

- **Hippocampus:** The hippocampus is a seahorse-shaped structure located in the **medial temporal lobe**, within the limbic system. We have two hippocampi (left and right), each tucked into the inferior horn of the lateral ventricle. It lies along the floor of that ventricular horn, extending from the posterior of the amygdala and curving back towards the splenium of the corpus callosum. The hippocampus proper, together with adjoining structures (dentate gyrus and subiculum), is often termed the hippocampal formation. **Function:** The hippocampus is best known for its critical role in **memory** – specifically the formation of **new declarative memories** (facts and events) and spatial navigation. It is essential for consolidating short-term memories into long-term memory storage. Damage to the hippocampi (as in Alzheimer's disease or anoxia) leads to profound difficulties in forming new memories (anterograde amnesia). The hippocampus is also involved in spatial memory and orientation (as shown by "place cells" that encode locations). In the limbic circuitry, the hippocampus communicates with the hypothalamus via the **fornix** (a white matter tract) to influence emotional and autonomic responses to memory (e.g. stress responses). Overall, the hippocampi act as the brain's index for memory storage, linking together information stored in disparate cortical areas and reactivating those networks during recall.

- **Amygdala:** The amygdala (amygdaloid body) is an **almond-shaped** collection of nuclei located deep in the anterior medial temporal lobe. It is positioned just anterior to the hippocampus, near the uncus of the temporal lobe, and superior to the tip of the inferior horn of the lateral ventricle [27]. The amygdala sits anterior to the hippocampal formation, with the tail of the caudate nucleus curving above it. **Function:** The amygdala is a key part of the limbic system involved in **emotion processing, especially fear and threat detection**. It receives sensory inputs (especially smell and emotional facial expressions) and helps assign emotional significance to those stimuli. For example, the amygdala rapidly activates fear responses to perceived dangers (the classic "fight or flight" response). It is crucial for **fear conditioning and emotional learning**, linking experiences with emotional reactions. Besides fear, the amygdala contributes to other emotions, memory modulation (emotional arousal can strengthen memories via the amygdala-hippocampus interaction), and social behavior. It has extensive connections with the hypothalamus and brainstem to execute autonomic responses (like changes in heart rate or stress hormone release) in response to emotional stimuli. In sum, the amygdala is the brain's alarm system, evaluating threats and triggering appropriate emotional and physiological reactions.

Brainstem (Midbrain, Pons, Medulla Oblongata)

The **brainstem** is the stalk-like part of the brain that connects the cerebrum with the spinal cord. It consists of three contiguous regions: the **midbrain** (uppermost), the **pons** (middle), and the **medulla oblongata** (lowest). The brainstem lies in front of the cerebellum and below the diencephalon. It contains numerous important nuclei and tracts and is sometimes called the "reptilian brain" due to its fundamental life-sustaining functions. **Overall Functions:** The brainstem controls many **basic vital functions** – it houses centers that regulate **breathing, heart rate, blood pressure, and consciousness/arousal**. It also contains the origins of most of the cranial nerves (III–XII emerge from the brainstem) which control face and head sensations and movements. The brainstem provides a conduit for all ascending sensory and descending motor pathways between the brain and spinal cord. Below is a breakdown of its parts:

- **Midbrain (Mesencephalon):** The midbrain is the **upper segment of the brainstem**, about 2 cm long, sitting between the diencephalon (thalamus) and the pons. Its dorsal surface features the **tectum** ("roof") with the **superior and inferior colliculi** (paired hillocks involved in visual and auditory reflexes, respectively). The midbrain's ventral portion contains the **cerebral peduncles** (large fiber bundles, also called crus cerebri, carrying corticospinal and corticopontine motor fibers from the cortex) [28]. Running through the midbrain's core is the **tegmentum**, which contains nuclei of cranial nerves III (oculomotor) and IV (trochlear) for eye movements, the **red nucleus** (involved in motor coordination), and the **substantia nigra** (dopamine-producing nucleus critical for movement control, part of basal ganglia circuit). The cerebral aqueduct (connecting 3rd and 4th ventricles) runs through the midbrain as well. **Function:** The midbrain orchestrates **reflexive vision and hearing responses** via the colliculi – for example, turning your head toward a sudden sound (inferior colliculus) or a flash of light (superior colliculus). It also plays a role in controlling eye movements (cranial nerves III and IV) and maintaining alertness (part of the reticular activating system is in the midbrain). The substantia nigra of the midbrain is integral to modulating movements (its degeneration causes Parkinson's disease).

- **Pons:** The pons is the **middle portion of the brainstem**, appearing as a broad anterior bulge between the midbrain above and medulla below. It is the **largest part of the brainstem, located above the medulla and below the midbrain** [29]. The term "pons" means bridge, reflecting its role: the pons contains thick bundles of fibers (the **cerebellar peduncles**) that connect the brainstem to the **cerebellum**, serving as a bridge between the cerebrum and cerebellum [29]. **Anatomy:** The ventral pons is dominated by transverse pontine fibers and pontine nuclei (relaying information from the cortex to the cerebellum), giving it a striped appearance. Emerging from the sides of the pons are the trigeminal nerves (CN V), and at the junction of the pons and medulla emerge the abducens (VI), facial (VII), and vestibulocochlear (VIII) nerves. The dorsal part of the pons (pontine tegmentum) contains nuclei for these cranial nerves and tracts like the medial lemniscus (sensory pathway). **Function:** The pons acts as a **relay station** between the cortex and cerebellum (crucial for coordination of movements). It also contains **respiratory centers** (pneumotaxic center) that help regulate breathing rhythm. Cranial nerve nuclei within the pons are responsible for **facial sensations and expressions, lateral eye movement, and hearing/balance reflexes**. For example, the trigeminal nerve from the pons mediates facial sensation and chewing movements, while the facial nerve controls facial muscles. The pons, as part of the reticular formation, also plays a role in sleep and arousal.

- **Medulla Oblongata:** The medulla is the **lowest part of the brainstem**, continuous with the spinal cord at the level of the foramen magnum. It is cone-shaped and about 3 cm long. The medulla lies anterior to the cerebellum (partially separated by the fourth ventricle). **Anatomy:** On the medulla's anterior surface are the **pyramids**, two longitudinal ridges formed by the corticospinal (pyramidal) tracts; at the junction with the spinal cord, most of these motor fibers cross over – the **pyramidal decussation**, which is why each side of the brain controls the opposite side of the body. Lateral to each pyramid is the **olive** – an oval bump over the inferior olivary nucleus (involved in cerebellar motor learning). The medulla contains the nuclei of cranial nerves IX (glossopharyngeal), X (vagus), XI (accessory), and XII (hypoglossal). **Function:** The medulla is sometimes called the **"vital center"** of the brain because it houses essential autonomic nuclei. It **regulates involuntary functions** like breathing, heart rate, blood pressure, and reflexes such as swallowing, coughing, and vomiting [30]. Within the medulla are the **respiratory rhythmicity centers** that control the depth and rate of breathing, and the **cardiovascular center** that adjusts heart rate and vessel diameter to regulate blood pressure [30]. Damage to the medulla can be life-threatening due to these critical functions. Additionally, the medulla serves as a conduit for all ascending sensory tracts (e.g. dorsal column-medial lemniscus for touch, which synapses in the medulla's gracile/cuneate nuclei) and descending motor tracts. In summary, the medulla oblongata is the autonomic powerhouse of the CNS, keeping the body's basic functions running and relaying neural signals between brain and spinal cord.

Cerebellum

The **cerebellum** (Latin for “little brain”) is a large structure perched at the back of the brain, underneath the occipital lobes and behind the brainstem. It is the second-largest part of the brain (after the cerebrum) and accounts for about 10% of brain volume but over 50% of its neurons. The cerebellum has a distinctive appearance with a tightly folded cortex forming leaf-like folia. **Anatomy:** It consists of two hemispheres connected by a narrow midline strip called the **vermis**. The cerebellar cortex is grey matter arranged in thin folia, while white matter (the arbor vitae) lies underneath, containing the deep cerebellar nuclei (dentate, interposed, and fastigial nuclei). The cerebellum is connected to the brainstem by three pairs of fiber bundles: the superior, middle, and inferior cerebellar peduncles. It can be divided into **three lobes** per hemisphere: the anterior lobe (above the primary fissure), the posterior lobe, and the small flocculonodular lobe (on the inferior side). Functionally, the cerebellum can also be partitioned into **three zones**: the **vermis** (median zone), **intermediate (paravermal) zone**, and **lateral hemispheric zone**, which correspond to functional divisions. **Function:** The cerebellum is crucial for **coordination of movement, balance, and posture**. It fine-tunes motor activity to make movements smooth and precise. The cerebellum continuously receives input about body position (proprioception) and desired movement, then adjusts motor output accordingly.

- The **vestibulocerebellum** (flocculonodular lobe) helps maintain **balance and eye movements**; it receives input from the vestibular system and is important for equilibrium and coordinating head and eye movements.
- The **spinocerebellum** (vermis and intermediate zone) regulates **posture and gait** and coordinates the **proximal limb movements**. It receives proprioceptive information from the spinal cord and sends corrections to descending motor pathways, allowing for error correction during movement (such as adjusting your step on uneven ground).
- The **cerebrocerebellum** (lateral hemispheres) is involved in **planning and initiating voluntary movements** of the limbs and in motor learning. It communicates with the cerebral motor cortex (via the pontine nuclei and thalamus) to time movements properly and also has roles in cognitive functions like motor memory.

Clinically, cerebellar dysfunction leads to ataxia – uncoordinated movement, tremor, imbalance, and difficulty with rapid movements – underscoring its role as the brain’s quality control center for motor actions.

Ventricular System

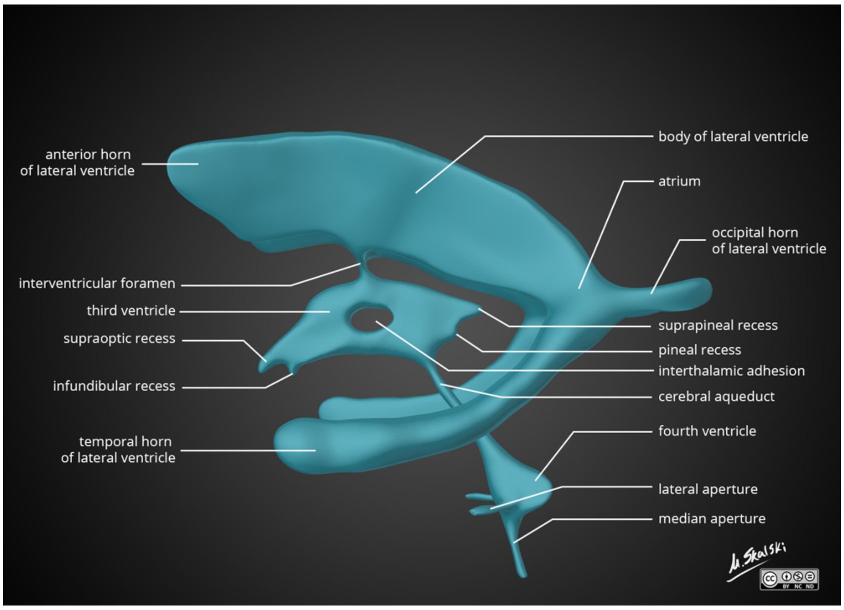


Diagram of the brain's ventricular system (rendered in blue), showing the two C-shaped lateral ventricles (with anterior, temporal, and occipital horns), the midline third ventricle, cerebral aqueduct, and fourth ventricle. Openings (apertures) from the fourth ventricle allow cerebrospinal fluid to circulate around the brain and spinal cord.

The **ventricular system** consists of four interlinked CSF-filled cavities within the brain that develop from the central canal of the embryonic neural tube [31]. These ventricles produce and circulate **cerebrospinal fluid (CSF)**, which cushions the brain and maintains chemical stability. The ventricles are:

- **Two Lateral Ventricles:** a pair of large, arch-shaped ventricles, one in each cerebral hemisphere. They have anterior horns (in frontal lobes), bodies (in parietal lobes), posterior horns (into occipital lobes), and inferior (temporal) horns extending into the temporal lobes. The lateral ventricles are the largest cavities and each communicates with the third ventricle via an opening called the **interventricular foramen** (foramen of Monro). The corpus callosum forms the roof of each lateral ventricle, and the caudate nucleus forms part of the lateral wall.

- **Third Ventricle:** a narrow midline chamber in the diencephalon, between the two thalami. The third ventricle's walls are the thalamus and hypothalamus on either side. The third ventricle connects forward and laterally to the two lateral ventricles (via the two interventricular foramina). Posteriorly and inferiorly, it tapers into the **cerebral aqueduct**.

- **Cerebral Aqueduct:** a slender canal (within the midbrain) that links the third ventricle to the fourth ventricle. It has no choroid plexus (no CSF production here) but is a crucial pathway; blockage of the aqueduct can lead to obstructive hydrocephalus (fluid buildup).

- **Fourth Ventricle:** a tent-shaped cavity located between the cerebellum (posteriorly) and the pons & medulla (anteriorly). It is continuous inferiorly with the **central canal** of the spinal cord [31]. The fourth ventricle has three openings (apertures) that allow CSF to flow out into the subarachnoid space: one **median aperture** (foramen of Magendie) in the midline, and two **lateral apertures** (foramina of Luschka) on the sides. CSF produced in the ventricles (mainly by the choroid plexus in the lateral and third ventricles) circulates through this system: lateral ventricles → third ventricle → aqueduct → fourth ventricle → subarachnoid space (via apertures) → around brain and spinal cord, before being absorbed into the venous circulation. The ventricular system thus represents the internal waterway of the brain, cushioning it and maintaining intracranial pressure and homeostasis [31] .

Major White Matter Tracts

Deep to the cortical gray matter lies the **white matter** of the brain, composed of myelinated axonal fiber tracts that connect different regions. These tracts are categorized as association fibers (connecting regions within the same hemisphere), commissural fibers (connecting left and right hemispheres), and projection fibers (connecting the cortex with lower brain or spinal cord). Two of the most prominent white matter structures are:

- **Corpus Callosum:** This is the **largest commissural tract** in the brain, a thick C-shaped band of white matter that connects the two cerebral hemispheres across the midline. The corpus callosum forms the floor of the longitudinal fissure and the roof of much of the lateral ventricles. It is divided into parts: the **rostrum** (anterior inferior segment), **genu** (anterior bend), **body/trunk** (central portion), and **splenium** (posterior rounded end) [32] . **Function:** The corpus callosum contains ~200 million axons and enables the left and right hemispheres to **communicate** [33] . This interhemispheric communication is essential for integrating sensory, motor, and cognitive functions across the two sides of the body. For example, it allows the right hemisphere to know what the left is doing (and vice versa) – such as coordinating bimanual tasks or unifying perceptual experiences. If the corpus callosum is damaged or severed (as in "split-brain" patients), the two hemispheres cannot share information properly, leading to characteristic deficits (each hemisphere may operate independently to an extent). In summary, the corpus callosum is the critical bridge ensuring our brain operates as a unified whole rather than two separate halves.

- **Internal Capsule:** The internal capsule is a major **projection fiber tract** – a compact bundle of myelinated fibers carrying information **to and from the cerebral cortex**. There are two internal capsules (left and right), each a V-shaped structure in horizontal section, located deep in the hemisphere. **Location:** It lies **inferomedially in each hemisphere**, with the **thalamus and caudate nucleus** medially and the **lentiform nucleus (putamen and globus pallidus)** laterally. Thus, the internal capsule is essentially the white matter highway passing between the basal ganglia and thalamus. It is subdivided into an anterior limb (between caudate and lentiform nucleus), a **genu** (the "bend"), and a posterior limb (between the thalamus and lentiform nucleus), plus retrolenticular and sublenticular parts extending behind/below the lentiform nucleus. **Function:** The internal capsule contains **ascending sensory fibers and descending motor fibers** connecting the cortex with the brainstem and spinal cord. For example, the **corticospinal tract** (voluntary motor pathway) descends through the posterior limb of the internal capsule on its way to the spinal cord. Likewise, thalamocortical fibers carrying somatosensory information ascend through the internal capsule to reach the primary somatosensory cortex. Because so many critical pathways funnel through the internal capsule, even a small lesion here (such as a stroke in a lateral striate artery) can have a **profound impact**, often causing contralateral paralysis and sensory loss. The internal capsule's dense concentration of fibers makes it a cornerstone structure for brain connectivity, linking the cortex with subcortical nuclei, the brainstem, and beyond.

Other Notable White Matter Tracts: In addition to the corpus callosum and internal capsule, the brain has several other important tracts: - **Anterior Commissure:** a smaller commissural fiber bundle connecting the two temporal lobes, especially the amygdalae and olfactory cortices, across the midline front of the fornix. - **Fornix:** the main output tract of the hippocampus, arching under the corpus callosum, connecting each hippocampus to the mammillary bodies of the hypothalamus (crucial for memory circuits). - **Association tracts:** e.g., the **superior longitudinal fasciculus** connecting frontal, parietal, and occipital lobes within a hemisphere; the **uncinate fasciculus** connecting anterior temporal lobe with orbitofrontal cortex; and others that integrate functions within the same side of the brain.

Together, these neuroanatomical regions – the cortical lobes, subcortical nuclei, brainstem, cerebellum, ventricular system, and connecting tracts – constitute the complex but beautifully organized architecture of the human brain. Each structure has distinct anatomical landmarks and roles, yet they work in concert as a network to enable everything from basic life support to higher cognition [34] [26].

Sources: This reference sheet compiles information from academic neuroanatomy resources and peer-reviewed texts, including Kenhub Anatomy articles, NCBI's StatPearls and Bookshelf (e.g., Ackerman *Discovering the Brain*), and established neuroanatomy textbooks. All content has been kept factual and up-to-date (as of 2025) to reflect current understanding of brain structure and function.

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