An Illustrated Guide to Human Neuroanatomy

INTRODUCTION

As we will see in the remainder of the book, a fruitful way to explore the nervous system is to divide it up into functional systems. Thus, the *olfactory system* consists of those parts of the brain that are devoted to the sense of smell, the *visual system* includes those parts that are devoted to vision, and so on. While this functional approach to investigating nervous system structure has many merits, it can make the "big picture"—how all these systems fit together inside the box we call the brain—difficult to see. The goal of this Illustrated Guide is to help you learn, in advance, about some of the anatomy that will be discussed in the subsequent chapters. Here we concentrate on naming the structures and seeing how they are related physically; their functional significance is discussed in the remainder of the book.

The Guide is organized into six main parts. The first part covers the surface anatomy of the brain—the structures that can been seen by inspection of the whole brain, as well as those parts that are visible when the two cerebral hemispheres are separated by a cut in the midsagittal plane. Next, we explore the cross-sectional anatomy of the brain, using a series of slabs that contain structures of interest. The brief third and fourth parts cover the spinal cord and the autonomic nervous system. The fifth part of the Guide illustrates the cranial nerves and summarizes their diverse functions. The last part illustrates the blood supply of the brain.

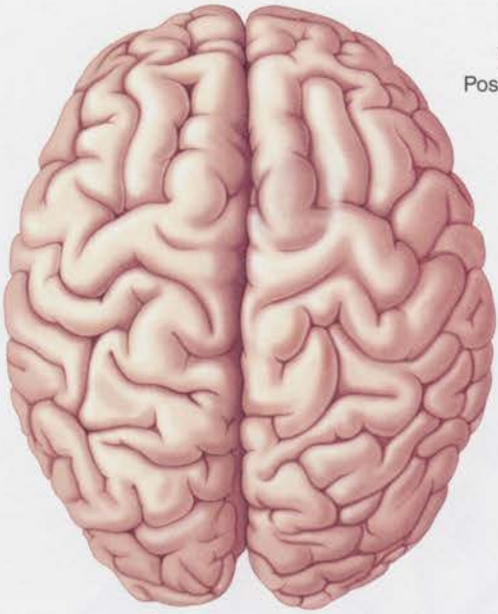
The nervous system has an astonishing number of bits and pieces. In this Guide, we focus on those structures that will appear later in the book when we discuss the various functional systems. Nonetheless, even this abbreviated atlas of neuroanatomy yields a formidable list of new vocabulary. Therefore, to help you learn the terminology, an extensive self-quiz review is provided at the end, in the form of a perforated workbook with labeling exercises.

SURFACE ANATOMY OF THE BRAIN

Imagine that you hold in your hands a human brain that has been dissected from the skull. It is wet and spongy and weighs about 1.4 kg (3 lb). Looking down on the brain's dorsal surface reveals the convoluted surface of the cerebrum. Flipping the brain over shows the complex ventral surface that normally rests on the floor of the skull. Holding the brain up and looking at its side—the lateral view—shows the "ram's horn" shape of the cerebrum coming off the stalk of the brain stem. The brain stem is shown more clearly if we slice the brain right down the middle and view its medial surface. In the part of the Guide that follows, we will name the important structures that are revealed by such an inspection of the brain. Notice the magnification of the drawings: 1× is life-size, 2× is twice life-size, 0.6× is 60% of life-size, and so on.

Dorsal view

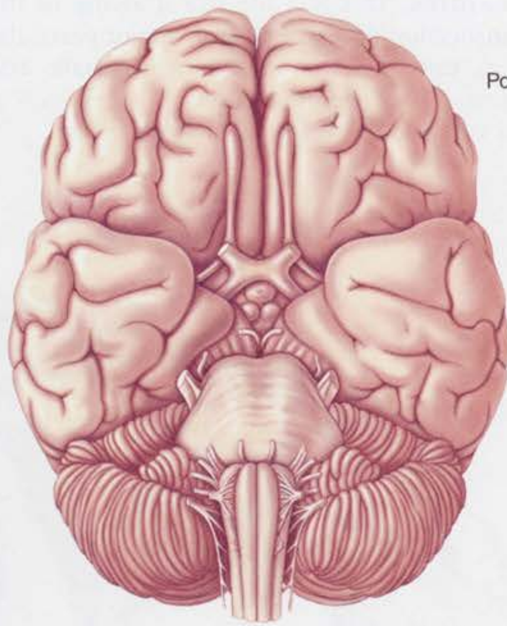
Anterior ↔ Posterior



(0.5X)

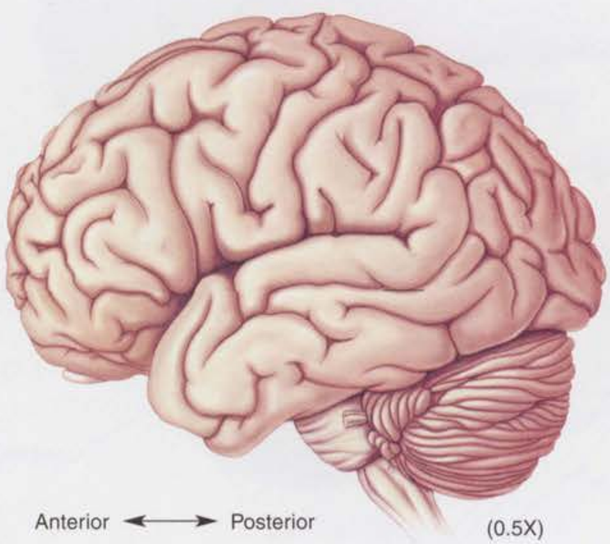
Ventral view

Anterior ↔ Posterior



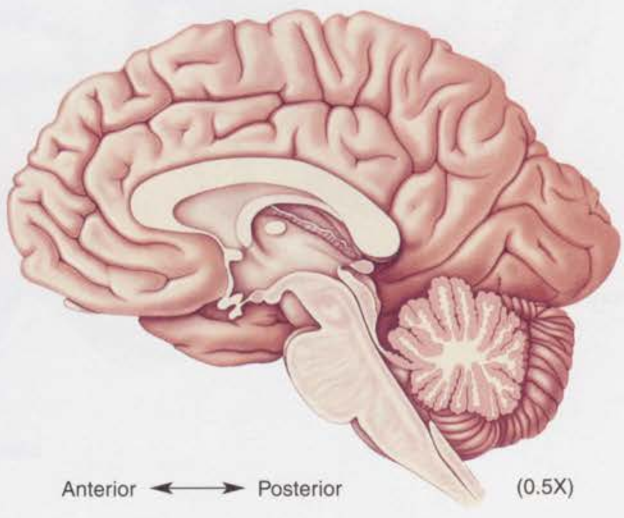
(0.5X)

Lateral view



Anterior ↔ Posterior (0.5X)

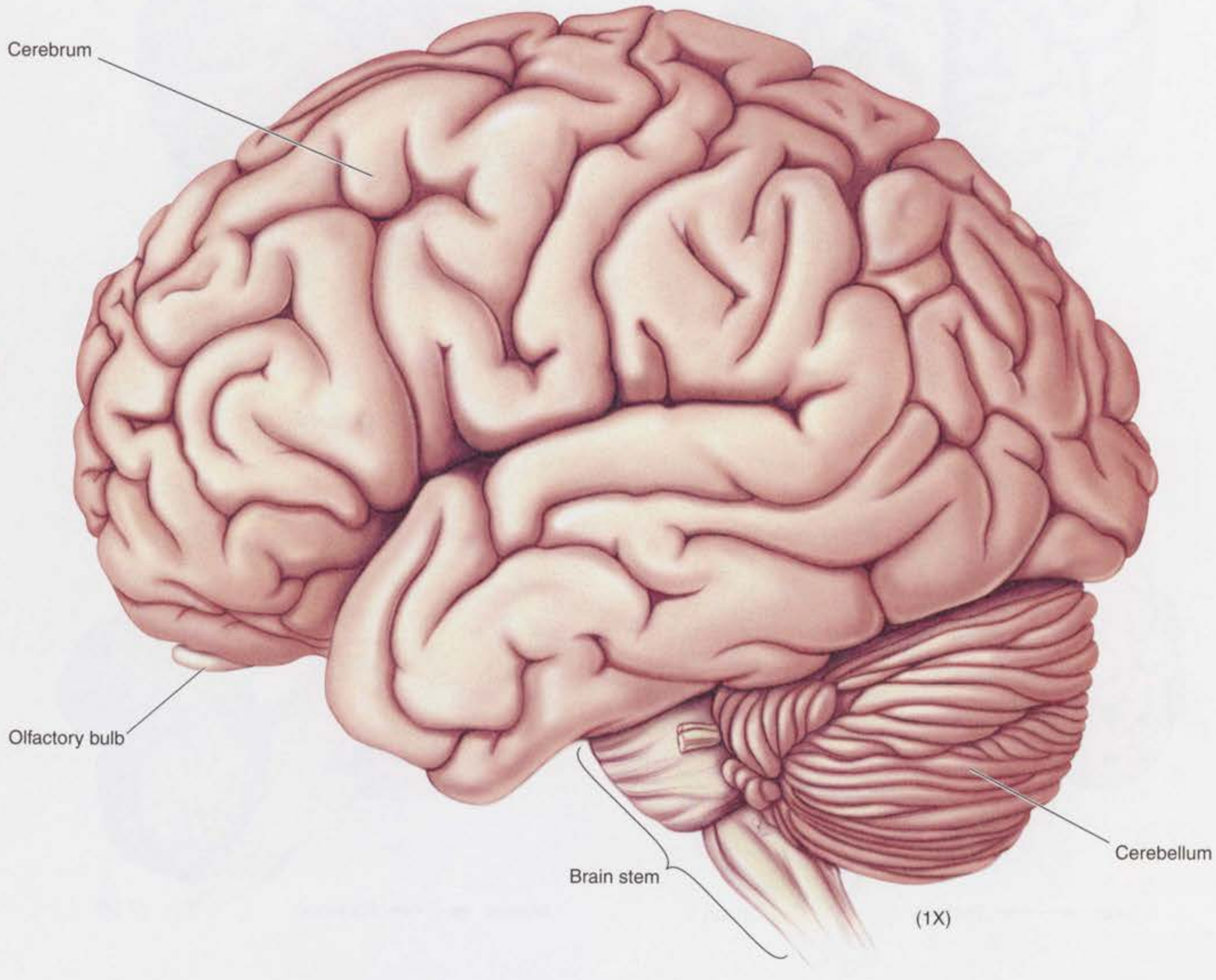
Medial view



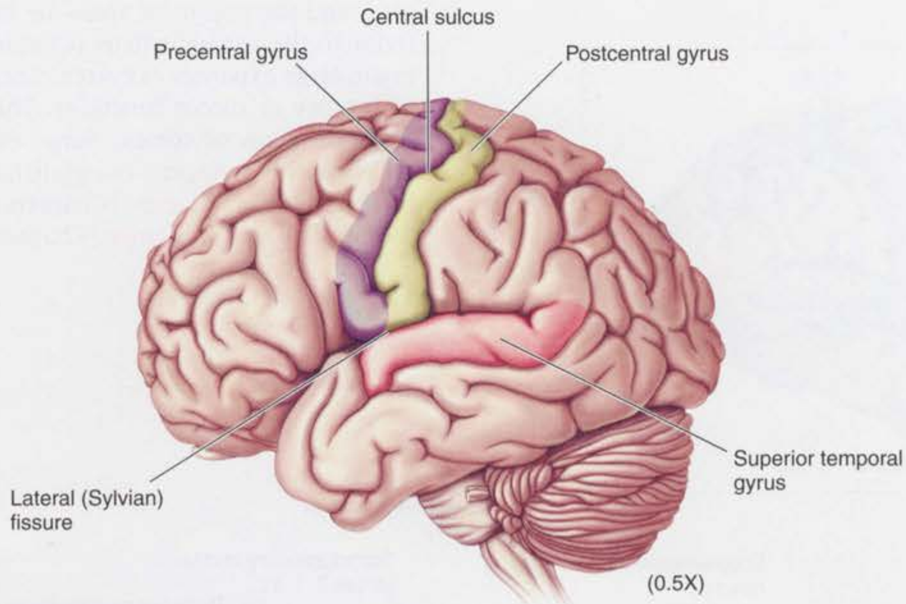
Anterior ↔ Posterior (0.5X)

The Lateral Surface of the Brain

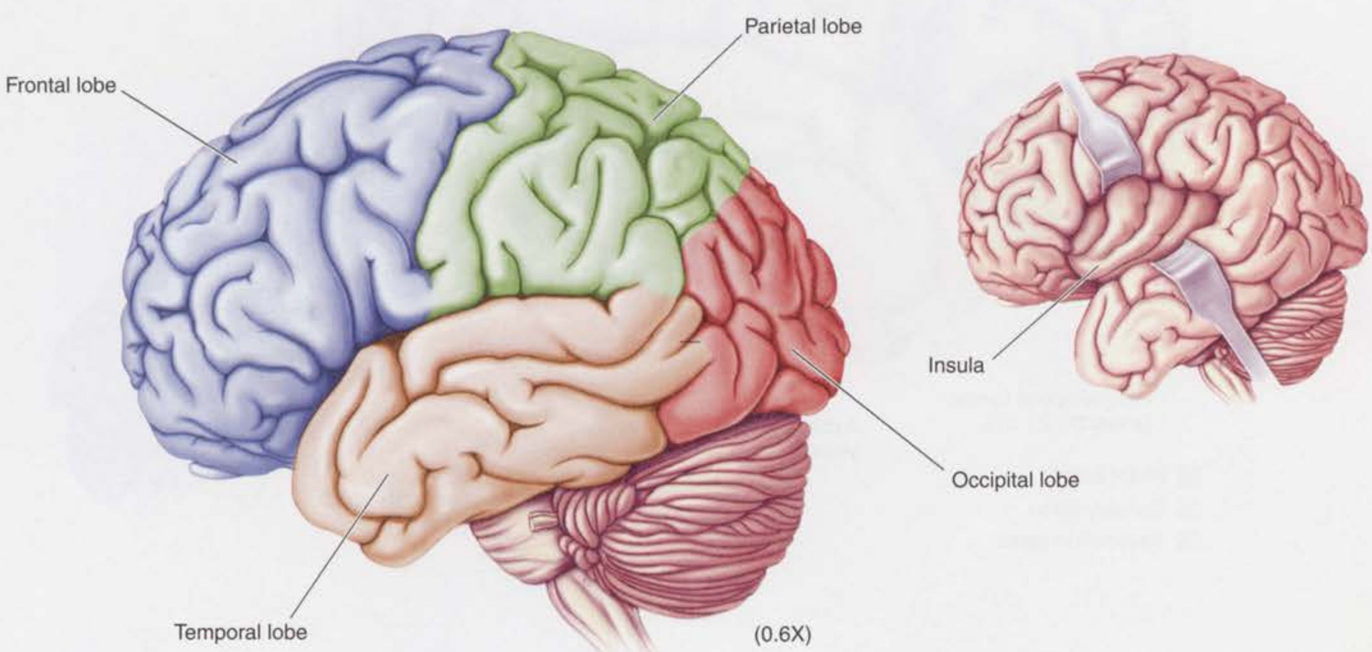
(a) Gross Features. This is a life-size drawing of the brain. Gross inspection reveals the three major parts: the large cerebrum, the brain stem that forms its stalk, and the rippled cerebellum. The diminutive olfactory bulb of the cerebrum can also be seen in this lateral view.



(b) Selected Gyri, Sulci, and Fissures. The cerebrum is noteworthy for its convoluted surface. The bumps are called gyri, and the grooves are called sulci or, if they are especially deep, fissures. The precise pattern of gyri and sulci can vary considerably from individual to individual, but many features are common to all human brains. Some of the important landmarks are labeled here. The postcentral gyrus lies immediately posterior to the central sulcus, and the precentral gyrus lies immediately anterior to the central sulcus. The neurons of the postcentral gyrus are involved in somatic sensation (touch; Chapter 12), and those of the precentral gyrus control voluntary movement (Chapter 14). Neurons in the superior temporal gyrus are involved in audition (hearing; Chapter 11).

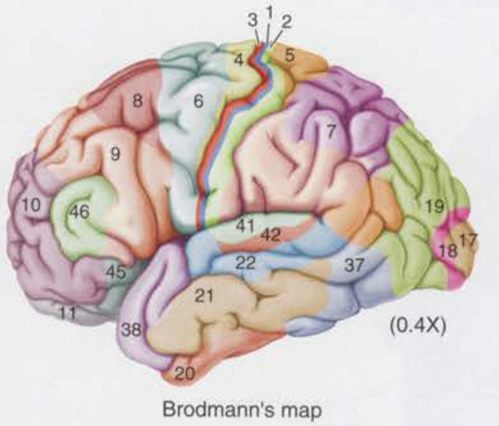


(c) Cerebral Lobes and the Insula. By convention, the cerebrum is subdivided into lobes named after the bones of the skull that lie over them. The central sulcus divides the frontal lobe from the parietal lobe. The temporal lobe lies immediately ventral to the deep lateral (Sylvian) fissure. The occipital lobe lies at the very back of the cerebrum, bordering both parietal and temporal lobes. A buried piece of the cerebral cortex, called the insula (Latin for "island"), is revealed if the margins of the lateral fissure are gently pulled apart (inset). The insula borders and separates the temporal and frontal lobes.

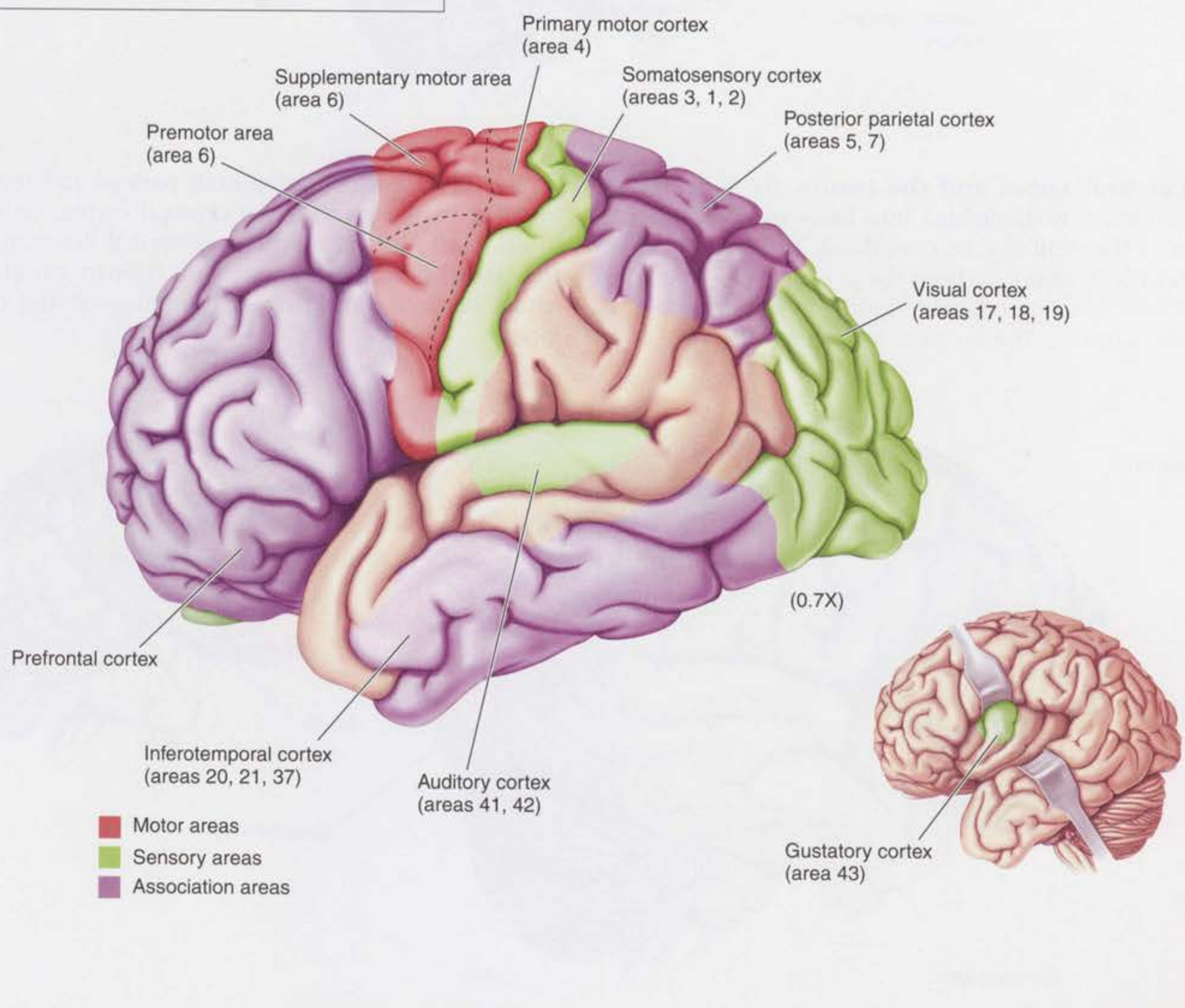


(d) Major Sensory, Motor, and Association Areas of Cortex. The cerebral cortex is organized like a patchwork quilt. The various areas, first identified by Brodmann, differ from one another in terms of microscopic structure and function. Visual areas 17, 18, and 19 (Chapter 10) are in the occipital lobe, somatic sensory areas 3, 1, and 2 (Chapter 12) are in the parietal lobe, and auditory areas 41 and 42 (Chapter 11) are in the temporal lobe. On the inferior surface of the parietal lobe (the operculum) and buried in the insula is gustatory area 43, devoted to the sense of taste (Chapter 8).

In addition to the analysis of sensory information, the cerebral cortex plays an important role in the control of voluntary movement. The major motor control areas—primary motor cortex (area 4), the supplementary motor area, and the premotor area—lie in the frontal lobe, anterior to the central sulcus (Chapter 14). In the human brain, large expanses of cortex cannot be simply assigned to sensory or motor functions. These constitute the association areas of cortex. Some of the more important areas are the prefrontal cortex (Chapters 21 and 24), the posterior parietal cortex (Chapters 12, 21, and 24), and the inferotemporal cortex (Chapter 24).

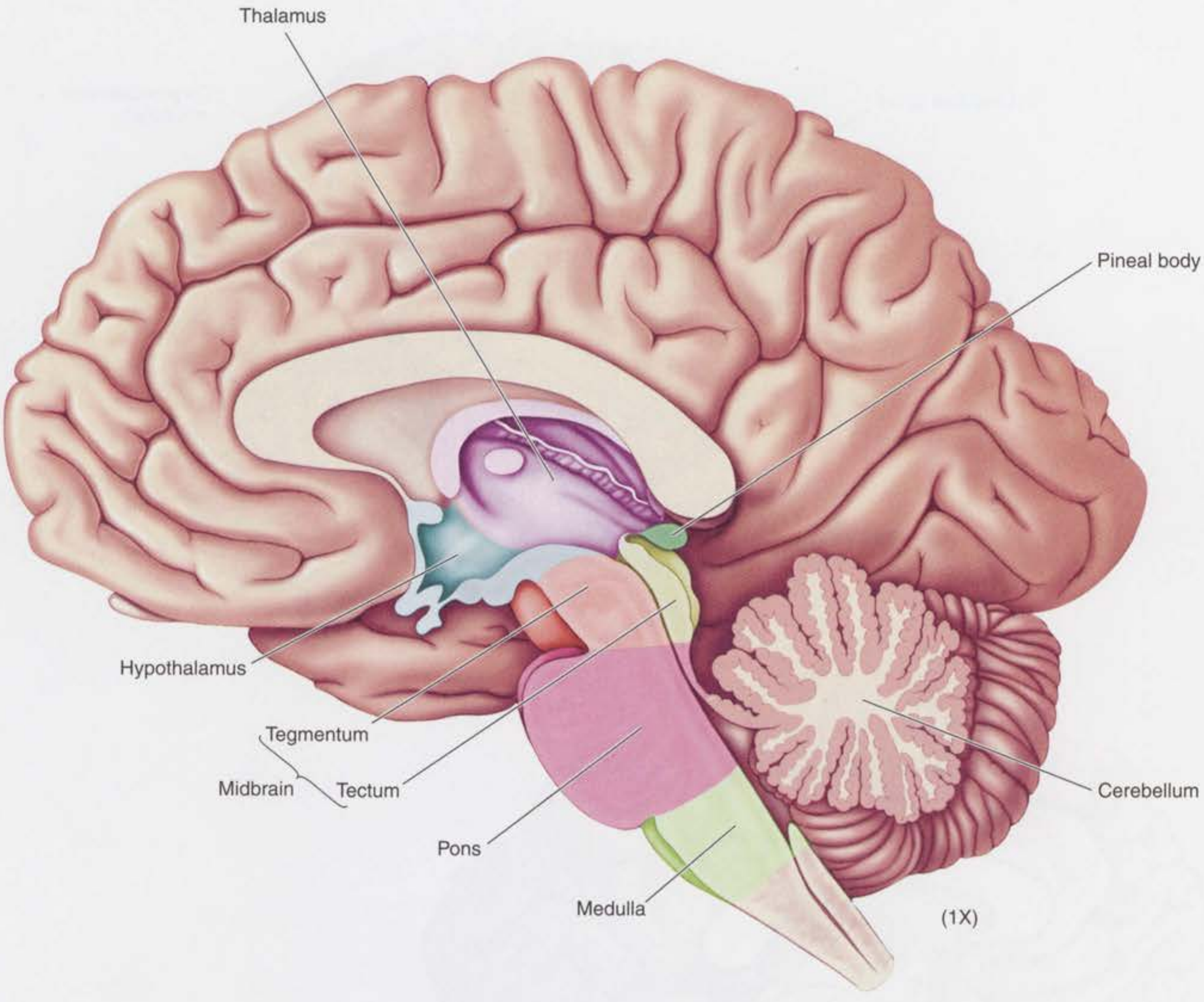


Brodmann's map



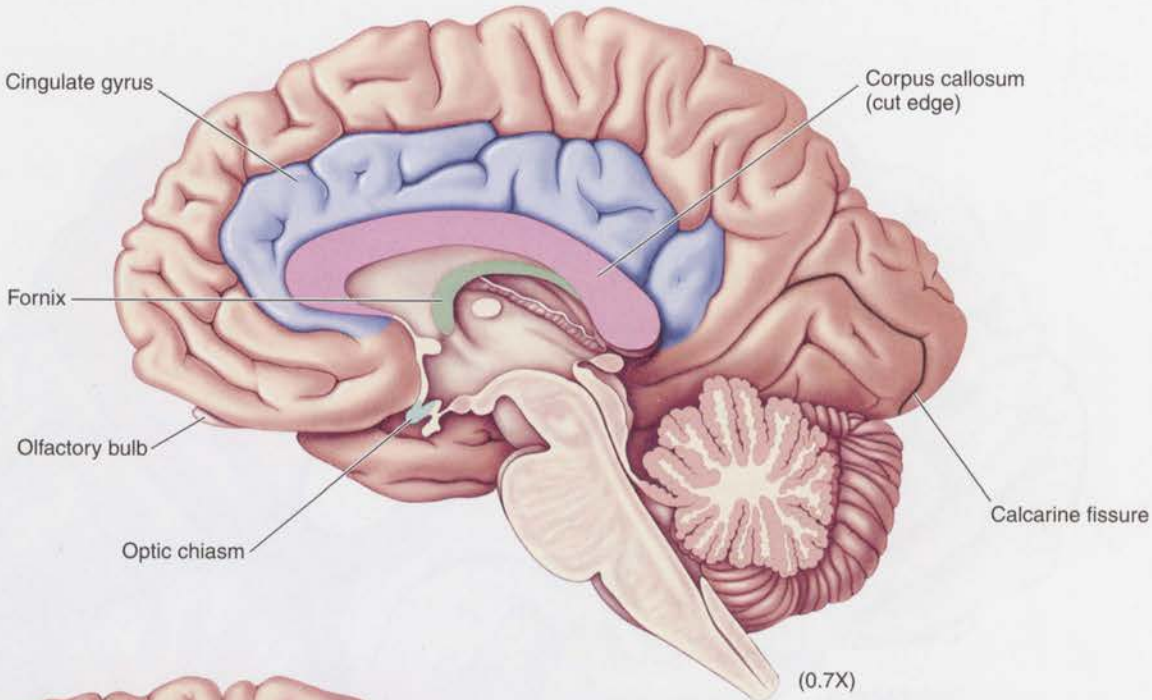
The Medial Surface of the Brain

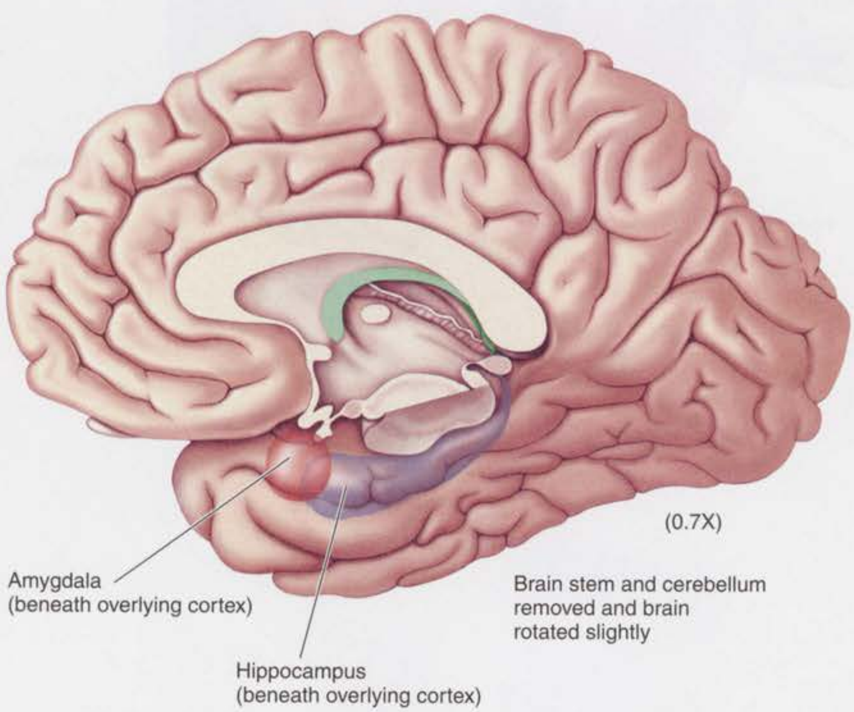
(a) Brain Stem Structures. Splitting the brain down the middle exposes the medial surface of the cerebrum, shown in this life-size illustration. This view also shows the midsagittal cut surface of the brain stem, consisting of the diencephalon (thalamus and hypothalamus), the midbrain (tectum and tegmentum), the pons, and the medulla. (Some anatomists define the brain stem as consisting only of the midbrain, pons, and medulla.)



(b) Forebrain Structures. Shown here are the important forebrain structures that can be observed by viewing the medial surface of the brain. Notice the cut surface of the corpus callosum, a huge bundle of axons that connects the two sides of the cerebrum. The unique contributions of the two cerebral hemispheres to human brain function can be studied in patients in which the callosum has been sectioned (Chapter 20). The fornix is another prominent fiber bundle that connects the hippocampus on each side with the hypothalamus. (*Fornix* is Latin for "arch.") Some of the axons in the fornix regulate memory storage (Chapter 24).

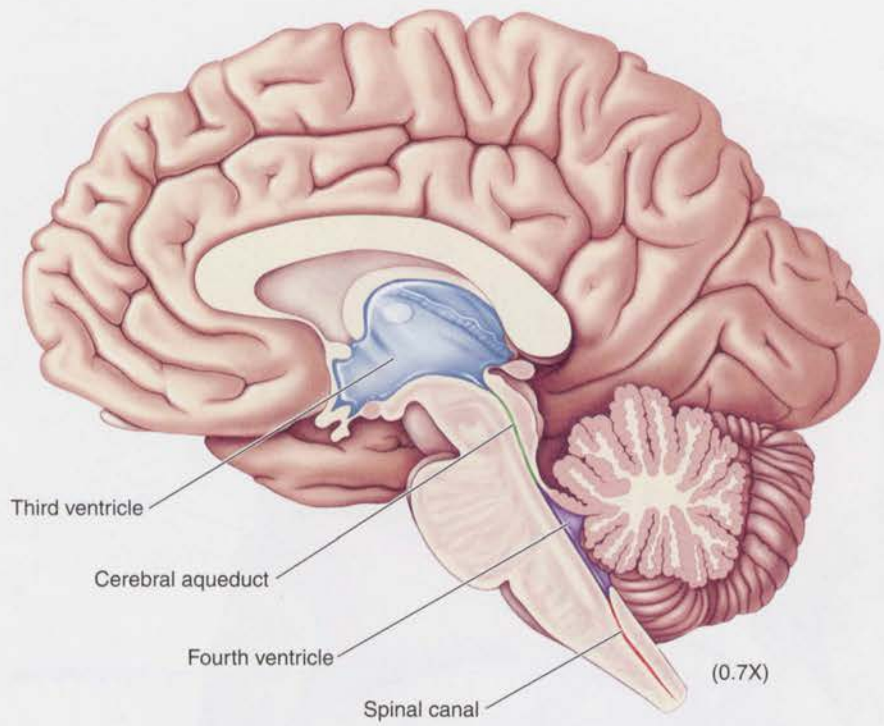
In the lower illustration, the brain has been tilted slightly to show the positions of the amygdala and hippocampus. These are "phantom views" of these structures, because they cannot be observed directly from the surface. Both lie deep to the overlying cortex. We will see them again in cross section later in the Guide. The amygdala (Latin for "almond") is important for regulating emotional states (Chapter 18), and the hippocampus is important for memory (Chapters 24 and 25).

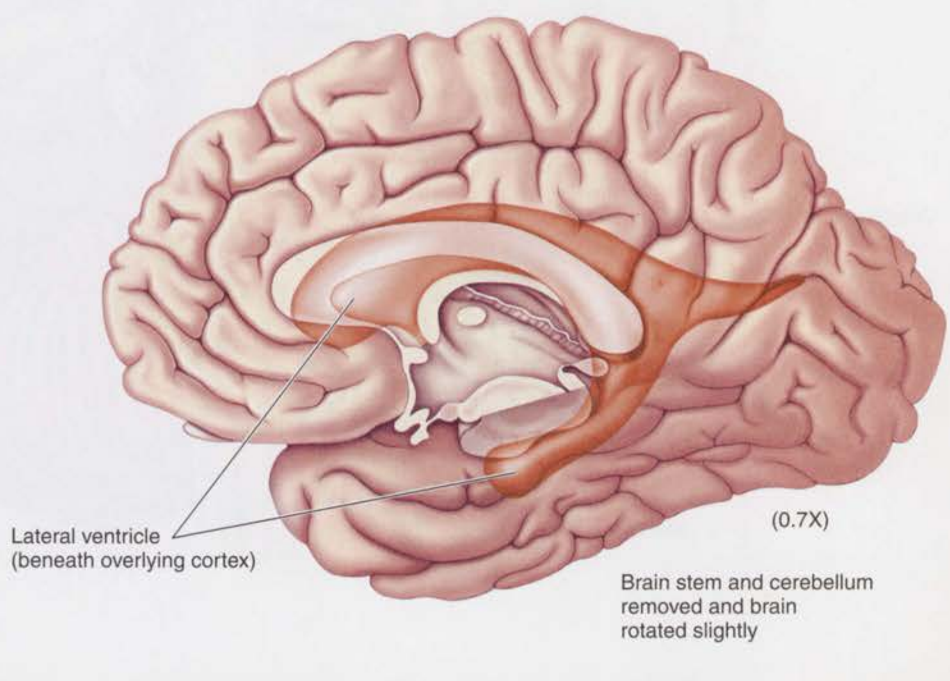




(c) Ventricles. The lateral walls of the unpaired parts of the ventricular system—the third ventricle, the cerebral aqueduct, the fourth ventricle, and the spinal canal—can be observed in the medial view of the brain. These are handy landmarks, because the thalamus and hypothalamus lie next to the third ventricle; the midbrain lies next to the aqueduct; the pons, cerebellum, and medulla lie next to the fourth ventricle; and the spinal cord forms the walls of the spinal canal.

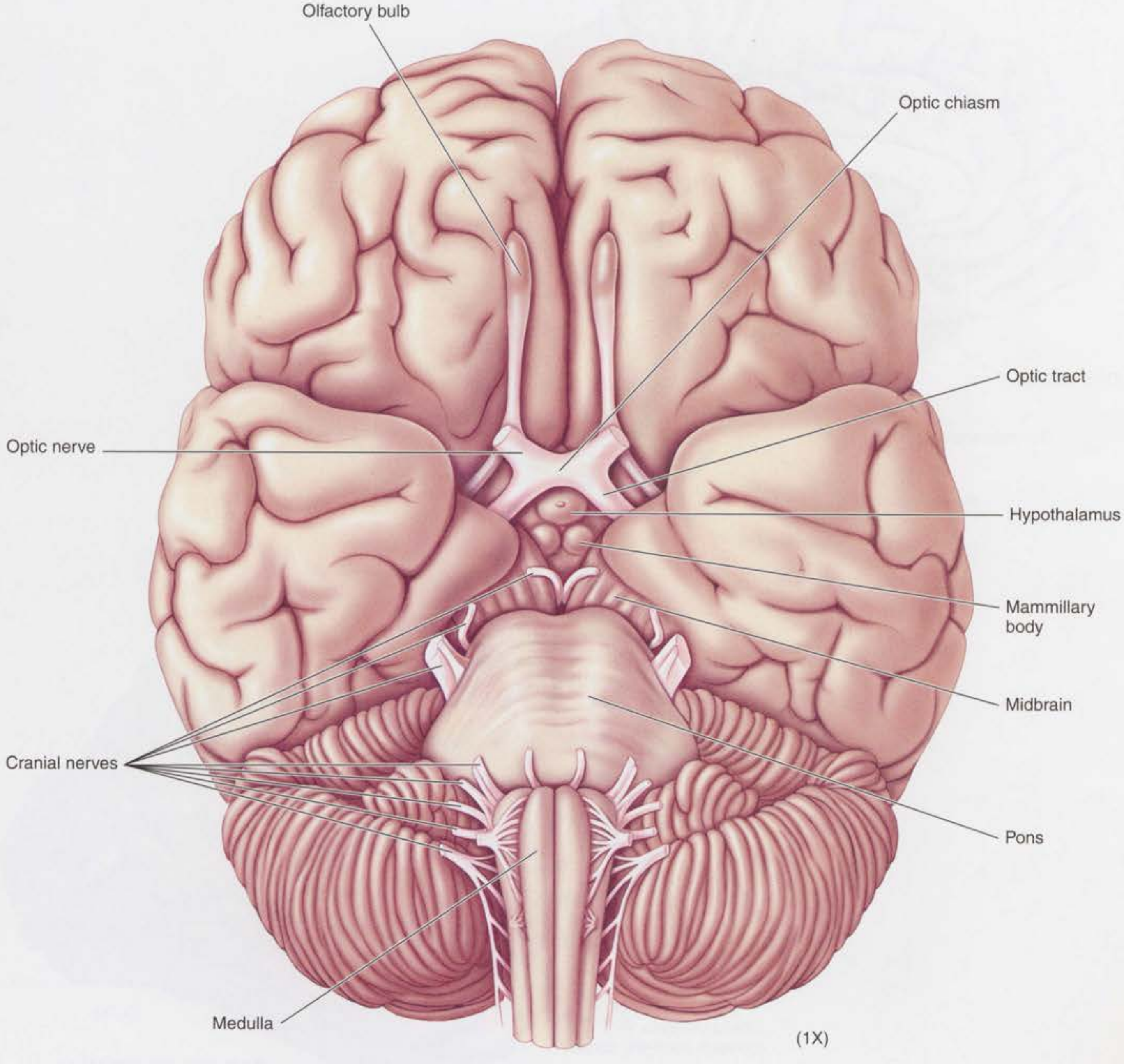
The lateral ventricles are paired structures that sprout like antlers from the third ventricle. A phantom view of the right lateral ventricle, which lies underneath the overlying cortex, is shown in the lower illustration. The two cerebral hemispheres surround the two lateral ventricles. Notice how a coronal section of the brain at the thalamus-midbrain junction will intersect the "horns" of the lateral ventricle of each hemisphere twice.





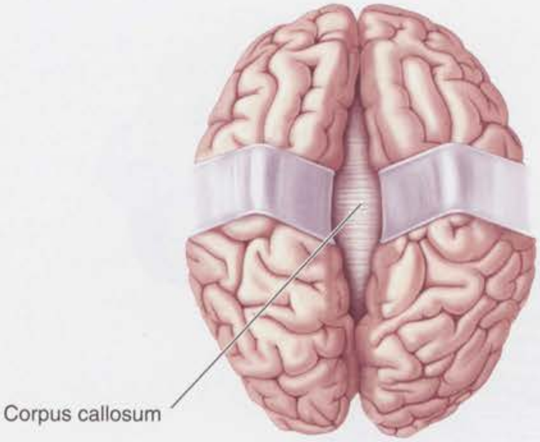
The Ventral Surface of the Brain

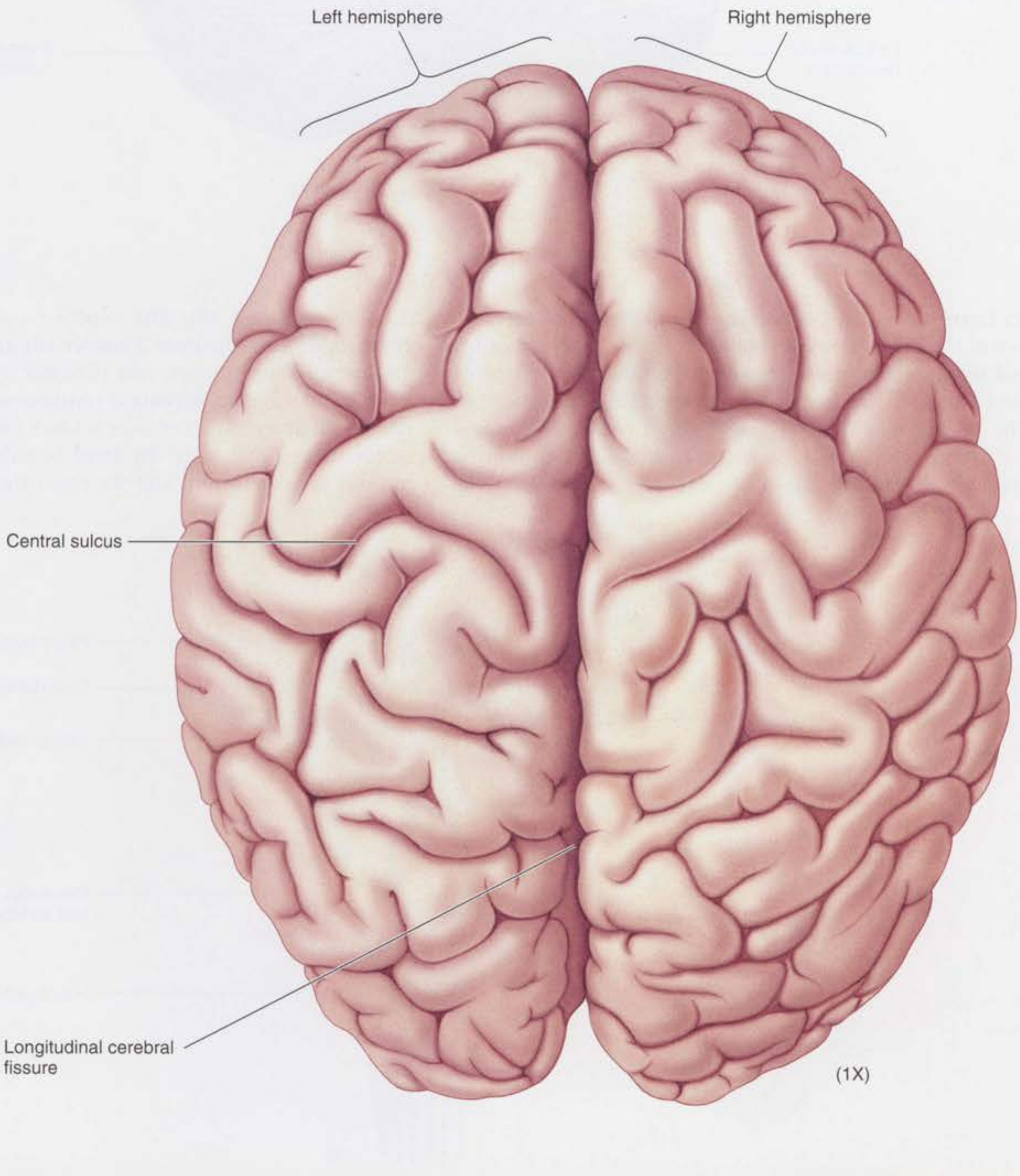
The underside of the brain has a lot of distinct anatomical features. Notice the nerves emerging from the brain stem; these are the cranial nerves, which are illustrated in more detail later in the Guide. Also notice the X-shaped optic chiasm just anterior to the hypothalamus. The chiasm is the place where many axons from the eyes decussate (cross) from one side to another. The bundles of axons anterior to the chiasm, which emerge from the backs of the eyes, are the optic nerves. The bundles lying posterior to the chiasm, that disappear into the thalamus, are called the optic tracts (Chapter 10). The paired mammillary bodies (Latin for "nipple") are a prominent feature of the ventral surface of the brain. These nuclei of the hypothalamus are part of the circuitry that stores memory (Chapter 24) and are a major target of the axons of the fornix (seen in the medial view). Notice also the olfactory bulbs (Chapter 8) and the midbrain, pons, and medulla.



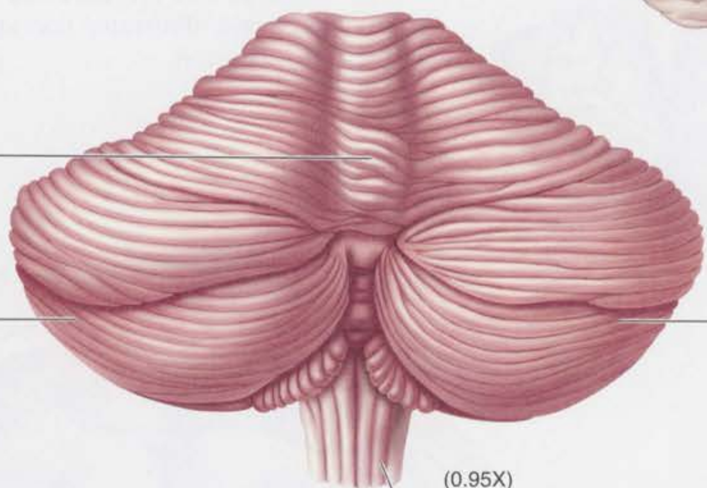
The Dorsal Surface of the Brain

(a) Cerebrum. The dorsal view of the brain is dominated by the large cerebrum. Notice the paired cerebral hemispheres. These are connected by the axons of the corpus callosum (Chapter 20), which can be seen if the hemispheres are retracted slightly. The medial view of the brain, illustrated previously, showed the callosum in cross section.

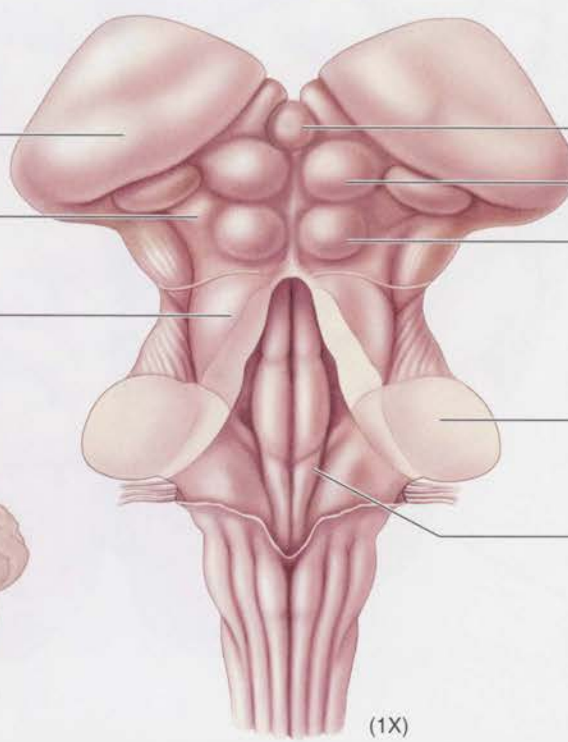




(b) Cerebrum Removed. The cerebellum dominates the dorsal view of the brain if the cerebrum is removed and the brain is tilted slightly forward. The cerebellum, an important motor control structure (Chapter 14), is divided into two hemispheres and a midline region called the vermis (Latin for "worm").



(c) Cerebrum and Cerebellum Removed. The top surface of the brain stem is exposed when both the cerebrum and the cerebellum are removed. The major divisions of the brain stem are labeled on the left side, and some specific structures are labeled on the right side. The pineal body, lying atop the thalamus, secretes melatonin and is involved in the regulation of sleep and sexual behavior (Chapters 17 and 19). The superior colliculus receives direct input from the eyes (Chapter 10) and is involved in the control of eye movements (Chapter 14), while the inferior colliculus is an important component of the auditory system (Chapter 11). (*Colliculus* is Latin for "mound.") The cerebellar peduncles are the large bundles of axons that connect the cerebellum and the brain stem (Chapter 14).

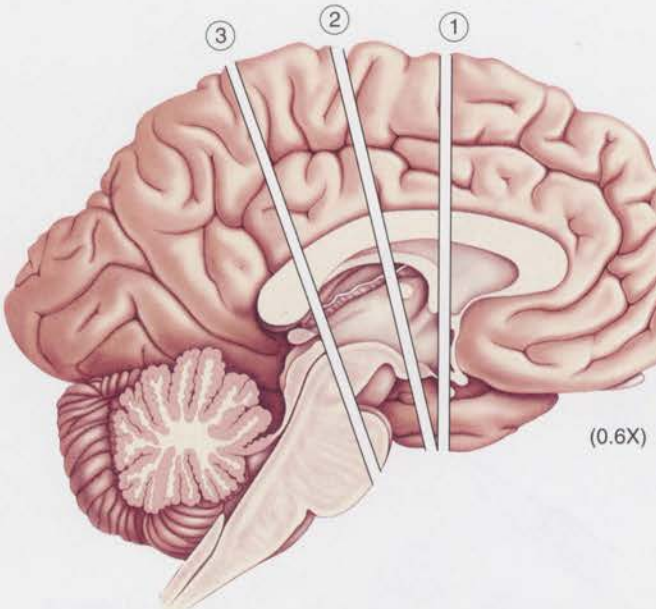


▼ CROSS-SECTIONAL ANATOMY OF THE BRAIN

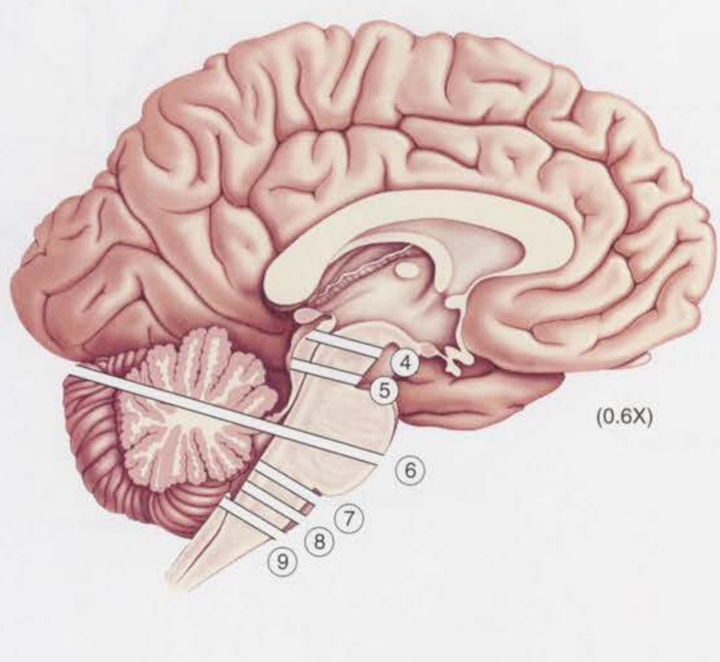
Understanding the brain requires that we peer inside it, and this is accomplished by making cross sections. Cross sections can be made physically with a knife or, in the case of noninvasive imaging of the living brain, digitally with an MRI or a CT scan. For learning the internal organization of the brain, the best approach is to make cross sections that are perpendicular to the axis defined by the embryonic neural tube, called the *neuraxis*. The neuraxis bends as the human fetus grows, particularly at the junction of the midbrain and thalamus. Consequently, the best plane of section depends on exactly where along the neuraxis we are looking.

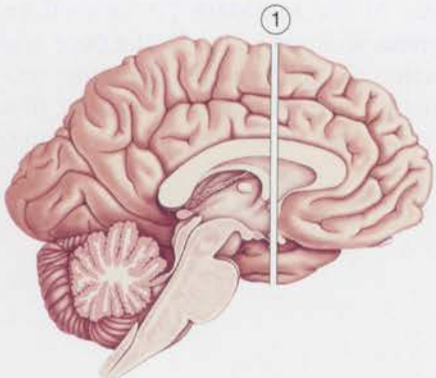
In this part of the Guide, we take a look at drawings of a series of cross-sectional slabs of the brain, showing the internal structure of the forebrain (cross sections 1–3), the midbrain (cross sections 4 and 5), the pons and cerebellum (cross section 6), and the medulla (cross sections 7–9). The drawings are schematic, meaning that structures within the slab are sometimes projected onto the slab's visible surface.

Forebrain Sections



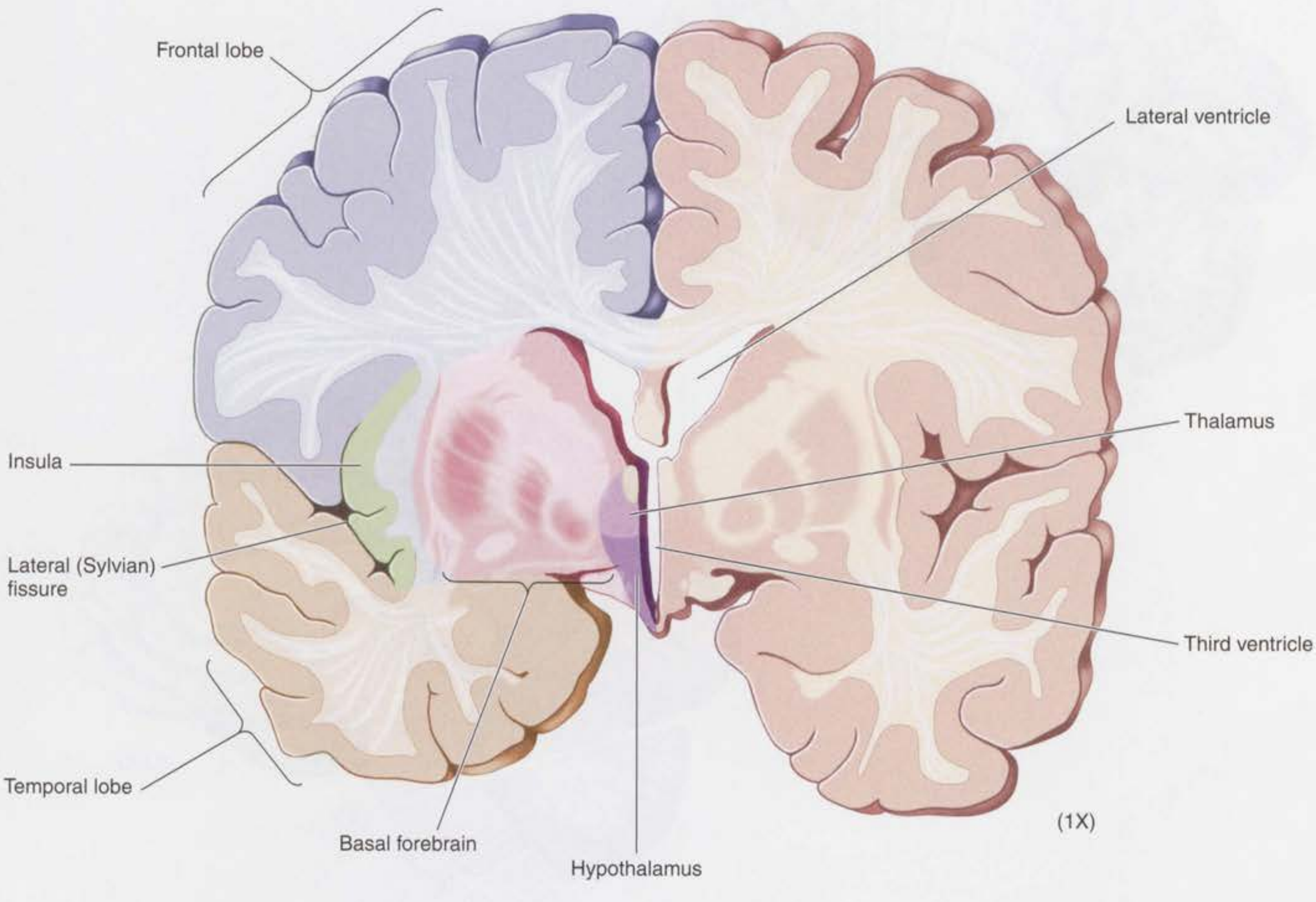
Brain Stem Sections

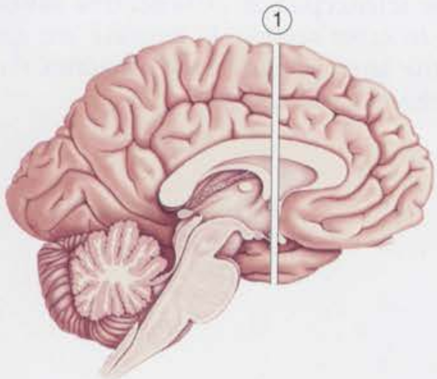




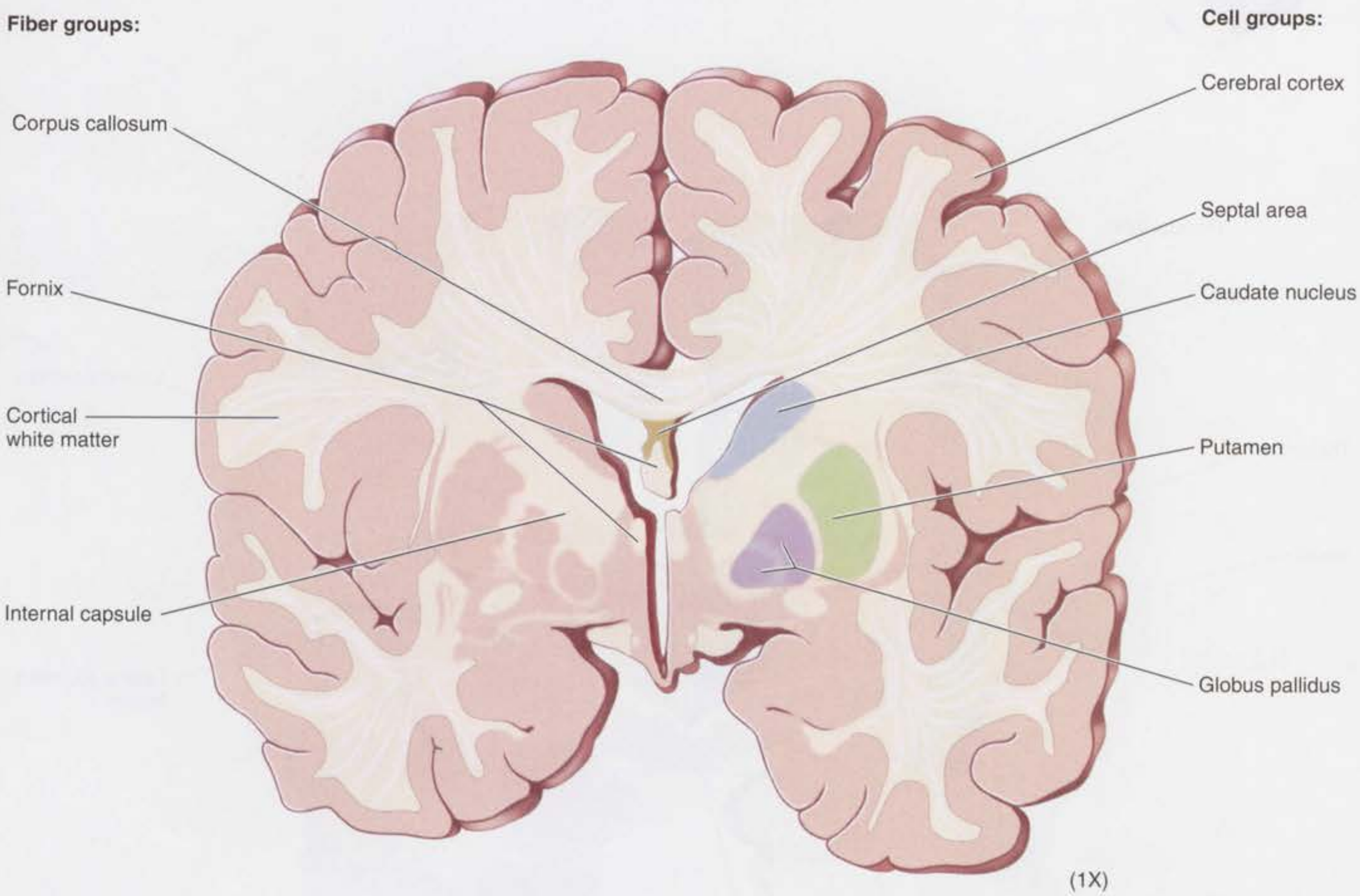
Cross Section I: Forebrain at Thalamus-Telencephalon Junction

(a) Gross Features. The telencephalon surrounds the lateral ventricles, and the thalamus surrounds the third ventricle. In this section, the lateral ventricles can be seen sprouting from the slitlike third ventricle. The hypothalamus, forming the floor of the third ventricle, is a vital control center for many basic bodily functions (Chapters 15–17). The insula (Chapter 8) lies at the base of the lateral (Sylvian) fissure, here separating the frontal lobe from the temporal lobe. The heterogeneous region lying deep within the telencephalon, medial to the insula and lateral to the thalamus, is called the basal forebrain.



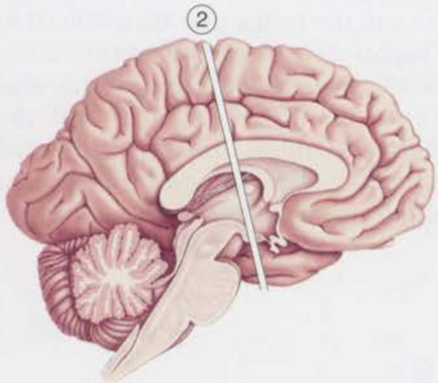


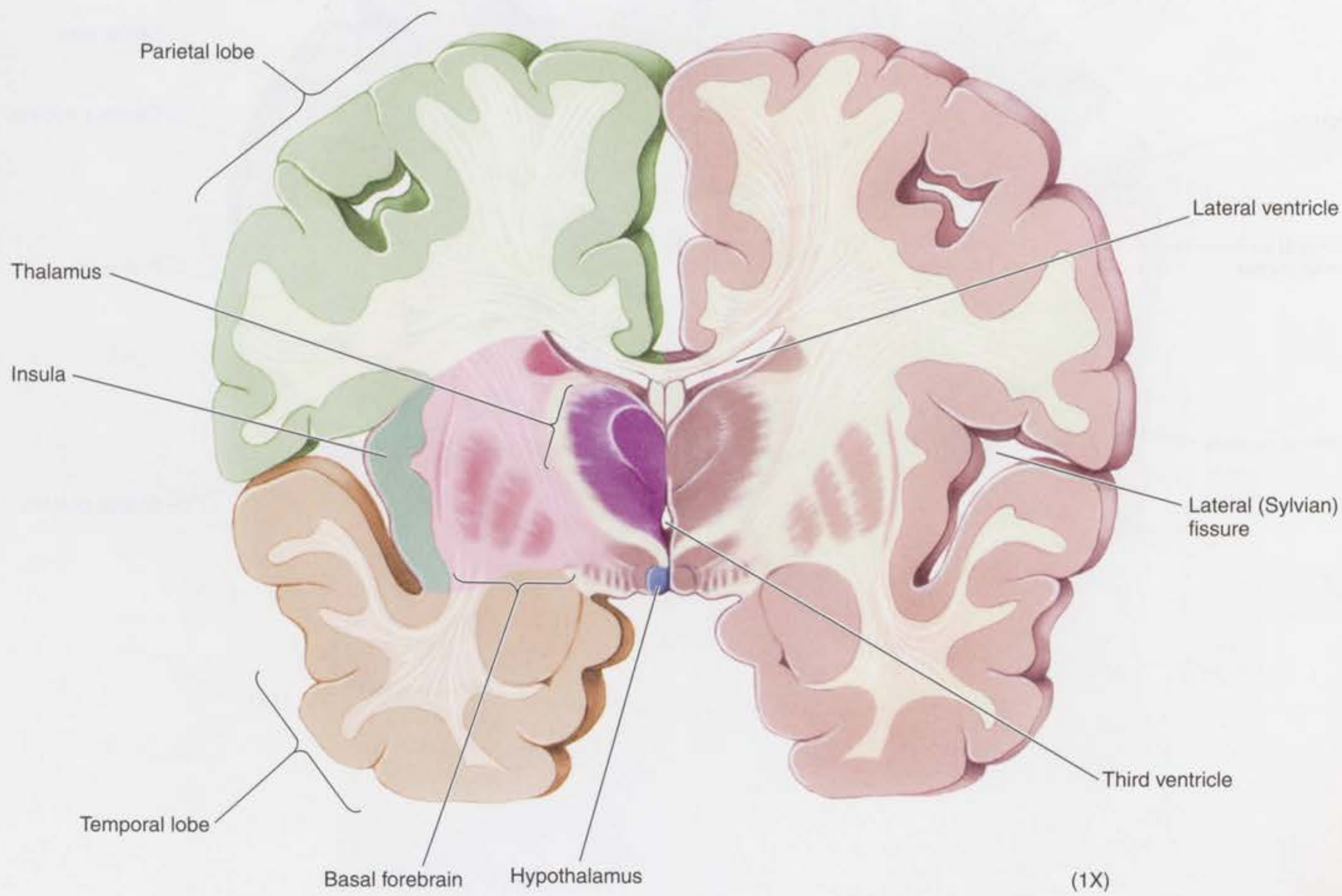
(b) Selected Cell and Fiber Groups. Here we take a more detailed look at the structures of the forebrain. The internal capsule is the large collection of axons connecting the cortical white matter with the thalamus, and the corpus callosum is the enormous sling of axons connecting the cerebral cortex of the two hemispheres. The fornix, shown earlier in the medial view of the brain, is shown here in cross section where it loops around the stalk of the lateral ventricle. The neurons of the closely associated septal area (from *saeptum*, Latin for "partition") contribute axons to the fornix and are involved in memory storage (Chapter 24). Three important collections of neurons in the basal telencephalon are also shown: the caudate nucleus, the putamen, and the globus pallidus. Collectively, these structures are called the basal ganglia and are an important part of the brain systems that control movement (Chapter 14).



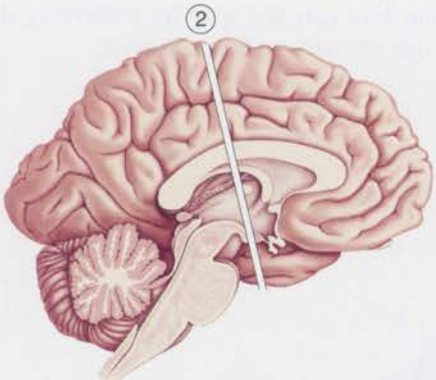
Cross Section 2: Forebrain at Mid-Thalamus

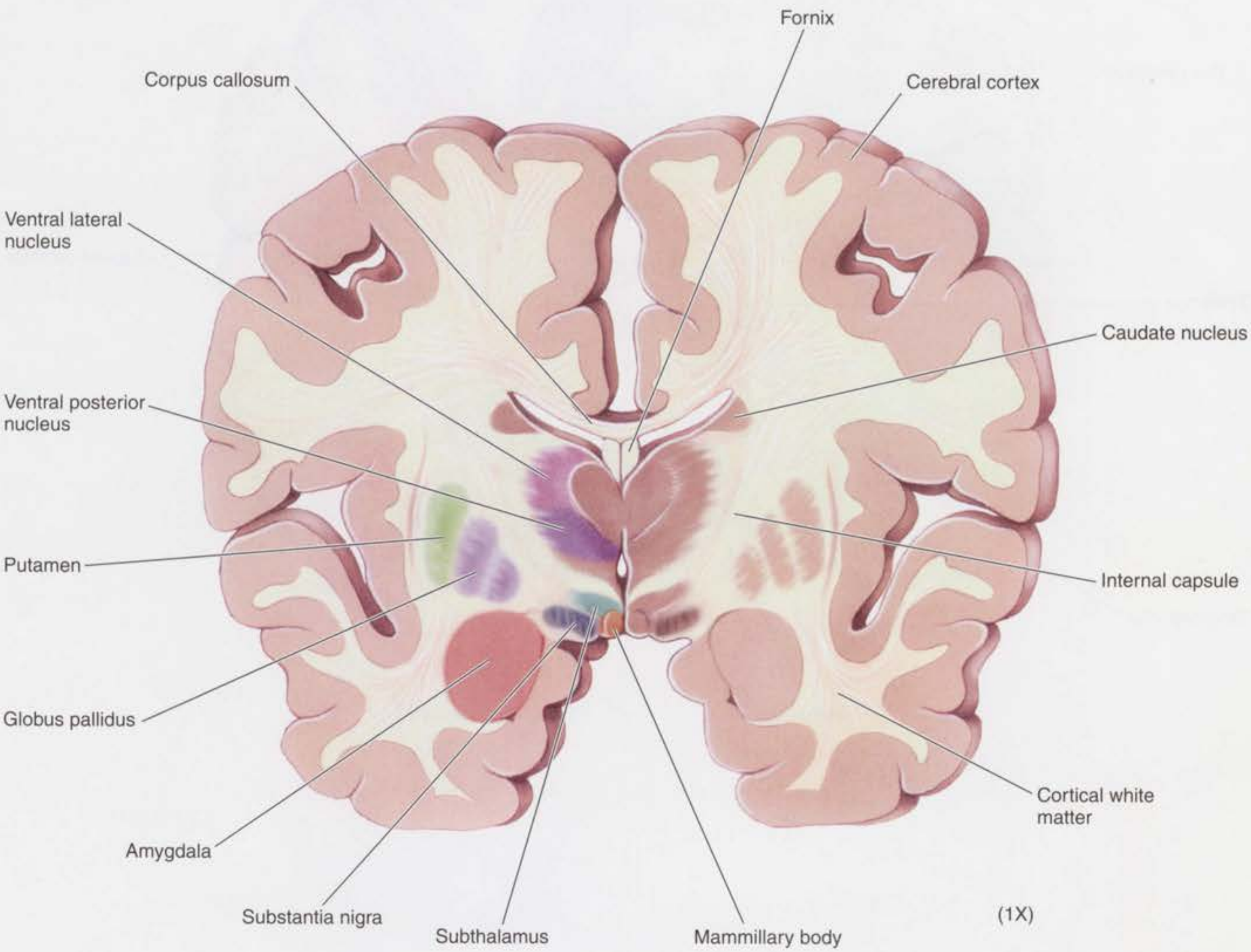
(a) Gross Features. As we move slightly caudal in the neuraxis, we see the heart-shaped thalamus (Greek for "inner chamber") surrounding the small third ventricle at the brain's core. Just ventral to the thalamus lies the hypothalamus. The telencephalon is organized much like what we saw in cross section 1. Because we are slightly posterior, the lateral fissure here separates the parietal lobe from the temporal lobe.

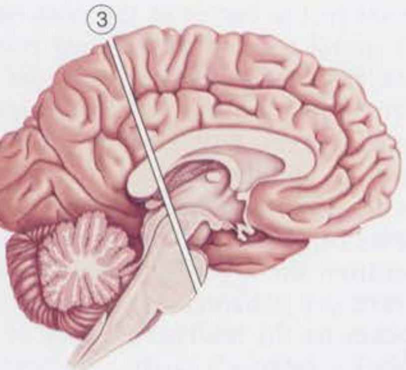




(b) Selected Cell and Fiber Groups. Many important cell and fiber groups appear at this level of the neuraxis. One new structure apparent in the telencephalon is the amygdala, involved in the regulation of emotion (Chapter 18) and memory (Chapter 24). The thalamus is divided into separate nuclei, two of which—the ventral posterior nucleus and the ventral lateral nucleus—are labeled. The thalamus provides much of the input to the cerebral cortex, with different thalamic nuclei projecting axons to different areas of cortex. The ventral posterior nucleus, a part of the somatic sensory system (Chapter 12), projects to the cortex of the postcentral gyrus. The ventral lateral nucleus and closely related ventral anterior nucleus (not shown) are parts of the motor system (Chapter 14); they project to the motor cortex of the precentral gyrus. Visible below the thalamus are the subthalamus and the mammillary bodies of the hypothalamus. The subthalamus is a part of the motor system (Chapter 14), while the mammillary bodies receive information from the fornix and contribute to the regulation of memory (Chapter 24). Because this section also encroaches on the midbrain, a little of the substantia nigra ("black substance") can be seen near the base of the brain stem. The substantia nigra is also a part of the motor system (Chapter 14). Parkinson's disease results from the degeneration of this structure.

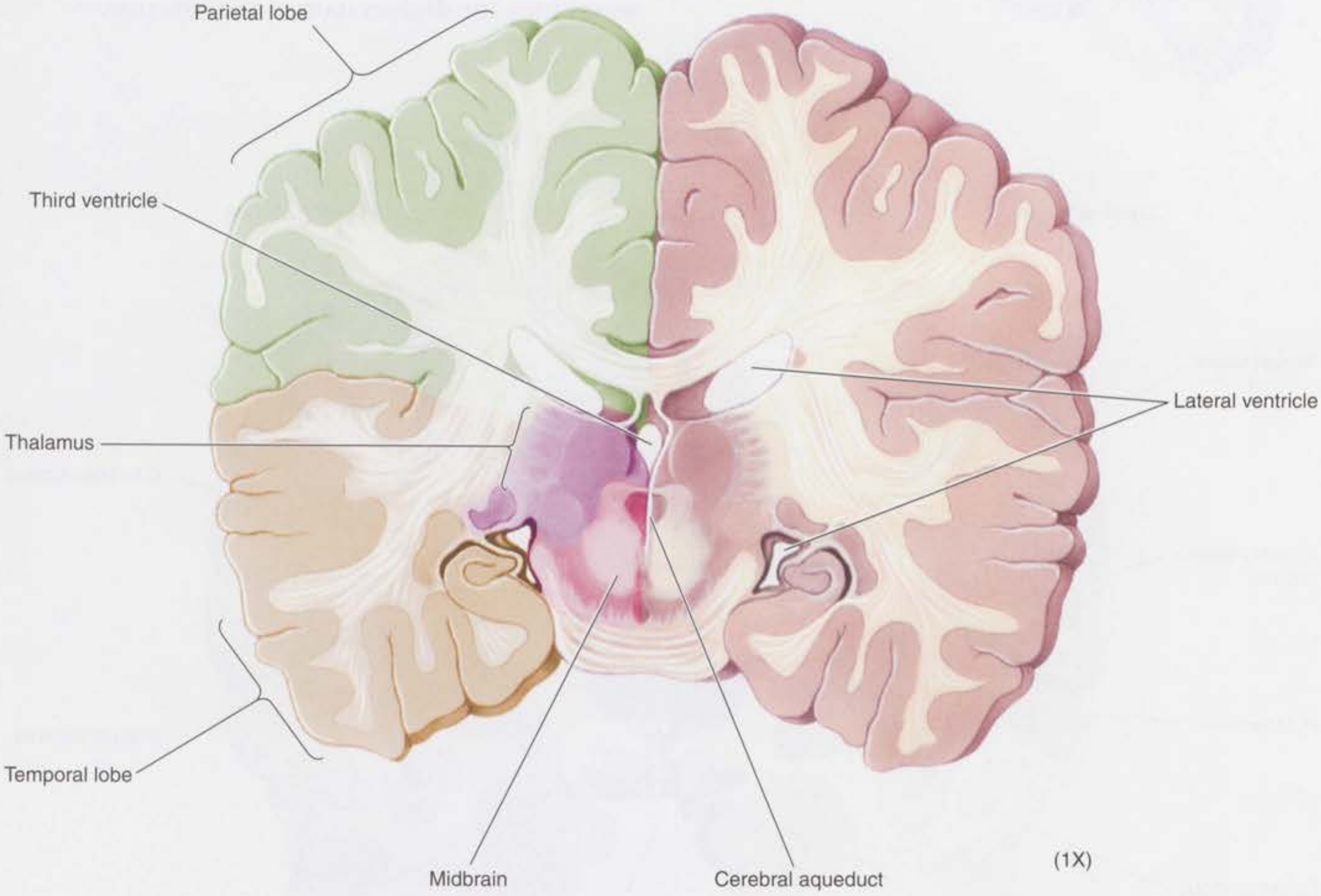


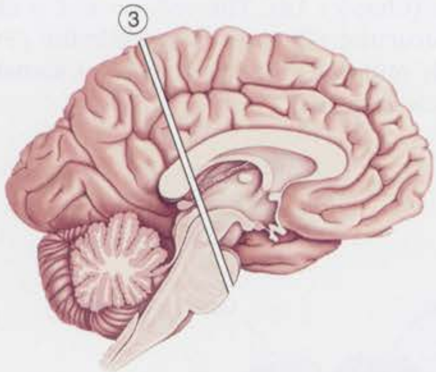




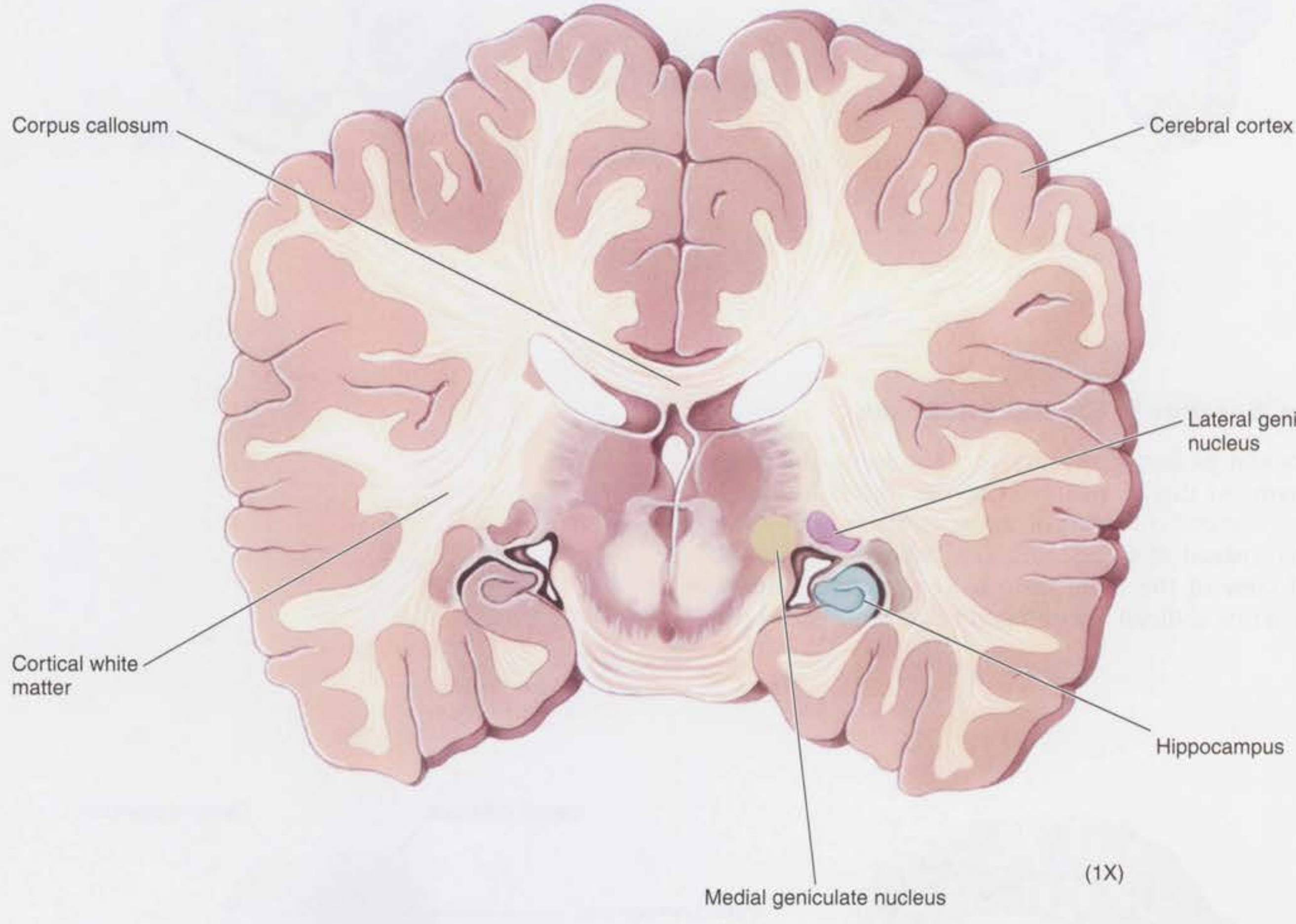
Cross Section 3: Forebrain at Thalamus-Midbrain Junction

(a) Gross Features. The neuraxis bends sharply at the junction of the thalamus and the midbrain. This cross section is taken at a level where the teardrop-shaped third ventricle communicates with the cerebral aqueduct. The brain surrounding the third ventricle is thalamus, and the brain around the cerebral aqueduct is midbrain. The lateral ventricles of each hemisphere appear twice in this section. You can see why by reviewing the phantom view of the ventricle, shown earlier.



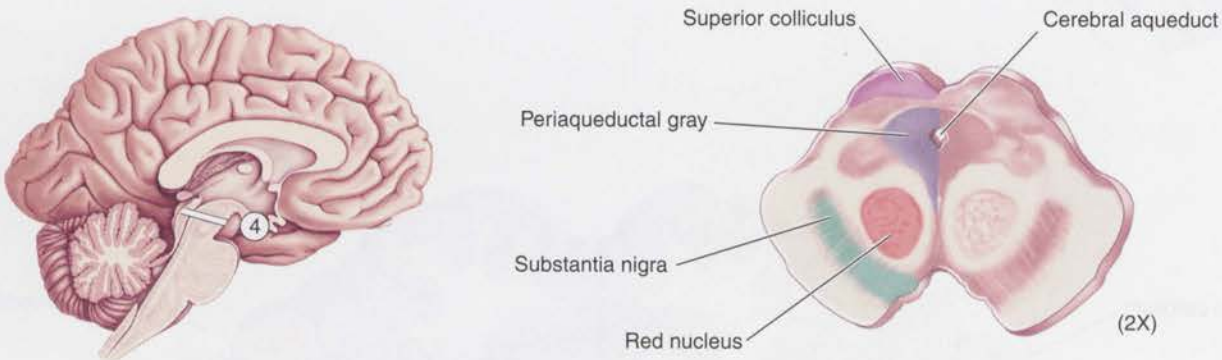


(b) Selected Cell and Fiber Groups. Notice that this section contains two more important nuclei of the thalamus: the medial and lateral geniculate nuclei. (*Geniculate* is Latin for "knee.") The lateral geniculate nucleus relays information to the visual cortex (Chapter 10), and the medial geniculate nucleus relays information to the auditory cortex (Chapter 11). Also notice the location of the hippocampus, a relatively simple form of cerebral cortex bordering the lateral ventricle of the temporal lobe. The hippocampus (Greek for "seahorse") plays an important role in learning and memory (Chapters 24 and 25).



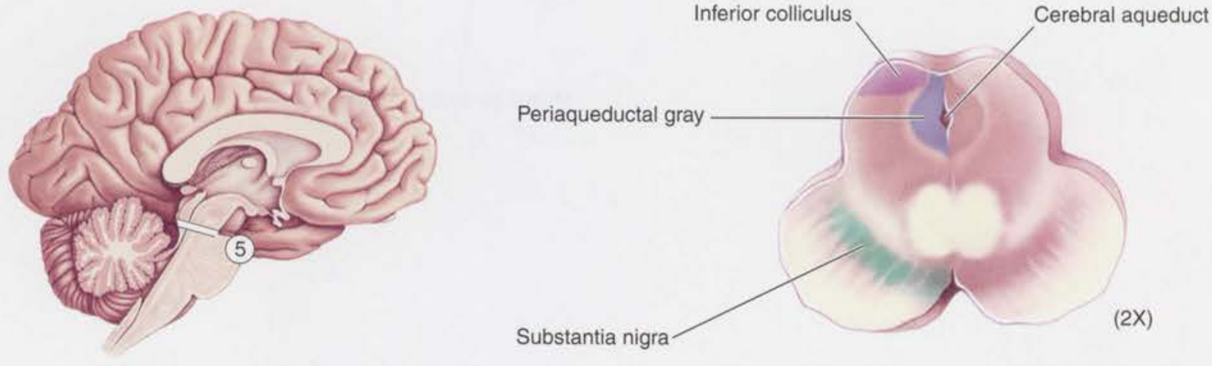
Cross Section 4: Rostral Midbrain

We are now at the midbrain. The plane of section has been angled relative to the forebrain sections, so that it remains perpendicular to the neuraxis. The core of the midbrain is the small cerebral aqueduct. Here, the roof of the midbrain, also called the tectum (Latin for "roof"), consists of the paired superior colliculi. As discussed earlier, the superior colliculus is a part of the visual system (Chapter 10) and the substantia nigra is a part of the motor system (Chapter 14). The red nucleus is also a motor control structure (Chapter 14), while the periaqueductal gray is important in the control of somatic pain sensations (Chapter 12).



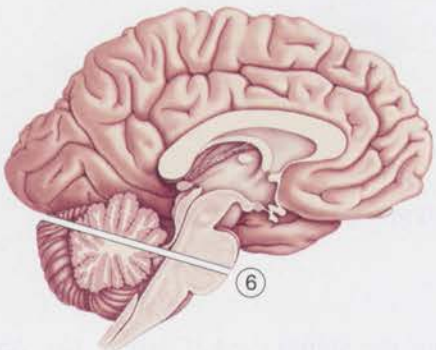
Cross Section 5: Caudal Midbrain

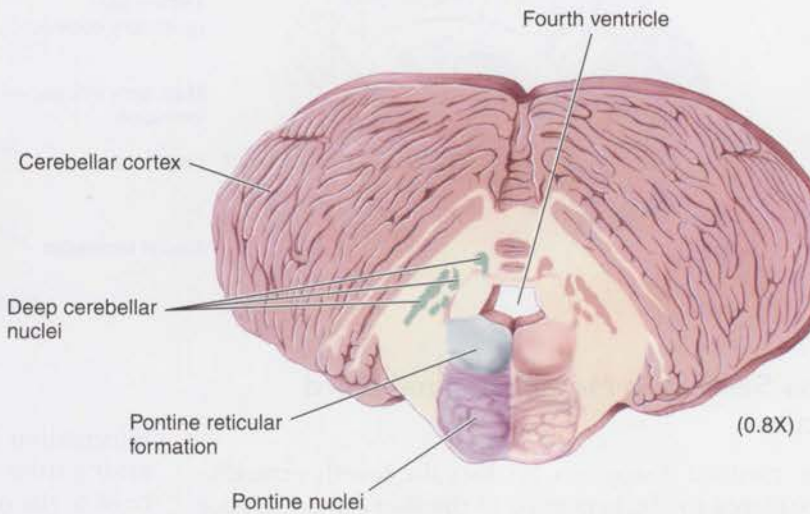
The caudal midbrain appears very similar to the rostral midbrain. At this level, however, the roof is formed by the inferior colliculi (part of the auditory system; Chapter 11) instead of by the superior colliculi. Review the dorsal view of the brain stem to see how the superior and inferior colliculi are situated relative to each other.



Cross Section 6: Pons and Cerebellum

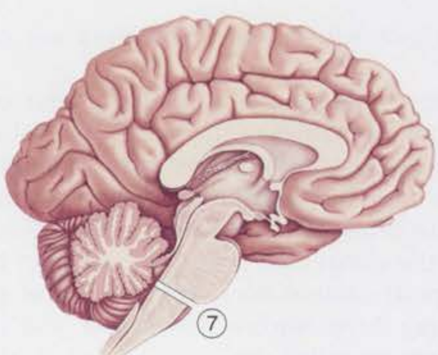
This section shows the pons and cerebellum, parts of the rostral hindbrain that border the fourth ventricle. As mentioned earlier, the cerebellum is important in the control of movement. Much of the input to the cerebellar cortex derives from the pontine nuclei, while the output of the cerebellum is from neurons of the deep cerebellar nuclei (Chapter 14). The reticular formation (*reticulum* is Latin for "net") runs from the midbrain to the medulla at the core of the brain stem, just under the cerebral aqueduct and fourth ventricle. One function of the reticular formation is to regulate sleep and wakefulness (Chapter 19). In addition, a function of the pontine reticular formation is to control body posture (Chapter 14).

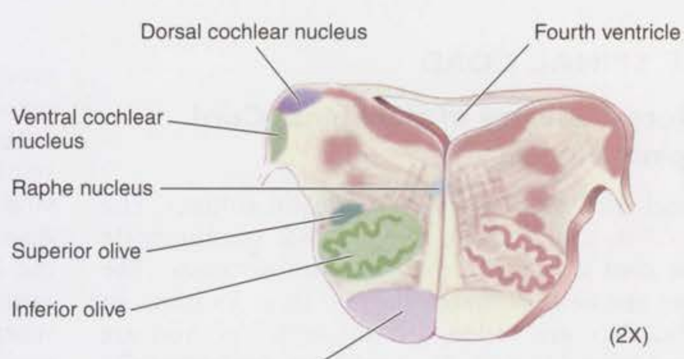




Cross Section 7: Rostral Medulla

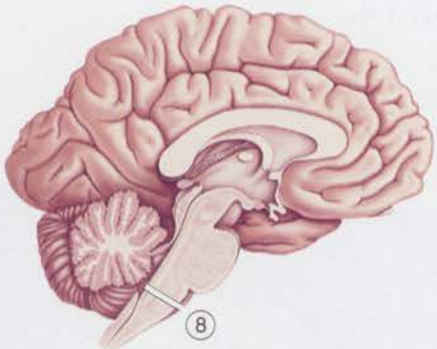
As we move farther caudally along the neuraxis, the brain surrounding the fourth ventricle becomes the medulla. The medulla is a complex region of the brain. Here we focus only on those structures whose functions are discussed later in the book. At the very floor of the medulla lie the medullary pyramids, huge bundles of axons descending from the forebrain toward the spinal cord. The pyramids contain the corticospinal tracts, which are involved in the control of voluntary movement (Chapter 14). Several nuclei that are important for hearing are also found in the rostral medulla: the dorsal and ventral cochlear nuclei and the superior olive (Chapter 11). Also shown are the inferior olive, important for motor control (Chapter 14), and the raphe nucleus, important for the modulation of pain, mood, and wakefulness (Chapters 12, 19, and 22).

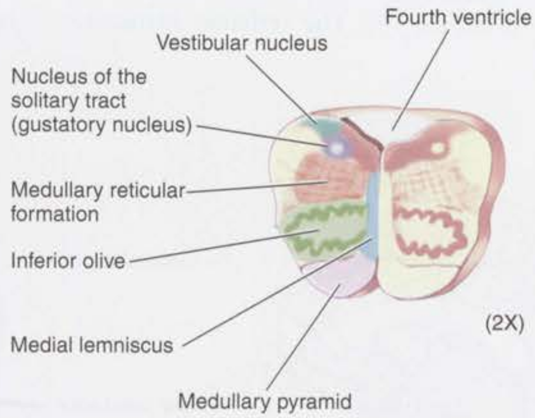




Cross Section 8: Mid-Medulla

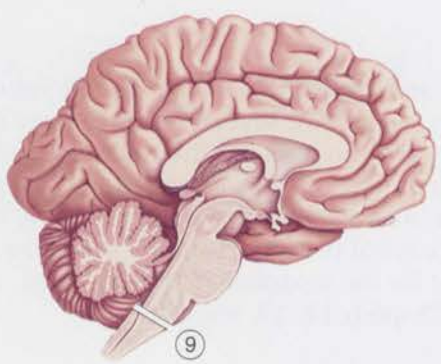
The mid-medulla contains some of the same structures labeled in cross section 7. Notice also the medial lemniscus (Latin for "ribbon"). The medial lemniscus contains axons bringing information about somatic sensation to the thalamus (Chapter 12). The gustatory nucleus, serving the sense of taste (Chapter 8), is part of a larger nucleus of the solitary tract, which regulates aspects of visceral function (Chapters 15 and 16). The vestibular nuclei serve the sense of balance (Chapter 11).

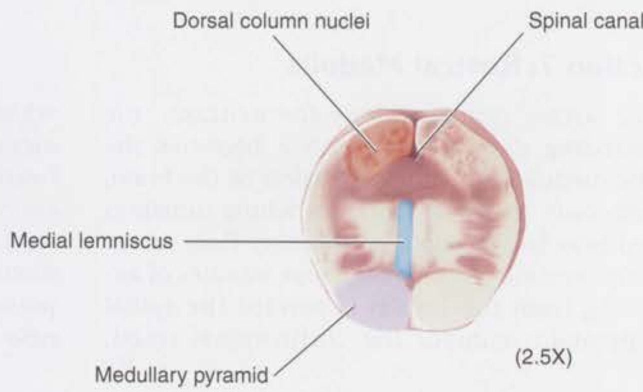




Cross Section 9: Medulla–Spinal Cord Junction

As the medulla disappears, so does the fourth ventricle, now replaced by the beginning of the spinal canal. Notice the dorsal column nuclei, which receive somatic sensory information from the spinal cord (Chapter 12). Axons arising from the neurons in each dorsal column nucleus cross to the other side of the brain (decussate) and ascend to the thalamus via the medial lemniscus.



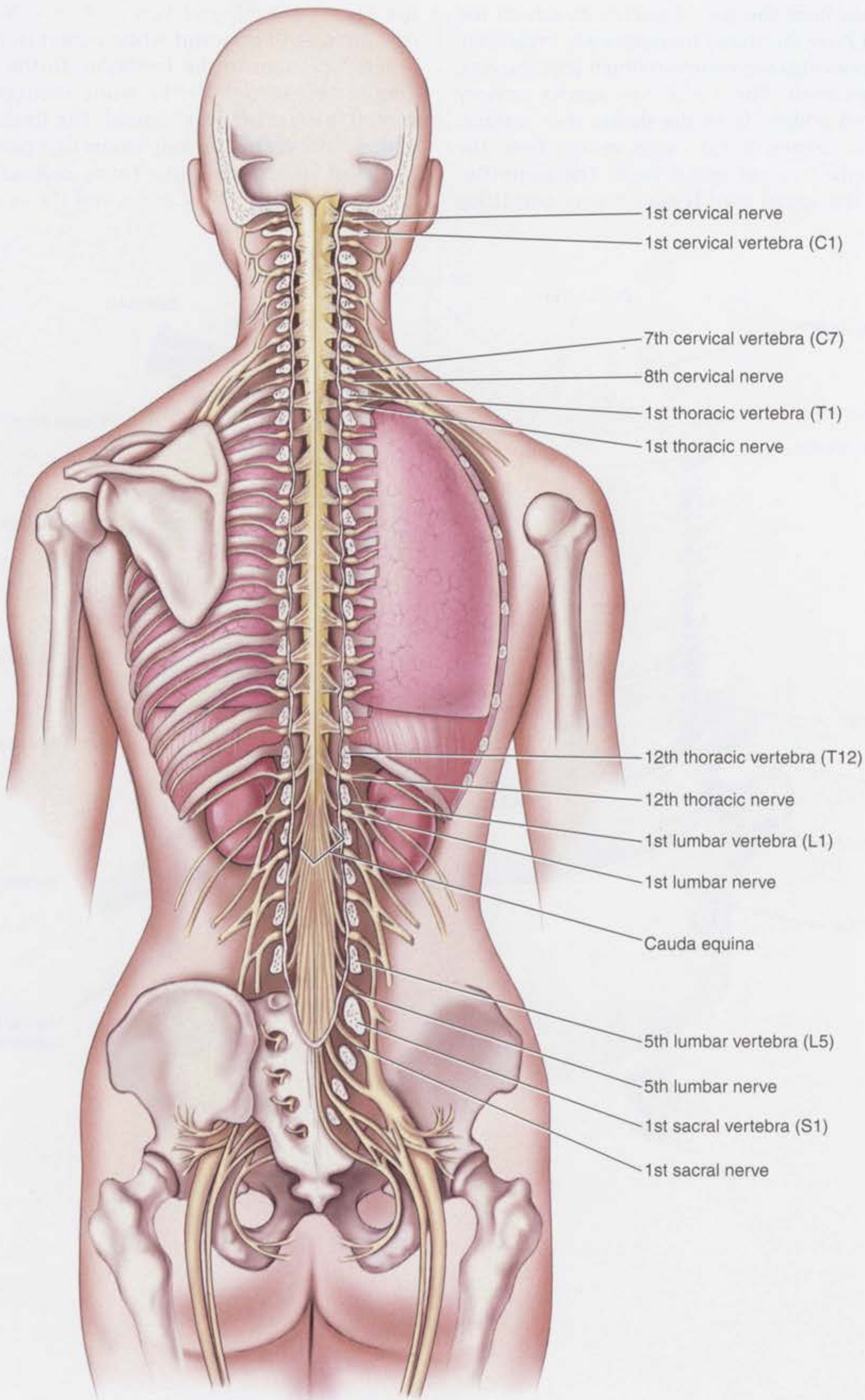


▼ THE SPINAL CORD

The Dorsal Surface of the Spinal Cord and Spinal Nerves

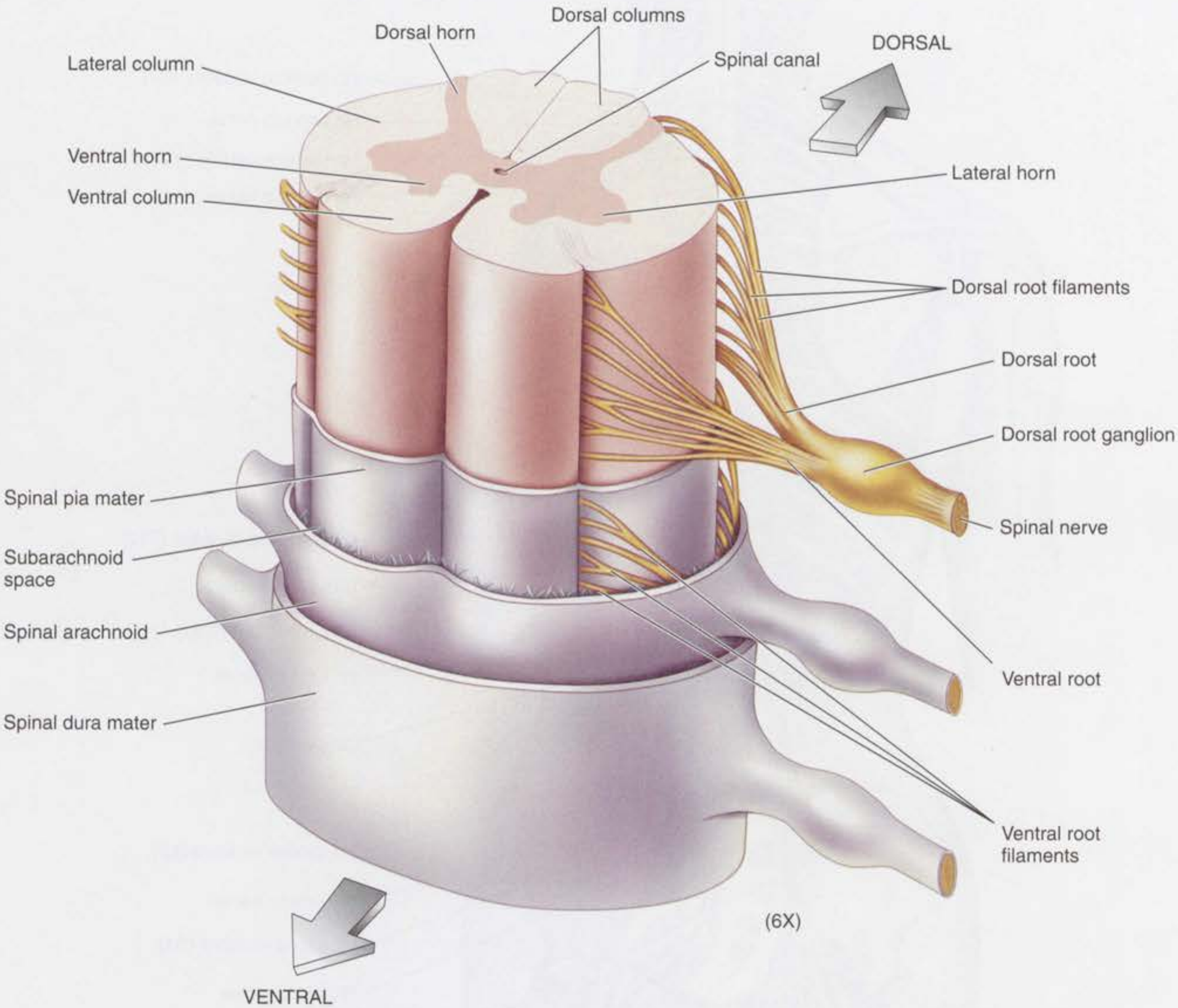
The spinal cord lies within the vertebral column. The spinal nerves, a part of the somatic PNS, communicate with the cord via notches between the vertebrae. The vertebrae are described according to their location. In the neck, they are called cervical vertebrae and are numbered from C1 to C7. The vertebrae attached to ribs are called thoracic vertebrae and are numbered from T1 to T12. The five vertebrae of the lower back are called lumbar, and those within the pelvic area are called sacral.

The spinal nerves and the associated segments of the spinal cord adopt the names of the vertebrae; eight cervical nerves are associated with seven cervical vertebrae. Also, the spinal cord in the adult human ends at about the level of the third lumbar vertebra. This disparity arises because the spinal cord does not grow after birth, whereas the spinal column does. The bundles of spinal nerves streaming down within the lumbar and sacral vertebral column are called the cauda equina (Latin for "horse's tail").


1st cervical nerve
1st cervical vertebra (C1)
7th cervical vertebra (C7)
8th cervical nerve
1st thoracic vertebra (T1)
1st thoracic nerve
12th thoracic vertebra (T12)
12th thoracic nerve
1st lumbar vertebra (L1)
1st lumbar nerve
Cauda equina
5th lumbar vertebra (L5)
5th lumbar nerve
1st sacral vertebra (S1)
1st sacral nerve

The Ventral-Lateral Surface

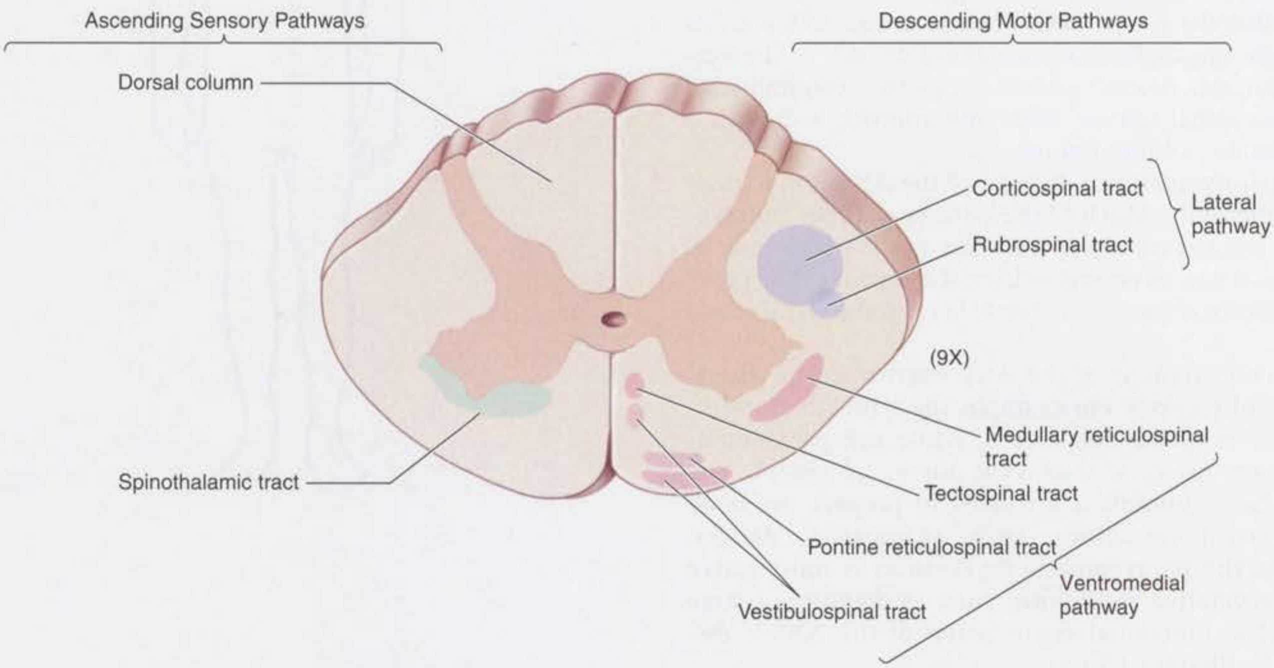
This view shows how the spinal nerves attach to the spinal cord and how the spinal meninges are organized. As the nerve passes into the vertebral notch (not shown), it splits into two roots. The dorsal root carries sensory axons whose cell bodies lie in the dorsal root ganglia. The ventral root carries motor axons arising from the gray matter of the ventral spinal cord. The butterfly-shaped core of the spinal cord is gray matter consisting of neuronal cell bodies. The gray matter is divided into the dorsal, lateral, and ventral horns. Notice how the organization of gray and white matter in the spinal cord differs from that in the forebrain. In the forebrain, the gray matter surrounds the white matter; in the spinal cord, it is the other way around. The thick shell of white matter, containing the long axons that run up and down the cord, is divided into three columns: the dorsal columns, the lateral columns, and the ventral columns.



Cross-Sectional Anatomy

Illustrated in this view are some of the important tracts of axons running up and down the spinal cord. On the left side, the major ascending sensory pathways are indicated. The entire dorsal column consists of sensory axons ascending to the brain. This pathway is important for the conscious appreciation of touch. The spinothalamic tract carries information about painful stimuli and temperature. The somatic sensory system is the topic of Chapter 12.

On the right side are some of the descending tracts important for the control of movement (Chapter 14). The names of the tracts accurately describe their origins and terminations (e.g., the vestibulospinal tract originates in the vestibular nuclei of the medulla and terminates in the spinal cord). The descending tracts contribute to two pathways: the lateral and ventromedial pathways. The lateral pathway carries the commands for voluntary movements, especially of the extremities. The ventromedial pathway participates primarily in the maintenance of posture and certain reflex movements.



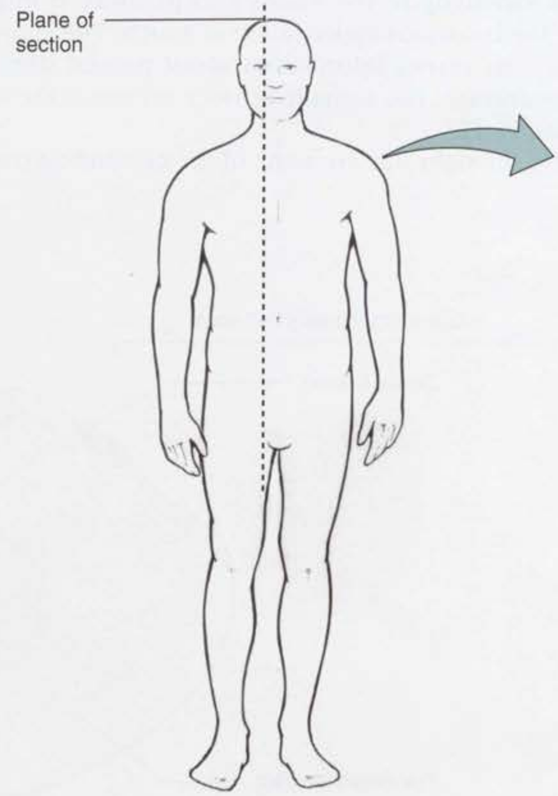
THE AUTONOMIC NERVOUS SYSTEM

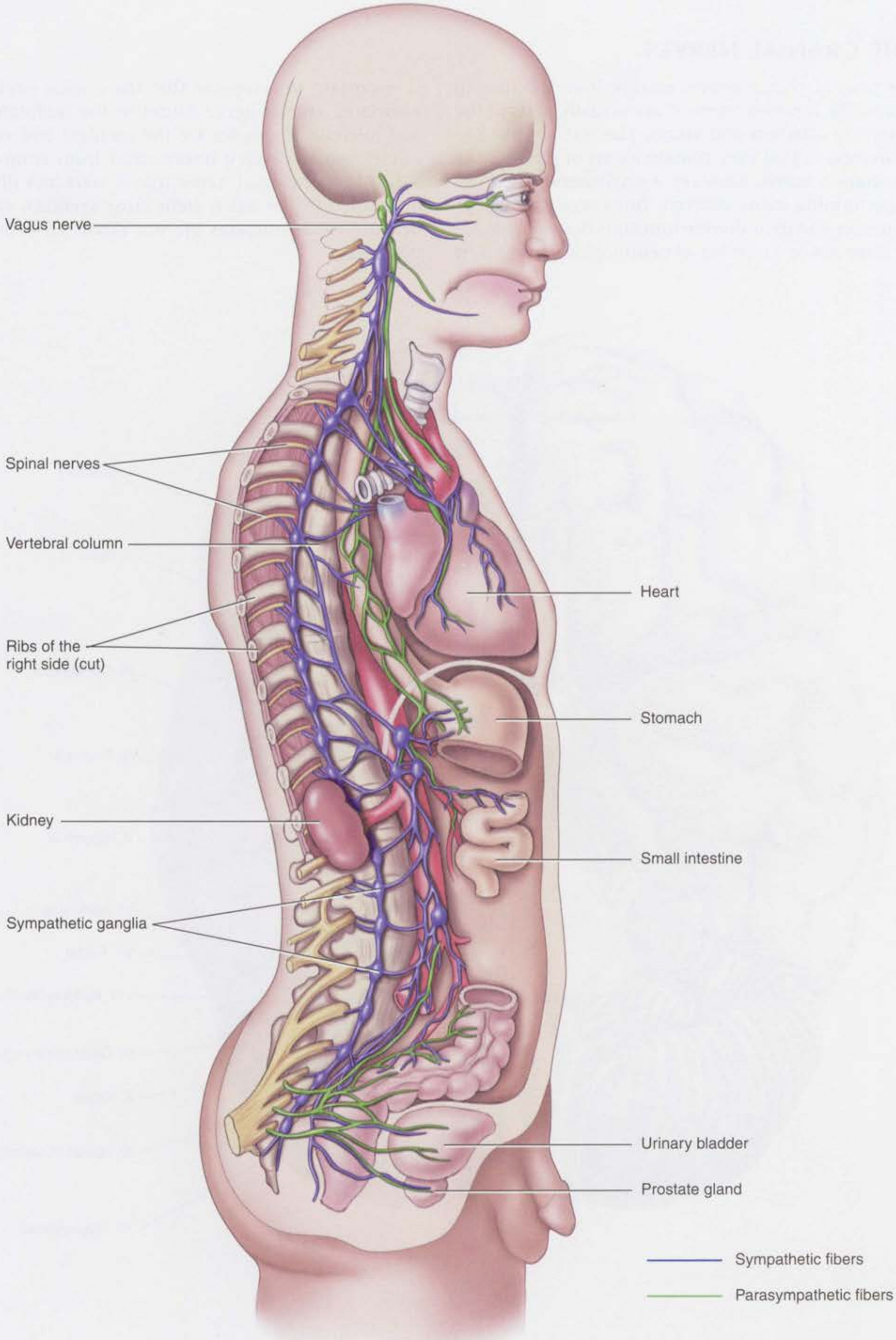
In addition to the somatic PNS, which is devoted largely to the voluntary control of movement and conscious skin sensations, there is the visceral PNS, devoted to the regulation of the internal organs, glands, and vasculature. Because this regulation occurs automatically and is not under direct conscious control, this system is called the autonomic nervous system, or ANS. The two most important divisions of the ANS are the sympathetic and parasympathetic divisions.

The illustration on the facing page shows the cavity of the body as it appears when it has been sectioned sagittally at the level of the eye. Notice the vertebral column, which is encased in a thick wall of connective tissue. The spinal nerves can be seen emerging from the column. Notice that the sympathetic division of the ANS consists of a chain of ganglia that runs along the side of the vertebral column. These sympathetic ganglia communicate with the spinal nerves, with one another, and with a large number of internal organs.

The parasympathetic division of the ANS is organized quite differently. Much of the parasympathetic innervation of the viscera arises from the vagus nerve, one of the cranial nerves emerging from the medulla. The other major source of parasympathetic fibers is the sacral spinal nerves.

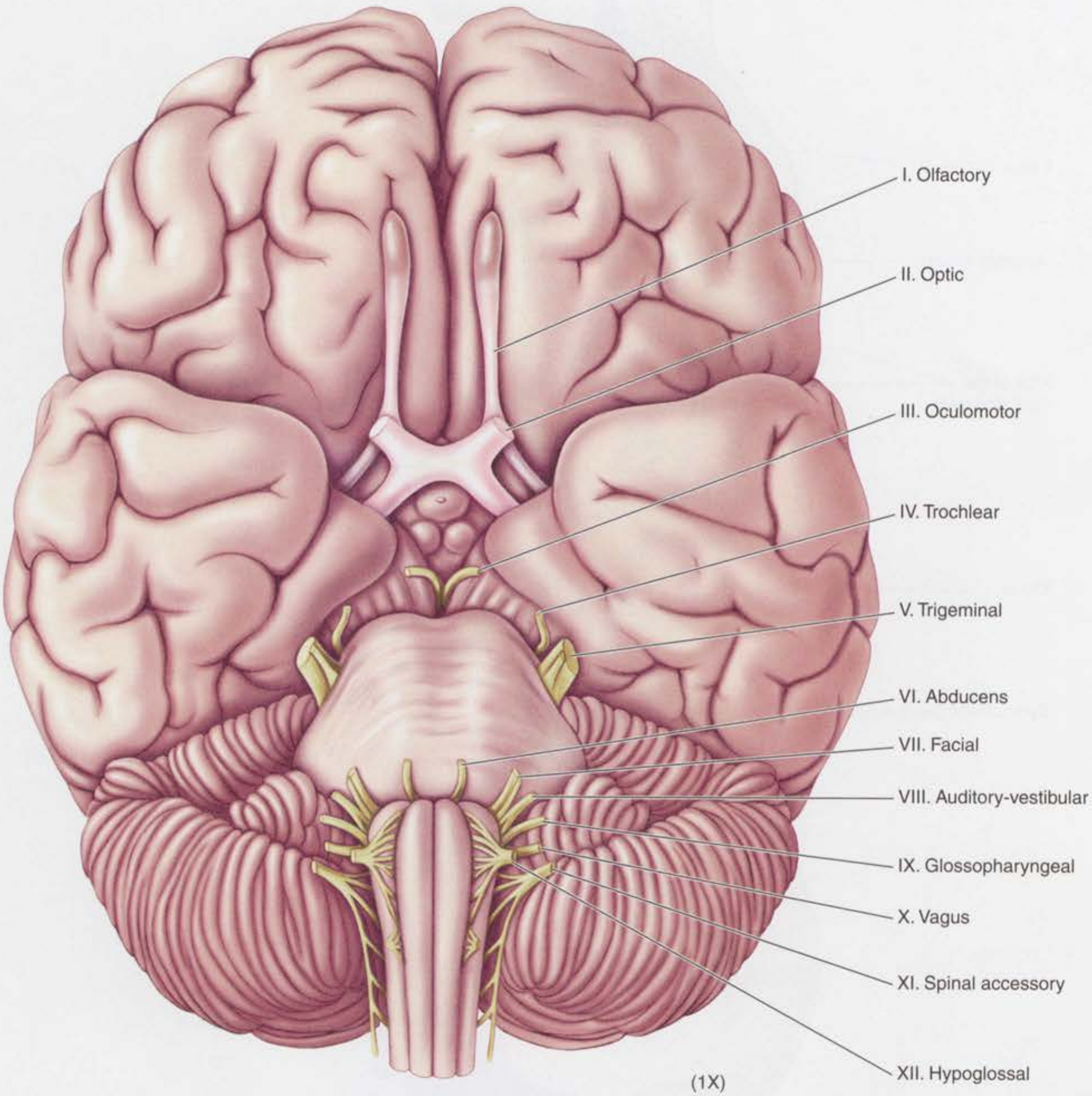
The two divisions of the ANS exert opposite effects on body physiology. For example, the sympathetic nervous system speeds heart rate, while the parasympathetic nervous system slows it down. In general, the sympathetic division is activated to prepare the body for stressful conditions, such as escaping danger, whereas the parasympathetic division is most active under vegetative conditions, such as digesting a large meal. (The functional organization of the ANS is discussed in Chapter 15.)




Vagus nerve
Spinal nerves
Vertebral column
Ribs of the right side (cut)
Kidney
Sympathetic ganglia
Heart
Stomach
Small intestine
Urinary bladder
Prostate gland
Sympathetic fibers
Parasympathetic fibers

▼ THE CRANIAL NERVES

Twelve pairs of cranial nerves emerge from the base of the brain. The first two "nerves" are actually parts of the CNS, serving olfaction and vision. The rest are like the spinal nerves, in that they contain axons of the PNS. As the illustration shows, however, a single nerve often has fibers performing many different functions. Knowledge of the nerves and their diverse functions is a valuable aid in the diagnosis of a number of neurological disorders. It is important to recognize that the cranial nerves have associated cranial nerve nuclei in the midbrain, pons, and medulla. Examples are the cochlear and vestibular nuclei, which receive information from cranial nerve VIII. Most of cranial nerve nuclei were not illustrated or labeled in the brain stem cross sections, however, because their functions are not discussed explicitly in this book.

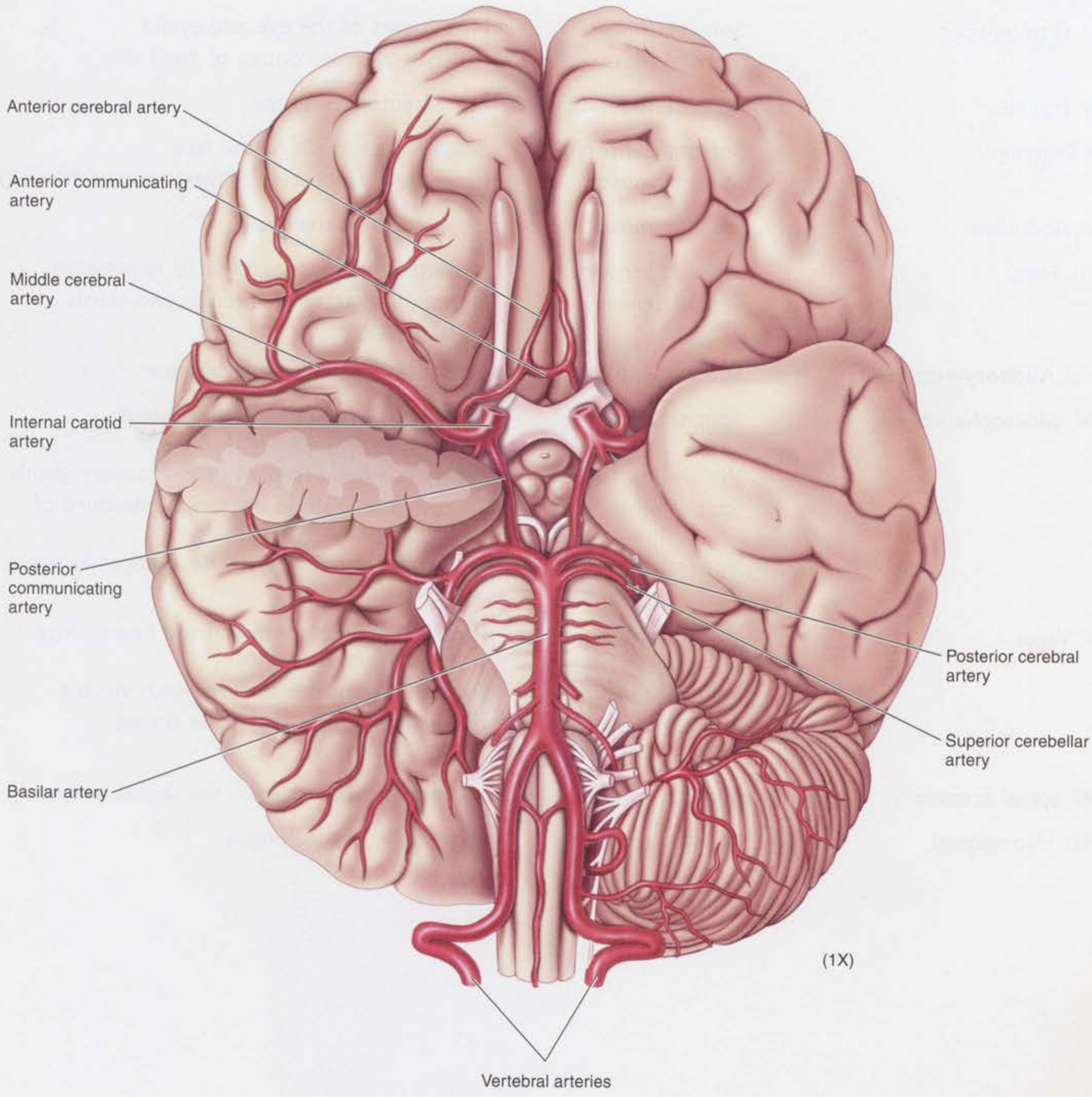


NERVE NUMBER AND NAME	TYPES OF AXONS	IMPORTANT FUNCTIONS
I. Olfactory	Special sensory	Sensation of smell
II. Optic	Special sensory	Sensation of vision
III. Oculomotor	Somatic motor	Movements of the eye and eyelid
	Visceral motor	Parasympathetic control of pupil size
IV. Trochlear	Somatic motor	Movements of the eye
V. Trigeminal	Somatic sensory	Sensation of touch to the face
	Somatic motor	Movement of muscles of mastication (chewing)
VI. Abducens	Somatic motor	Movements of the eye
VII. Facial	Somatic sensory	Movement of muscles of facial expression
	Special sensory	Sensation of taste in anterior two-thirds of the tongue
VIII. Auditory-vestibular	Special sensory	Sensation of hearing and balance
IX. Glossopharyngeal	Somatic motor	Movement of muscles in the throat (oropharynx)
	Visceral motor	Parasympathetic control of the salivary glands
	Special sensory	Sensation of taste in posterior one-third of the tongue
	Visceral sensory	Detection of blood pressure changes in the aorta
X. Vagus	Visceral motor	Parasympathetic control of the heart, lungs, and abdominal organs
	Visceral sensory	Sensation of pain associated with viscera
	Somatic motor	Movement of muscles in the throat (oropharynx)
XI. Spinal accessory	Somatic motor	Movement of muscles in the throat and neck
XII. Hypoglossal	Somatic motor	Movement of the tongue

THE BLOOD SUPPLY OF THE BRAIN

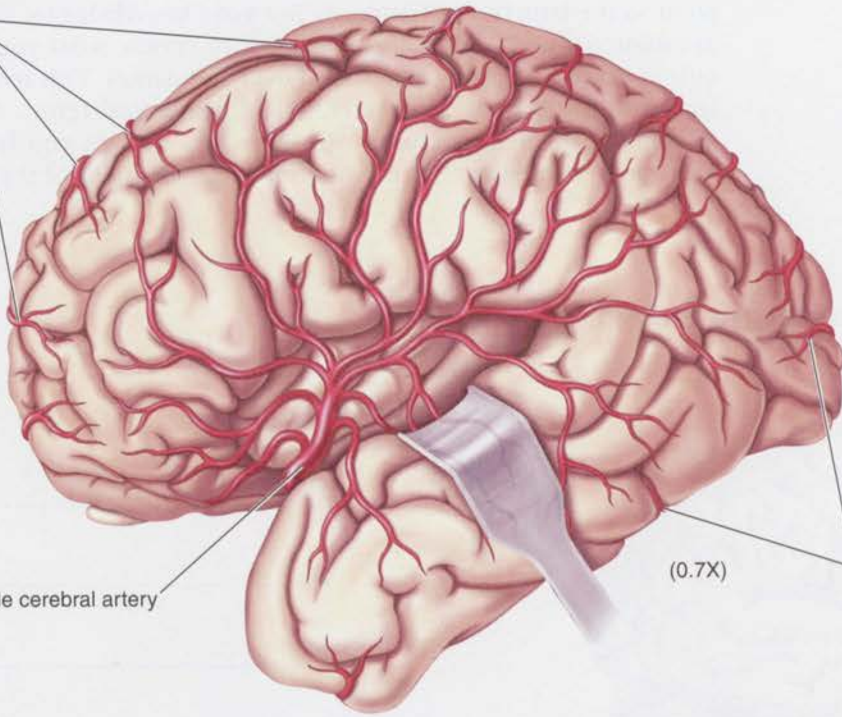
Ventral View

Two pairs of arteries supply blood to the brain: the vertebral arteries and the internal carotid arteries. The vertebral arteries converge near the base of the pons to form the unpaired basilar artery. At the level of the midbrain, the basilar artery splits into the right and left superior cerebellar arteries and the posterior cerebral arteries. The posterior cerebral arteries send branches, called posterior communicating arteries, that connect them to the internal carotids. The internal carotids branch to form the middle cerebral arteries and the anterior cerebral arteries. The anterior cerebral arteries of each side are connected by the anterior communicating artery. Thus, there is a ring of connected arteries at the base of the brain, formed by the posterior cerebral and communicating arteries, the internal carotids, and the anterior cerebral and communicating arteries. This ring is called the *circle of Willis*.



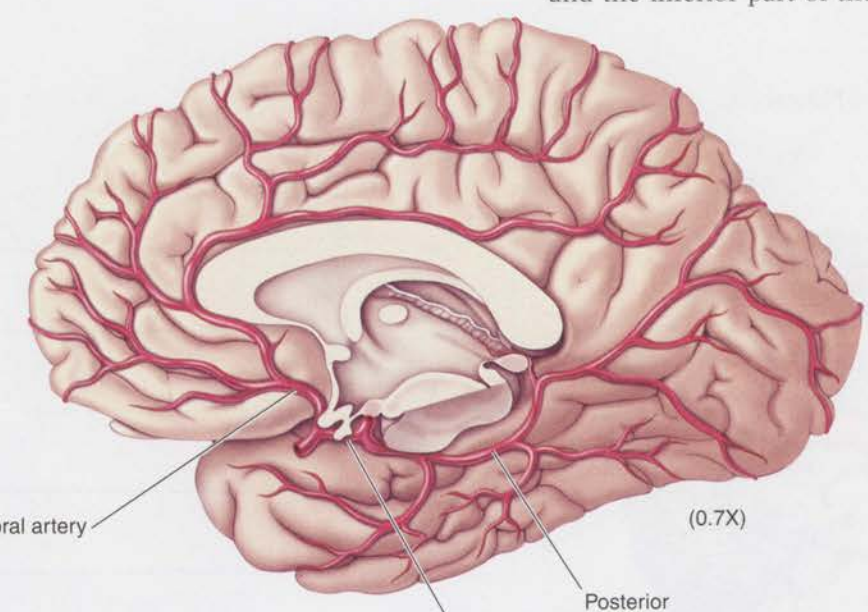
Lateral View

Most of the lateral surface of the cerebrum is supplied by the middle cerebral artery. This artery also feeds the deep structures of the basal forebrain.



Medial View (Brain Stem Removed)

Most of the medial wall of the cerebral hemisphere is supplied by the anterior cerebral artery. The posterior cerebral artery feeds the medial wall of the occipital lobe and the inferior part of the temporal lobe.

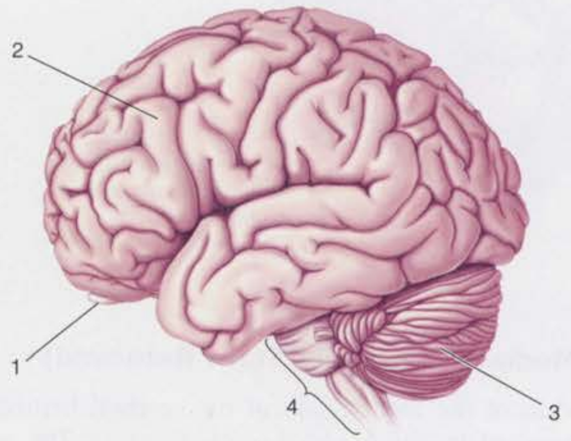


▼ SELF-QUIZ

This review workbook is designed to help you learn the neuroanatomy that has been presented. Here we have reproduced the images from the Guide; instead of labels, however, numbered leader lines (arranged clockwise) point to the structures of interest. Test your knowledge by filling in the appropriate names in the spaces provided. To review what you have learned, quiz yourself by putting your hand over the names. This technique greatly facilitates the learning and retention of anatomical terms. Mastery of the vocabulary of neuroanatomy will serve you well as you learn about the functional organization of the brain in the remainder of the book.

THE LATERAL SURFACE OF THE BRAIN

(a) Gross Features



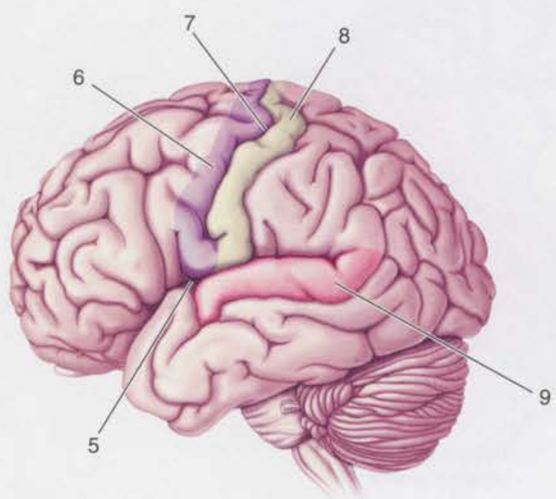
1. ______________________

2. ______________________

3. ______________________

4. ______________________

(b) Selected Gyri, Sulci, and Fissures



5. ______________________

6. ______________________

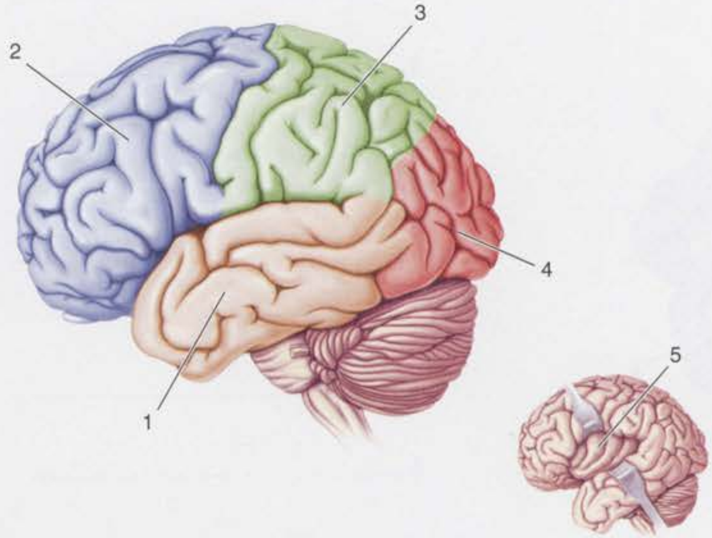
7. ______________________

8. ______________________

9. ______________________

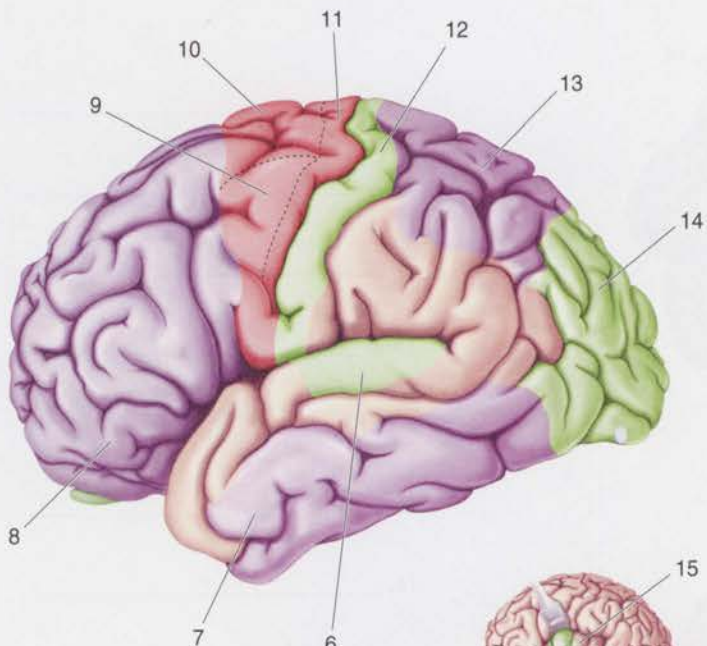
THE LATERAL SURFACE OF THE BRAIN

(c) Cerebral Lobes and the Insula



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________

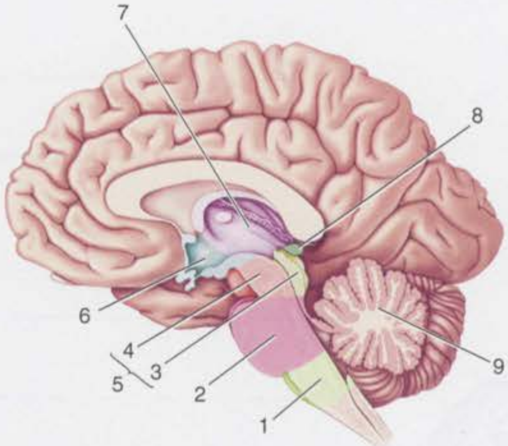
(d) Major Sensory, Motor, and Association Areas of Cortex



6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________
11. ______________________
12. ______________________
13. ______________________
14. ______________________
15. ______________________

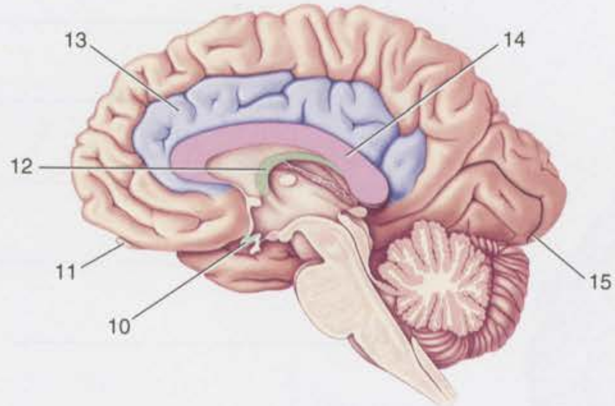
THE MEDIAL SURFACE OF THE BRAIN

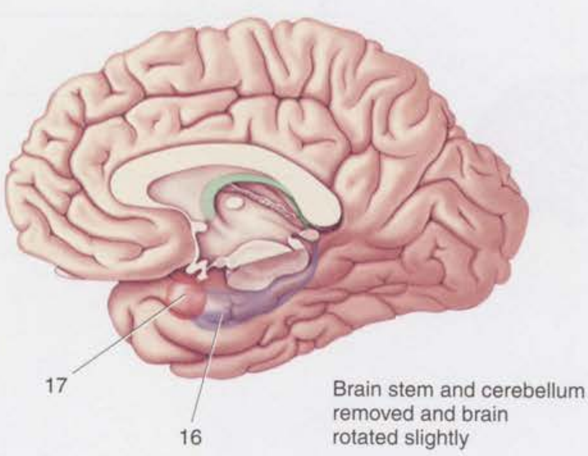
(a) Brain Stem Structures



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________

(b) Forebrain Structures



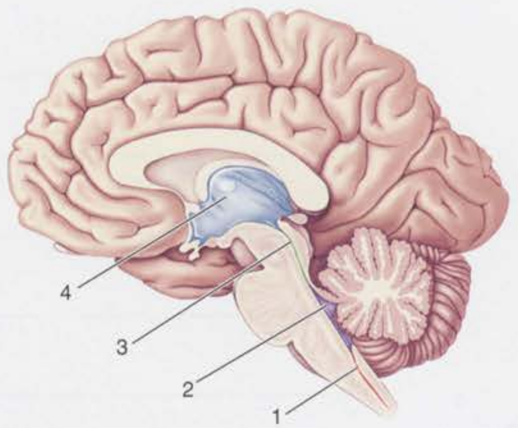


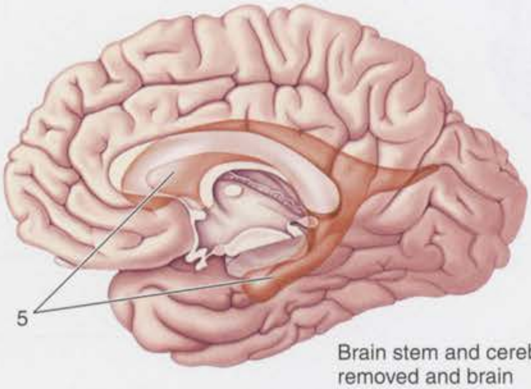
Brain stem and cerebellum removed and brain rotated slightly

10. ______________________
11. ______________________
12. ______________________
13. ______________________
14. ______________________
15. ______________________
16. ______________________
17. ______________________

THE MEDIAL SURFACE OF THE BRAIN

(c) Ventricles





Brain stem and cerebellum removed and brain rotated slightly

1. ____________________

2. ____________________

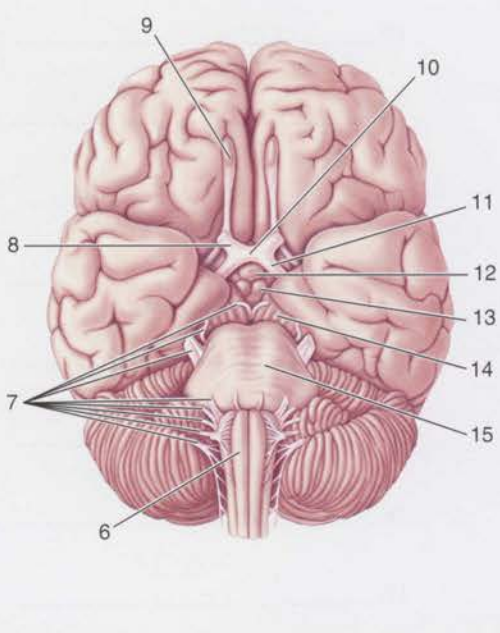
3. ____________________

4. ____________________

5. ____________________

THE VENTRAL SURFACE OF THE BRAIN

(a) Gross Features



6. ____________________

7. ____________________

8. ____________________

9. ____________________

10. ____________________

11. ____________________

12. ____________________

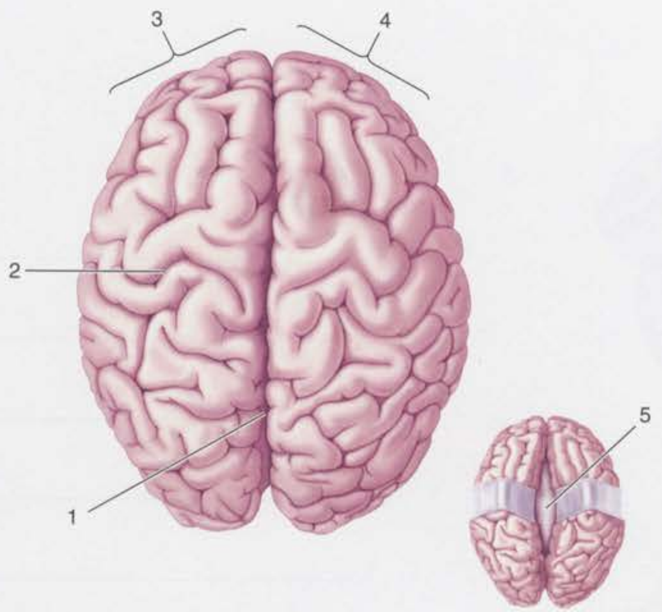
13. ____________________

14. ____________________

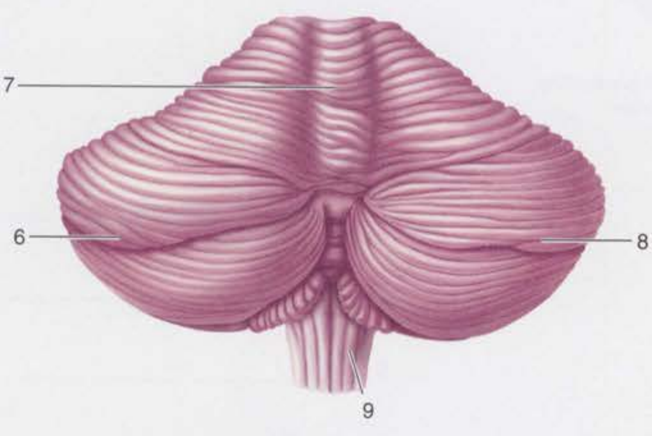
15. ____________________

THE DORSAL SURFACE OF THE BRAIN

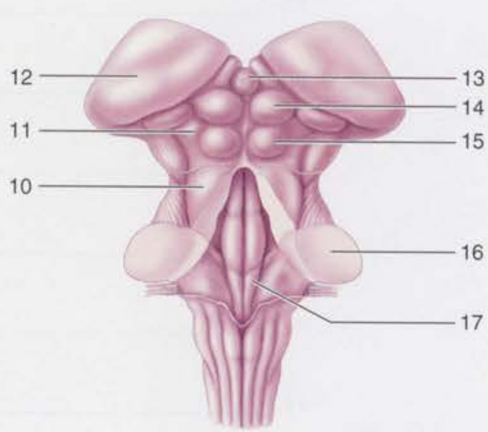
(a) Cerebrum



(b) Cerebrum Removed



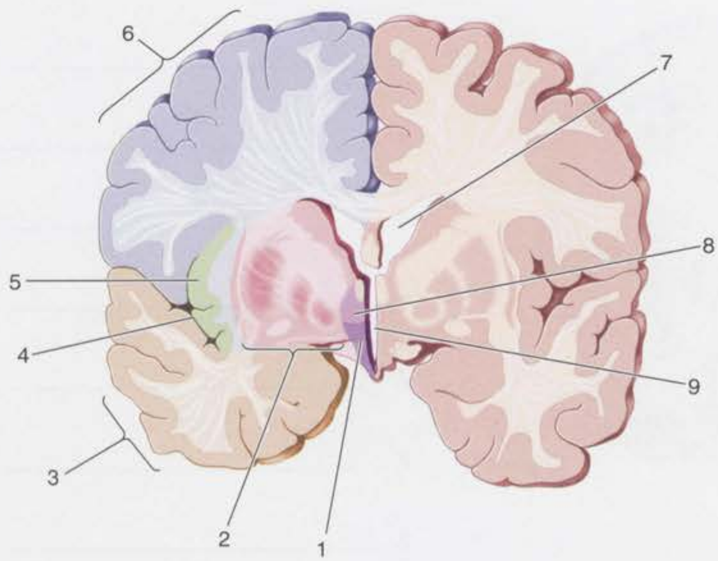
(c) Cerebrum and Cerebellum Removed



1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________
16. ____________________
17. ____________________

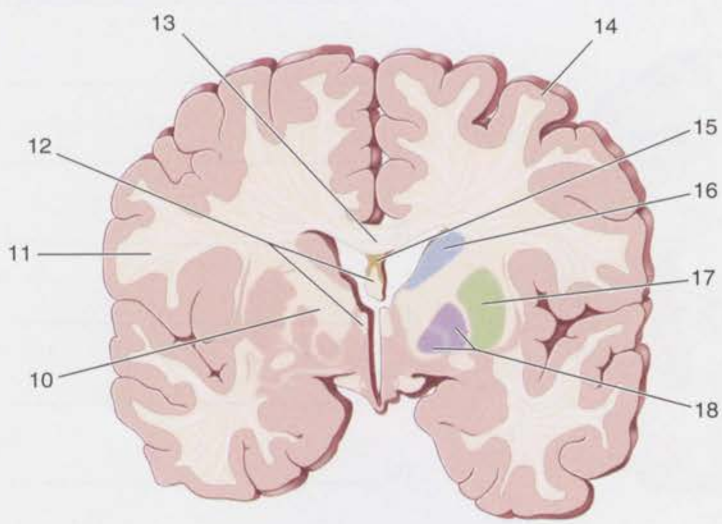
FOREBRAIN AT THALAMUS-TELENCEPHALON JUNCTION

(a) Gross Features



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________

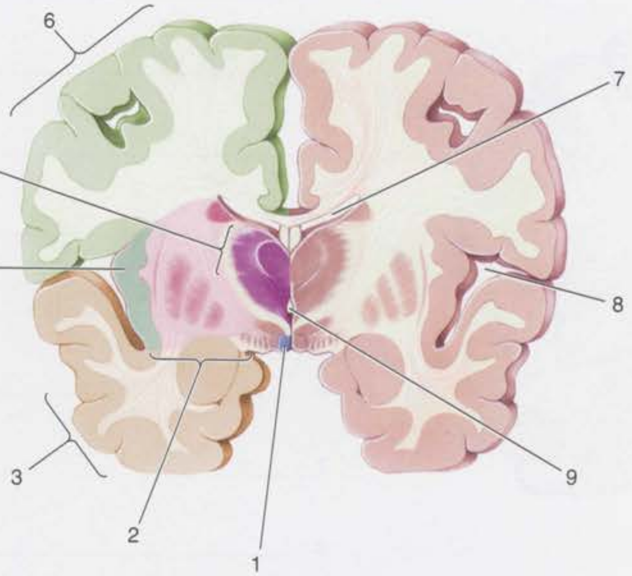
(b) Selected Cell and Fiber Groups



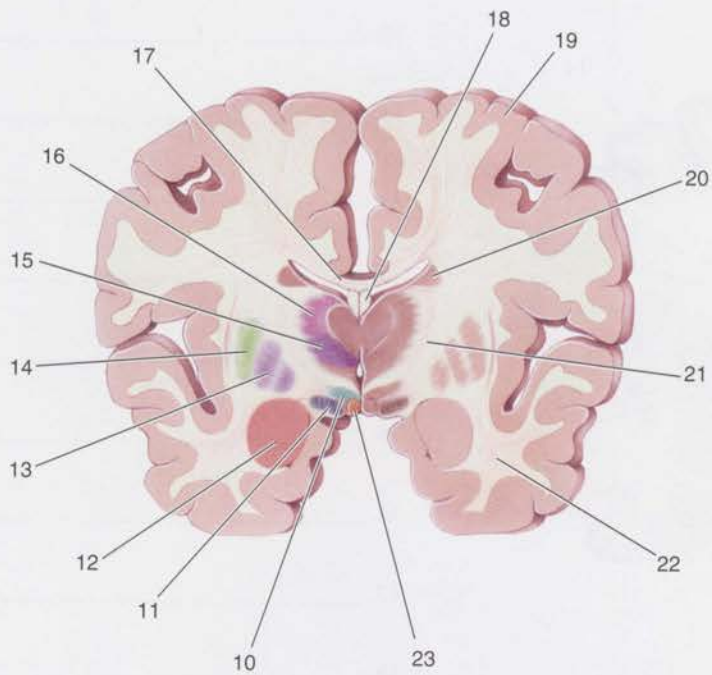
10. ______________________
11. ______________________
12. ______________________
13. ______________________
14. ______________________
15. ______________________
16. ______________________
17. ______________________
18. ______________________

FORebrain AT MID-THALAMUS

(a) Gross Features



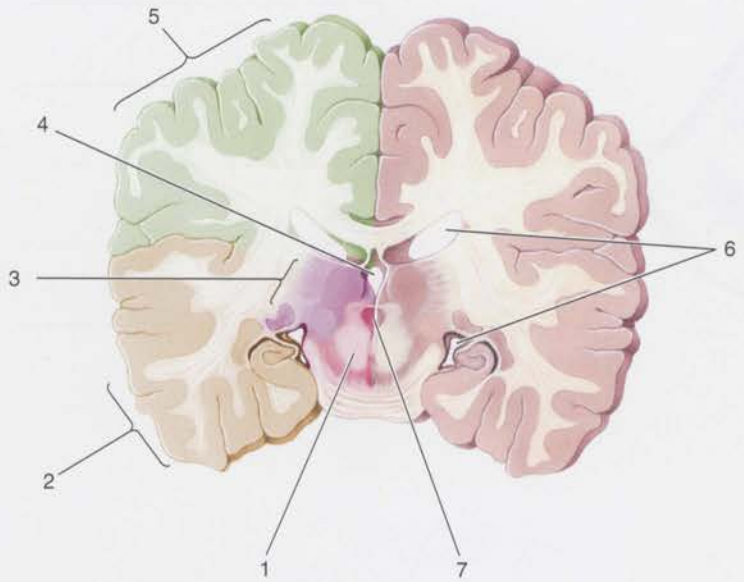
(b) Selected Cell and Fiber Groups



1. __________
2. __________
3. __________
4. __________
5. __________
6. __________
7. __________
8. __________
9. __________
10. __________
11. __________
12. __________
13. __________
14. __________
15. __________
16. __________
17. __________
18. __________
19. __________
20. __________
21. __________
22. __________
23. __________

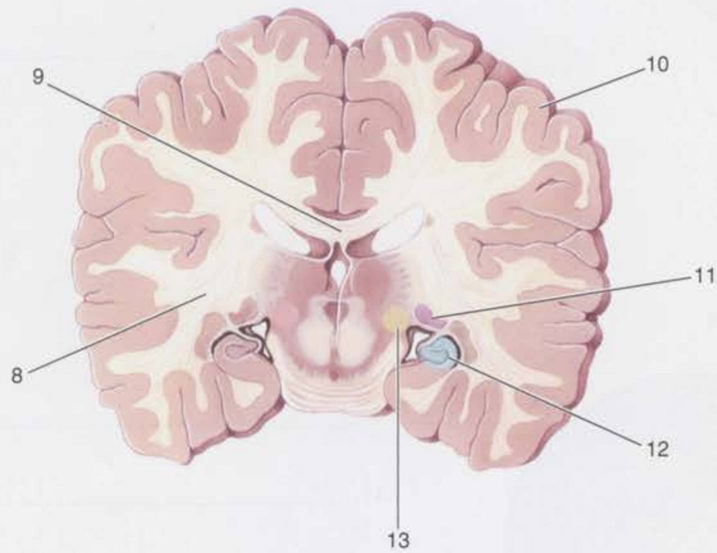
FOREBRAIN AT THALAMUS-MIDBRAIN JUNCTION

(a) Gross Features



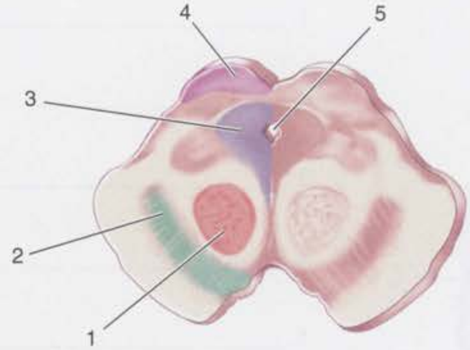
1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________

(b) Selected Cell and Fiber Groups



8. ______________________
9. ______________________
10. ______________________
11. ______________________
12. ______________________
13. ______________________

ROSTRAL MIDBRAIN



1. ______________________________

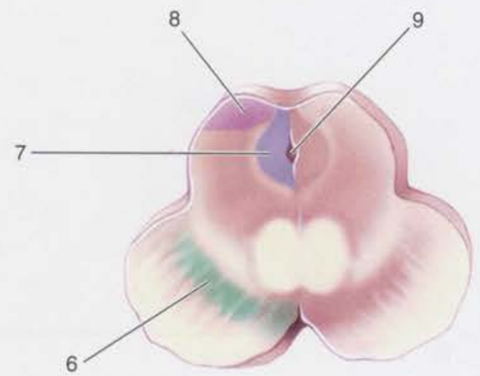
2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

CAUDAL MIDBRAIN



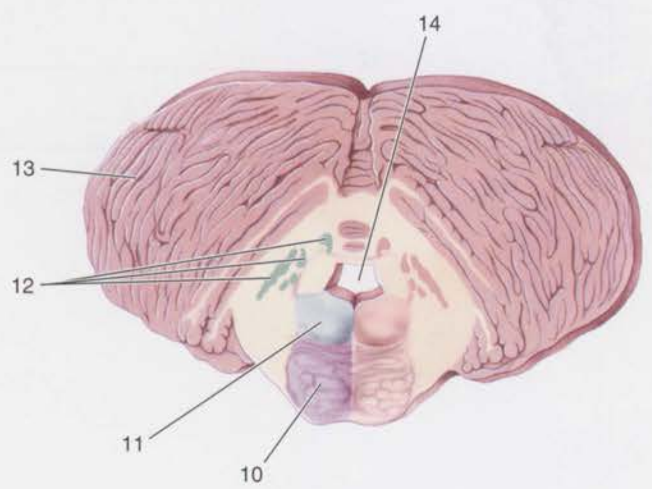
6. ______________________________

7. ______________________________

8. ______________________________

9. ______________________________

PONS AND CEREBELLUM



10. ______________________________

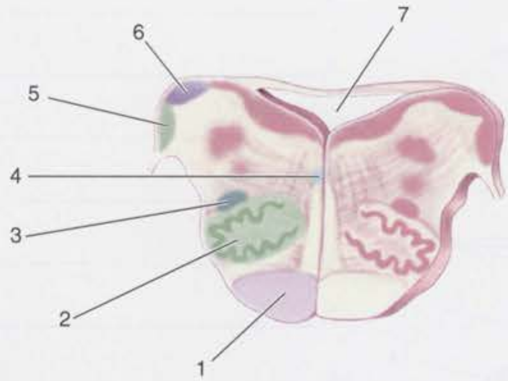
11. ______________________________

12. ______________________________

13. ______________________________

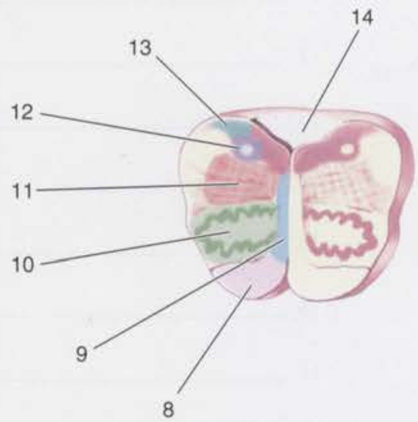
14. ______________________________

ROSTRAL MEDULLA



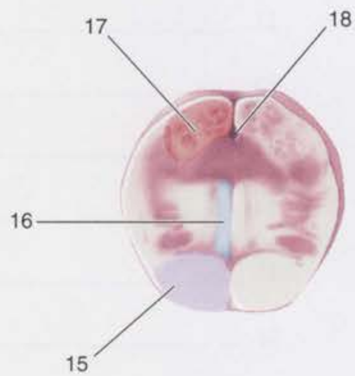
1. ______
2. ______
3. ______
4. ______
5. ______
6. ______
7. ______

MID-MEDULLA



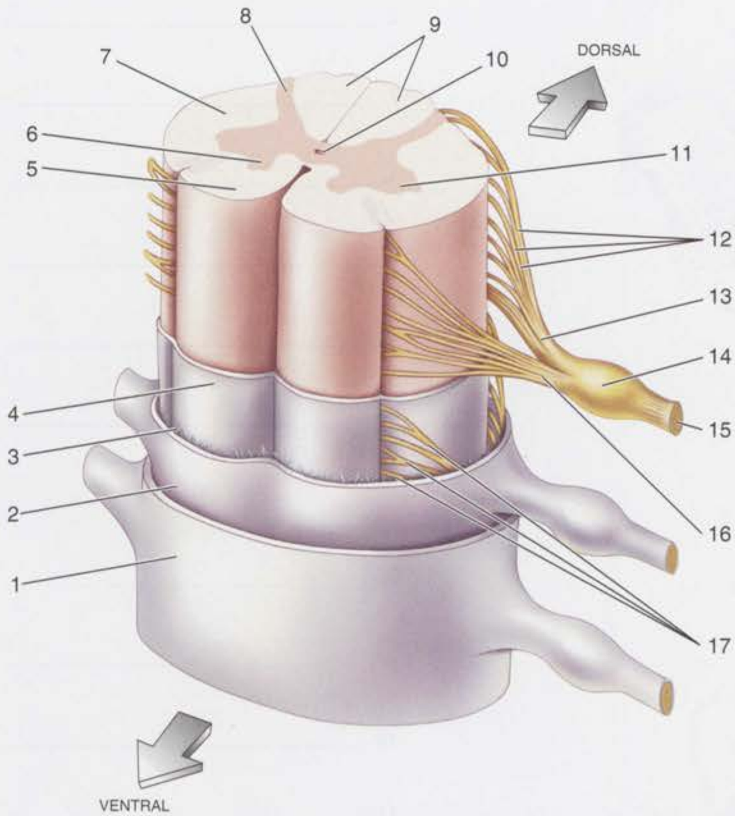
8. ______
9. ______
10. ______
11. ______
12. ______
13. ______
14. ______

MEDULLA–SPINAL CORD JUNCTION

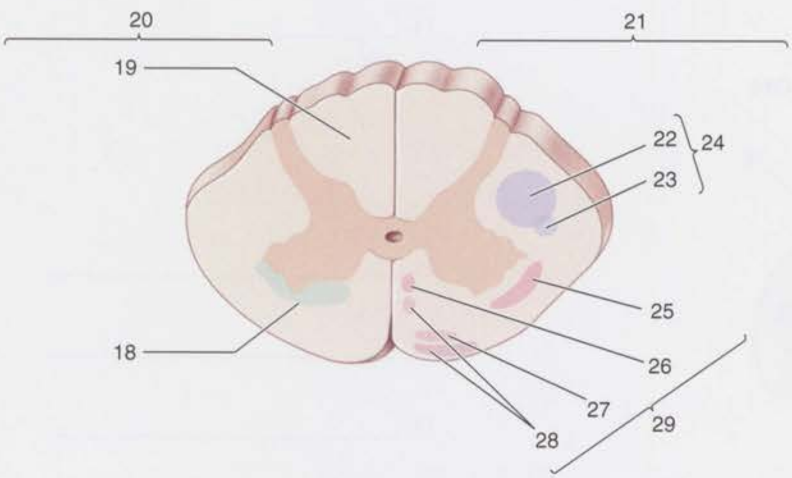


15. ______
16. ______
17. ______
18. ______

SPINAL CORD, VENTRAL-LATERAL SURFACE

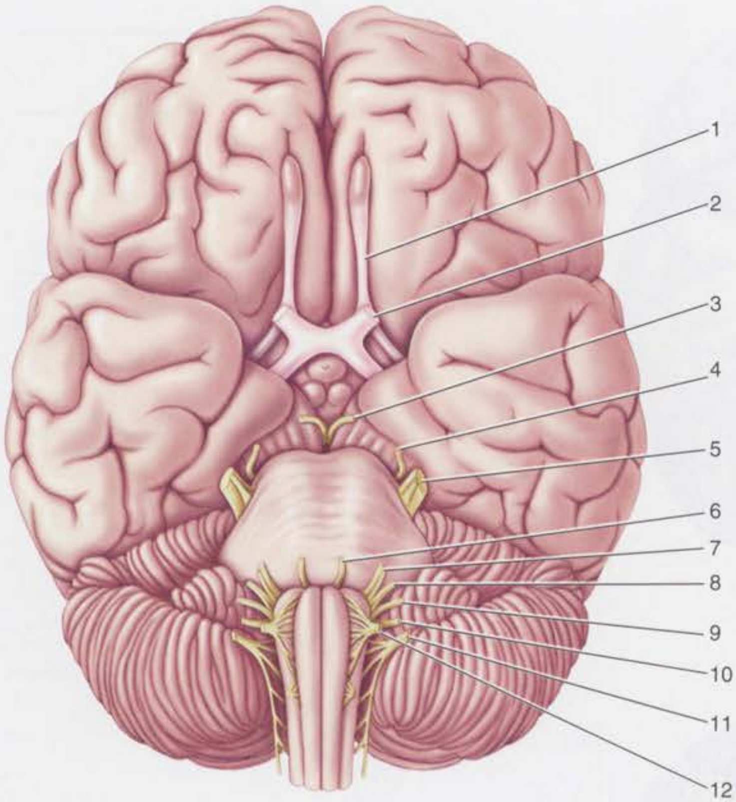


SPINAL CORD, CROSS-SECTIONAL ANATOMY



1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________
16. ____________________
17. ____________________
18. ____________________
19. ____________________
20. ____________________
21. ____________________
22. ____________________
23. ____________________
24. ____________________
25. ____________________
26. ____________________
27. ____________________
28. ____________________
29. ____________________

THE CRANIAL NERVES



1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

7. ____________________

8. ____________________

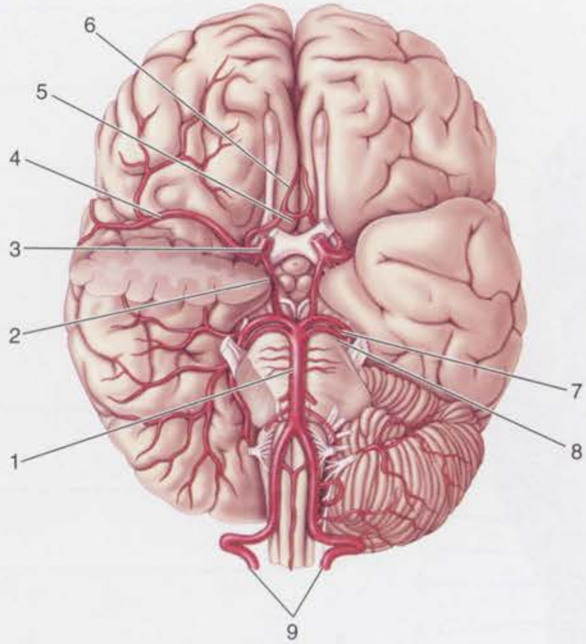
9. ____________________

10. ____________________

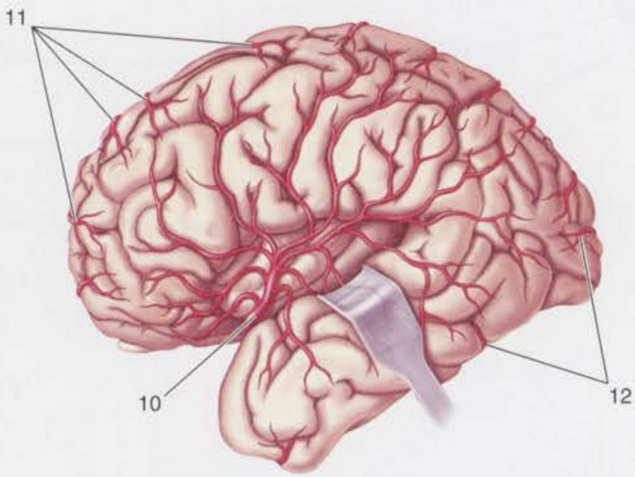
11. ____________________

12. ____________________

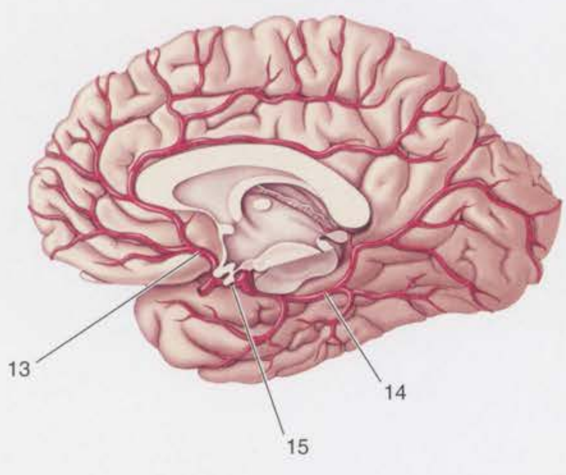
THE BLOOD SUPPLY OF THE BRAIN



1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________



10. ______________________
11. ______________________
12. ______________________



13. ______________________
14. ______________________
15. ______________________