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*To Marie for her love, patience, wisdom, and understanding.
To Maggie and Lulu for all the joy they bring.*



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Preface

BRS Neuroanatomy, fifth edition, is a concise review of human neuroanatomy intended for health professions students including medical and dental students preparing for the United States Medical Licensing Examination (USMLE) Step 1 and other examinations. It presents the essentials of human neuroanatomy in a concise, tightly-outlined, well-illustrated format. There are more than 600 board-type questions with complete answers and explanations, some included at the end of each chapter and some in a comprehensive examination at the end of the book.

NEW TO THIS EDITION

- Color used throughout to enhance neuroanatomic pathways
- Color used to block in tables and highlight clinical correlations
- Localization of sensory disorders
- Updated color artwork throughout
- Updated terminology to conform with Terminologia Anatomica

To the Student

To make the most of this book, carefully study the illustrations, computed tomography scans, magnetic resonance images, angiograms as well as the figure legends; much of the board question information lies within the images and legends. The answers to at least 30 common USMLE questions are outlined below; refer to these tips as you review the chapters.



Acknowledgments

Special thanks to and in respectful memory of **Dr. James Fix**, for creating the first four editions of *BRS Neuroanatomy*—the foundation upon which this fifth edition is based. I thank my students and colleagues for their valuable input as the fifth edition was developed. I also thank the Lippincott Williams & Wilkins staff and their associates for their contributions to this edition—Crystal Taylor, Acquisitions Editor; Catherine Noonan, Managing Editor; and the student and faculty reviewers, who were invited by the publisher to provide valuable feedback and suggestions.

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Gross Anatomy of the Brain

Objectives

- Identify the major structures of the brain from typical brain sections and diagrams—use the Atlas of the Brain and Brainscan on p. 10.
- Describe the telencephalon, including the lobes of the cerebral hemispheres and the major gyri of each.
- Differentiate the structures of the limbic and olfactory senses from other parts of the brain.
- List the different parts of the diencephalon, brainstem, and cerebellum.

I. INTRODUCTION

- part of the central nervous system (CNS) that lies within the cranial vault—the **encephalon**. Its surface is convoluted and exhibits **gyri** and **sulci**.
- consists of the **cerebrum** (cerebral hemispheres and diencephalon), the **brainstem** (midbrain, pons, and medulla), and the **cerebellum**.
- weighs 350 g in the newborn and 1400 g in the adult.
- covered by three connective tissue membranes, the **meninges**.
- surrounded by **cerebrospinal fluid (CSF)** that supports it and protects it from trauma.

II. DIVISIONS OF THE BRAIN

The brain is classified into six postembryonic divisions: **telencephalon**, **diencephalon**, **mesencephalon**, **pons**, **medulla oblongata**, and **cerebellum**.

A. Telencephalon

- consists of the **cerebral hemispheres** and the **basal nuclei**. The cerebral hemispheres contain the **lateral ventricles**.
 1. **Cerebral hemispheres** (figures 1.1 through 1.5)
 - separated by the **longitudinal cerebral fissure** and the **faix cerebri**.
 - interconnected by **commissural fiber bundles** (i.e., **corpus callosum**).
 - consists of six lobes and the olfactory structures:
 - a. **Frontal lobe** (see figures 1.3 and 1.4)
 - extends from the **central sulcus** to the **frontal pole**.
 - lies superior to the **lateral sulcus** and anterior to the **central sulcus**.
 - made up of the following gyri:
 - (1) **Precentral gyrus**
 - consists of the **primary motor area** (area 4).

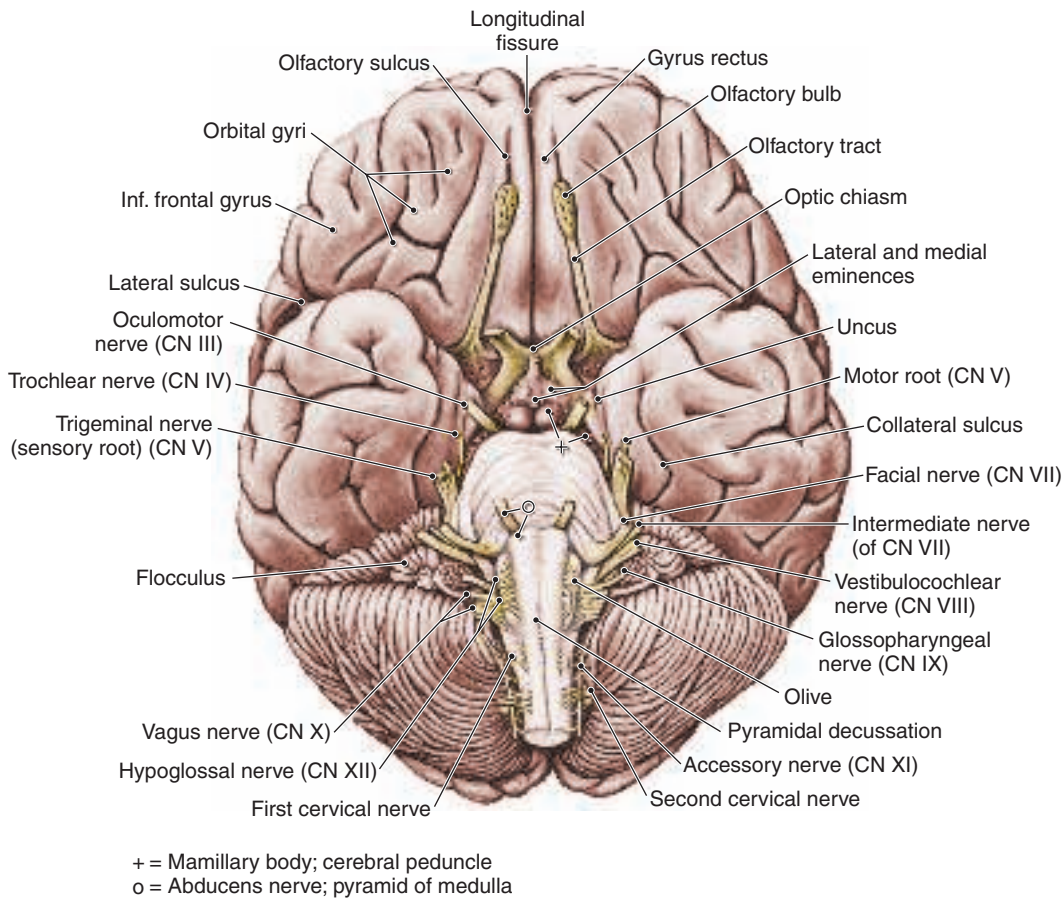
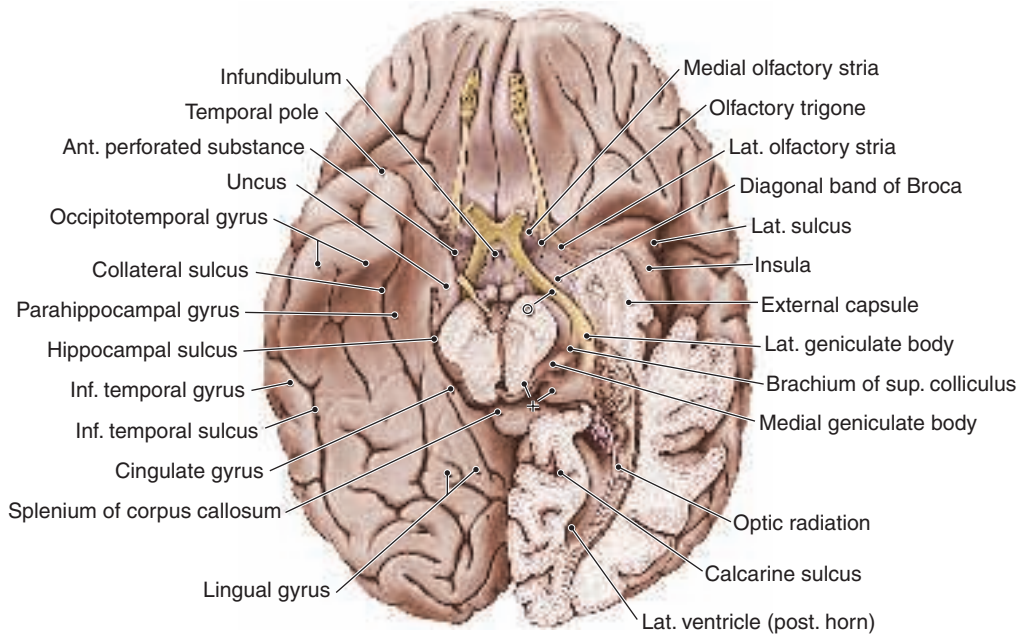


FIGURE 1.1. Base of the brain. (Modified from Truex RC, Kellner CE. *Detailed Atlas of the Head and Neck*. New York, NY: Oxford University Press; 1958:34.)

- (2) **Superior frontal gyrus**
 - contains supplementary motor cortex on the medial surface (area 6).
 - (3) **Middle frontal gyrus**
 - contains the frontal eye field (area 8).
 - (4) **Inferior frontal gyrus**
 - contains the Broca speech area in the dominant hemisphere (areas 44 and 45).
 - (5) **Gyrus rectus and orbital gyri**
 - separated by the olfactory sulcus.
 - (6) **Anterior paracentral lobule**
 - found on the medial surface between the superior frontal gyrus (paracentral sulcus) and the central sulcus.
 - represents a continuation of the precentral gyrus on the medial surface.
- b. Parietal lobe** (see Figures 1.3 through 1.5)
- extends from the central sulcus to the occipital lobe and lies superior to the temporal lobe.
 - contains the following lobules and gyri:
 - (1) **Postcentral gyrus**
 - the primary somatosensory area of the cerebral cortex (areas 3, 1, and 2).
 - (2) **Superior parietal lobule**
 - comprises association areas involved in somatosensory functions (areas 5 and 7).



o = Optic tract
 + = Brachium of inf. colliculus

FIGURE 12. Inferior surface of the brain showing the principal gyri and sulci. The left hemisphere has been dissected to show the visual pathways and relation of the optic radiation to the lateral ventricle. (Modified from Truex RC, Kellner CE. *Detailed Atlas of the Head and Neck*. New York, NY: Oxford University Press; 1958:46.)

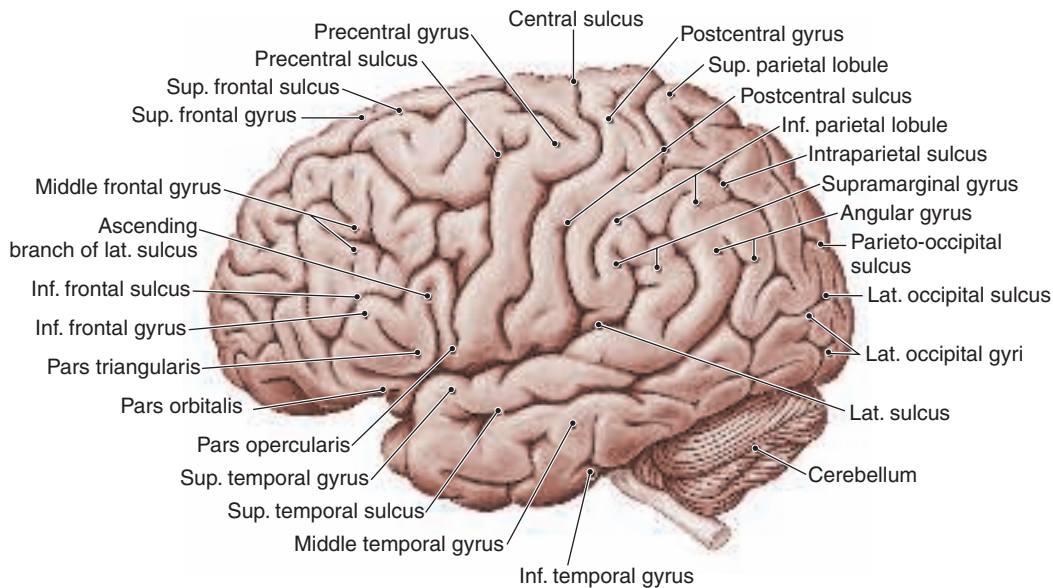
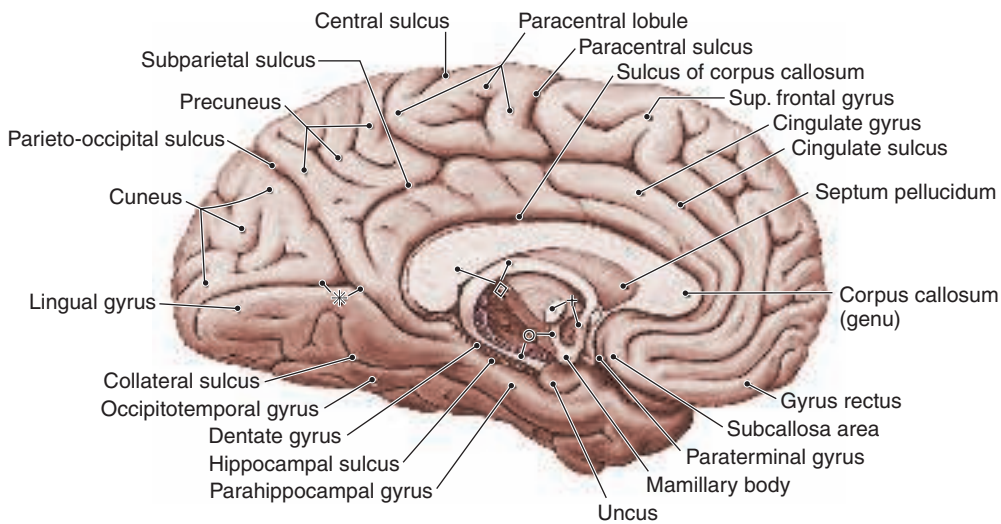


FIGURE 13. Lateral surface of the brain showing the principal gyri and sulci. (Modified from Truex RC, Kellner CE. *Detailed Atlas of the Head and Neck*. New York, NY: Oxford University Press; 1958:47.)



* = Calcarine fissure

◇ = Splenium of corpus callosum; body of fornix

+ = Interthalamic adhesion: ant. column of fornix

o = Fimbria of fornix; mamillothalamic tract

FIGURE 1.4. Medial surface of the brain showing the principal gyri and sulci. Parts of the thalamus and hypothalamus have been removed to show the fimbria and anterior column of the fornix and the mamillothalamic tract. (Modified from Truex RC, Kellner CE. *Detailed Atlas of the Head and Neck*. New York, NY: Oxford University Press; 1958:49.)

(3) Inferior parietal lobule

- **Supramarginal gyrus**

- (a) interrelates somatosensory, auditory, and visual inputs (area 40).

- **Angular gyrus** (area 39)

- (a) receives impulses from primary visual cortex.

(4) Precuneus

- located between the paracentral lobule and the cuneus.

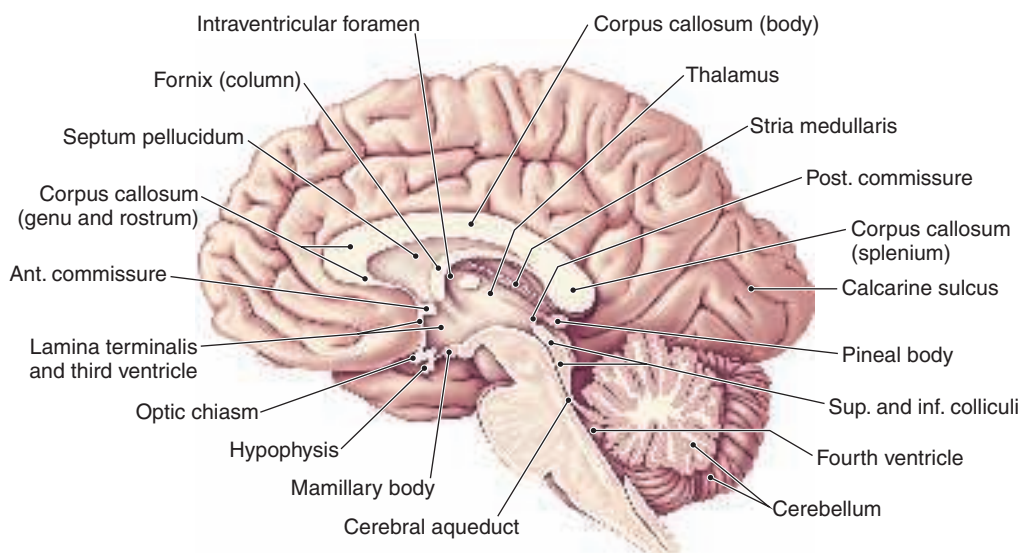


FIGURE 1.5. Midsagittal section of the brain and brainstem showing the structures surrounding the third and fourth ventricles. (Modified from Bear MF, Connors BW, Paradiso MA: *Neuroscience: Exploring the Brain*. 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins; 2007:207.)

(5) Posterior paracentral lobule

- located on the medial surface between the central sulcus and the precuneus.
- represents a continuation of the postcentral gyrus on the medial surface.

c. Temporal lobe (see Figures 1.2 through 1.4)

- extends from the temporal pole to the occipital lobe, lying inferior to the lateral sulcus.
- extends from the lateral sulcus to the collateral sulcus.
- contains the following gyri:

(1) Transverse temporal gyri of Heschl

- found within the lateral sulcus.
- extends from the superior temporal gyrus toward the medial geniculate body (Figure 1.6).
- the primary auditory areas of the cerebral cortex (areas 41 and 42).

(2) Superior temporal gyrus

- associated with auditory functions.
- contains the **Wernicke speech area** in the dominant hemisphere (area 22).
- contains the planum temporale on its superior (hidden) surface.

(3) Middle temporal gyrus**(4) Inferior temporal gyrus****(5) Lateral occipitotemporal gyrus (fusiform gyrus)**

- lies between the inferior temporal sulcus and the collateral sulcus.

d. Occipital lobe (see Figures 1.3 through 1.5)

- lies posterior to a line connecting the parieto-occipital sulcus and the preoccipital notch.

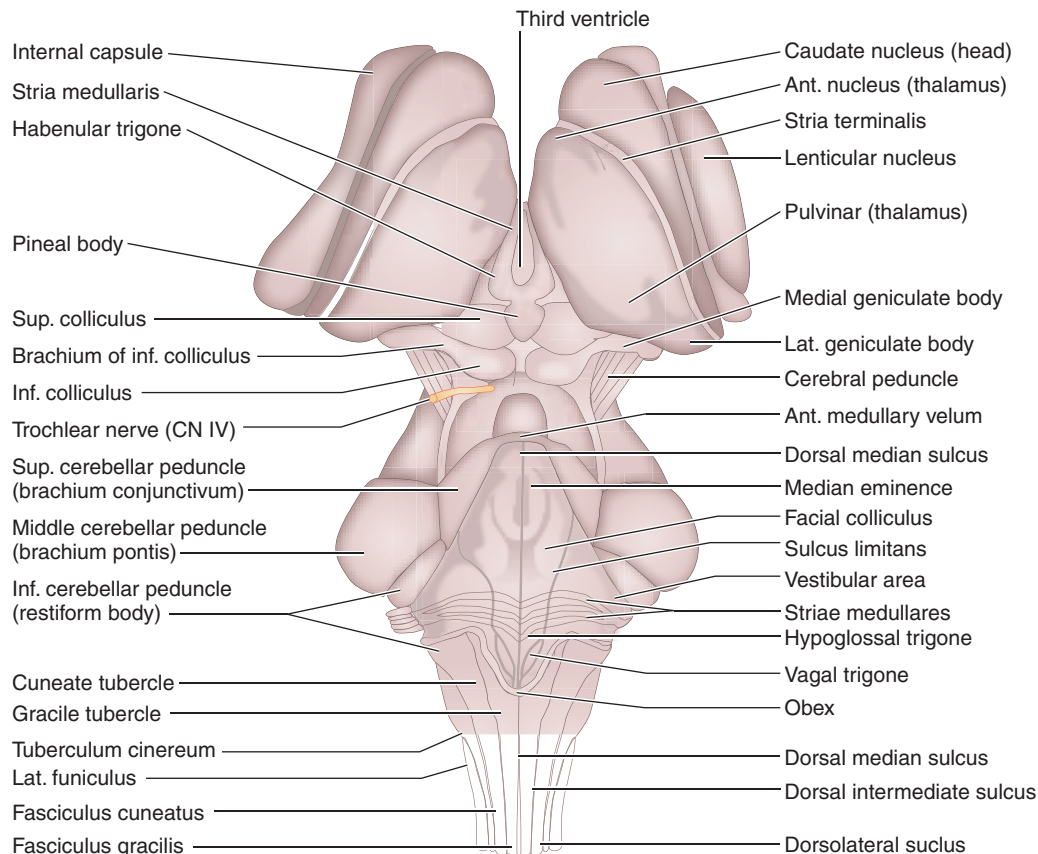


FIGURE 1.6. Posterior surface anatomy of the brainstem. The cerebellum has been removed to show the three cerebellar peduncles and the floor of the fourth ventricle (rhomboid fossa). (Modified from Truex RC, Carpenter MB. *Human Neuroanatomy*. Baltimore, MD: Williams & Wilkins; 1969:31.)

- contains two structures:
 - (1) **Cuneus**
 - situated between the parieto-occipital sulcus and the calcarine sulcus.
 - contains the visual cortex (areas 17, 18, and 19).
 - (2) **Lingual gyrus**
 - lies inferior to the calcarine sulcus.
 - contains the visual cortex (areas 17, 18, and 19).
 - e. **Insular lobe** (insula) (see Figure 1.2)
 - lies within the lateral sulcus.
 - has short and long gyri.
 - f. **Limbic lobe** (see Figures 1.4 and 22.1B)
 - a C-shaped collection of structures found on the medial hemispheric surface that encircles the corpus callosum and the lateral aspect of the midbrain.
 - includes the following structures:
 - (1) **Paraterminal gyrus and subcallosal area** (see Figure 1.4)
 - located anterior to the lamina terminalis and inferior to the rostrum of the corpus callosum.
 - (2) **Cingulate gyrus**
 - parallel and superior to the corpus callosum.
 - merges with the parahippocampal gyrus.
 - (3) **Parahippocampal gyrus**¹
 - lies between the hippocampal and collateral sulci and terminates in the **uncus**.
 - (4) **Hippocampal formation** (see Figures 1.2 and 1.4)
 - lies between the choroidal and hippocampal fissures.
 - connected to the hypothalamus and septal area via the **fornix**.
 - includes three structures:
 - (a) **Dentate gyrus** (see Figure 1.4)
 - (b) **Hippocampus** and
 - (c) **Subiculum** (see Figure 17.5)
 - g. **Olfactory structures** (see Figure 1.2)
 - found on the orbital surface of the brain and include the following:
 - (1) **Olfactory bulb and tract**
 - an outpouching of the telencephalon.
 - (2) **Olfactory bulb**
 - receives the olfactory nerve (CN I).
 - (3) **Olfactory trigone and striae**
 - (4) **Anterior perforated substance**
 - created by penetrating striate arteries.
 - (5) **Diagonal band of Broca** (see Figure 1.2)
 - interconnects the amygdaloid nucleus and the septal area.
- 2. Basal nuclei (ganglia)** (Figure 1.7; see Figures 1.6 and 18.1)
- constitute the subcortical nuclei of the telencephalon.
 - include the following structures:
 - a. **Caudate nucleus**
 - part of the striatum, together with the putamen.
 - b. **Putamen**
 - part of the striatum, together with the caudate nucleus.
 - part of the lentiform nucleus along with the globus pallidus.
 - c. **Globus pallidus**
 - part of the lentiform nucleus, together with the putamen.
 - d. **Subthalamic nucleus**
 - part of the diencephalon that functions with the basal nuclei.
- 3. Lateral ventricles** (see Figure 2.4)
- ependyma-lined cavities of the cerebral hemispheres.
 - contain **CSF** and **choroid plexus**.

¹Some authorities include the parahippocampal gyrus as a temporal lobe structure.

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