

Medical Neuroscience | Tutorial Notes

Lateral Surface of the Brain

MAP TO NEUROSCIENCE CORE CONCEPTS¹

NCC1. The brain is the body's most complex organ.

LEARNING OBJECTIVES

After study of the assigned learning materials, the student will:

1. Demonstrate the four paired lobes of the cerebral cortex and describe the boundaries of each.
2. Sketch the major features of each cerebral lobe, as seen from the lateral view, identifying major gyri and sulci that characterize each lobe.

NARRATIVE

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Overview

When you view the lateral aspect of a human brain specimen (see [Figures A3A](#) and [A10²](#)), three structures are usually visible: the **cerebral hemispheres**, the **cerebellum**, and part of the **brainstem** (although the brainstem is not visible in the specimen photographed in lateral view for [Fig. 1](#) below). The spinal cord has usually been severed (but we'll consider the spinal cord later), and the rest of the subdivisions are hidden from lateral view by the hemispheres. The diencephalon and the rest of the brainstem are visible on the medial surface of a brain that has been cut in the midsagittal plane. Parts of all of the subdivisions are also visible from the ventral surface of the whole brain. Over the next several tutorials, you will find video demonstrations (from the brain anatomy lab) and photographs (in the tutorial notes) of these brain surfaces, and sufficient detail in the narrative to appreciate the overall organization of the parts of the brain that are visible from each perspective. As you work through this text and if you have access to an interactive digital atlas of the human brain, such as [Sylvius4 Online](#), find the structures and regions that are described here³.

The **cerebral hemispheres** are especially large in humans. They are entirely covered by a 2–3-mm thick layer of cells and cellular processes called the **cerebral cortex**. The surface of each hemisphere is highly

¹ Visit [BrainFacts.org](#) for *Neuroscience Core Concepts* (©2012 Society for Neuroscience) that offer fundamental principles about the brain and nervous system, the most complex living structure known in the universe.

² Figure references to Purves et al., *Neuroscience, 5th Ed.*, Sinauer Assoc., Inc., 2012. [\[click here\]](#)

³ To do so, launch [Sylvius4 Online](#) and go to [Photographic Atlas](#), then select one of the atlas filters, such as [Gyri](#), [Lobes](#), or [Sulci and Fissures](#).

infolded; the ridges thus formed are known as **gyri** (singular: gyrus) and the valleys are called **sulci** (singular: sulcus) or **fissures** (if they are especially deep). The appearance of the sulci and gyri varies somewhat from brain to brain. (As you might guess, each one has its own name, but it is necessary to become familiar with only a few of them.) The hemispheres are conventionally divided into lobes named for the bones of the skull that overlie them, namely the **frontal**, **parietal**, **occipital** and **temporal lobes** (see **Figure A3**).

If it were possible to unfold the cerebral cortex from one hemisphere (which can be done in digital representations of the cerebral hemisphere), the surface area of the resulting, flattened cerebral cortex would be roughly approximated by the crust of a 13-inch pizza (thin crust, New York style, of course, given the thinness of the cortex).

Lateral aspect of the brain

The frontal lobe is the most anterior of the four lobes and is separated from the parietal lobe by the **central sulcus**, which is one of the most important landmarks in the cerebral cortex (in **Figure A3**, boundary between blue and red colored regions; see tutorial on **Finding the Central Sulcus**). An important gyrus in the frontal lobe is the **precentral gyrus**. (The prefix ‘pre,’ when used to refer to anatomical position, refers to something that is in front of something else or that is anterior.) The cortex of the precentral gyrus is the somatic ‘motor cortex,’ which contains neurons whose axons project to the motor nuclei in the brainstem and spinal cord that innervate the striated muscles of the body.

Fine, skilled movements are dependent on the integrity of the motor cortex (and, of course, the axons extending from it). The axons that arise from neurons in the motor cortex and extend to the spinal cord are known as the **corticospinal tract**. Those axons that extend from the motor cortex to nuclei in the brainstem are known as the **corticobulbar tract**. (The brainstem is sometimes referred to as ‘bulbar’ because it has a shape resembling a bulb.) While you can’t see the individual fibers that make up the tracts, you can see the structures through which they pass as they course between the cortex and their targets in the brainstem and spinal cord.

On the inferior-lateral aspect of the hemisphere, you should readily appreciate a deep, fairly straight fissure that separates the frontal and parietal lobes from the temporal lobe; this space is called the **lateral fissure** or Sylvian fissure, named after the important Renaissance neuroanatomist, *Franciscus Sylvius*⁴. If viewed from above, you would see that the hemispheres are separated by an even deeper fissure called the **longitudinal fissure** (or superior sagittal fissure) (see **Figure A11**). The gyral formations anterior to the precentral gyrus on the dorsal-lateral aspect of the frontal lobe between the lateral fissure and the longitudinal fissure can be recognized as three parallel, longitudinal gyri. Adjacent to the longitudinal fissure is the **superior frontal gyrus**, which is typically the most obvious of the three. This gyrus continues on the medial surface of the hemisphere in the depths of the longitudinal fissure; we will see it again when we examine the midsagittal section through the brain. Just inferior to the superior frontal gyrus is the **middle frontal gyrus**, with the **superior frontal sulcus** separating the two. Note that these two gyral formations are fairly straight and parallel to the longitudinal fissure in the parasagittal plane. At their posterior end, they sometimes merge with the precentral gyrus, which forms, of course, the anterior bank of the central sulcus. However, there is often an interrupted (i.e., a superficially discontinuous) sulcus that separates them from the precentral gyrus, named the **precentral sulcus**.

⁴ *Franciscus Sylvius* was the inspiration for the title of our digital brain atlas, [Sylvius4 Online](#); [click here](#) for more on this important figure in the history of human neuroanatomy.

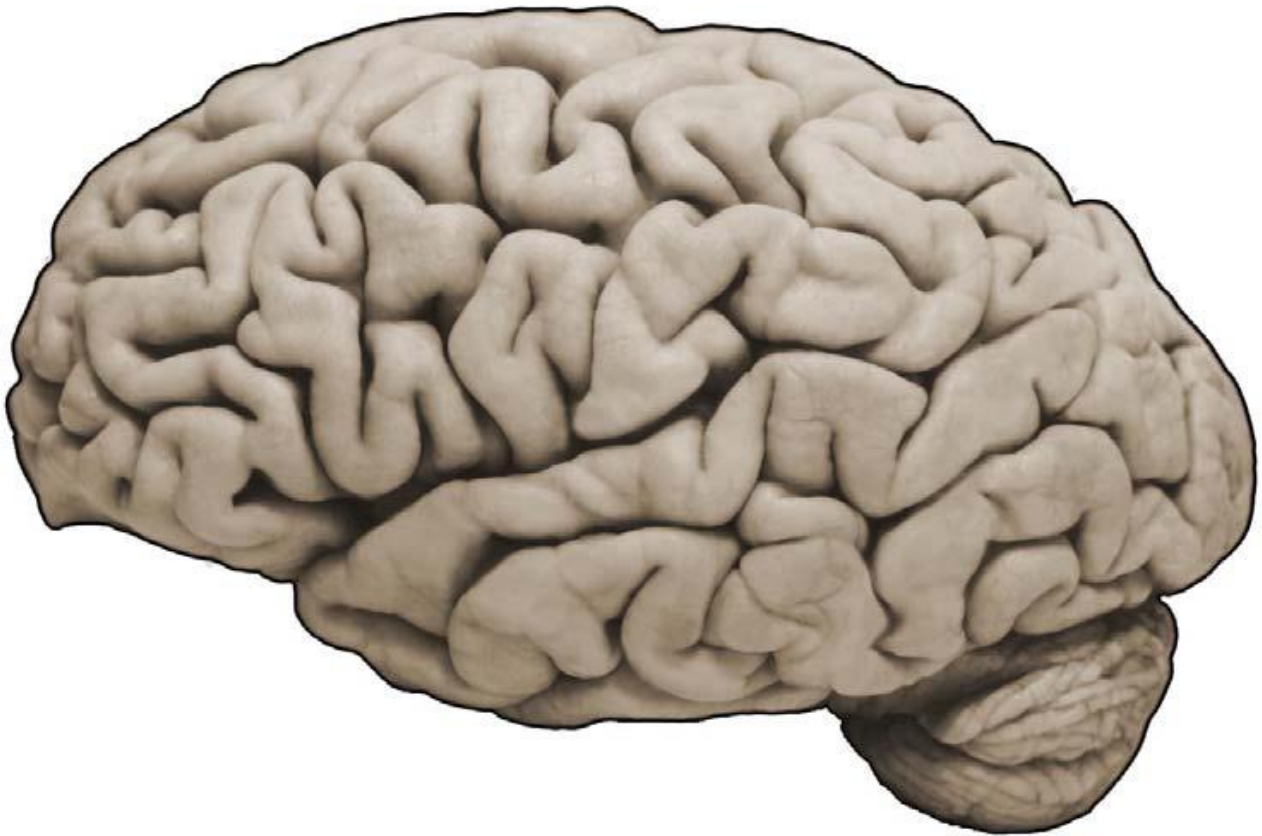


Fig. 1. Lateral surface of the human brain. This figure is not labeled so that you may refer to it for review; see **Figures A3 & A10** for an illustrated and labeled view of the same hemisphere. (Image from [Sylvius4 Online](#))

Just inferior to the middle frontal gyrus, across the **inferior frontal sulcus**, is a much more complex gyral formation. For our purposes, we won't be concerned with the names of these subcomponents or their differential functional contributions to cognition and behavior. Suffice it to say that the **inferior frontal gyrus** contains a critical functional division of the motor cortex that participates in the production of speech. This division has a special name, **Broca's Area**, given in honor of the famous French neurologist, Pierre Paul Broca⁵, who first recognized the significance of this gyral formation for human speech in the mid-19th century. Interestingly, the left hemisphere is dominant in most individuals (especially males and right-handers) for this function, such that damage to the left inferior frontal gyrus is more likely to produce an impairment of language expression, called *Broca's aphasia* (aphasia means "without speech"), than a comparable lesion involving the right inferior frontal gyrus. Interestingly, this is also the division of the premotor cortex where in non-human primates neurons with "mirror" properties have been characterized. That is, neurons in the posterior part of the inferior frontal gyrus fire when certain

⁵ [click here](#) for more on this important figure in the history of human neuroanatomy.

actions are executed *and* when those same actions are observed (mirrored) in the behavior of another individual. Whether these neurons participate in imitation learning—or perhaps even decoding the intentions of others—remains an area of intense investigation.

Next, let's cross the lateral fissure. The gyral structure that forms the inferior bank of the lateral fissure is the **superior temporal gyrus**. This gyrus is arranged parallel to the lateral fissure and extends from the anterior pole of the temporal lobe to the parietal lobe (specifically, the angular gyrus of the inferior parietal lobule). The elongation of this structure in nearly the horizontal plane establishes a framework for considering the remaining temporal gyral formations of the lateral surface. Including the superior temporal gyrus, it should be possible to recognize three elongated gyral structures that lie parallel to the lateral fissure: the **superior, middle** and **inferior temporal gyri**. The superior and middle temporal gyri are separated by the **superior temporal sulcus** and the middle and inferior gyri are separated by the **inferior temporal sulcus**, although the latter sulcus is often discontinuous and sometimes difficult to recognize.

Notice how the lateral aspects of the frontal and temporal lobes bear some resemblance (at least conceptually): they both comprise three, parallel longitudinal gyri that extend from the anterior pole of each lobe back toward the parietal lobe.

Once you are familiar with these gyral features in one specimen, spend some time examining as many specimens as are available in digital format (a number of free digital resources are available that show lateral views of the human brain). As you do so, look for differences and common structural themes among brains and between hemispheres. If you can, carefully examine the pattern and length of the lateral fissure and consider the following questions.

- Are the two lateral fissures of the same brain roughly the same? If not, how are they different?
- Does the left lateral fissure tend to run mainly in the horizontal plane and extend further posteriorly, compared to the right lateral fissure?
- Is there an ascending branch of the posterior lateral fissure in the right hemisphere, but not the left?

These questions have been asked and addressed in studies of hemispheric asymmetries and gender differences related to language lateralization in the human brain. The superior aspect of the temporal lobe contains the cortical divisions whose functions pertain to audition and the reception of language. The posterior aspect of the superior temporal gyrus has a special functional name, **Wernicke's Area**, named in recognition of the seminal contributions of the 19th century German physician, Carl Wernicke⁶, who described a disturbance of understanding speech, now called *Wernicke's aphasia*. You may find differences in the structure of the superior temporal gyrus in the two hemispheres reflected in the pattern and length of the lateral fissure; such differences may, in turn, be related to the language dominance of the left hemisphere. Hemispheric differences in this cortical region may even relate to musical abilities and other special talents that pertain to audition and semantic encoding.

Other regions of the temporal lobe serve visual processing, emotional processing, memory, and the integration of sensory experience; we will consider these functions later in the course.

Since you already worked through recognition of the central sulcus, you should now be able to view the lateral surface of any hemisphere and know to look for the central sulcus lazily coursing from the longitudinal fissure over the dorsal-lateral surface of the cerebrum in a lateral-ventral and slightly anterior direction (hopefully, the directional terms applied to the forebrain are also becoming second-nature to you). Much of the cortex that you observe posterior to the central sulcus is part of the parietal lobe. The prominent gyral structure that forms the posterior bank of the central sulcus is the **postcentral**

⁶ [click here](#) for more on this important figure in the history of human neuroanatomy.

gyrus, which is parallel to the precentral gyrus of course. This gyrus is concerned with somatic sensation and will be a major focus for clinicians concerned with the cerebral localization of touch and body position sensations. Immediately posterior to the postcentral gyrus is the **postcentral sulcus**, which separates the postcentral gyrus from two major gyral formations of the parietal lobe: the **superior** and **inferior parietal lobules**. The boundary between these two lobules is often difficult to appreciate; it is recognized as a meandering and often discontinuous sulcus called the **intraparietal sulcus** that tends to run in a parasagittal plane. We will return to the superior parietal lobule when we explore the medial surface of the hemisphere.

The gyral formations just inferior to the intraparietal sulcus include the **supramarginal gyrus** and the **angular gyrus**, two principal components of the inferior parietal lobule. The inferior margin of the parietal lobe is formed mostly by the prominent lateral fissure. However, the posterior limit of the lateral fissure does not define the entire inferior boundary of the parietal lobe. The supramarginal gyrus usually forms a “horseshoe” shape around the posterior limit of the lateral fissure, with the angular gyrus just posterior to the supramarginal gyrus.

Likewise, it is often difficult to discern the boundaries where the posterior parietal and temporal lobes meet the anterior occipital lobe on the lateral surface of the cerebrum, and it may make no functional sense to attempt to do so. Nevertheless, we can define an imaginary lateral boundary between the parietal and occipital lobes in this complex and variable region. Emerging from the depths of the longitudinal fissure along the medial bank of the cerebral hemisphere (about one-fourth of the length of the fissure from its posterior limit) is the **parieto-occipital sulcus** (see [Figure A10](#)). We will see this sulcus more plainly when we explore the medial face of the hemisphere in another tutorial. For now, appreciate that the parieto-occipital sulcus is the medial boundary between the parietal and occipital lobes. View the lateral surface of the hemisphere again and carefully inspect its inferior margin. Just above the cerebellum, there is often a small groove or notch in the gyral structure that can be appreciated 3-4 cm anterior from the caudal pole of the hemisphere. This groove is called the “pre-occipital notch” (see [Figure A10](#)). Now, draw an imaginary line between the parieto-occipital sulcus dorsally and the pre-occipital notch ventrally; this line will serve as the lateral boundary between the parietal and occipital lobes. Simply put, all gyral structures posterior to this line are occipital and have some role to play in elaborating visual perception. Fortunately for you, the complexity and inter-individual variation of these gyri defies easy application of standard nomenclature; for this reason, we will refer to these gyral structures as **lateral occipital gyri** and leave the business of naming these gyri for the cortical cartographers.

Lastly, there is a region of cortex called the **insula**, which is not visible from the lateral surface of the hemisphere because it is hidden beneath the frontal, temporal, and parietal lobes. The components of these lobes that cover the insular cortex are often called ‘opercular’ components (‘opercular’ means a lid or cover). It can be seen if portions of these two lobes are retracted (as is illustrated in [Figure A10](#)). In spite of its name, the insular cortex does not form an island; it is a part of the continuous sheet of cortex and is deeply buried only because of the relatively greater growth of the cortex around it. Neurons in the insular cortex are concerned with visceral, autonomic, and taste functions and are thought to contribute in complex ways to integrative brain functions that impact emotion and social cognition.

STUDY QUESTIONS

- Q1. Which of the following statements concerning the **central sulcus** is most correct?
- A. The central sulcus terminates laterally in or very near the longitudinal fissure.
 - B. The central sulcus is the principal landmark that divides the two cerebral hemispheres from one another.
 - C. The central sulcus terminates medially in or very near the lateral (Sylvian) fissure.
 - D. The central sulcus is formed by gyral formations that harbor the somatic sensory and motor divisions of the cerebral cortex in the human brain.
 - E. The central sulcus is mainly in the axial plane of the cranium.
- Q2. Which two lobes of the cerebral hemisphere feature three **parallel, longitudinal gyri** on their lateral aspect?
- A. frontal and temporal lobes
 - B. frontal and parietal lobes
 - C. parietal and occipital lobes
 - D. temporal and occipital lobes
 - E. temporal and parietal lobes