

# Medical Neuroscience | Tutorial Notes

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## Basic Orientation in the Human CNS

### MAP TO NEUROSCIENCE CORE CONCEPTS<sup>1</sup>

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

### LEARNING OBJECTIVES

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

1. Discuss position in various divisions of the central nervous system (CNS) using the following pairs of direction terms: anterior/posterior; rostral/caudal; superior/inferior; dorsal/ventral; and medial/lateral
2. Demonstrate the three orthogonal planes that are used to section the CNS.

### NARRATIVE

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### Specification of location in the nervous system

The terms used to specify location in the central nervous system are the same as those used in gross vertebrate anatomy. One complication (that can become a source of confusion if you don't understand it) arises because some terms refer to the long axis of the body, which is straight, and others refer to the long axis of the central nervous system, which has a bend in it (see [Figure A1A<sup>2</sup>](#)). A flexure in the long axis of the nervous system arose as humans evolved upright posture. This flexure leads to a ~120 degree angle between the long axes of the hindbrain and forebrain. The two axes intersect at the junction of the midbrain and diencephalon.

This flexure has consequences for the application of standard anatomical terms used to specify location. The terms **anterior** and **posterior** and **superior** and **inferior** are used with reference to the long axis of the body, which is straight. Therefore, these terms refer to the same direction in space for both the forebrain and the hindbrain. In contrast, the terms **dorsal** and **ventral** and **rostral** and **caudal** are used with reference to the long axis of the nervous system, which bends. Thus, dorsal is toward the back for the hindbrain, but toward the top of the head for the forebrain. Ventral is toward the gut. Rostral is toward the top of the head for the hindbrain, but toward the front for the forebrain. Caudal is opposite.

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<sup>1</sup> Visit [BrainFacts.org](https://www.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.

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

When you understand these terms and how they are used, you will see why the terminology of neuroanatomy can be confusing at first. For example, the ventral aspect of the spinal cord is also referred to as the anterior aspect in humans, since for the human spinal cord, the two words are synonymous. However, there is a nucleus (cluster of neurons) in the thalamus called the “ventral anterior nucleus”. When reference is to the forebrain, the two terms specify different directions, so the compound name of this nucleus is not redundant.

Use of the terms discussed in this section allows us to specify the location of any part of the nervous system with reference to any other part.

## The standard planes of section

The brain is commonly cut in one of the three standard planes of section that you may be familiar with from your studies of human (or mammalian) anatomy (see [Figure A1B](#)). Magnetic resonance images (MRIs) are also usually made in these planes (or close approximations of them). It will help you to understand three-dimensional relationships in the brain if you become familiar with these planes, the application of the positional terms discussed above, and the appearance of the internal structures of the brain in all three planes of section.

The **horizontal** or **axial plane** (hint: think, horizon) shows structures as they would appear from above or below. The **frontal** or **coronal plane** (hint: think, tiara-style crown) shows structures as they would appear from the front or back. The **sagittal plane** shows structures as they would appear from the side (hint: think, Sagittarius—the archer’s plane).

Other pairs of terms that are important to know are:

**Lateral**—toward the side and away from the midline

**Medial**—toward the midline and away from the side

**Ipsilateral**—on the same side (as another structure)

**Contralateral**—on the opposite side

Because of the flexure at the junction of the midbrain and diencephalon, coronal sections are the closest to cross-sections of the forebrain, whereas horizontal sections are the closest to cross-sections of the brainstem. (Cross-sections—also called transverse sections—are sections cut perpendicular to the long axis of the CNS.) Your first task when confronted with a new section of the brain is to figure out the plane of section.

## STUDY QUESTIONS

In conventional human radiological imaging (e.g., MRI, PET, CT) of the head, the axial plane is synonymous with the horizontal plane. Which of the following statements about this plane is most accurate?

- A. The axial plane is parallel to the coronal plane.
- B. The axial plane is parallel to the sagittal plane.
- C. The axial plane is parallel to the floor of the cranium.
- D. The axial plane is in the plane of the face.
- E. The long axis of the spinal cord is in the axial plane of the cranium.

Of the following pairs of **directional terms**, which pair contains terms that define PERPENDICULAR (orthogonal) directions when applied to the identified region of the central nervous system? [hint: you may wish to extend your arms and point in the indicated directions]

- A. in the forebrain, rostral & anterior
- B. in the forebrain, dorsal & superior
- C. in the forebrain, ventral & inferior
- D. in the brainstem, ventral & anterior
- E. in the spinal cord, caudal & posterior