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神经解剖学

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Clinical Neuroanatomy

Clinical Neuroanatomy
for Medical Students

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Preface

Frequently physicians have expressed to the author their concern because the type of neuroanatomy taught to medical students is too detailed and often far removed from the basic neuroanatomy that one uses in clinical practice. While it is fascinating to learn about the ultramicroscopic structure of synapses and the detailed connections of the hypothalamus, it is first essential that a student understand such phenomena as the pupillary light reflex, be able to explain why a patient with cerebellar disease tends to fall to the same side as the lesion, and know the level at which the spinal cord terminates within the vertebral canal.

Too many students complain of the complexity of the terminology in neuroanatomy and the difficulty they experience in understanding the relations of the different parts of the brain to one another. Unfortunately, this is often the fault of the professor. It is not unusual in the author's experience for the lecturer to become carried away on the flowing tides of his enthusiasm, introducing detailed comparative anatomy or the detailed results of his own latest investigations, leaving the student high and dry and more confused than when the lecture began.

The purpose of this book is not to replace the larger reference textbooks of neuroanatomy, but, rather, to offer the practical aspects of neuroanatomy in a simplified manner. Clinical problems requiring a knowledge of anatomy for solution are presented at the end of each section. References to neuroanatomical literature are included so that the student can acquire a deeper knowledge of an area of interest, should he so desire. The illustrations have purposely been kept simple, and for the most part they are diagrammatic in form.

I thank the many medical students, clinical colleagues, and friends who stimulated me to write this book. I am most grateful to the following colleagues in anatomy who provided me with photographic examples of neuroanatomical material: Dr. Nikolajs Cauna, Emeritus Professor of Anatomy, University of Pittsburgh School of Medicine; Dr. Turlough M. J. Fitzgerald, Professor of Anatomy, University College, Galway, Ireland; Dr. James M. Kerns, Assistant Professor of Anatomy, George Washington University School of Medicine and Health Sciences, Washington, D.C.; and Dr. Alan Peters, Professor and Chairman of Anatomy, Boston University School of Medicine. I wish to thank the staff of the Audiovisual Services of the George Washington University School of Medicine and Health Sciences for their skill in preparing suitable photographic prints for publication, and to extend sincere thanks to my artist, Myra Feldman, for her careful interpretation of my rough sketches for the illustrations and for her patience in executing the final artwork. To the librarians of George Washington University School of Medicine and Health Sciences my thanks are due for their continued help in obtaining for me much-needed reference material. Special thanks are due to Michele Boyd and Donna Gosnell for their skill and patience in typing the manuscript. Finally, to the staff of Little, Brown and Company go my gratitude and thanks for their harmonious collaboration throughout the preparation of this book.

R. S. S.

Contents

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Organization of the Nervous System

The nervous system is composed basically of specialized cells, whose function is to receive sensory stimuli and to transmit them to effector organs, whether muscular or glandular (Fig. 1-1). The sensory stimuli that arise either outside or inside the body are correlated within the nervous system, and the efferent impulses are coordinated so that the effector organs work harmoniously together for the well-being of the individual. In addition, the nervous system of higher species has the ability to store sensory information received during past experiences; and this information, when appropriate, is integrated with other nervous impulses and channeled into the common efferent pathway.

Central and Peripheral Nervous Systems

The nervous system is divided into two main parts, for purposes of description: the *central nervous system* (Fig. 1-2A), which consists of the brain and spinal cord, and the *peripheral nervous system* (Fig. 1-2B), which consists of the cranial and spinal nerves and their associated ganglia.

In the central nervous system the brain and spinal cord are the main centers where correlation and integration of nervous information occur; therefore, it is not surprising that they are well protected (Fig. 1-3). Both the brain and spinal cord are suspended in fluid, the *cerebrospinal fluid*, and they are further protected by the bones of the skull and the vertebral column.

The central nervous system is composed of large numbers of nerve cells and their processes, which are supported by specialized tissue called *neuroglia* (Fig. 1-4). *Neuron* is the name given to the nerve cell and all its processes. The long processes of a nerve cell are called *axons* or *nerve fibers*.

The interior of the central nervous system is organized into gray and white matter. *Gray matter* consists of nerve cells and the proximal portions of their processes embedded in neurologia. *White matter* consists of nerve fibers embedded in neuroglia.

In the peripheral nervous system the cranial and spinal nerves, which consist of bundles of nerve fibers or axons, conduct information to and from the central nervous system. Although surrounded by fibrous sheaths as they run to different parts of the body, they are relatively unprotected and are commonly damaged by trauma.

Autonomic Nervous System

The autonomic nervous system is the part of the nervous system concerned with the innervation of involuntary structures, such as the heart, smooth muscle, and glands within the body. It is distributed throughout the central and peripheral nervous systems. The autonomic system may be divided into two parts, the *sympathetic* and the *parasympathetic*, and in both parts there are afferent and efferent nerve fibers.

The activities of the sympathetic part of the autonomic system prepare the body for an emergency. It accelerates the heart rate, causes constriction of the peripheral blood vessels, and raises the blood pressure. It brings about a redistribution of the blood, so that blood leaves the areas of the skin and intestine and becomes available to the brain, heart, and skeletal muscle. At the same time it inhibits peristalsis of the intestinal tract and closes the sphincters.

The activities of the parasympathetic part of the autonomic system are aimed at conserving and restoring energy. It slows the heart rate, increases peristalsis of the intestine, increases glandular activity, and opens the sphincters.

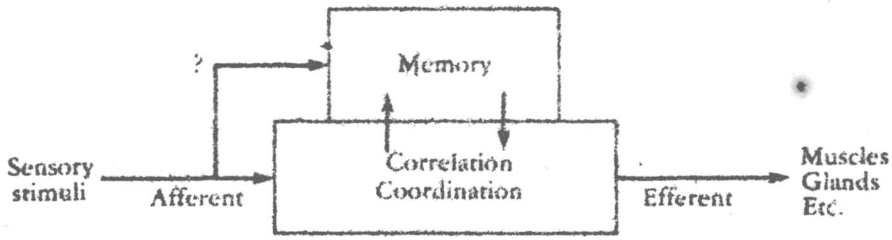


Fig. 1-1. The relationship of afferent sensory stimuli to memory bank, correlation and coordinating centers, and common efferent pathway.

Major Divisions of the Central Nervous System

Before proceeding to a detailed description of the spinal cord and brain, it is essential to understand the main features of these structures and their general relationship to one another. Later, the more intricate parts will be studied in depth.

Spinal Cord

The spinal cord is a grayish-white structure that begins superiorly at the foramen magnum in the skull, where it is continuous with the *medulla oblongata* of the brain (Figs. 1-5 and 1-6). It terminates inferiorly in the adult at the level of the *lower border of the first lumbar vertebra*. In the young child it is relatively longer and ends at the upper border of the third lumbar vertebra. The spinal cord is situated within the *vertebral canal* of the vertebral column and is surrounded by three meninges (Fig. 1-6): the *dura mater*, the *arachnoid mater*, and the *pia mater*. Further protection is provided by the *cerebrospinal fluid*, which surrounds the spinal cord in the *subarachnoid space*.

The spinal cord is roughly cylindrical in shape (Fig. 1-6). However, in the cervical region, where it gives origin to the brachial plexus, and in the lower thoracic and lumbar regions, where it gives origin to the lumbosacral plexus, there are fusiform enlargements, called the *cervical and lumbar enlargements* (Fig. 1-2A). Inferiorly, the spinal cord tapers off into the *conus medullaris*, from the apex of which a prolongation of the pia mater, the *filum terminale*, descends to be attached to the back of the coccyx (Fig. 1-5B). The cord possesses, in the midline anteriorly, a deep longitudinal fissure, the *anterior median fissure*, and, on the posterior surface, a shallow furrow, the *posterior median sulcus* (Fig. 1-7).

Along the entire length of the spinal cord are attached 31 pairs of spinal nerves by the *anterior or motor roots* and the *posterior or sensory roots* (Figs. 1-6 and 1-7). Each root is attached to the cord by a series of rootlets, which extend the whole length of the corresponding segment of the cord. Each posterior nerve root possesses a *posterior root ganglion*, the cells of which give rise to peripheral and central nerve fibers.

STRUCTURE OF SPINAL CORD. The spinal cord is composed of an inner core of *gray matter*, which is surrounded by an outer covering of *white matter* (Fig. 1-7). The gray matter is seen on cross section as an H-shaped pillar with *anterior and posterior gray columns, or horns*, united by a thin *gray commissure* containing the small *central canal*. The white matter, for purposes of description, may be divided into *anterior, lateral, and posterior white columns* (Fig. 1-7). The anterior column on each side lies between the midline and the point of emergence of the anterior nerve roots; the lateral column lies between the emergence of the anterior nerve roots and the entry of the posterior nerve roots; the posterior column lies between the entry of the posterior nerve roots and the midline.

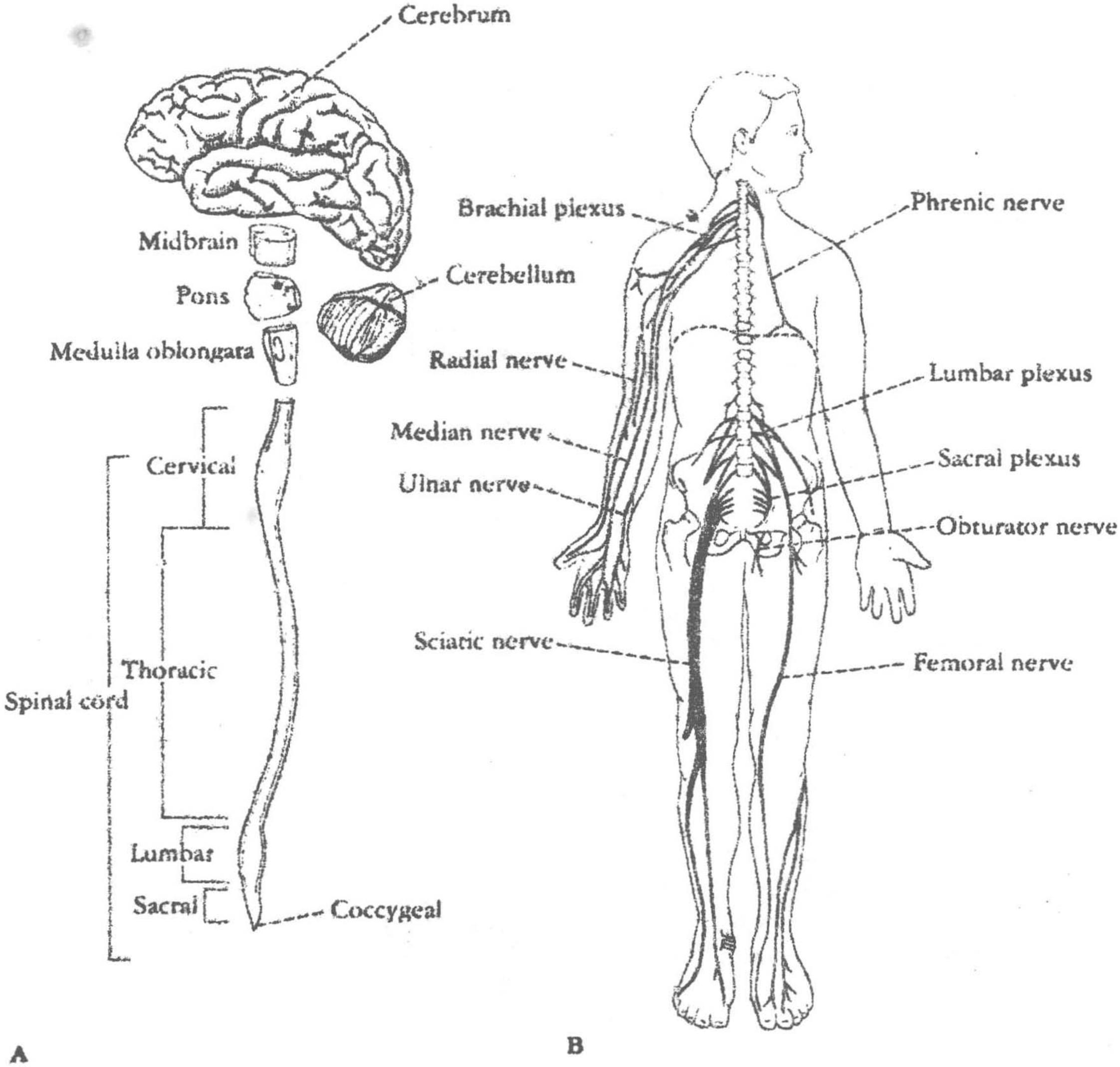
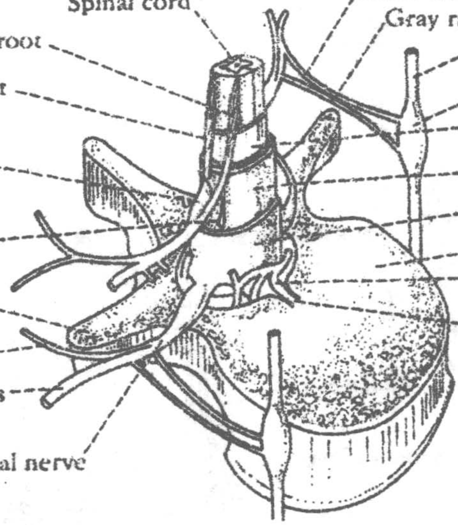


Fig. 1-2. A. The main divisions of the central nervous system.
B. The parts of the peripheral nervous system (the cranial nerves have been omitted).



A

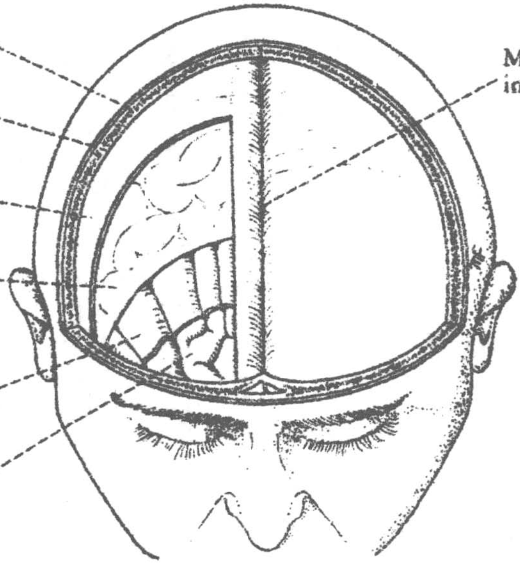


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Fig. 1-3. A. Protective coverings of spinal cord. B. Protective coverings of brain.

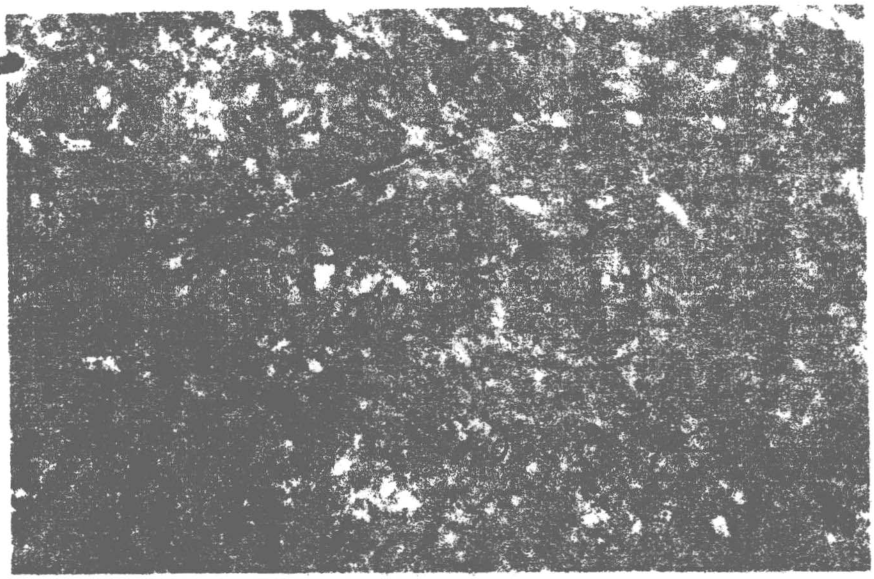


Fig. 1-4. Photomicrograph of several large nerve cells with surrounding neuroglia.

Brain

The brain lies in the cranial cavity and is continuous with the spinal cord through the foramen magnum (see Figs. 1-6A, 1-8, and 1-10). It is surrounded by three meninges: the ***dura mater***, the ***arachnoid mater***, and the ***pia mater*** and these are continuous with the corresponding meninges of the spinal cord (Fig. 1-9).

The brain is conventionally divided into three major divisions. These are, in ascending order from the spinal cord, the ***rhombencephalon*** or hindbrain, the ***mesencephalon*** or midbrain, the the ***prosencephalon*** or forebrain. The rhombencephalon may be subdivided into the ***myelencephalon*** or medulla oblongata, the ***metencephalon*** or pons, and the ***cerebellum***. The prosencephalon may also be subdivided into the ***diencephalon*** (between brain), which is the central part of the forebrain, and the ***telencephalon*** or cerebrum. The ***brainstem*** (a collective term for the medulla oblongata, pons, and midbrain) is that part of the brain that remains after the cerebral hemispheres and cerebellum are removed (see Fig. 1-8).

HINDBRAIN (RHOMBENCEPHALON). The hindbrain consists of the medulla oblongata (myelencephalon), the pons (metencephalon), and the cerebellum (Figs. 1-11 and 1-12).

Medulla Oblongata (Myelencephalon). The medulla oblongata is conical in shape and connects the pons superiorly to the spinal cord inferiorly (see Figs. 1-8 and 1-11). A ***median fissure*** is present on the anterior surface of the medulla, and on each side of this fissure is a swelling, called the ***pyramid***. Posterior to the pyramids are the ***olives***, which are oval elevations produced by the underlying ***olivary nuclei***. Posterior to the olives are the ***inferior cerebellar peduncles***, which connect the medulla to the cerebellum (Fig. 1-14).

On the posterior surface of the inferior part of the medulla oblongata (Fig. 1-14) are the ***gracile*** and ***cuneate tubercles***, produced by the medially placed underlying ***nucleus gracilis*** and the laterally placed underlying ***nucleus cuneatus***.

Pons (Metencephalon). The pons is situated on the anterior surface of the cerebellum, inferior to

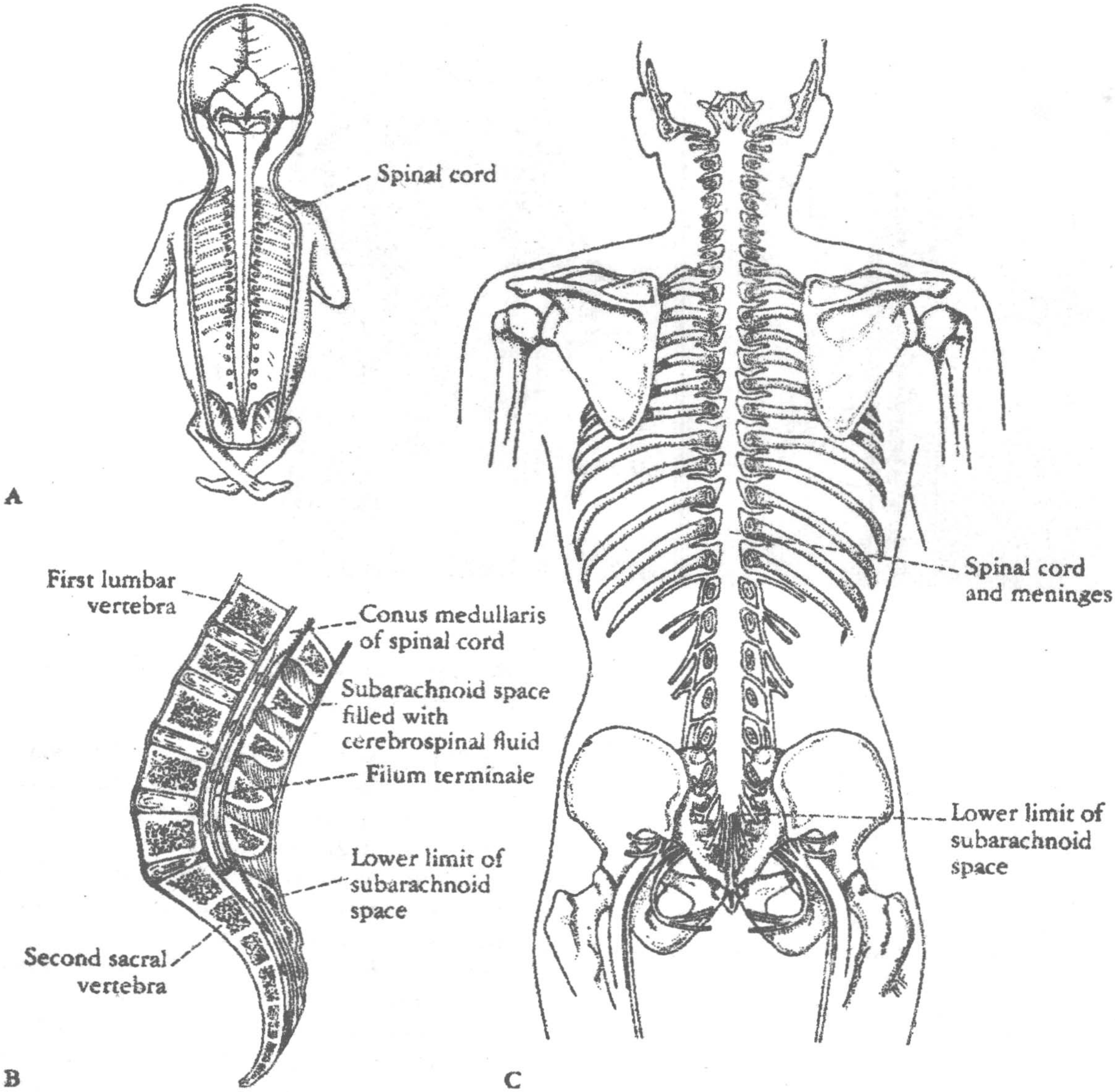


Fig. 1-5. A. Fetus with brain and spinal cord exposed on the posterior surface. Note that the spinal cord extends the full length of the vertebral column. B. Sagittal section of vertebral column in adult, showing spinal cord terminating inferiorly at the level of the lower border of the first lumbar vertebra. C. Adult spinal cord and covering meninges, showing relationship to surrounding structures.

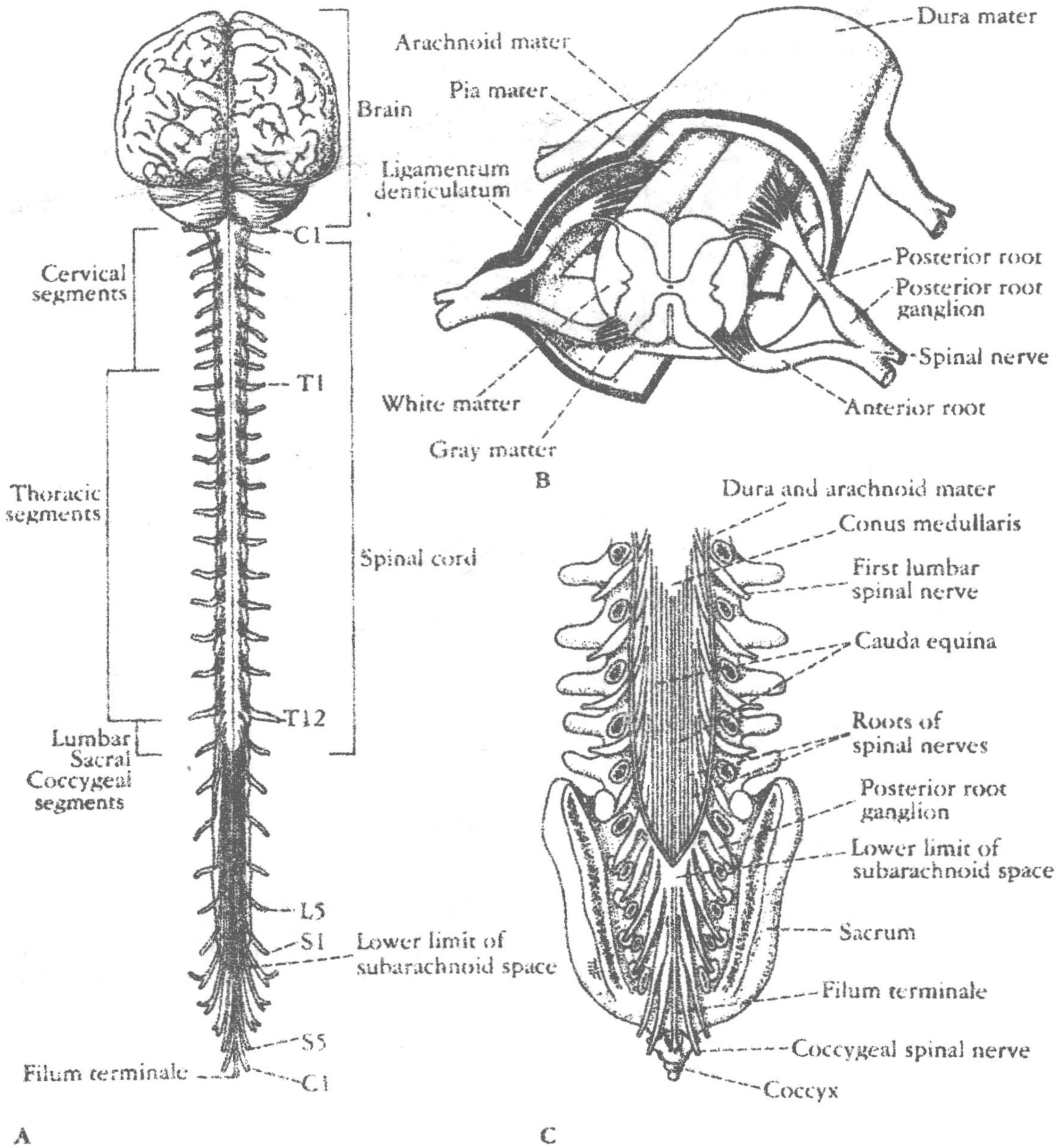


Fig. 1-6. A. Brain, spinal cord, spinal nerve roots, and spinal nerves as seen on their posterior aspect.
B. Transverse section through spinal cord in the thoracic region, showing anterior and posterior roots of a spinal nerve and the meninges.
C. Posterior view of lower end of spinal cord and cauda equina, showing their relationship with the lumbar vertebrae, sacrum, and coccyx.

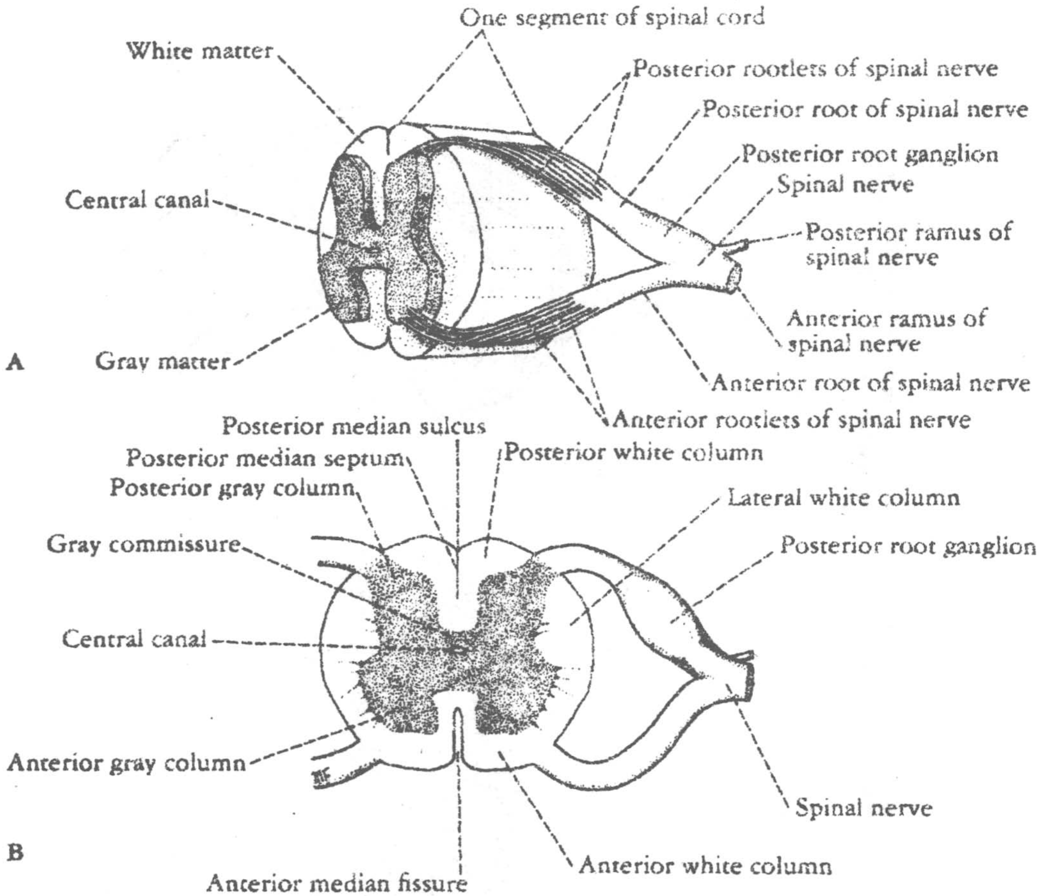


Fig. 1-7. A. Transverse section through lumbar part of spinal cord, oblique view.
B. Transverse section through lumbar part of spinal cord, face view. Sections show anterior and posterior roots of a spinal nerve.

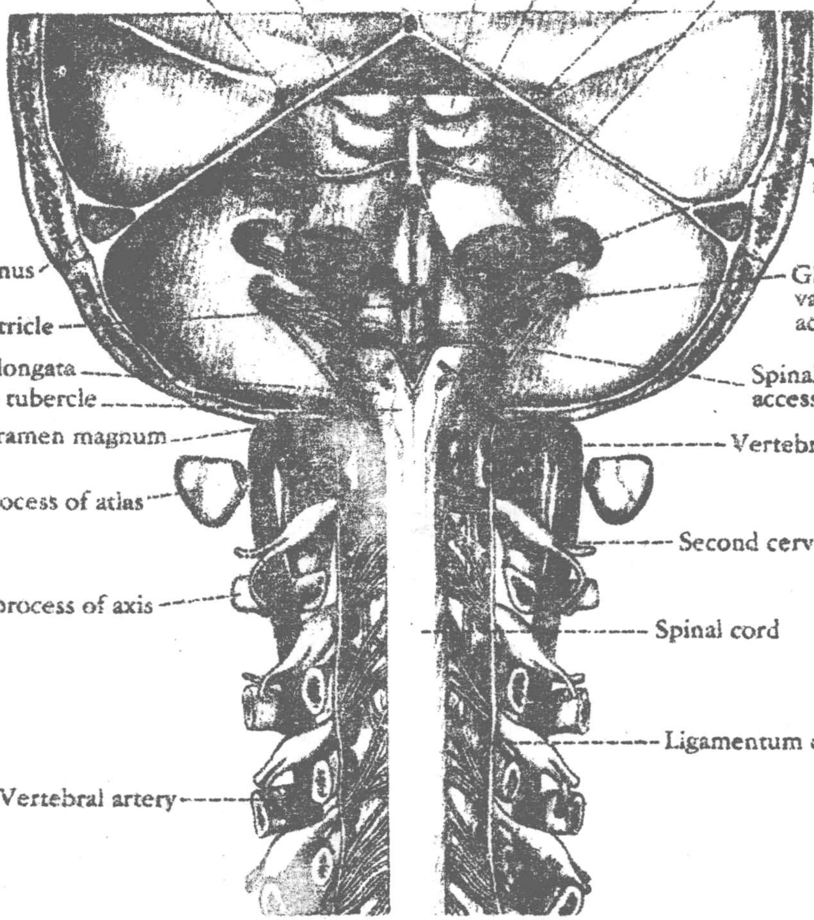
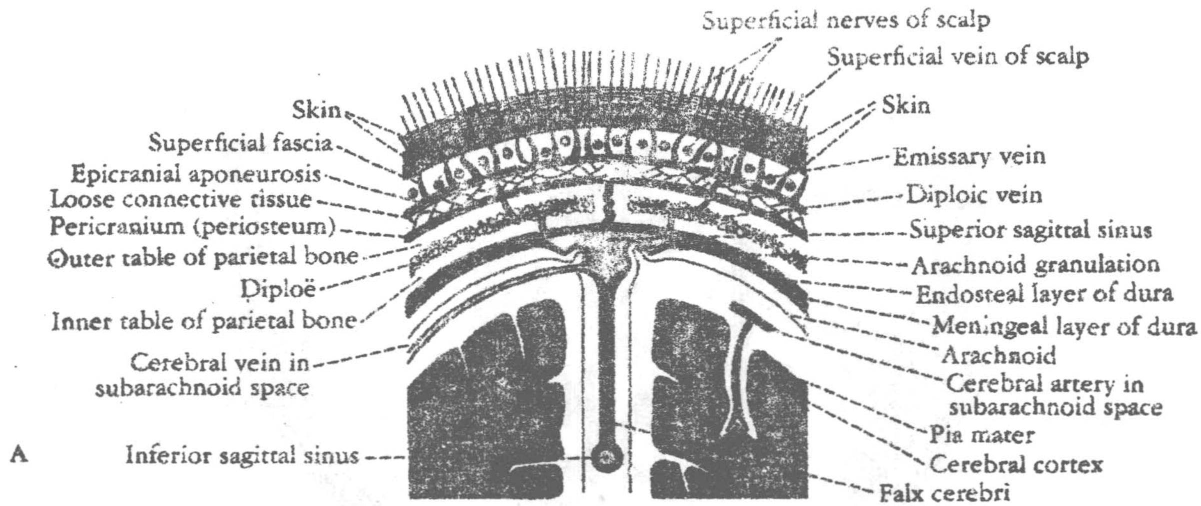


Fig. 1-8. Posterior view of the brainstem after removal of the occipital and parietal bones and the cerebrum, the cerebellum, and the roof of the fourth ventricle. Laminae of the upper cervical vertebrae have also been removed.



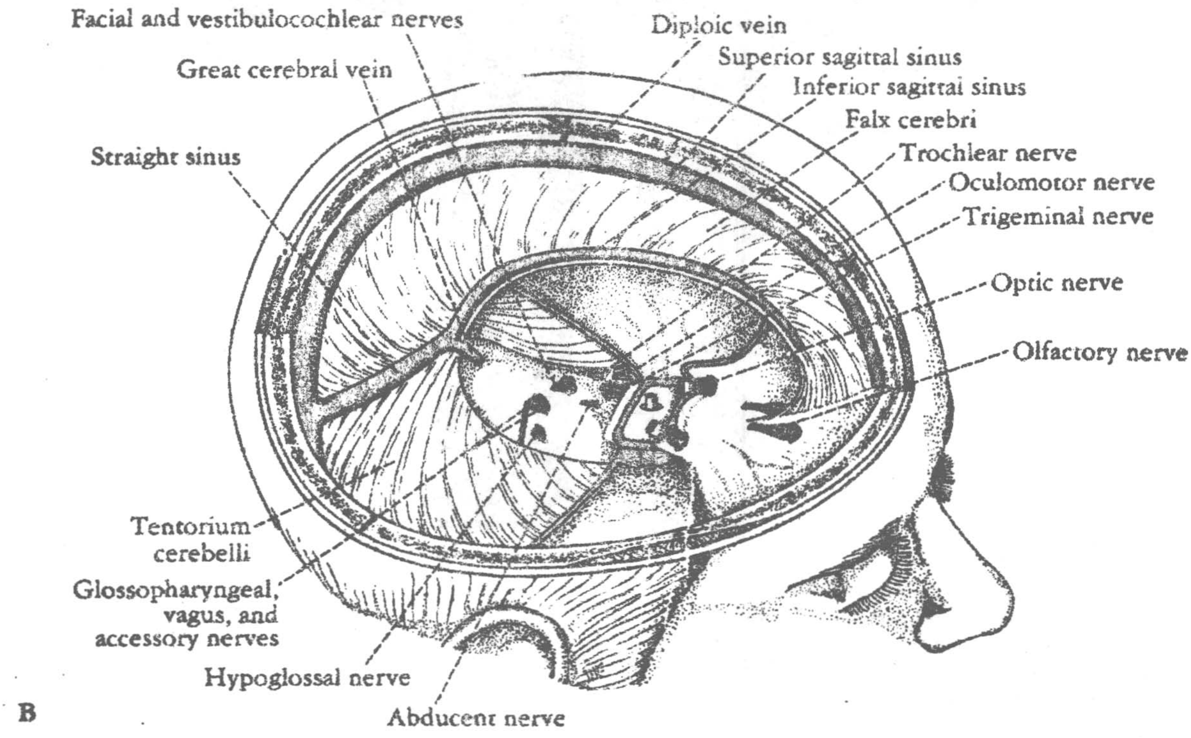


Fig. 1-9. A. Coronal section of upper part of head showing: layers of scalp, sagittal suture of skull, falx cerebri, venous sinuses, arachnoid granulations, emissary veins, and relation of cerebral blood vessels to subarachnoid space.
B. Interior of skull, showing dura mater and its contained venous sinuses.

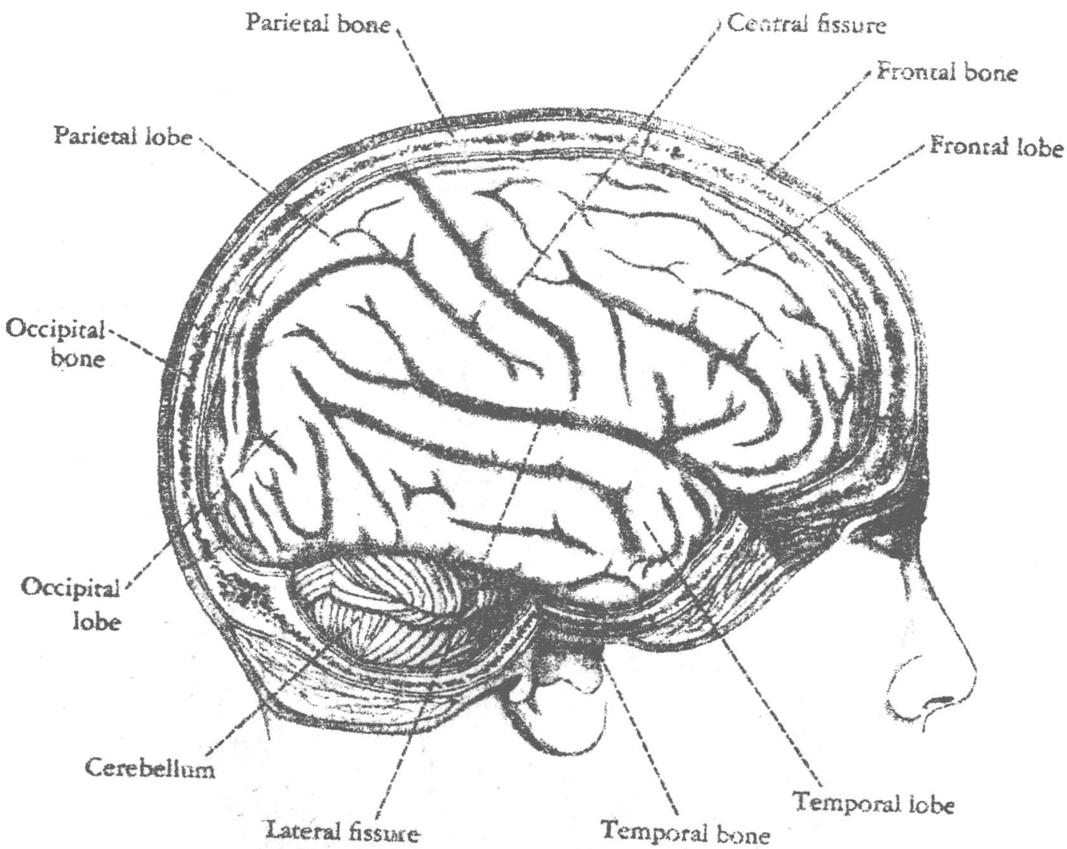


Fig. 1-10. Lateral view of the brain within the skull.

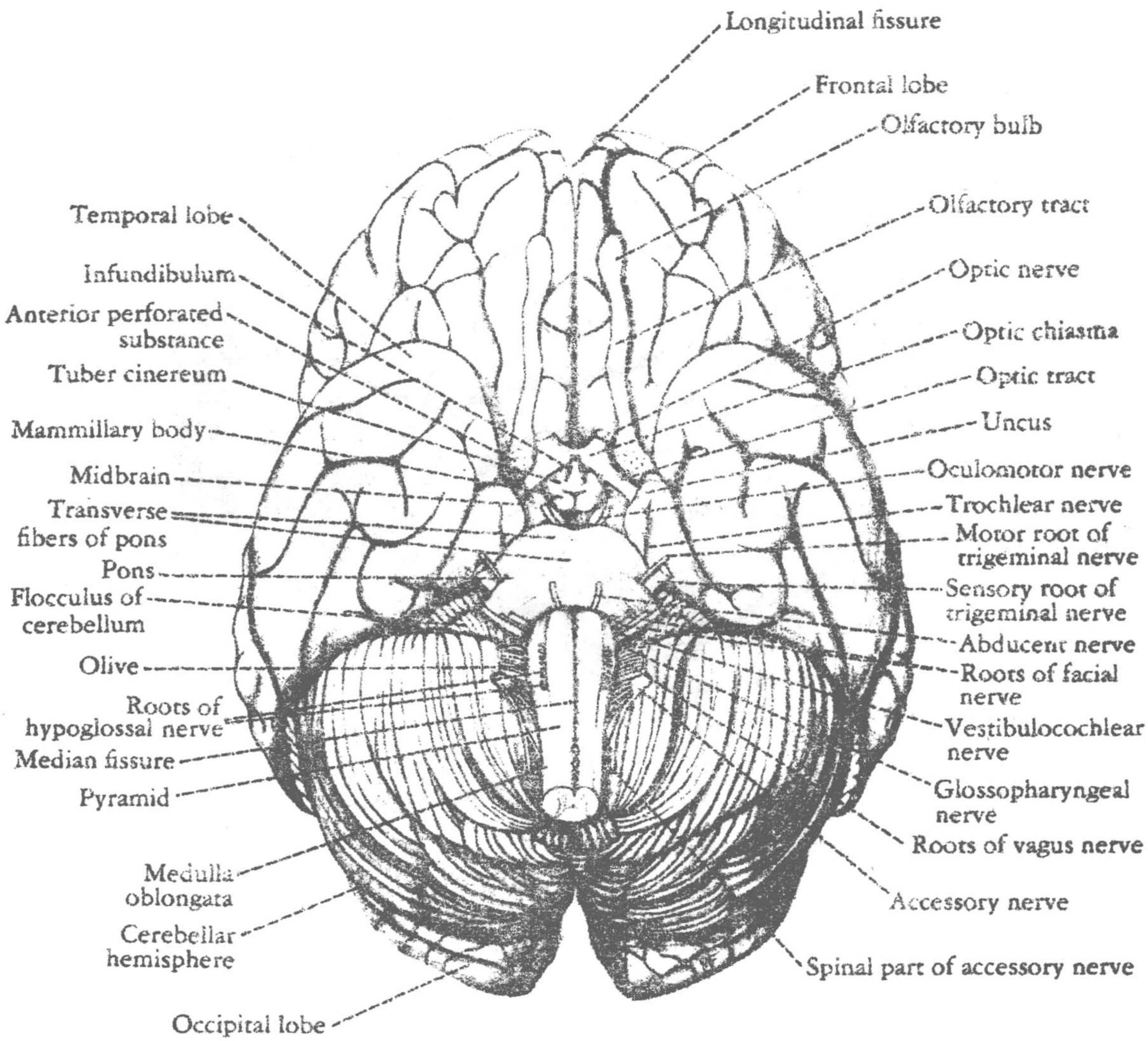


Fig. 1-11. Inferior view of the brain.