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ANATOMICAL STRUCTURE OF THE BRAIN AND SPINAL CORD: COMMON FEATURES AND DIFFERENCES

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АННОТАЦИЯ:

This article discusses the anatomical structure, location, physiological functions, and interrelationship of the brain and spinal cord, which are the principal components of the central nervous system. Their common anatomical features, structural differences, and significance in regulating human body functions are also examined from a scientific perspective.

The human body is a complex biological system in which all organs and systems function in a coordinated manner. The nervous system plays a central role in controlling these processes. It receives information from the external and internal environments, processes that information, and generates appropriate responses. The central nervous system consists of the brain and spinal cord. The brain participates in higher nervous functions, including thinking, memory, speech, emotions, and the control of movement. The spinal cord serves as a major pathway for communication between the brain and the peripheral nervous system and is responsible for many reflexes. Although the brain and spinal cord are anatomically connected, they differ in structure and function.

The brain (encephalon) is the principal part of the central nervous system. It is located inside the cranial cavity and is protected from external mechanical effects by the bones of the skull and by three layers of meninges. The average mass of the adult human brain is approximately 1,300–1,400 grams. The brain is divided into several anatomical regions: the cerebral hemispheres, diencephalon, midbrain, pons, medulla oblongata, and cerebellum. The

cerebral hemispheres form the largest part of the brain. They consist of right and left hemispheres connected by the corpus callosum. Their surface contains gyri and sulci, which increase the surface area of the cerebral cortex. The cerebral cortex is divided into the frontal, parietal, temporal, and occipital lobes. The frontal lobe is important for voluntary movement, planning, and reasoning; the parietal lobe processes sensory information; the temporal lobe is involved in hearing and memory; and the occipital lobe processes visual information. The cerebellum coordinates movement accuracy, balance, and muscle tone. The medulla oblongata contains vital centers involved in the regulation of breathing, cardiac activity, and vascular tone.

The spinal cord (medulla spinalis) is the second principal component of the central nervous system. It is located in the vertebral canal and continues superiorly from the medulla oblongata. In adults, it usually ends at the level of the first or second lumbar vertebra. The spinal cord is approximately 40–45 cm long and has a generally cylindrical shape. It has cervical and lumbosacral enlargements associated with the nerves supplying the upper and lower limbs. The spinal cord consists of 31 segments: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal segment. A pair of spinal nerves emerges from each segment. These nerves contain sensory and motor fibers. In cross-section, gray matter is located centrally and white matter surrounds it. Gray matter mainly contains neuronal cell bodies, whereas white matter consists primarily of nerve fibers, many of which are covered by myelin. The spinal cord has two principal functions: reflex and conduction. Its reflex function enables rapid responses to various stimuli. Its conduction function carries nerve impulses to the brain and transmits commands from the brain to peripheral organs and tissues.

The brain and spinal cord are components of the central nervous system and share several anatomical characteristics. First, both are composed of nervous tissue. Their principal cellular elements are neurons and neuroglial cells. Neurons receive, process, and transmit nerve impulses. Second, both structures are covered by three meningeal layers: the dura mater, arachnoid mater, and pia mater. These membranes help protect the central nervous system. Cerebrospinal fluid (CSF) is found in the subarachnoid space between the arachnoid and pia mater. It provides cushioning and helps maintain a stable environment for nervous tissue. Third, both structures contain gray and white matter. Gray matter is mainly composed of neuronal cell bodies, while white matter consists largely of nerve fibers. Finally, the brain and spinal cord are anatomically and functionally interconnected. Nerve impulses travel through these structures, allowing the body to operate as an integrated system.

Despite their shared features, the brain and spinal cord differ in location, shape, internal organization, and function. Location: the brain lies within the cranial cavity, whereas the spinal cord lies within the vertebral canal. Shape: the brain has a complex form with numerous folds and grooves, while the spinal cord is generally cylindrical. Distribution of gray and white matter: in the brain, gray matter forms the cerebral cortex and is also present in deep

nuclei; white matter lies largely beneath the cortex. In the spinal cord, gray matter is central and white matter is peripheral. Function: the brain is involved in higher mental processes, sensory integration, and the control of complex movements. The spinal cord primarily performs reflex and conduction functions. Organization: the brain consists of several specialized anatomical regions, whereas the spinal cord is organized into 31 segments.

These two components of the central nervous system are essential for human survival and daily activity. The brain supports conscious activity, perception, thinking, memory, and decision-making. It also participates in the regulation of vital processes such as breathing, cardiovascular activity, and body temperature. The spinal cord contributes to muscle contraction, protective reflexes, and the neural regulation of certain internal organs. The knee-jerk reflex is a familiar example of a reflex mediated at the spinal cord level. Through their coordinated activity, the brain and spinal cord enable the body to adapt to changes in the environment, maintain internal stability, and coordinate the functions of different organs. The brain and spinal cord are inseparable components of the human central nervous system. They are anatomically connected and function together as a unified system. The brain plays a major role in higher nervous activity, consciousness, memory, thinking, and the control of movement. The spinal cord ensures the continuity of body functions through reflex activity and the conduction of nerve impulses. A thorough understanding of their anatomical structures and functional characteristics is important in medicine, particularly in anatomy, neurology, and neurosurgery.

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