

Basic anatomic structures 3
Introduction to the nervous system

Curricular Objectives

By the end of this session students are expected to:

Theory

1. Describe the cellular structure of the nervous system
2. Outline the anatomical and functional classifications of the nervous system
3. Discuss the distribution of different parts of nervous systems within the body
4. List the meningeal layers covering the CNS
5. Define the terms spinal cord segment, efferent fibers, afferent fibers
6. Outline the parts of individual spinal nerve
7. Discuss the parts, functions and types of nerve fibers of the somatic nervous system
8. Compare the segmental (dermatomal) and multi-segmental innervations of skin
9. Describe basic features of spinal cord section
10. Describe the general organization of the ANS comparing its two parts
11. Acknowledge the presence of higher control of the ANS
12. Outline the main functions of each part of the autonomic nervous system

Practical

1. Distinguish the main cellular structures contributing to the function of the NS
2. Identify the major subdivisions of the nervous system
3. Label the structures seen in cross section of spinal cord
4. Trace and label the parts and distribution of a typical spinal nerve
5. Identify the spinal and peripheral parts of the ANS

Selected references and suggested resources

- ✦ Clinical Anatomy by Regions, Richard S. Snell, 10th edition
- ✦ Grant's Atlas of Anatomy, 13th Edition
- ✦ McMinn's Clinical Atlas of Human Anatomy, 7th Edition
- ✦ [Anatomy for Babylon medical students](#) (Facebook page)
- ✦ [Anatomy for Babylon medical students](#) (YouTube channel)
- ✦ [Human Anatomy Education](#) (Facebook page)
- ✦ [Human anatomy education](#) (YouTube channel)

Feedback and suggestions

- ✦ <http://goo.gl/forms/SjyjGeUpvH>

Session check list**❖ Clinical importance**

- Various parts of the nervous system (central and peripheral) are commonly affected in road traffic accidents, stab wounds, ischemic infarctions, and systemic diseases like diabetes
- Junior doctors face cases of in which the nervous system is affected by disease or trauma almost every day. Without fair knowledge on the anatomy of the nervous system, they cannot diagnose, and locate the site of, the lesion in these cases and so they cannot save lives

❖ Cellular structure:

- Nervous tissue consists of nerve cells (neurons) and glial cells
- Typically, the neuron has a cell body, axon and dendrites
- The peripheral nerves are made of axons (nerve fibers) of nerve cells
- The brain and spinal cord are organized into gray matter (concentrations of nerve cell bodies) and white matter (concentrations of axons)
- A **nucleus** is a collection of nerve cell bodies within the CNS white matter
- A **ganglion** is a cluster of nerve cell bodies located outside the CNS
- A **tract** is a bundle of nerve fibers (axons) within the CNS
- **Synapses**¹ are sites where nerve impulse transmitted from a neuron to another

❖ The nervous system and its classifications

- The NS is classified structurally (anatomically) into central and peripheral nervous system
- The NS is classified functionally into somatic and visceral (autonomic) nervous system
- Somatic and visceral systems are distributed in CNS and PNS parts of nervous system
- Three meninges surround the entire CNS: dura mater, arachnoid mater, and pia mater

❖ The central and peripheral nervous system:

- The central and peripheral systems are one continuous unit (a neuron and its axon can present in both central and peripheral systems)
- The parts of CNS are found within and protected by skull and vertebral column
- The parts of PNS are distributed throughout the body as peripheral nerves and ganglia
- The spinal cord is divided into segments, each segment give rise to a pair of spinal nerves
- There are 12 cranial and 31 spinal nerves attached to the brain and spinal cord respectively
- Peripheral nerves contain efferent² and afferent fibers
- At the root of the upper and lower limbs, the anterior rami of multiple spinal nerves join together to form nerve plexus

❖ The somatic³ nervous system

- It is found within both CNS and PNS
- It has motor (efferent) and sensory (afferent) fibers
- The motor fibers innervates all skeletal muscles of the body
- The sensory fibers is concerned with sensations like touch, pain, temperature, and position from all body parts except the viscera, smooth muscles, and glands
- Dermatomes are the areas of skin supplied by somatic sensory fibers of a single spinal nerve

❖ The visceral nervous system

- It is found within both CNS and PNS
- It has sympathetic and parasympathetic parts, and supply viscera, smooth muscles and glands
- Visceromotor (efferent) fibers stimulate smooth muscle and glandular (secretory) cells
- Visceral afferent fibers are concerned with conducting visceral pain impulses, autonomic reflexes, and regulation of visceral function
- The sympathetic and parasympathetic systems differ in the site of the nerve cells from which they originates within the central nervous system and the location of peripheral ganglia

¹ Fibers proximal to the site of synapse are called **presynaptic**, while those distal are called **postsynaptic**

² Efferent = away (outward) from nerve cell. It means efferent fibers carry impulses from the CNS to the body

³ Somatic = related to body (soma = body)

Lab activity list

For each task below, identify the listed structures then answer the related questions

❖ Task 1 (cellular structure of NS)

- ✓ Neurons (cell body, axons, dendrites)
- ✓ Glial cells
- ✓ Synapse
- ✓ Gray matter/ Nucleus/ Ganglion
- ✓ White matter/ Tract
- ⊕ What structures involved in synapse formation?
- ⊕ What is the difference between nucleus and ganglion?

❖ Task 2 (CNS and PNS)

- ✓ Brain/ Cranial nerves
- ✓ Spinal cord/ Spinal cord segment
- ✓ Spinal nerves (C8/T12/L5/S5/Co1)
- ✓ Nerve plexus/ Brachial plexus
- ⊕ Cranial and spinal nerves are different in their courses. Explain.
- ⊕ The gray matter is in contact with the outer surface of spinal cord at which site?
- ⊕ Where the brachial plexus is located? Which part of the body it supplies?

❖ Task 3 (spinal cord cross section)

- ✓ White matter⁴
- ✓ Gray matter/ Anterior horn/ Posterior horn/ Lateral horn⁵
- ✓ Anterior root/ Posterior root/ Posterior root ganglion
- ✓ Spinal nerve/ Anterior ramus/ Posterior ramus
- ⊕ The anterior root of spinal nerve is considered _____ nerve. (sensory, motor, mixed)
- ⊕ Visceral efferent fibers run through _____ of spinal nerve. (post. Ramus/ ant. Ramus)

❖ Task 4 (sympathetic system)

- ✓ Lateral horn
- ✓ Sympathetic (Paravertebral) ganglia/ ganglion impar/ Sympathetic trunk
- ✓ White rami communicantes/ Gray rami communicantes
- ⊕ The lateral horn is seen in S2 spinal segment. (True/False)
- ⊕ The sympathetic trunk can be seen extending from _____ above to _____ below.
- ⊕ The sympathetic trunk on both sides of vertebral column unites by mean of what structure?

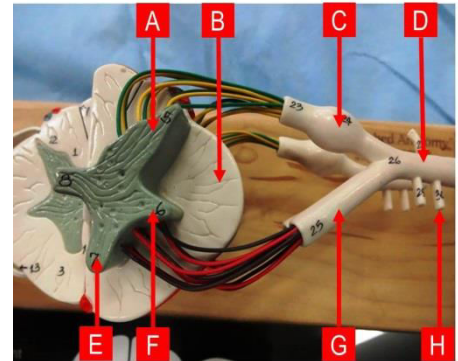
⁴ Ascending and descending tracts

⁵ Not present in all segments

Review questions:

1. What is the function of the glial cells
2. Gray matter is superficial in which part of the CNS? (brain, spinal cord)
3. There are three sympathetic ganglia in the cervical part of the sympathetic trunk, but there is no lateral horn present in the cervical segments of the spinal cord. Explain how these ganglia receive their sympathetic inflow
4. What are the functions of the sympathetic and parasympathetic nervous system in general?
5. Match each of the following statements with the correct corresponding letter from the figure on the right.

- I. (.....) Carries motor fibers only
- II. (.....) Carries afferent fibers only
- III. (.....) Carries sympathetic fibers only
- IV. (.....) Is a collection of autonomic nerve cells
- V. (.....) Is a collection of nerve cells outside the CNS
- VI. (.....) Is a common pathway for efferent and afferent fibers

**Homework:**

1. After a terrorist attack with a bomb, a 45 years old man reached the emergency unit suffering from a small shell that penetrated his back just lateral to the vertebral column. X-ray film showed that the shell was sitting opposite the lower cervical and upper thoracic vertebra. Patient was stabilized and now need to be examined for possible nerve injury. How to differentiate if the shell had cut a single spinal nerve (EX. C8) or peripheral nerve (EX. median nerve)?
2. Answer the following questions by looking at the cross sections of spinal cord below (A and B)
 - A. Identify the pointed structures
 - B. What type of nerve cell is located within the (3) pointed structure
 - C. Explain why is the gray matter has a different shape in the two sections
 - D. Nerve fibers forming the anterior and posterior roots in figure A show 4 colors, what do they represents?

