

Lesson Plan

NEUROHEADWAY

Neuroscience Into Education

THE BRAIN AND SPINAL CORD

CONTENT OF THE MODULE

Brain and spinal cord: how they function together

How the brain commands voluntary movements

How the spinal cord integrates several reflexes

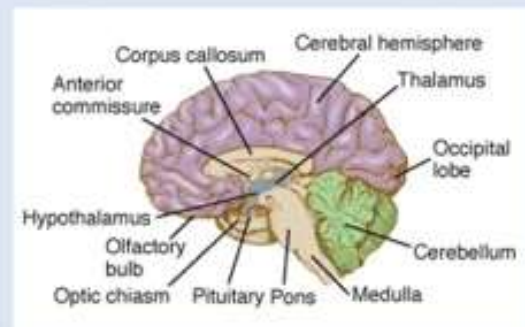
Control of smooth and cardiac muscle by the autonomic system

First, let's take a look to **the brain**:

- 1) The FOREBRAIN, comprising (among other parts) the cerebral hemispheres, which control **awareness** and the initiation of **voluntary movements**
- 2) The MIDBRAIN, which is responsible, for instance, of many **fixed marching movements**.

Are you thinking in any step for walking? Please explain why

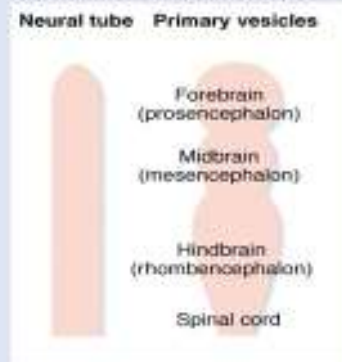
- 3) The HINDBRAIN, with several parts like the Pons and Medulla, which regulates right **posture** and many **vegetative functions** such as sleeping, arousal, breathing and blood pressure. Another part, the Cerebellum, is essential to coordinate the **sequence of movements**



Therefore, the brain commands complex movements; it has to coordinate the contraction of several muscles at the same time. Some of these contractions require our full attention and decision, while others occur more or less automatically

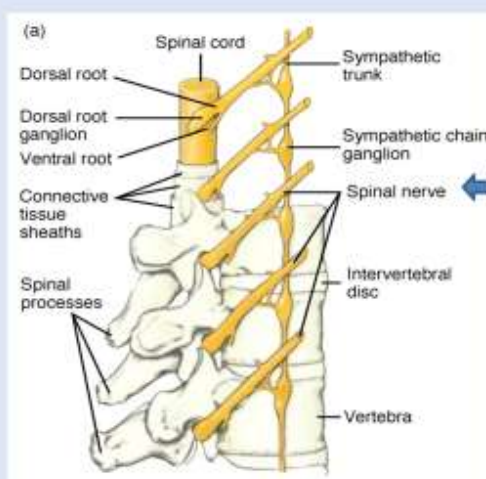
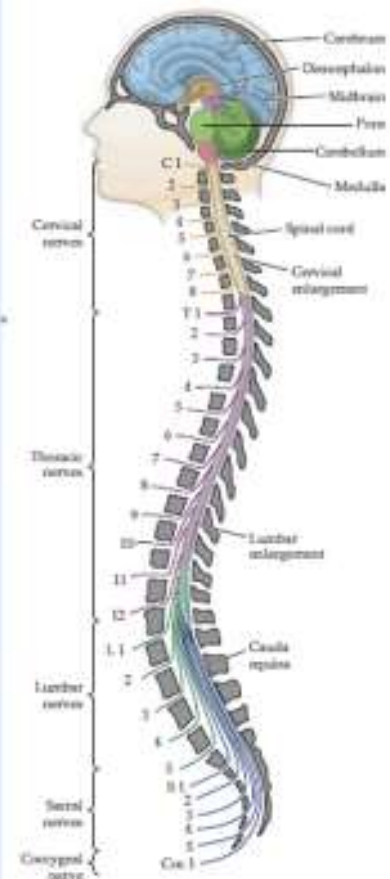
Now, let's take a look to the connection between **brain and the spinal cord**

The spinal cord represents the continuation of medulla, from the very early development of the central nervous system (CNS)



It is located at your back, extending from the nape to the coccyx

While the brain is inside the **skull**, the spinal cord is surrounded by the **spine**. Hence, the CNS is entirely protected by a **bone shield**



Although formed by bone, our dorsal spine is a flexible structure, because of the articulation among all vertebrae

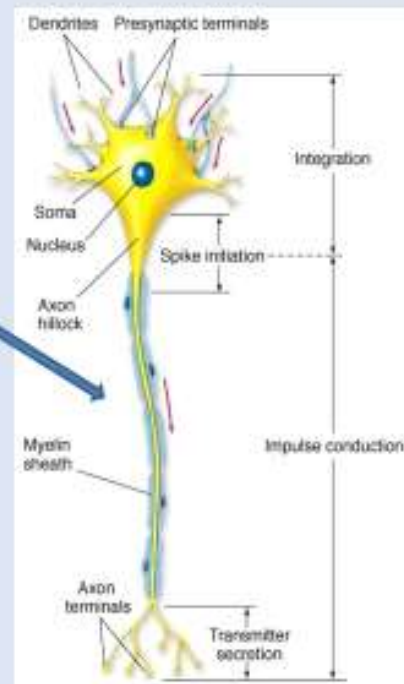
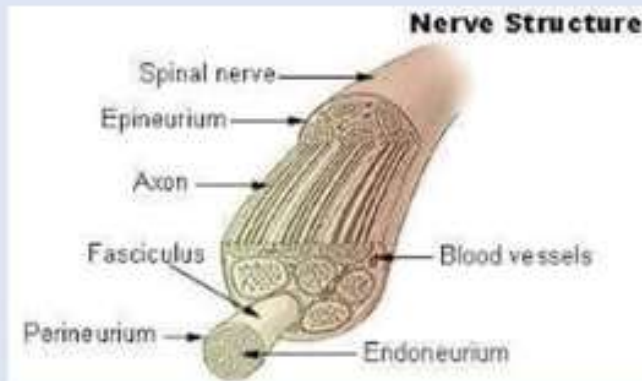
Besides, there are several nerves connecting with the spinal cord. These nerves conduct sensory information from the periphery (the skin, for instance) to the spinal cord, as well as motor commands from the spinal cord to the periphery (to a muscle, for instance)

Power point Example

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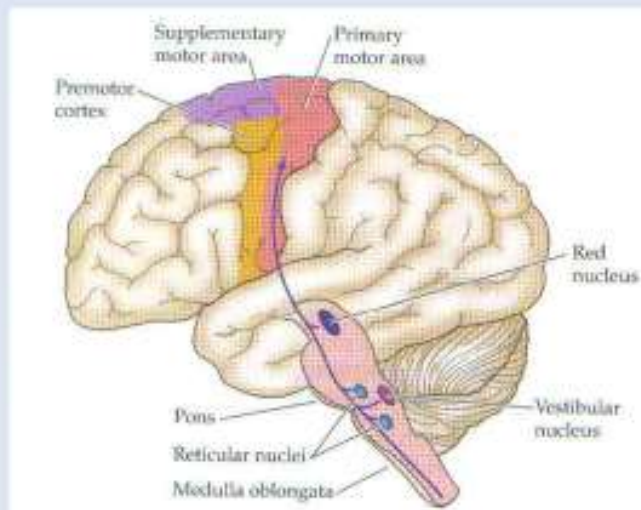
Imagine the nerves as electric cables, but while cables conduct electricity through metallic wires, nerves conduct electric impulses through neuronal axons.



Voluntary movements

The primary **motor cortex**, located at the parietal lobe of cerebral hemispheres, is responsible for executing the "motor plan" elaborated in the frontal cortex and other parts of the brain.

A lot of nervous fibers descends from the motor cortex to the spinal cord, stimulating the neurons whose axons carry electrical signals to the skeletal muscles for executing the voluntary movements.



➤ "Skeletal muscles" are those muscles connected to bones by tendons, to produce movements among them (for walking, jumping, playing tennis or whatever you decide to do)



Spinal reflexes: the spinal cord receives some sensory information from the periphery, and elaborates appropriated motor responses. **These are simple responses.**

It means that the spinal cord decides what to do !

First example: the stretch reflex

Objective: to maintain stable the length of muscles (very important for a right posture)



Nervous pathways:

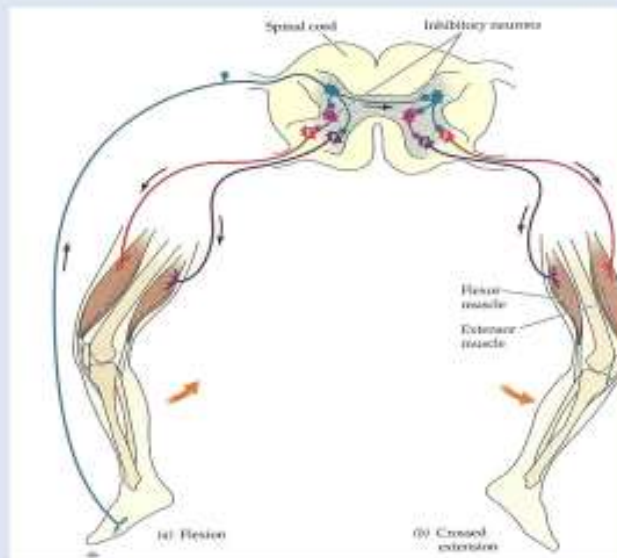
Blue: sensory information (the extensor muscle lengthens, after hitting the knee)

Red: stimulation of the extensor muscle (it shortens and foot goes up !)

Violet: decreased discharge to flexor muscle; it becomes relaxed to facilitate the movement

➤ **Flexor and extensor muscles are ANTAGONIC:** when one of them is contracting, the other is relaxing, to allow an efficient movement

Second example: the flexion reflex (very important to withdraw affected limbs)



1) A noxious stimulus affects left foot

2) Left foot is withdrawn, due to the stimulation of the flexor muscle of the left leg.

3) Right leg extend, helping to withdraw the affected limb from the noxious stimulus

However, could you keep your hand over the fire, for instance? Which nervous pathway would allow this?

Teachers Evaluation and Handouts