بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

PHYSIOLOGY

وَلَقَدْ خَلَقْنَا الْإِنسَانَ وَنَعْلَمُ مَا تُوَسْوِسُ بِهِ نَفْسُهُ ۖ وَنَحْنُ أَقْرَبُ إِلَيْهِ مِنْ حَبْلِ الْوَرِيدِ

Physiology | Lecture 7

Organization and Function of the Nervous System

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Introduction to Neurophysiology 1

Organization and functions of the nervous system

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Overview of the nervous system

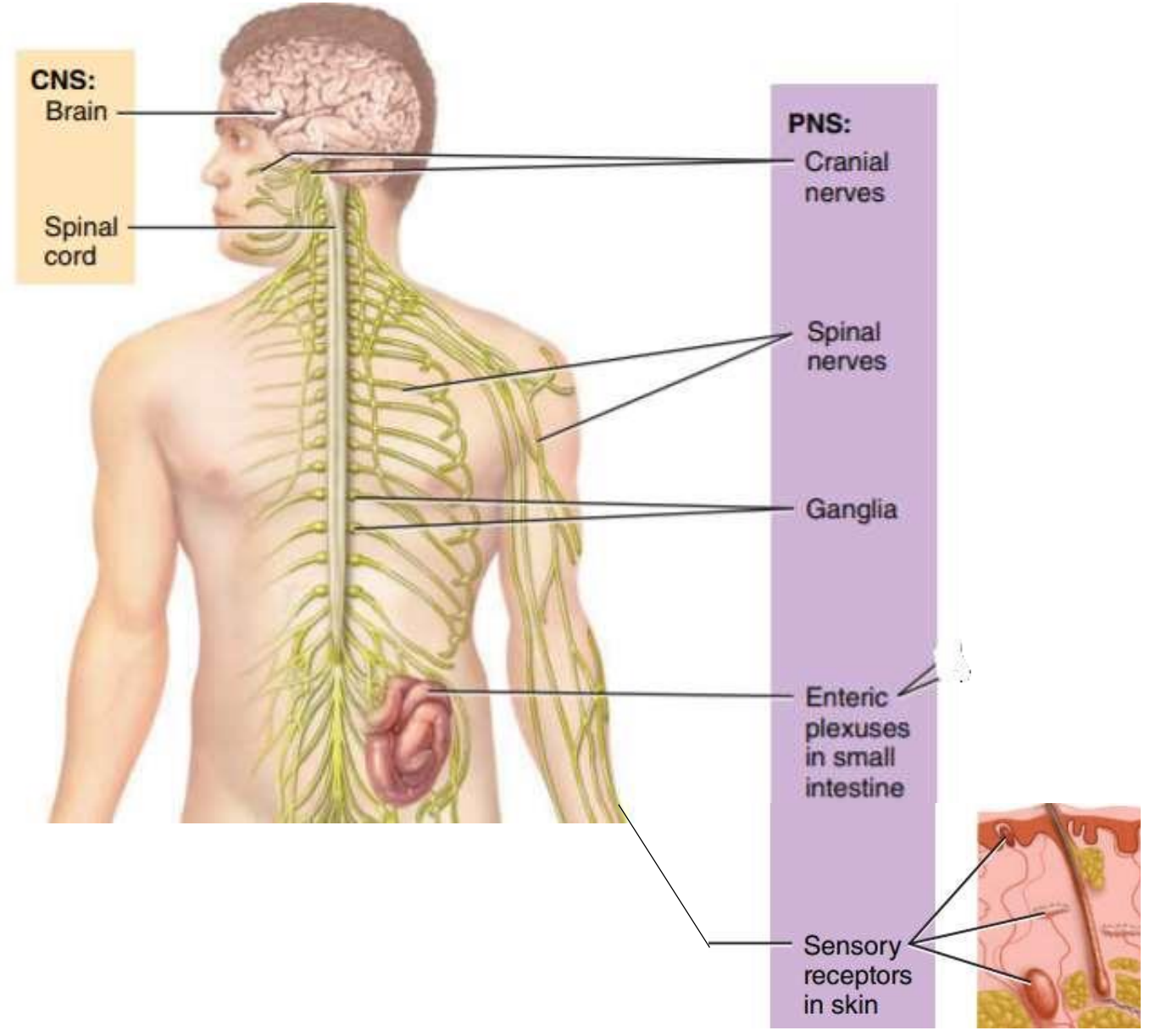
The control in our body either neuronal (usually fast reactant) or hormonal (slow).
Functions in general: control systems in order to maintain homeostasis, and control the various bodily activities (muscles or glands).

The nervous system is composed of two divisions:

- The **c**entral **n**ervous **s**ystem (CNS), which includes the brain and the spinal cord.

- The peripheral nervous system (PNS), is everything in NS outside the CNS, which includes sensory receptors, nerves, and ganglia.

Organization of the nervous system



Functions of the nervous system

The nervous system has 3 functions in general:

- **Sensory function**: sensory receptors detect internal or external stimuli. The sensory information is carried to the CNS through cranial and spinal nerves.

- **Integrative function**: process sensory information by analyzing it and making decision for appropriate responses. (Processing of data and making decision which happen all exclusively in CNS)

- **Motor function**: activation of effectors (muscles and glands) through cranial and spinal nerves.

Sensory function

Sensation is a process of being aware of exchanges of the environment.
These changes can be the internal (PH, blood pressure, chemicals ,..) or external (temperature, light, sound, ...).

Those changes can lead to changes in homeostasis, and as the main function of nervous system is to maintain homeostasis, it has to receive and process so many **stimuli** to do its function.

Stimuli are the changes that happen in the environment.


For nervous system to deal with them, it must sense them using special structures called **receptors**
NS is able to understand stimuli because of the presence of receptors.

These receptors are highly specific for the types of stimulus, that each receptor can sense a specific type of stimuli.

Sensory function

For example, There are **photoreceptors** in the retina of the eye that detect (sense) changes in light (electromagnetic waves). These receptors will not respond to other types of stimuli.

Also, **touch sensory receptors**)mechano receptors) respond to touch, if you put light on them, nothing will happen.

These receptors will convert the energy of the stimuli (whether its sound waves, lightwaves, chemical, thermal, mechanical…) into **electrical signals** (change in the membrane potential which can be action potential or graded potential) ,receptor potential is a graded potential.

Now, as the stimuli turned-into electrical signals nervous system the **sensory neurons (PNS)** carries **sensory signals** to **CNS** for processing.

Sensory function

- Most activities of the nervous system are initiated by sensory experiences that excite sensory receptors.

- These sensory experiences can either cause *immediate reactions* from the brain, or *memories of the experiences* can be **stored** in the brain for minutes, weeks, or years and determine bodily reactions at some future date.

Functions of the nervous system

- **Sensory function**: sensory receptors detect internal or external stimuli. The sensory information is carried to the CNS through cranial and spinal nerves.
- **Integrative function**: processes sensory information by analyzing it and making decision for appropriate responses. (Processing of data and making decision which happen all exclusively in CNS)
- **Motor function**: activation of effectors (muscles and glands) through cranial and spinal nerves.

Integrative function

- More than 99 percent of the sensory information is discarded by the brain as irrelevant and unimportant.

- However, when important sensory information excites the mind, it is immediately channeled into proper integrative and motor regions of the brain to cause desired responses. When sensory signals reach the CNV, different responses can happen because the CNV analyze the new information comparing it with previous information and experiences that it already has, which vary from person to other.

- This channeling and processing of information is called the integrative function of the nervous system.

Integrative function

- We call it an **integrative function** because the CNS integrates new information with previously stored information. It also integrates multiple types of information together. For example, to understand a lecture, it's not enough just to see the doctor; you also have to listen and be consciously aware of what is happening.

- The decision will be made by the CNS will be one of three types of decisions:

1. **immediate response**: whether it is very important that we have to react immediately

2. **store information** for later: the CNS will decide that it doesn't need this info for now but store it in the CNS for use in the future. The main store house for information in the cerebral-cortex.

3. **discard information**: the CNS will decide that this info isn't important and should be discarded. (more than 99% of info is discarded) You can try to imagine the amount of inputs you get as you are watching the lecture right now in addition to internal inputs, so NS has to focus on a specific type of information and discard the others.

Storage of information: memory

- Only a small fraction of even the most important sensory information usually causes ***immediate motor response***.

- Much of the information is **stored** for future control of motor activities and for use in the thinking processes.

- Most storage occurs in the **cerebral cortex**, but even the **basal regions** of the brain and the **spinal cord** can store **small** amounts of information.

Storage of information: memory

- Once memories have been stored in the nervous system, they become part of the brain processing mechanism for future “thinking.”

- The thinking processes of the brain compare new sensory experiences with stored memories; the memories then help to select the important new sensory information and to channel this into appropriate memory storage areas for future use or into motor areas to cause immediate bodily responses.

Spinal cord

- The spinal cord has two main functions:

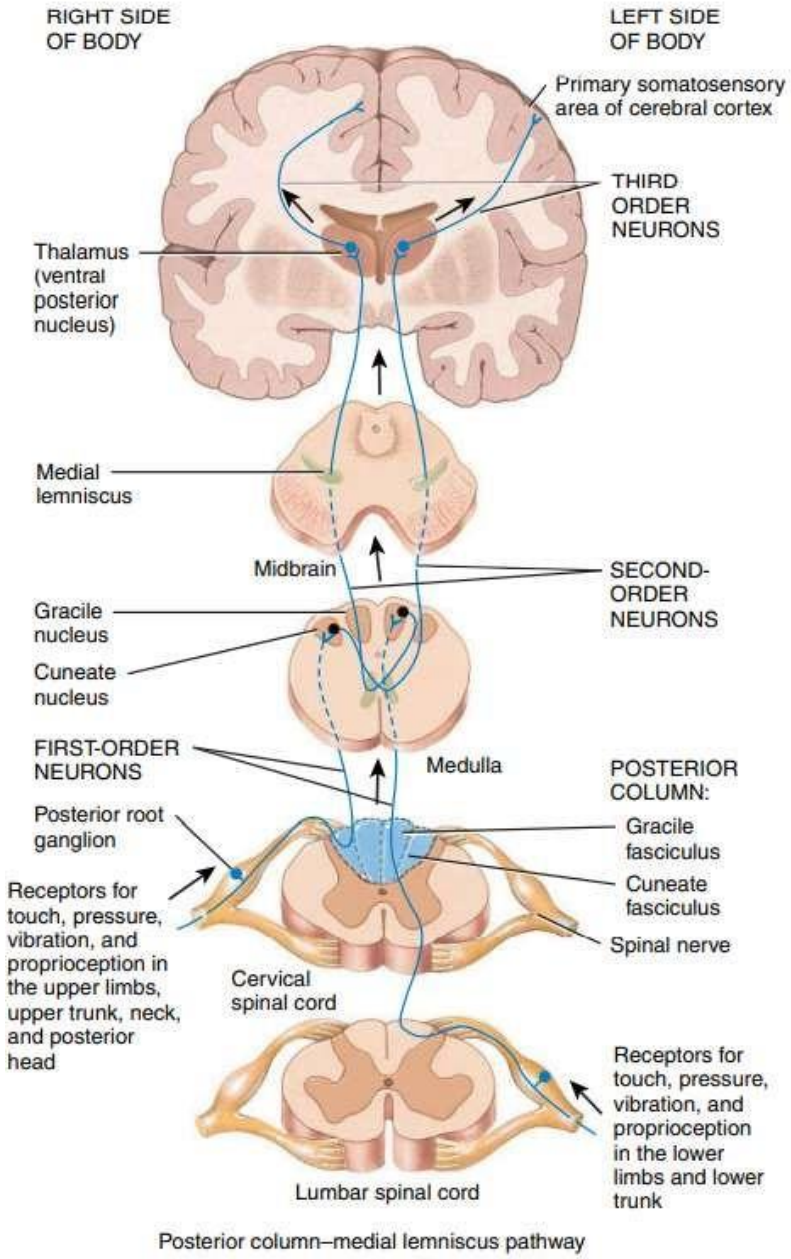
- 1- nerve impulse propagation (sensory and motor tracts): transmits signals from the periphery of the body to the brain, or in the opposite direction from the brain back to the body.

- 2- integration of information (such as in spinal reflexes-fast decision(-

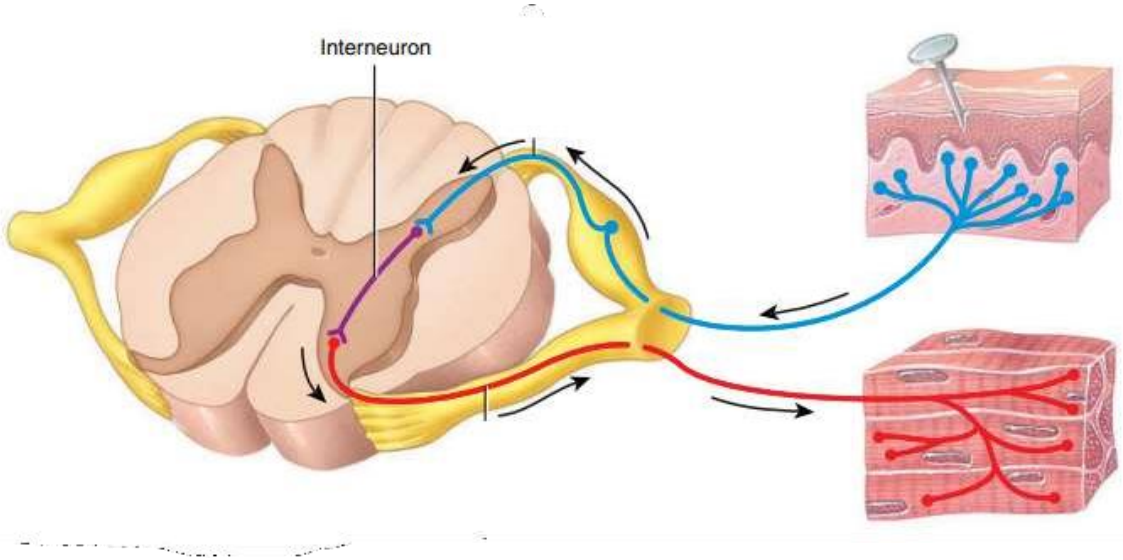
  Decision-making

See slide 23

Again : the brain and the spinal cord

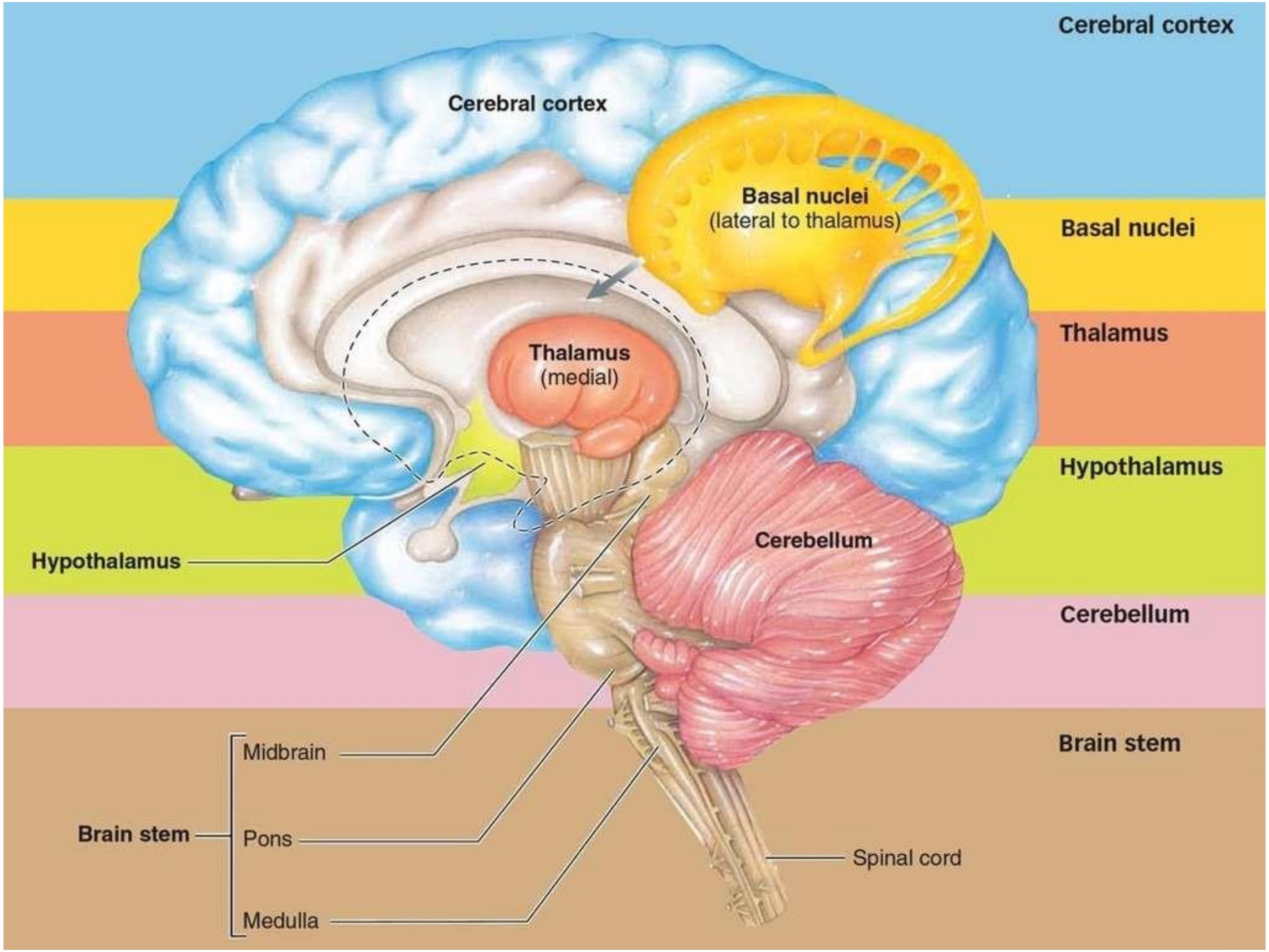


Posterior column–medial lemniscus pathway



There are parts responsible for sensation motors,sensation and Visual, etc.

It has the limbic system (diencephalon,hippocampus, amygdala), which is responsible for the emotions



The most sophisticated and developed structure in the Central nervous system

controls the movement, (if someone had Parkinson disease, you should know that it's a disease in the basal nuclei)

Huge, very important, the gate to the cerebral cortex (سكرتيرة القشرة الدماغية)

Controlling other hormones, and also the autonomic function

controls the balance in the body

Very important to control the vital functions like cardiovascular system and respiratory center

Lower brain (subcortical regions)

- Many, if not most, of the subconscious activities of the body are controlled in the lower areas of the brain.

- Examples of subcortical structures are brain stem, cerebellum, diencephalon, basal nuclei, hippocampus, and amygdala.

Higher brain (cerebral cortex)

- Cerebral cortex is an extremely large **memory storehouse**.

- Without the cerebral cortex, the functions of the lower brain centers are often imprecise. Cortical information usually converts these functions to determinative and **precise operations**. For example, while walking, The lower brain, including the brainstem and cerebellum, **controls basic muscle movements, balance, and rhythm automatically and quickly,** allowing the body to walk *without conscious* thought for each step. At the same time, the cerebral cortex **adds precision and conscious control**, such as changing direction, avoiding obstacles, and adjusting step speed, making the movement smooth and safe.

- The cerebral cortex is essential for most of our **thought processes**.

Functions of the nervous system

- **Sensory function**: sensory receptors detect internal or external stimuli. The sensory information is carried to the CNS through cranial and spinal nerves.

- **Integrative function**: process sensory information by analyzing it and making decision for appropriate responses.

Skeletal
cardiac
smooth

endocrine
exocrine

- **Motor function**: activation of effectors (muscles and glands) through cranial and spinal nerves.The performance of the decisions, neurons that are coming out of CNS holding the decisions and taking them to the effectors (the structures in their body that perform the function)

Motor function

- The most important eventual role of the nervous system is to **control the various bodily activities.**

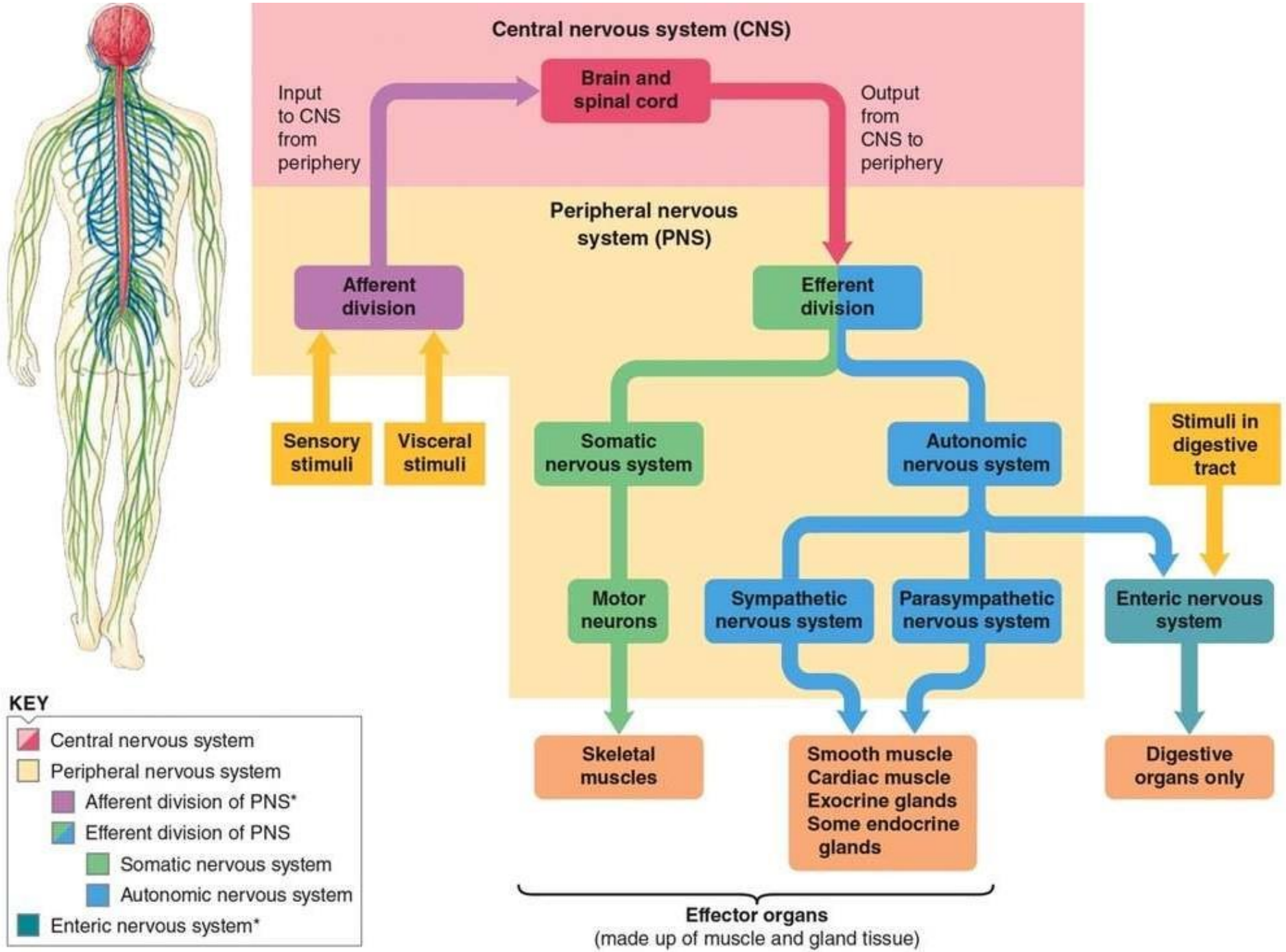
- This task is achieved by controlling:
- (1) contraction of appropriate skeletal muscles throughout the body.
- (2) contraction of smooth muscle in the internal organs.
- (3) secretion of active chemical substances by both exocrine and endocrine glands in many parts of the body.

It includes the changing of the activity of the muscles or the glands

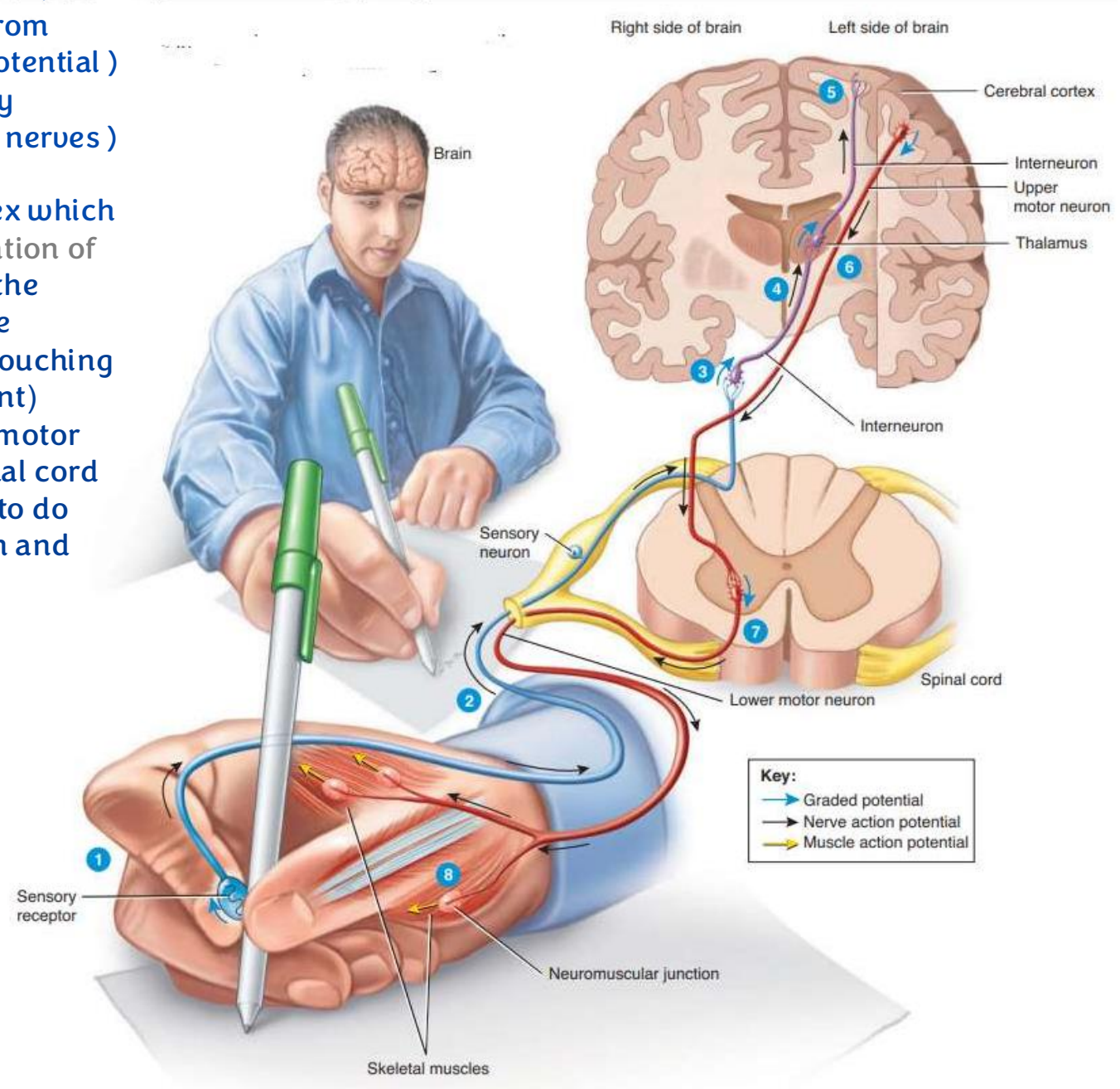
Motor function

- These activities are collectively called motor functions of the nervous system.

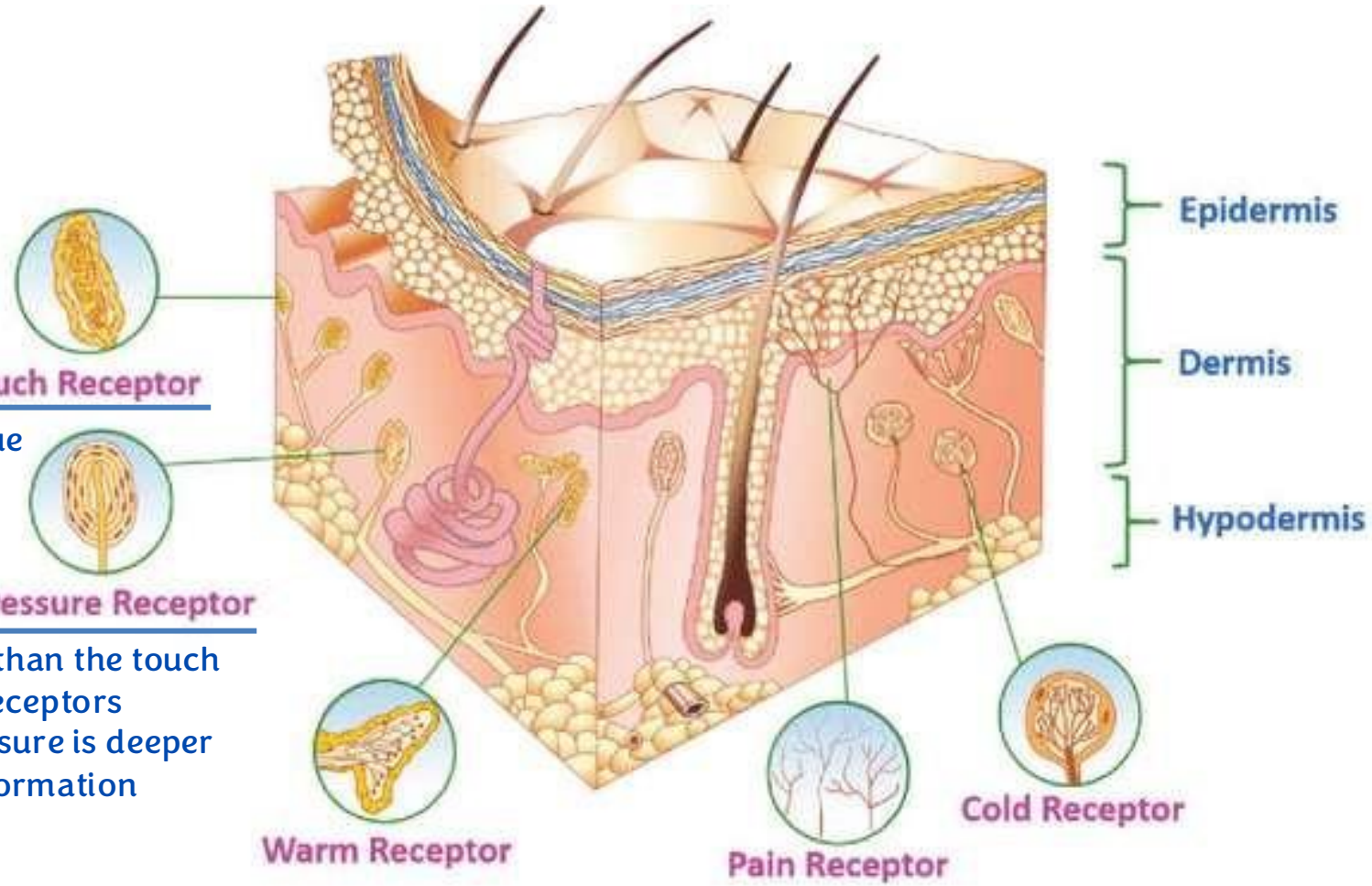
- The muscles and glands are called **effectors** because they are the actual anatomical structures that perform the functions dictated by the nerve signals.


Central nervous system (CNS)
Brain and spinal cord
Input to CNS from periphery
Output from CNS to periphery
Peripheral nervous system (PNS)
Afferent division
Efferent division
Sensory stimuli
Visceral stimuli
Somatic nervous system
Autonomic nervous system
Stimuli in digestive tract
Motor neurons
Sympathetic nervous system
Parasympathetic nervous system
Enteric nervous system
Skeletal muscles
Smooth muscle
Cardiac muscle
Exocrine glands
Some endocrine glands
Digestive organs only
Effector organs
(made up of muscle and gland tissue)
KEY
Central nervous system
Peripheral nervous system
Afferent division of PNS*
Efferent division of PNS
Somatic nervous system
Autonomic nervous system
Enteric nervous system*

1- Sensory receptors will be activated, then there will be signal transduction from mechanical to electrical (action potential)
2- it is moving through the sensory neurons to the spinal cord (spinal nerves)
3- to the brain (cranial nerves)
5- processing at the cerebral cortex which is known as Perception (Interpretation of stimulus) (you'll be conscious of the sensation if it was processed at the cerebral cortex, like the sense of touching which is from external environment)
6+7- signal transduction through motor neurons from the brain to the spinal cord
8- do the skeletal muscle muscles to do certain contraction to hold the pen and start write .



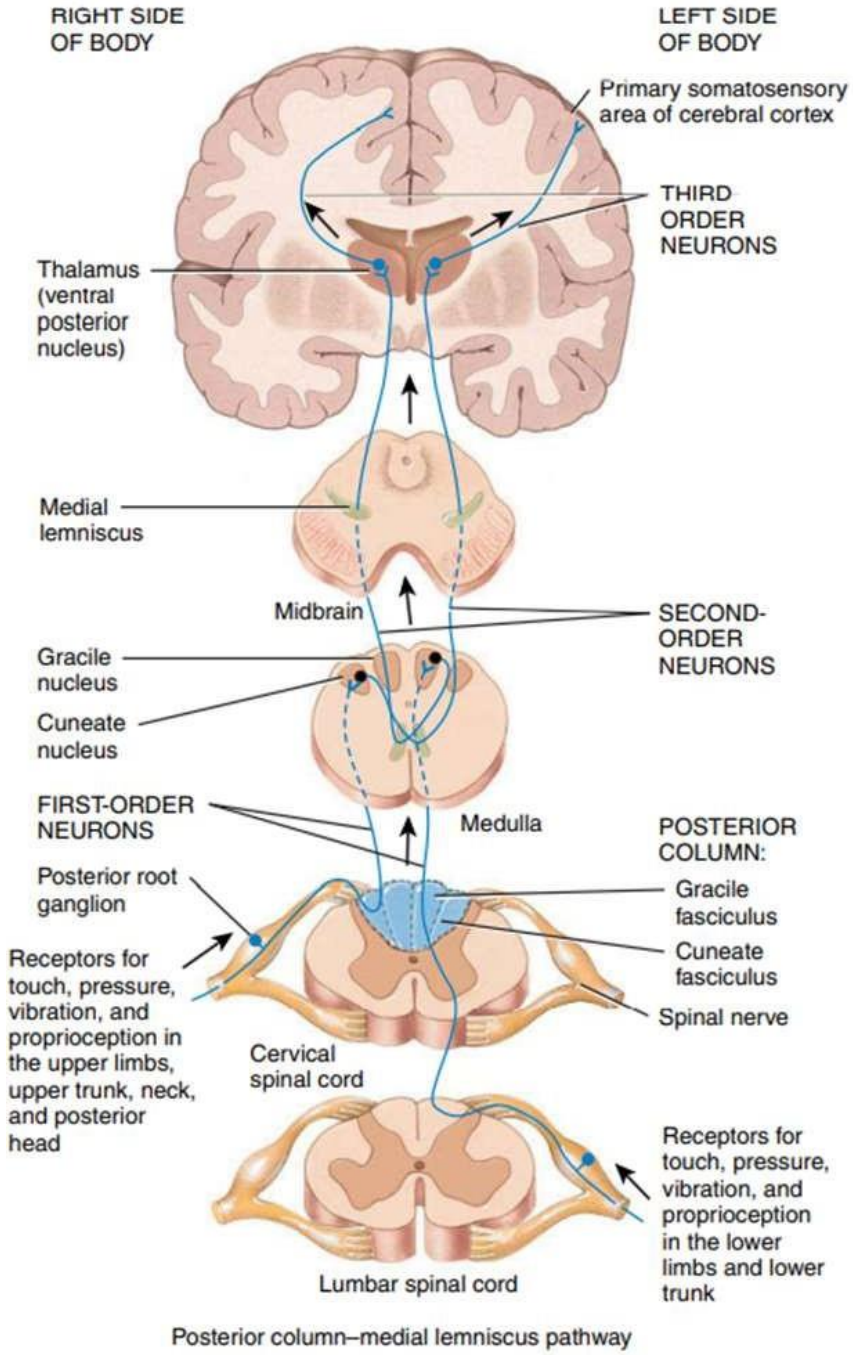
We have many types of sensory receptors



In Subcutaneously tissue

Deeper than the touch receptors
So pressure is deeper information

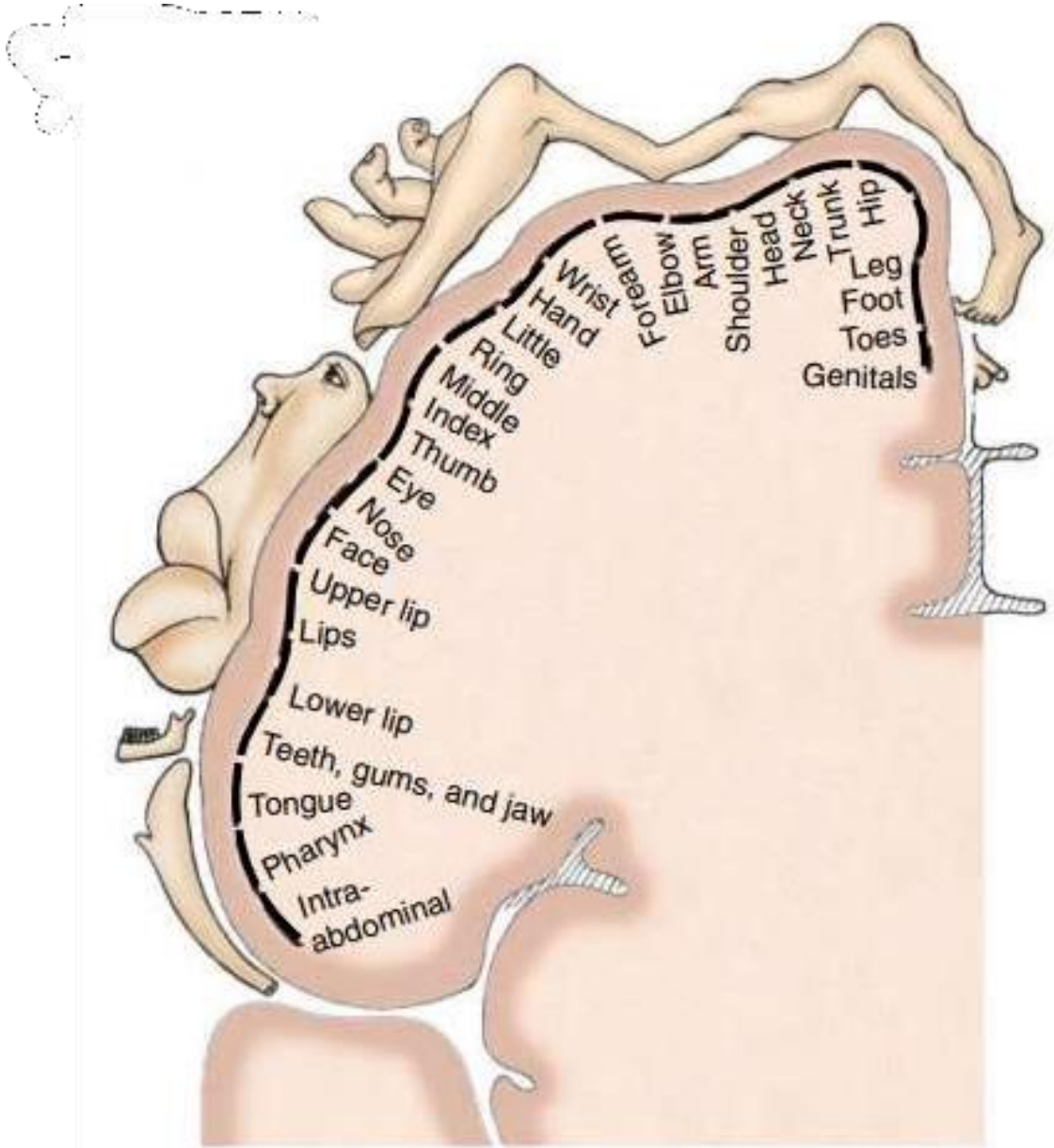
You don't have to remember the details or the names here, just a few illustrations to slide 23



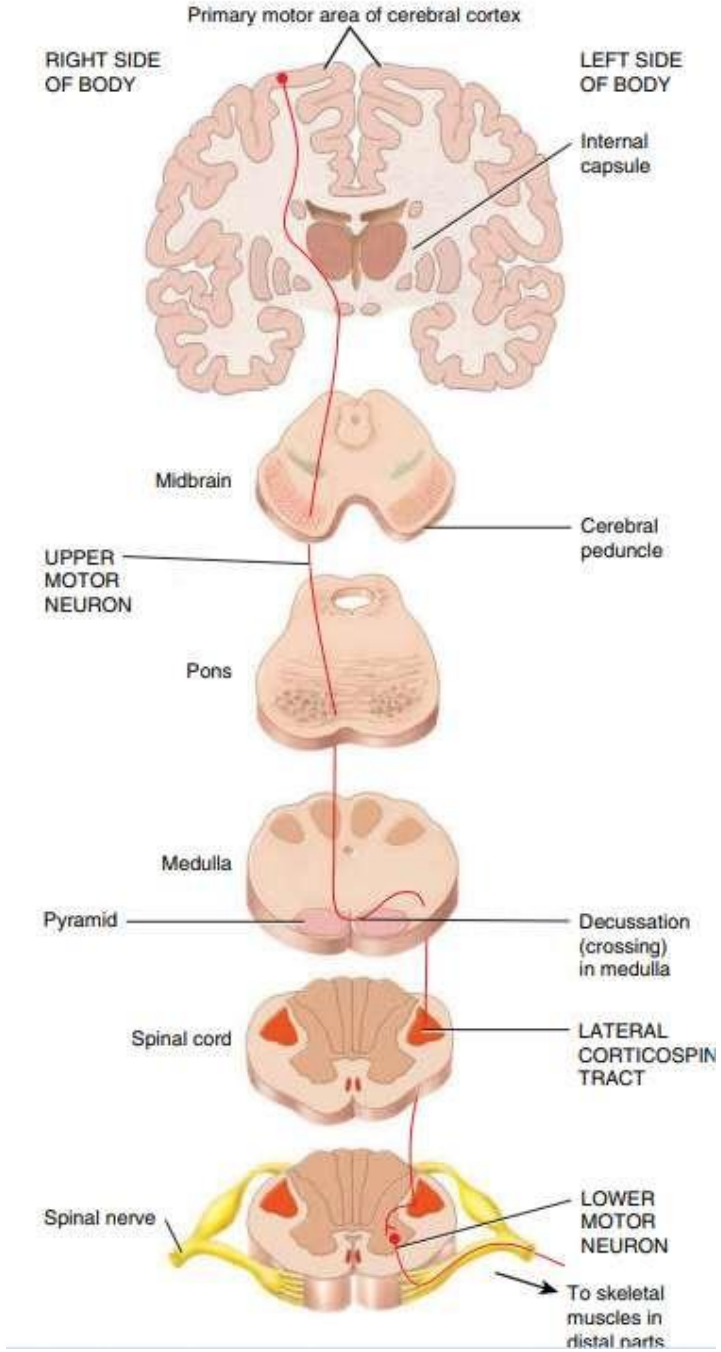
Posterior column–medial lemniscus pathway

Ascending Pathway to the cerebral cortex

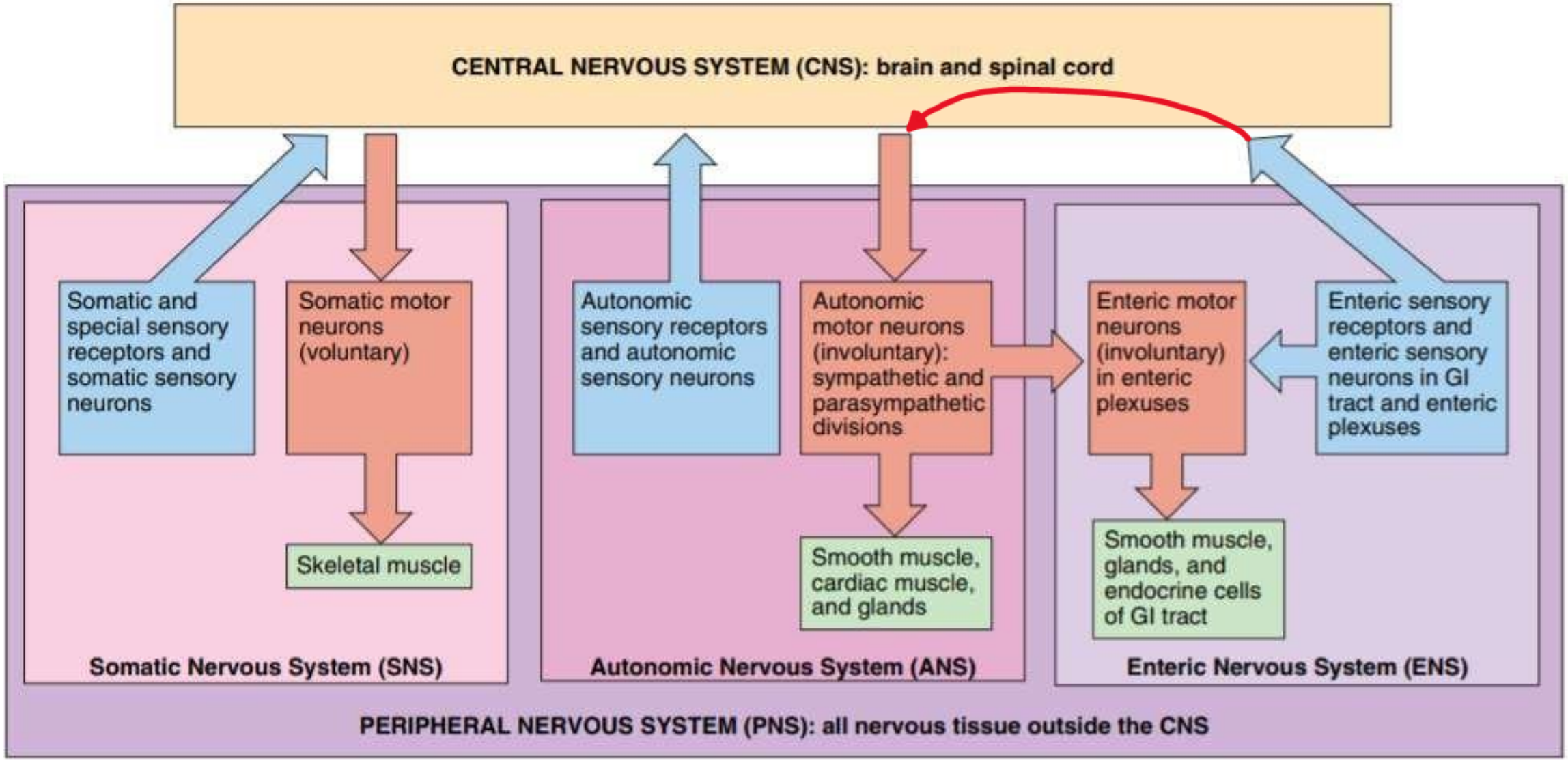
There are specific area for each different part of the body in the cerebral cortex



(a) Frontal section of primary somatosensory area in right cerebral hemisphere



Descending motor pathway



Depending on where does the information come from

Soma means : the body including skin, subcutaneous tissue, mucous membrane, joints, and bones

Somatic nervous system

(at the Brain cortex) I'm conscious So the integration occurs in the cerebral cortex

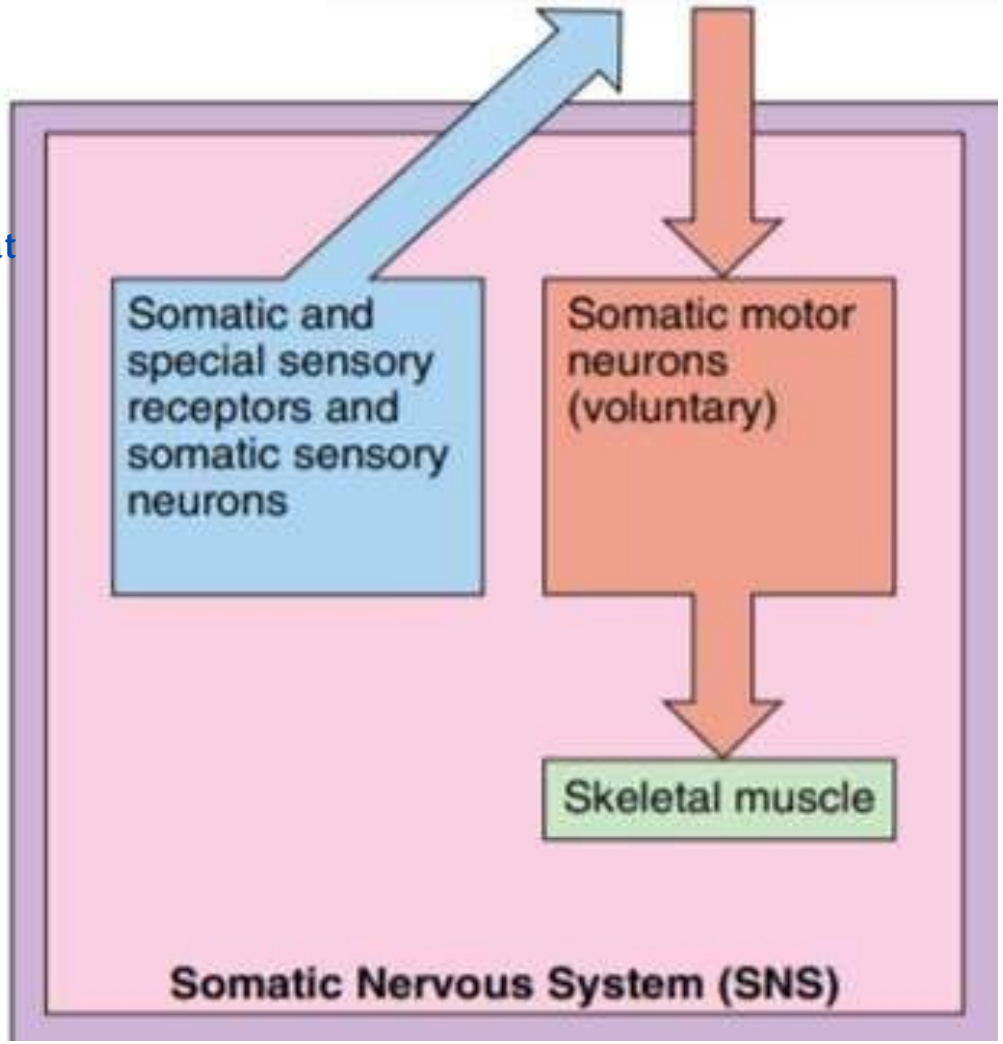
- **sensory neurons**: convey information from somatic receptors (in the in the head, body wall and limbs)and from receptors of special senses: vision, hearing and taste to the CNS.

From the external environment

- **motor neurons**: conduct impulses from CNS to skeletal muscles only.

Effectors

- It is the **voluntary** part of PNS because the motor response can be **consciously** controlled.



Autonomic nervous system

- **sensory neurons**: convey information from autonomic sensory receptors (located mainly in the visceral organs) to the CNS.

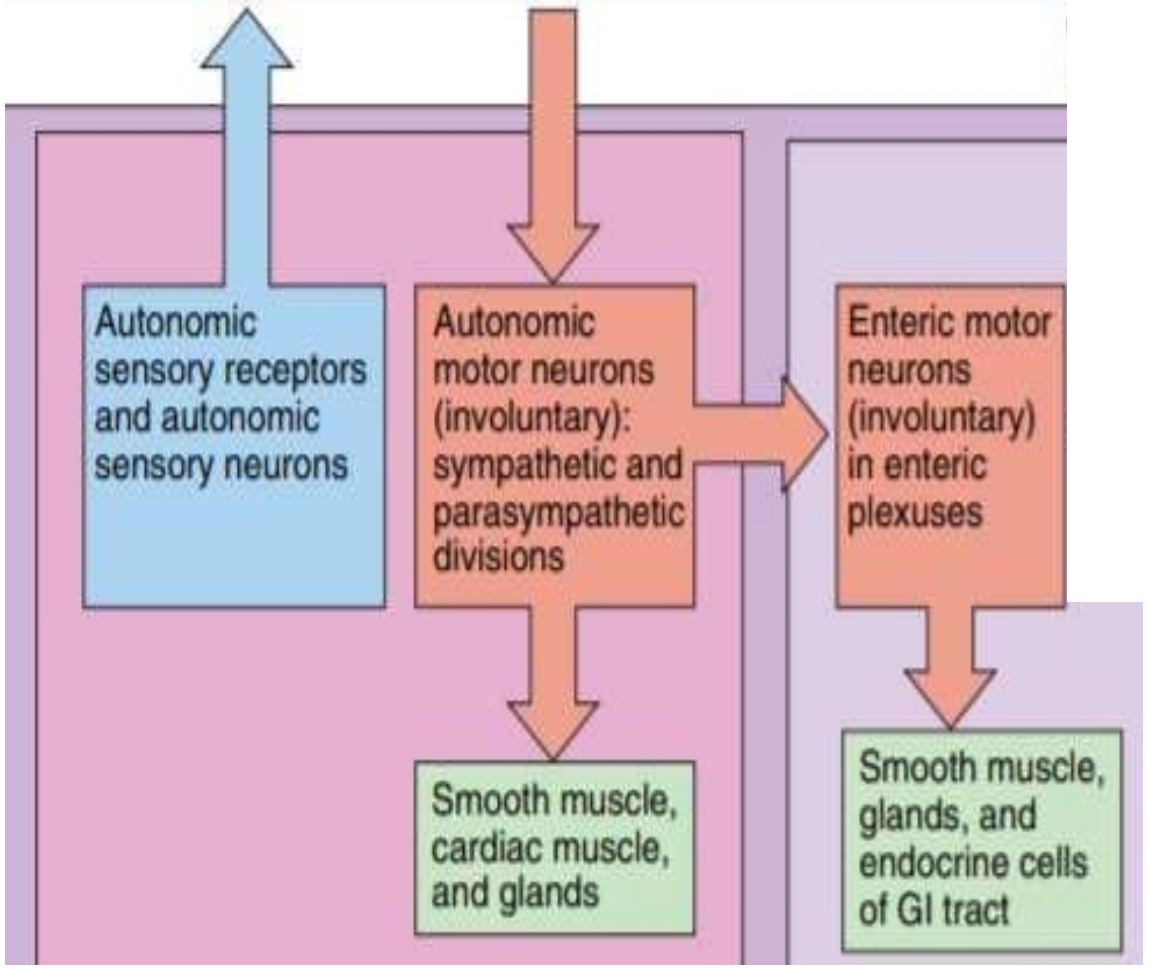
  From the internal organs) within the body)

- **motor neurons**: conduct impulses from CNS to <u>smooth muscles, cardiac muscles and glands</u>. because the motor responses are **not normally under conscious** control, its action is **involuntary**.

  Fight or flight response

- The motor part is divided into **sympathetic and parasympathetic** divisions.

  Rest and digest



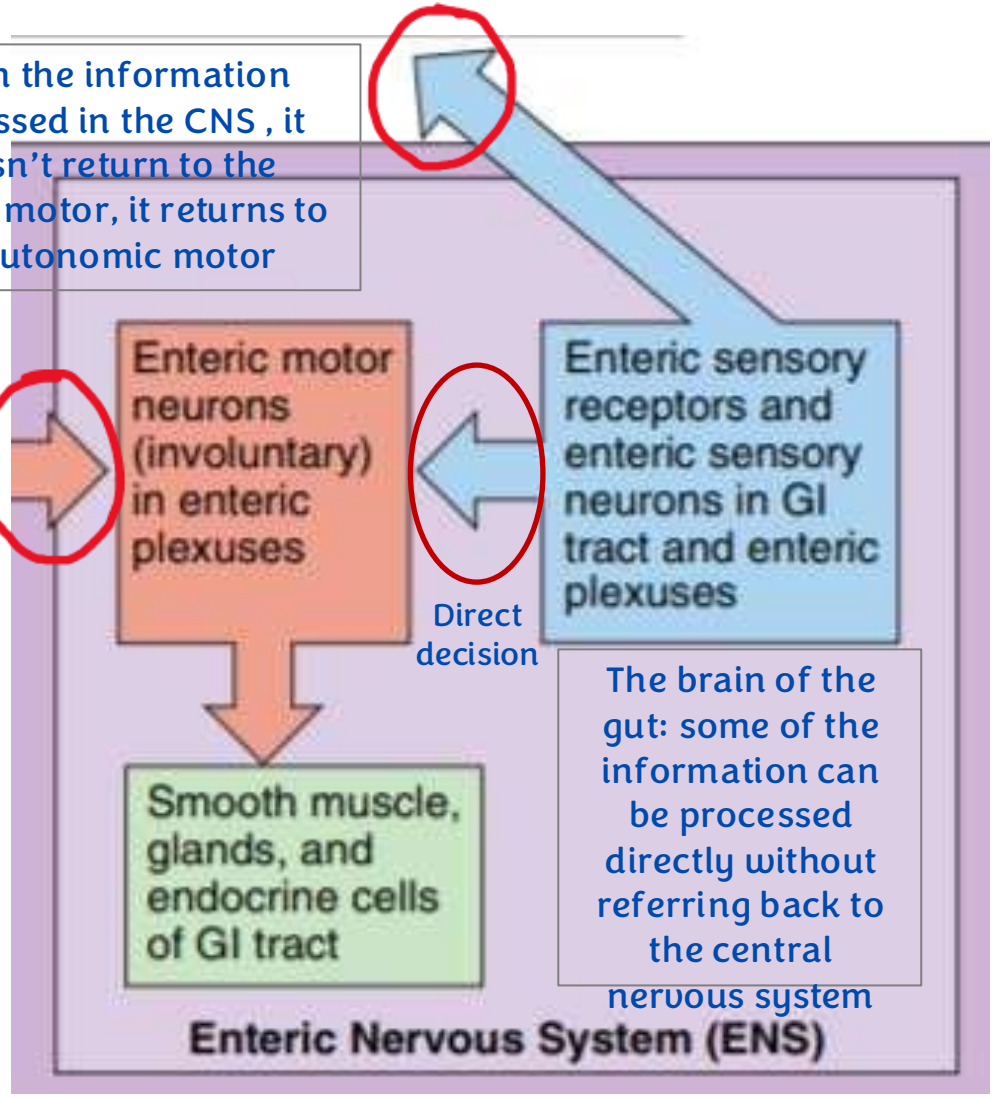
Related to the digestive system

Enteric nervous system

- **Sensory neurons**: monitor changes within the digestive system (gastrointestinal: GI).
- **Motor neurons**: control the contraction of GI smooth muscles , the secretions of GI organs, and the activities of GI endocrine cells. It is called the brain of the gut.
- It is **involuntary**. Many of ENS neurons function independent of ANS or CNS, although they also communicate with the CNS via **sympathetic** and **parasympathetic** neurons.

See slide 28

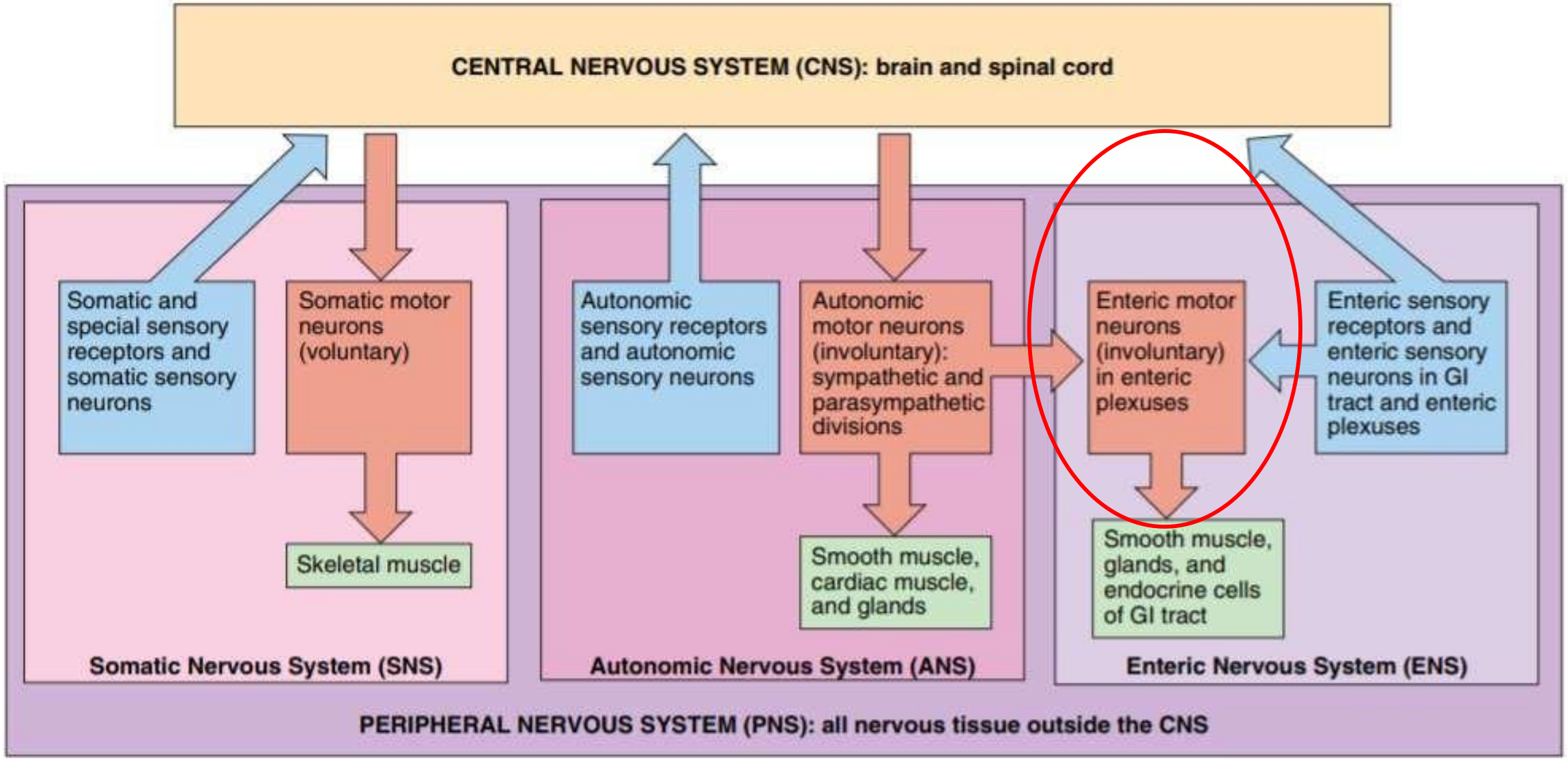
When the information processed in the CNS , it doesn't return to the Enteric motor, it returns to the autonomic motor



From the autonomic nervous system

Direct decision

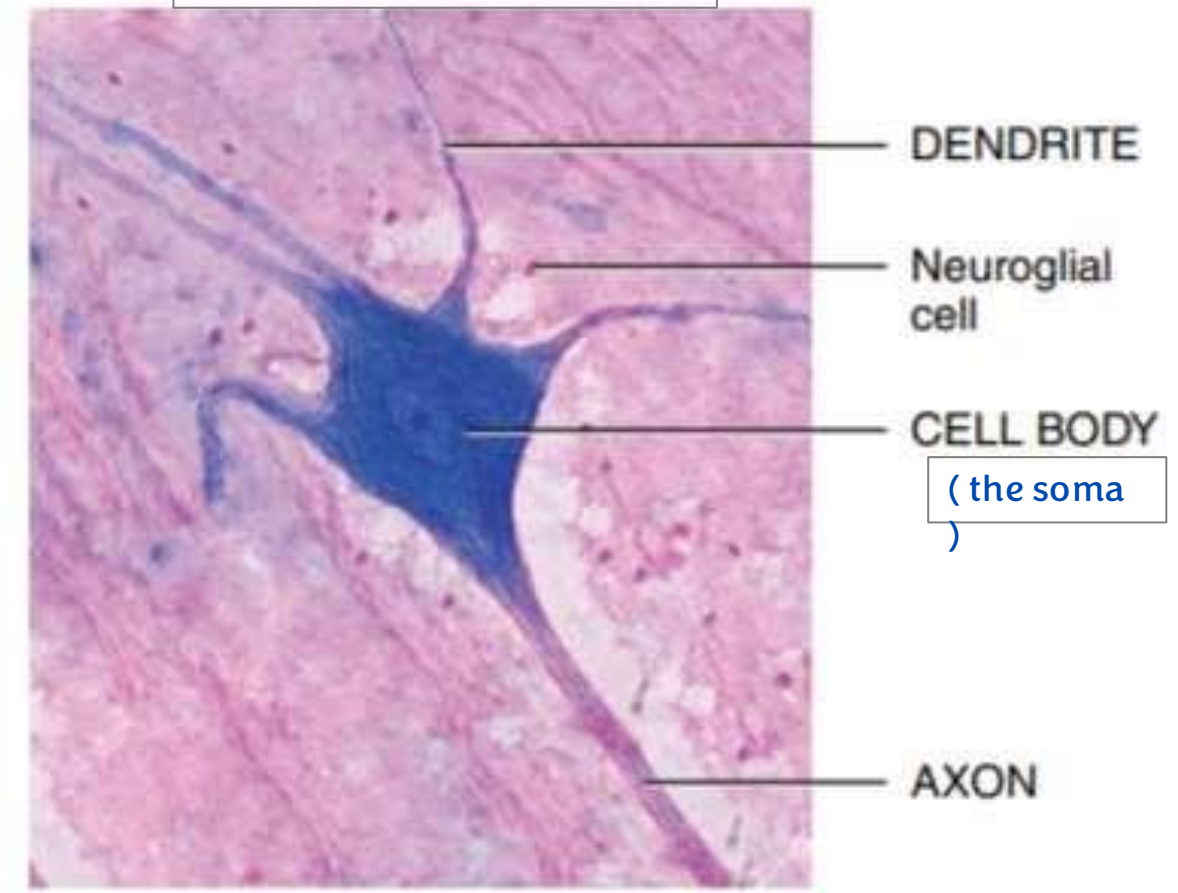
The brain of the gut: some of the information can be processed directly without referring back to the central nervous system


CENTRAL NERVOUS SYSTEM (CNS): brain and spinal cord
Somatic and special sensory receptors and somatic sensory neurons
Somatic motor neurons (voluntary)
Skeletal muscle
Somatic Nervous System (SNS)
Autonomic sensory receptors and autonomic sensory neurons
Autonomic motor neurons (involuntary): sympathetic and parasympathetic divisions
Smooth muscle, cardiac muscle, and glands
Autonomic Nervous System (ANS)
Enteric motor neurons (involuntary) in enteric plexuses
Enteric sensory receptors and enteric sensory neurons in GI tract and enteric plexuses
Smooth muscle, glands, and endocrine cells of GI tract
Enteric Nervous System (ENS)
PERIPHERAL NERVOUS SYSTEM (PNS): all nervous tissue outside the CNS

The functional unit of the nervous system is the **neuron**

Nerve cell

The NERVE is NOT a NEURON



Collections of nervous tissue

- Components of nervous tissue are grouped together in a variety of ways. Could being in peripheral or central

Collections of axons

- The widespread collection of axons in the CNS is called **white matter**.

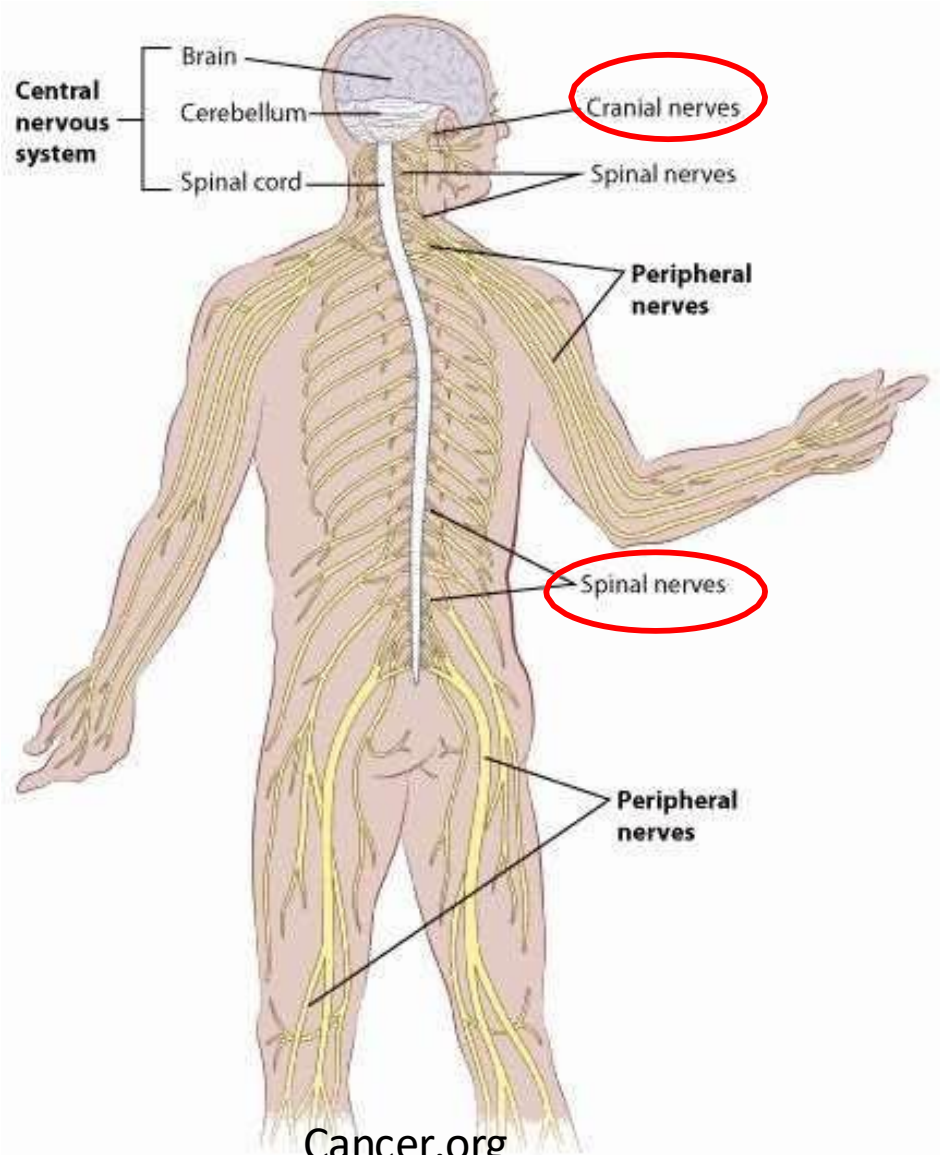
Collection

- A bundle of axons in the **CNS** is called **tract**. Slide 37

Collection

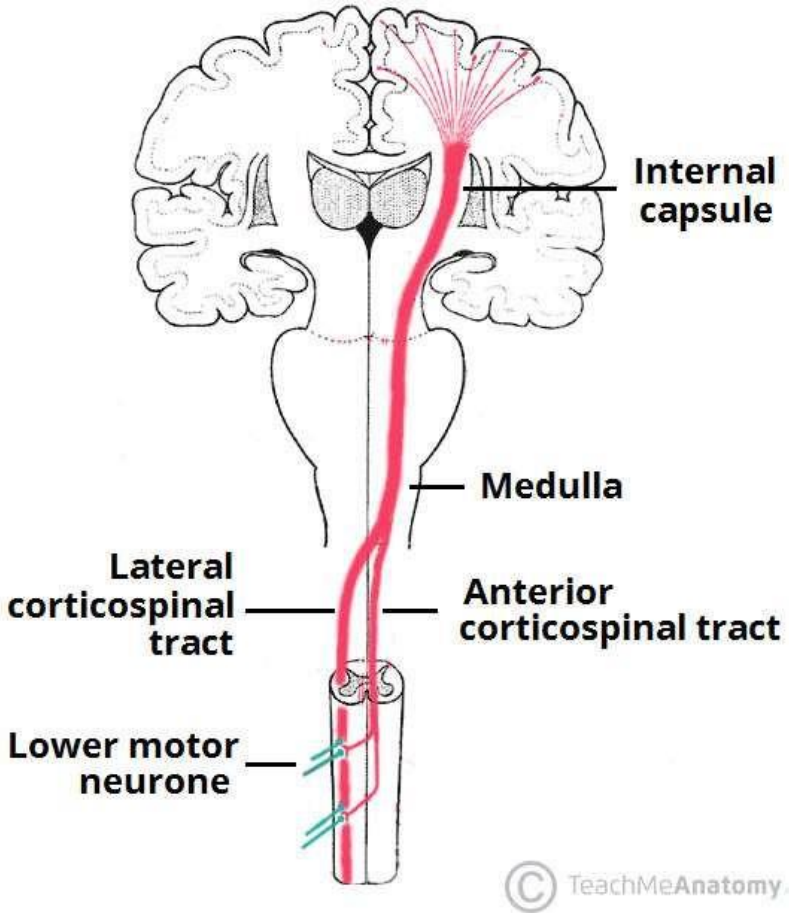
- A bundle of axons in the **PNS** is called **nerve**. Slide 36

Nerve



Cancer.org

Tract

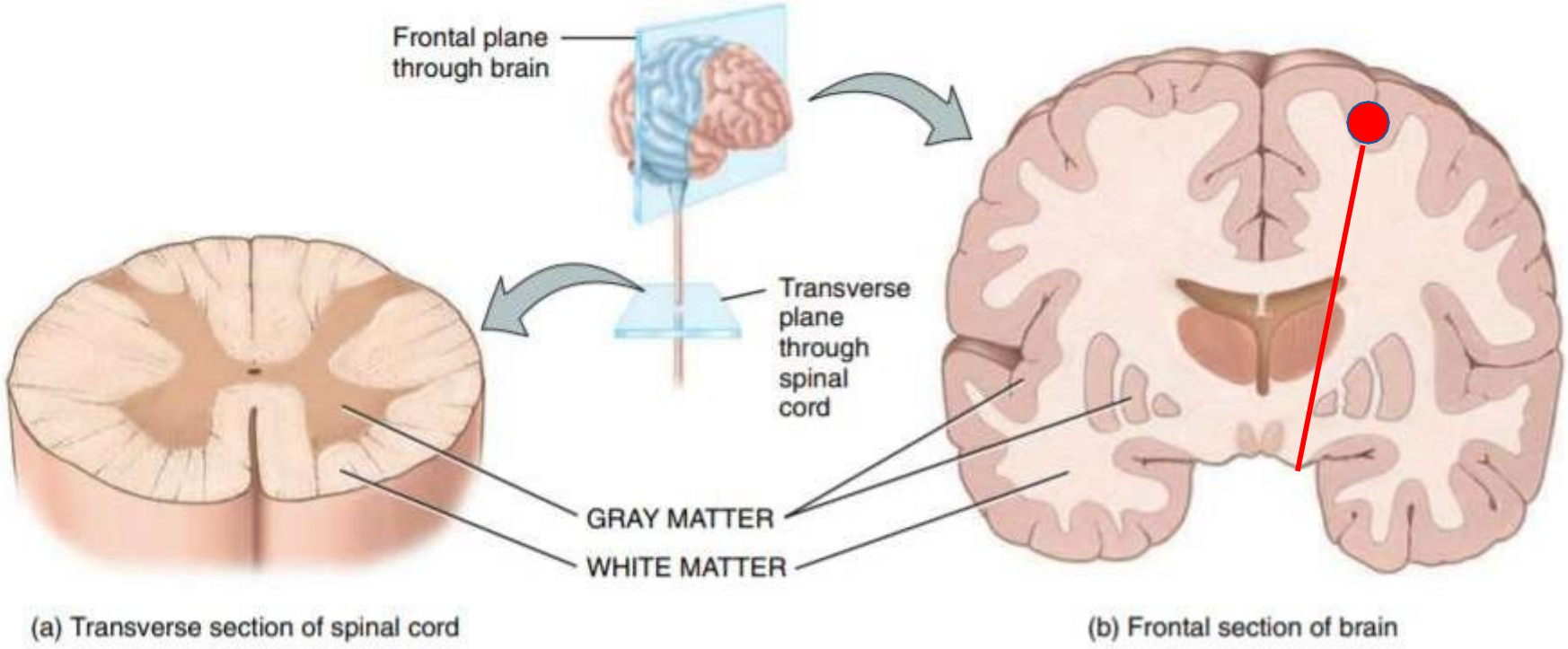


Descending pathway

White matter

The wide spread Axons in the spinal cord and the brain –CNS-

It's white because of the fatty myelin sheeth that covers it



Collections of neuronal cell bodies

A widespread collection of neuronal cell bodies is called **gray matter**.

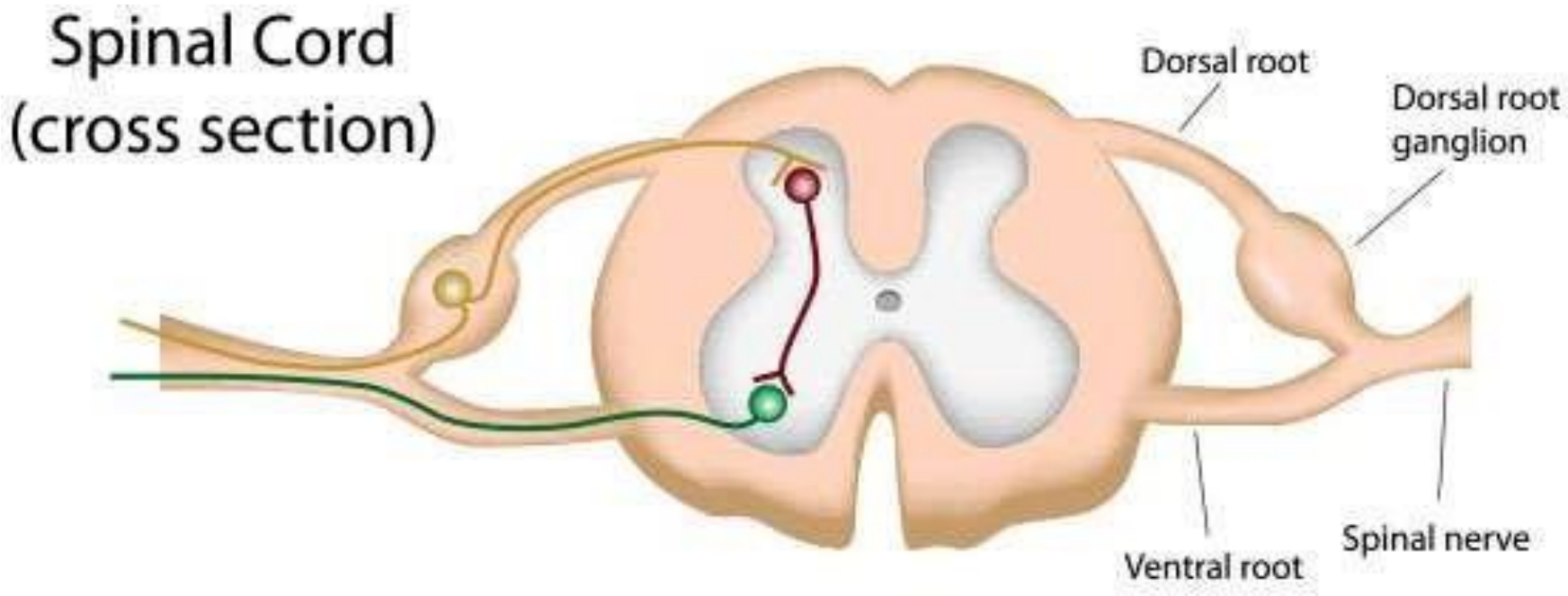
Collection

A cluster of neuronal cell bodies in the CNS is called **nucleus**. Slide 41

Collection

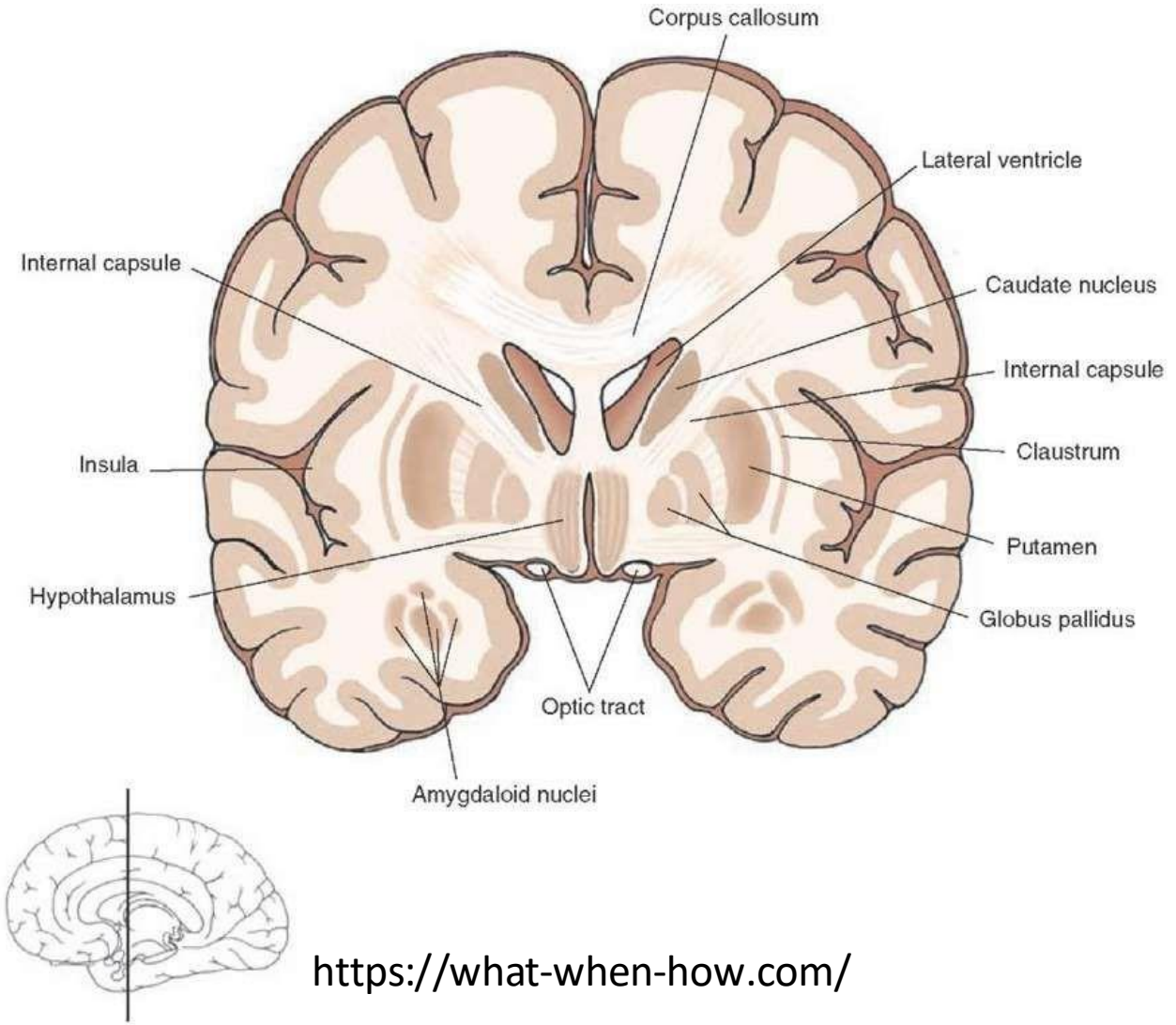
A cluster of neuronal cell bodies in the PNS is called **ganglion**. Slide 40

Ganglion



https://socratic.org

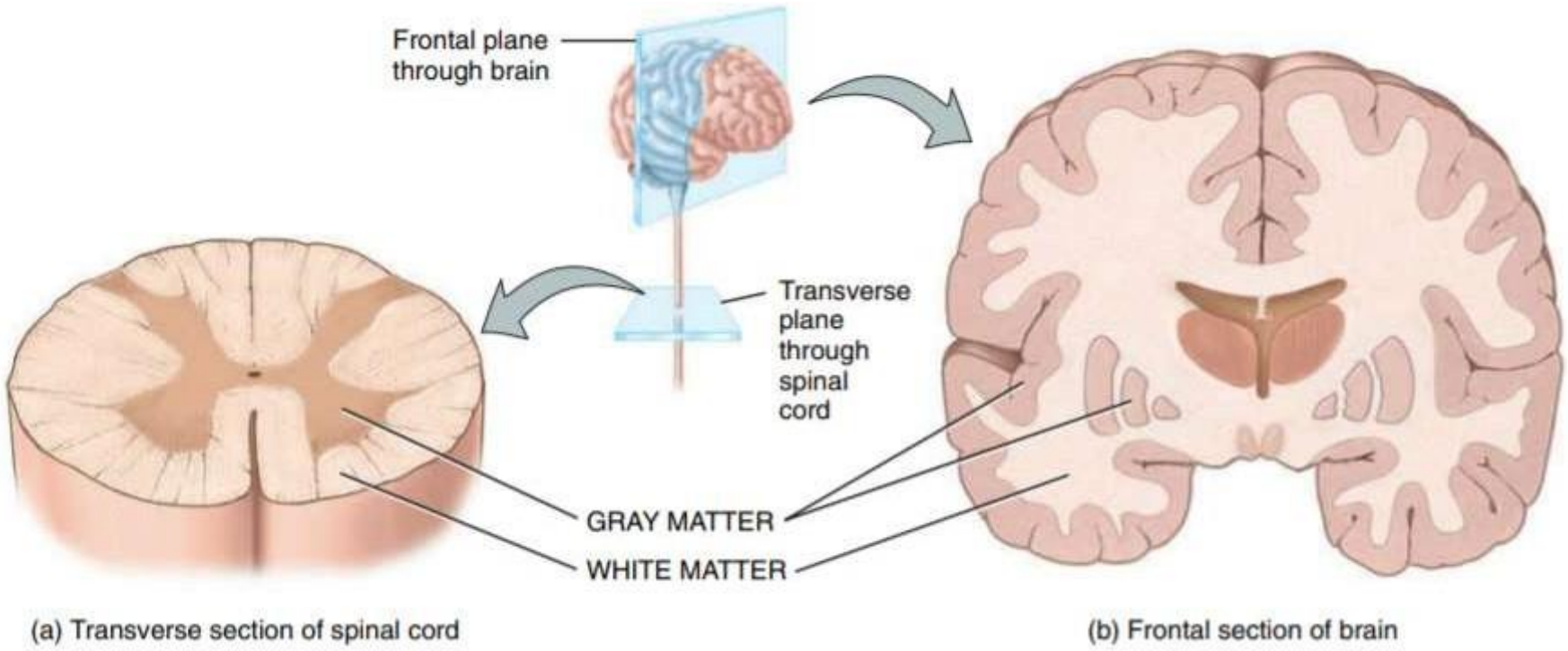
Nucleus



https://what-when-how.com/

Gray matter

The gray matter is the wide spread of collection of cell body in the CNS

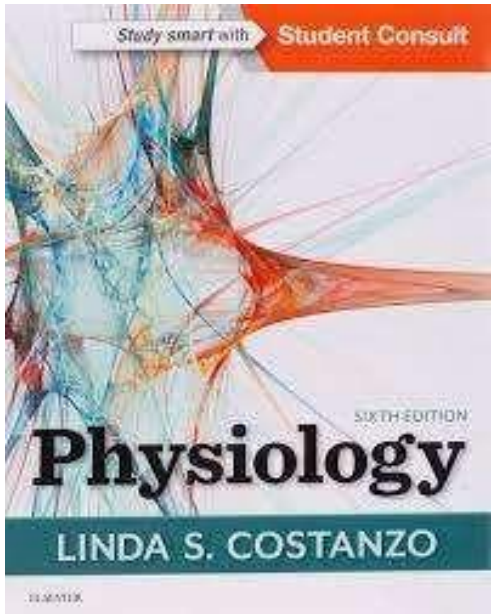


In the brain, gray matter located on the outer surface,while it located deeper in the spinal cord as a butterfly-shaped

Now , test yourself by this quiz :

https://forms.gle/LAMgH81uHvWadZf88

References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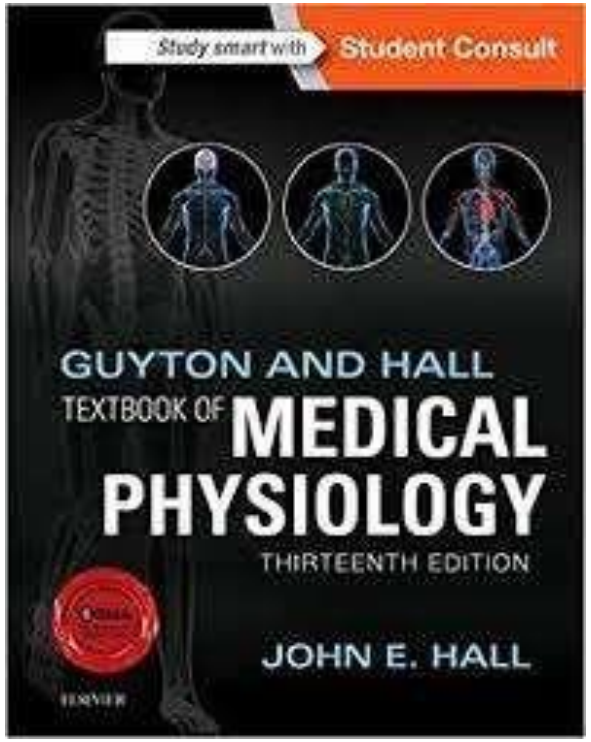
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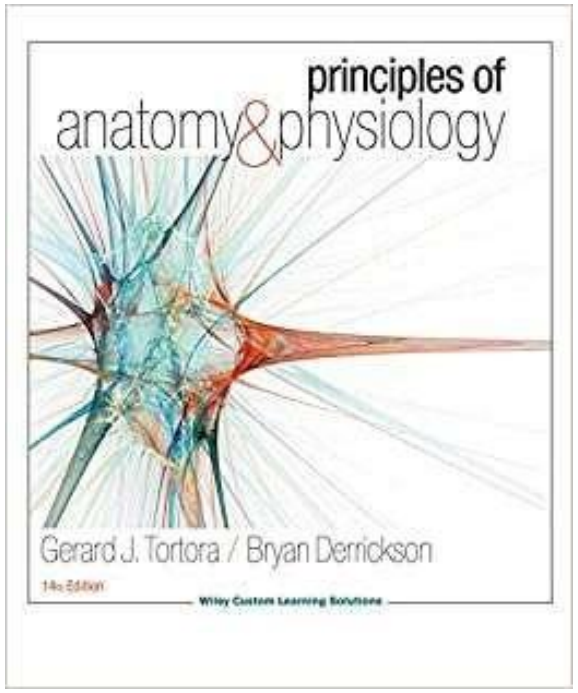
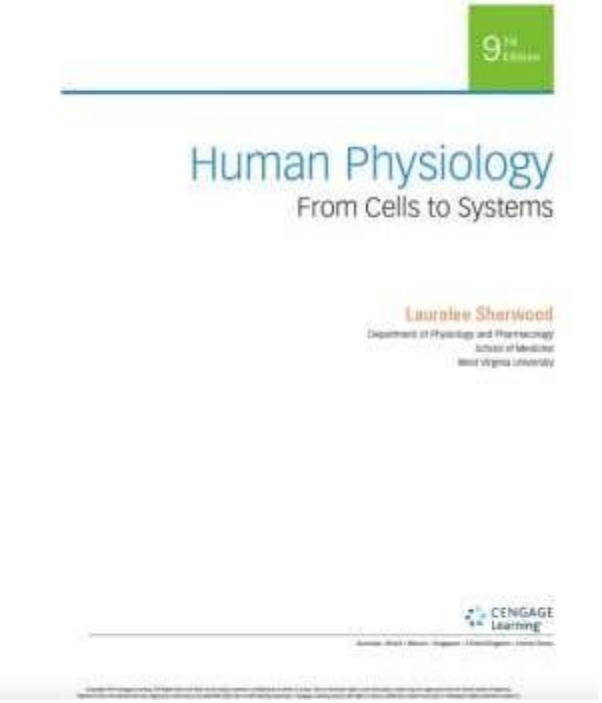

principles of
anatomy & physiology
Gerard J. Tortora / Bryan Derrickson


Human Physiology
From Cells to Systems
Lauralee Sherwood
CENGAGE Learning

Questions? Feedback?

Thank you

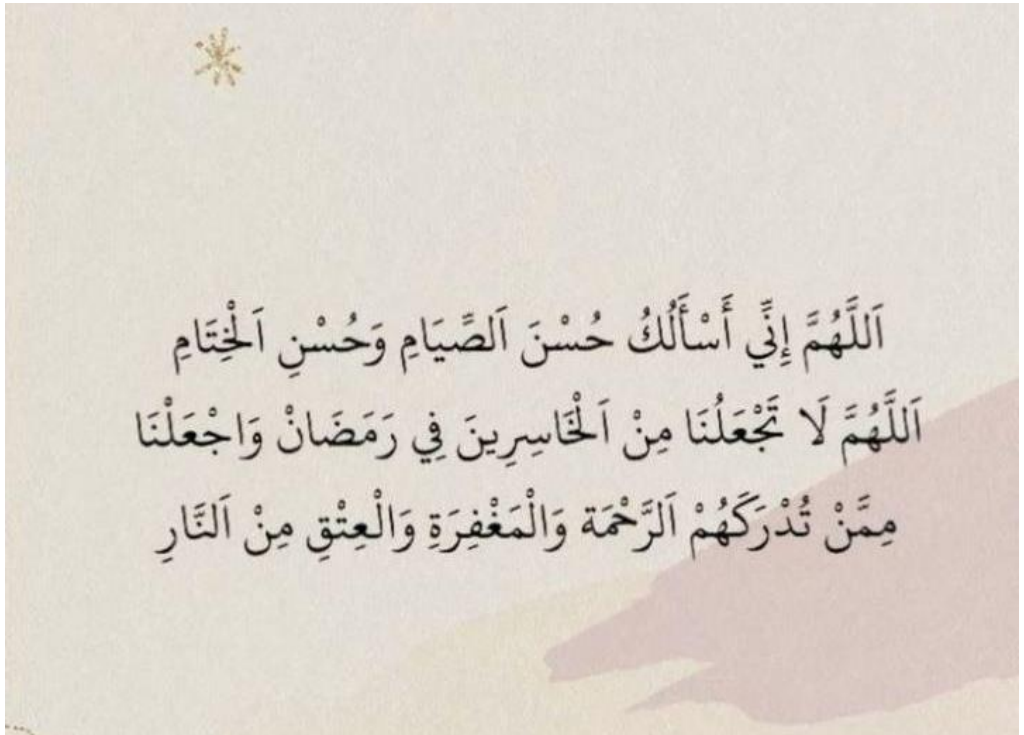
For any feedback, scan the code or click on it.

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	11 18	(more than 90% of info is discarded)	(more than 99% of info is discarded) Note added
V1 → V2			

Additional Resources:

رسالة من الفريق العلمي:

إنَّ لِرَبكُم في هذهِ الأيّام نَفَحات وعطيَّات فتعرَّضوا لِنَفَحاتِه وَتَقرَّبوا إلَيه بصالح أعمالِكُم واغتَنموا ما بَقيَ مِن شَهْركُم ...
فلَئِن مَضى جُلُّه
فلَقَد بَقِيَ أَفضَلُه...



Reference Used:
(numbered in order as cited in the text)

1. Dr.Fatima’s lecture