Introduction to Neurophysiology 1

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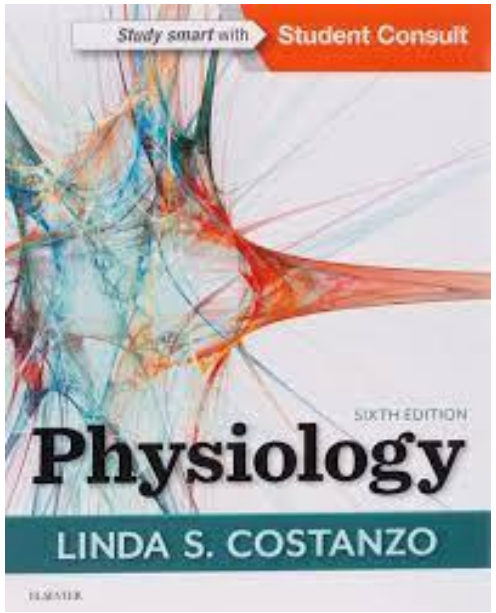
References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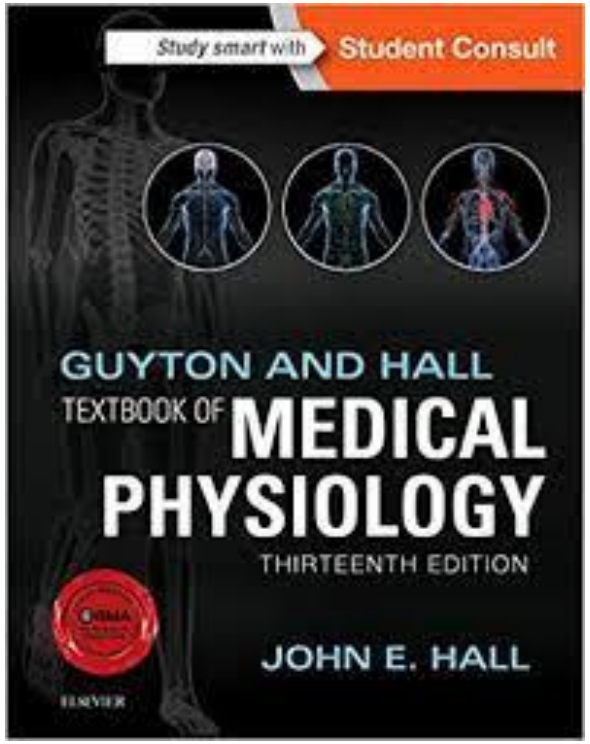
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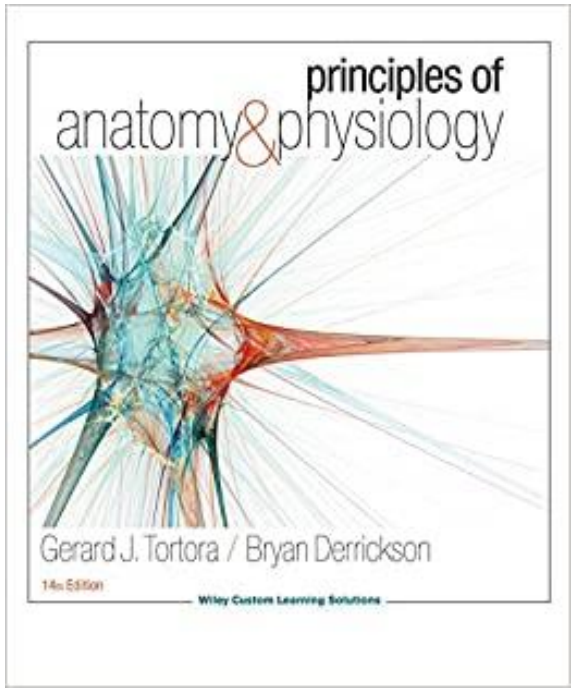
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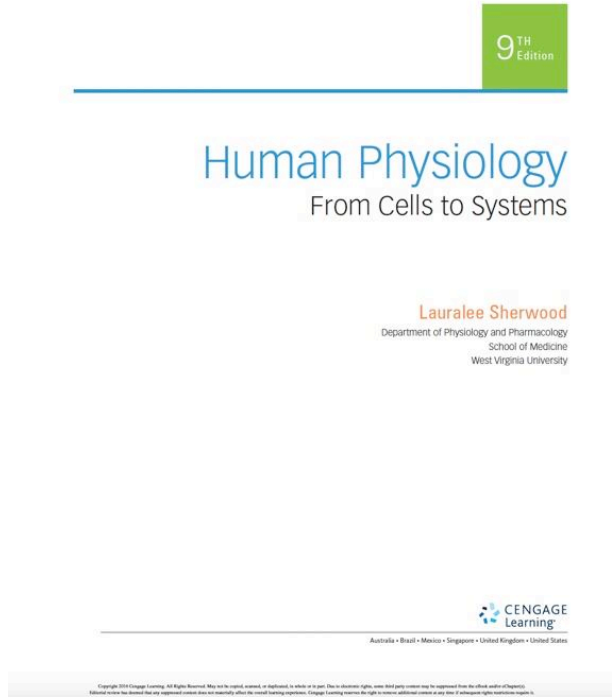
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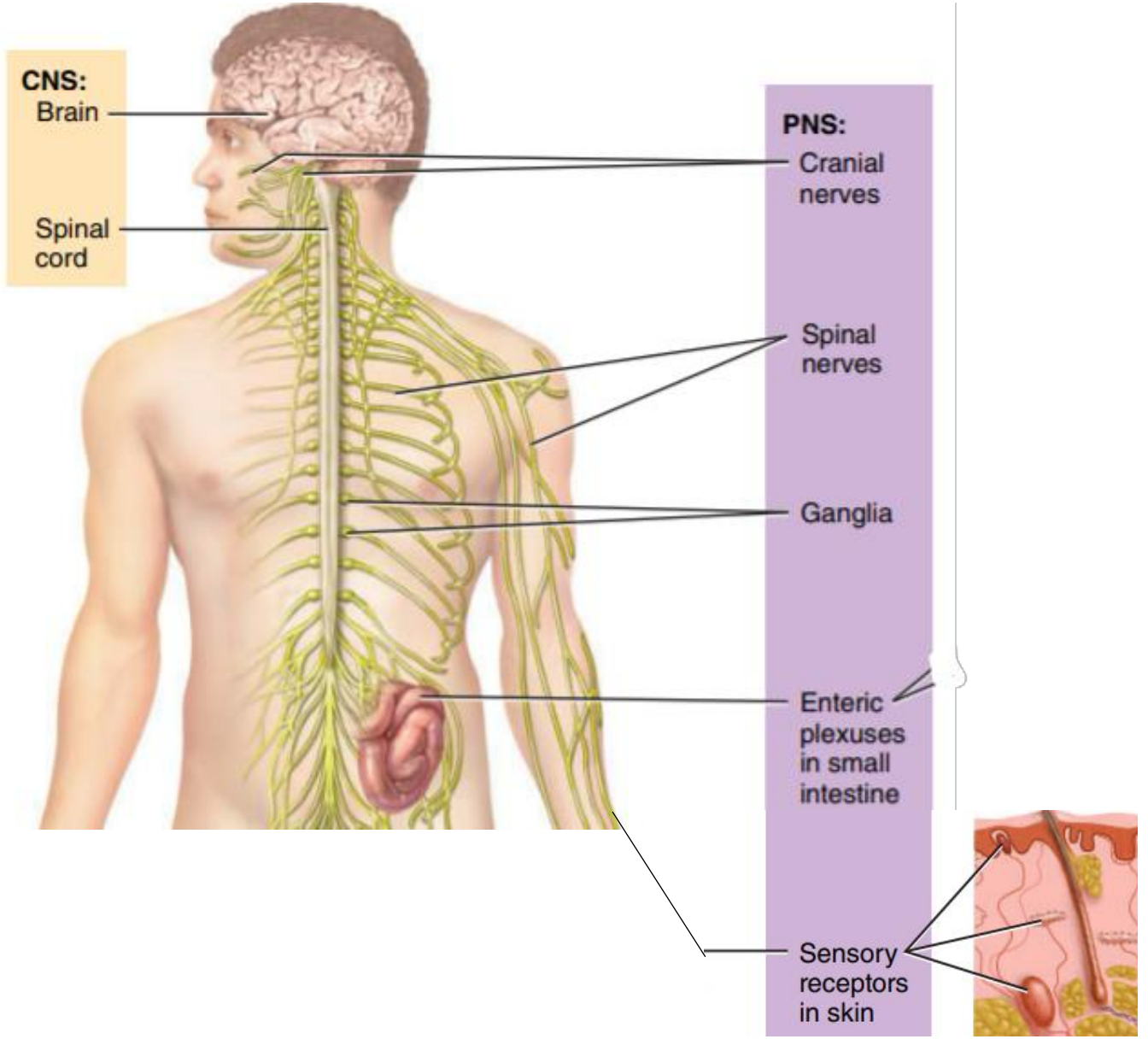
Overview of the nervous system

- The nervous system is composed of two divisions:
- The central nervous system (CNS), which includes the brain and the spinal cord.
- The peripheral nervous system (PNS), which includes sensory receptors, nerves, and ganglia.

Organization of the nervous system



Functions of the nervous system

Sensation :- the process of being of changes in the enviroment (Internal & External).

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

Crainal nerves mean the nerves that emerges from Brain or go to Brain stem (go to Brain stem in the context of sensory function).

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

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

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.

① ② ③ or it could be just discard. (more than 99% of sensory experiences).

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.

processing

by comparing sensory information to previous information.

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

→ Immediate reaction
→ Store the information
→ discard the information

- **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 (توجة) into proper integrative and motor regions of the brain to cause desired responses.

These are parts of the brain responsible for processing the information (integrative) and triggering movement or action (motor).

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

Storage of information: memory

sensory information that didn't get discard.

- 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.

المعلومات الحسية نستقبلها عن طريق ال **receptors** الموجودة في مختلف مناطق الجسم سواء **internal or external** وعملية التفكير هي مقارنة هاي المعلومات بالمعلومات القديمة وتحديد اذا كانت المعلومات الحسية مهمة او لا بناءً على عملية التفكير وينتج عنها اما تخزين المعلومات الحسية ب **cerebral cortex** او عمل رد فعل سريع عن طريق ال **motor neurons** او يتم التخلص منها.

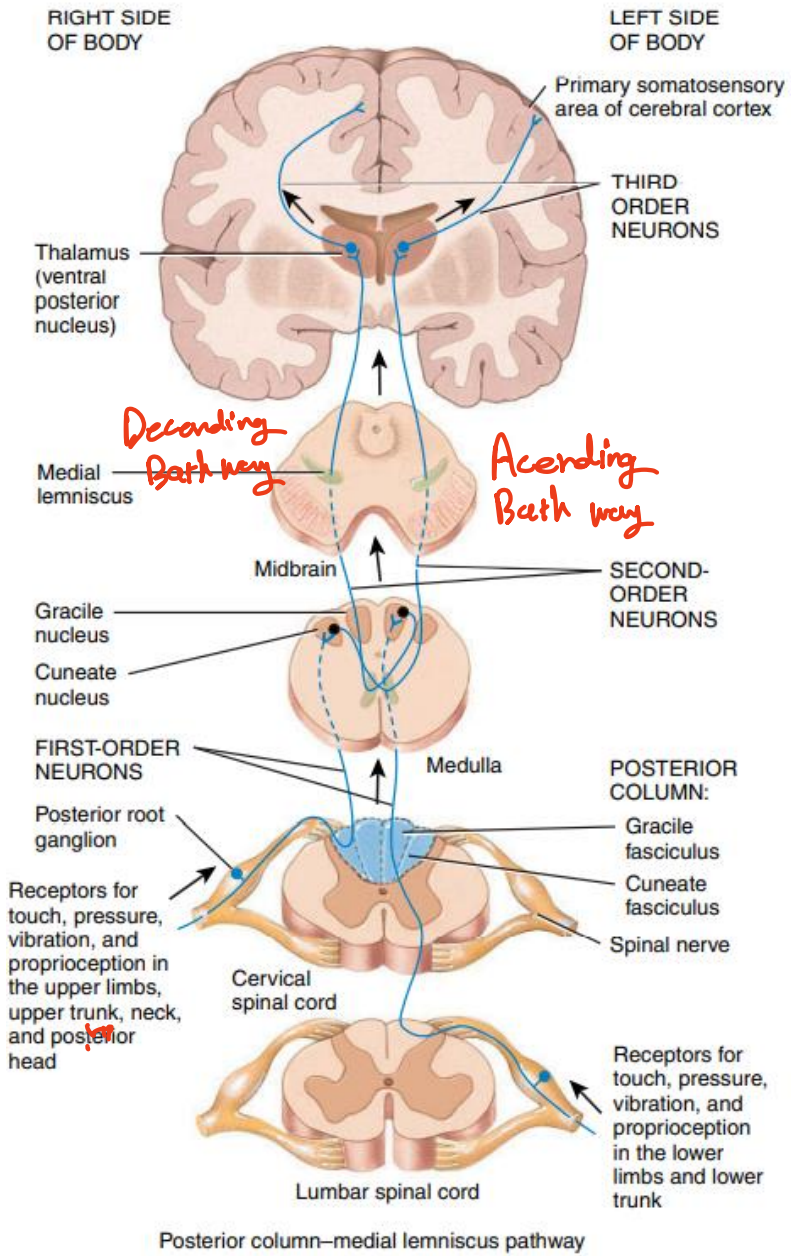
Spinal cord

- 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.

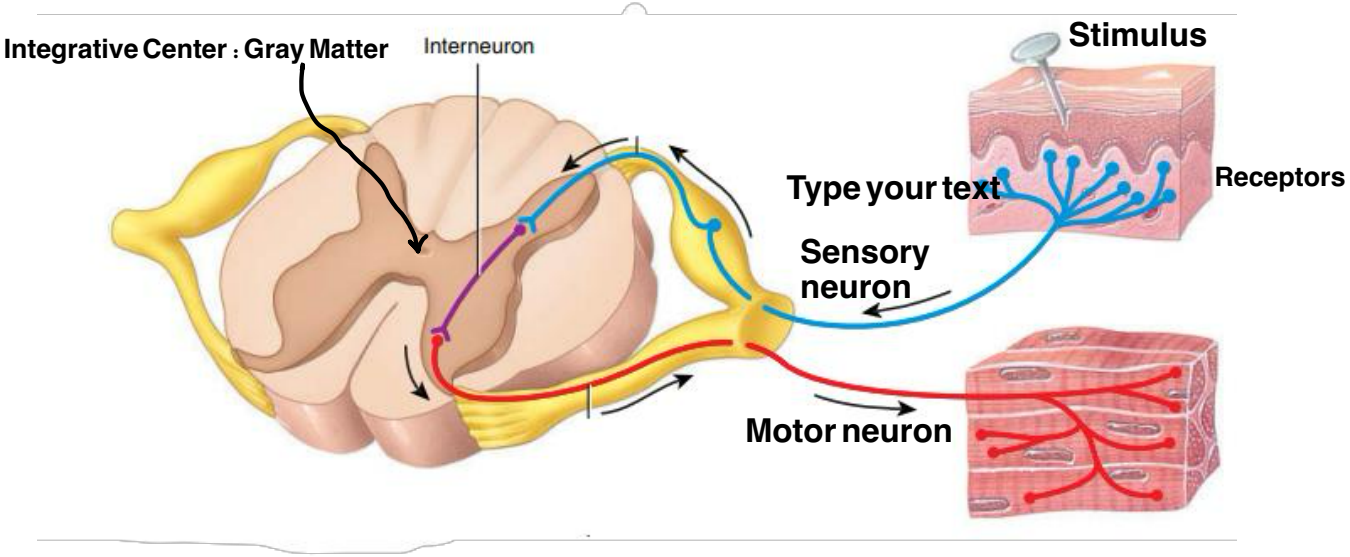
- 2- integration of information (such as in spinal reflexes).

fast respones done by ANS without any involvment of the brain



Posterior column–medial lemniscus pathway

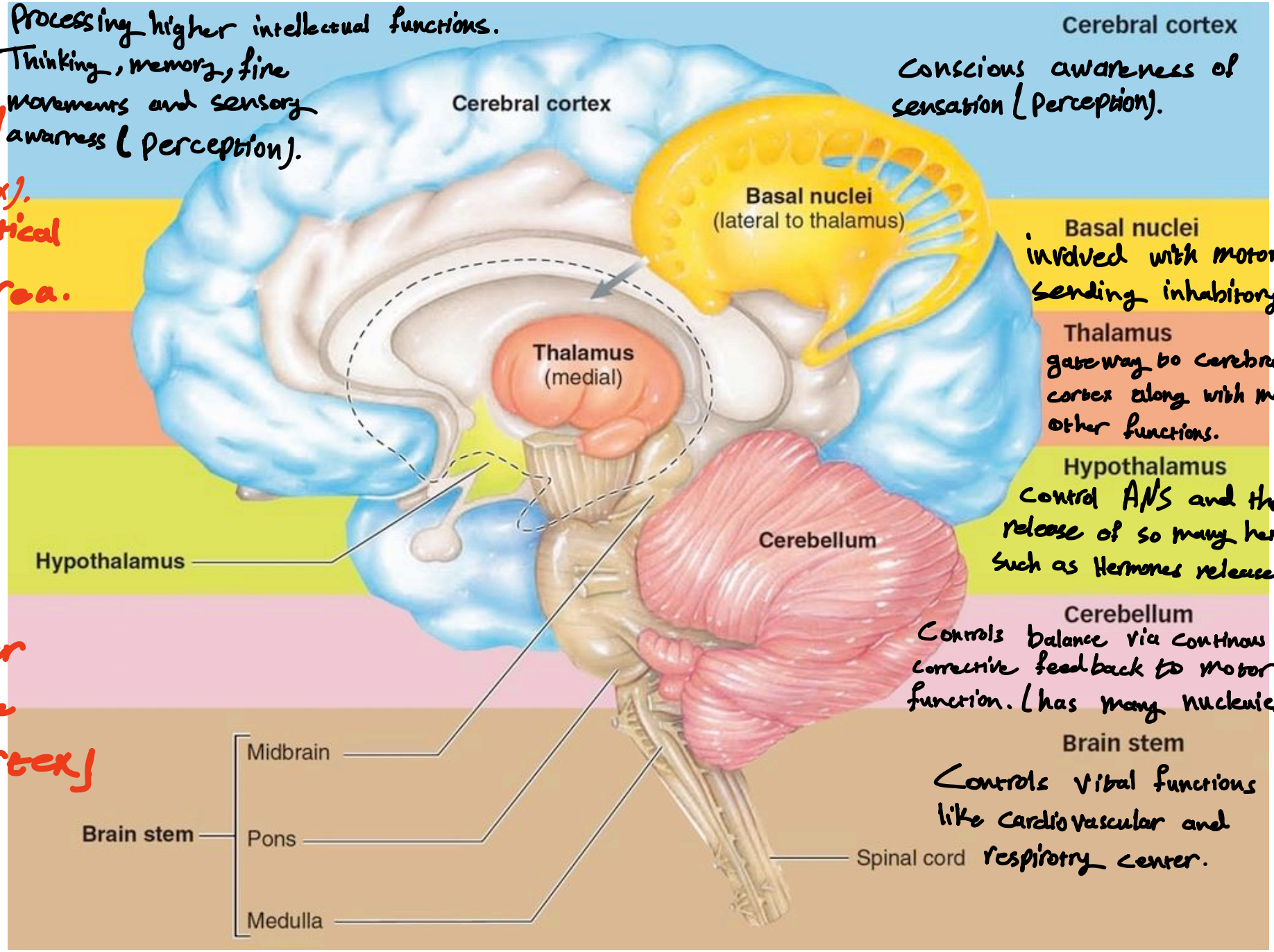
Spinal reflex Arc



The brain is devided into cortical (cerberal cortex). and Sub cortical (other parts) Area.

OR

lower brain and higher brain (higher brain is the cerbral cortex)



Processing higher intellectual functions. Thinking, memory, fine movements and sensory awarness (perception).

Cerebral cortex

Conscious awareness of sensation (perception).

Basal nuclei

involved with motor control by sending inhabitory and Ecitatory.

Thalamus

gateway to cerebral cortex along with many other functions.

Hypothalamus

control ANS and the release of so many hormones such as Hormones released by pitutary.

Cerebellum

Controls balance via continous corrective feedback to motor function. (has many nucleuies).

Brain stem

Controls vital functions like cardiovascular and respiratry center.

Lower brain (subcortical regions)

الأنشطة اللاوعية

- 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**.
- 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.

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

Motor function

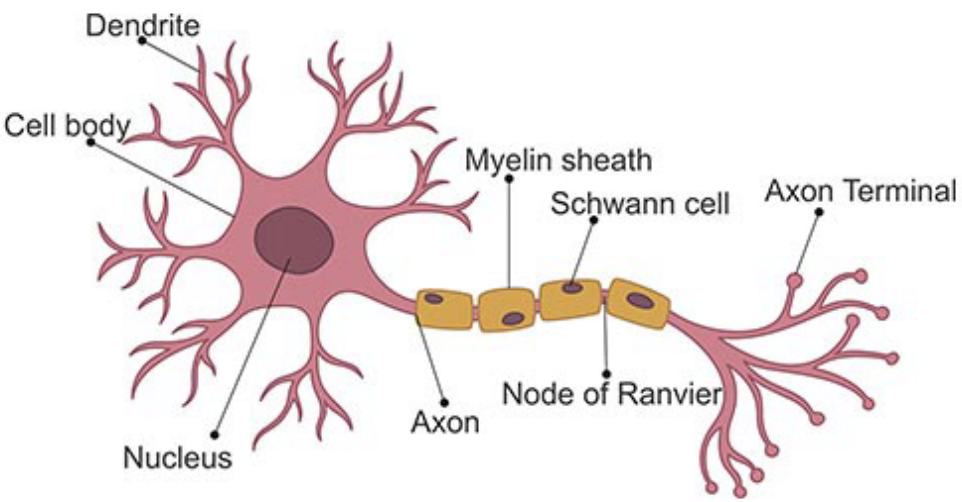
- The most important eventual role of the nervous system is to **control the various bodily activities.**

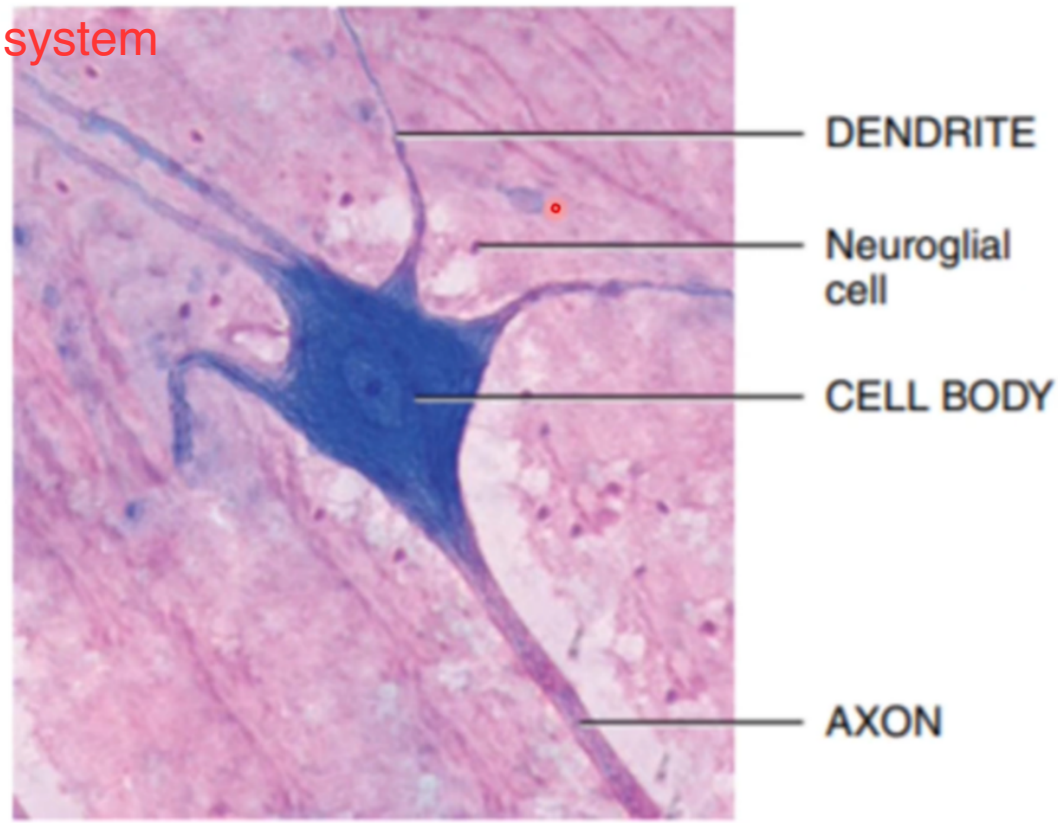
- This task is achieved by controlling:
- (1) contraction of appropriate skeletal muscles throughout the body.
- (2) contraction of smooth muscle in the internal organs.
- (3) secretion of active chemical substances by both exocrine and endocrine glands in many parts of the body.

- It is very important to understand the difference between Nerve and Neuron :

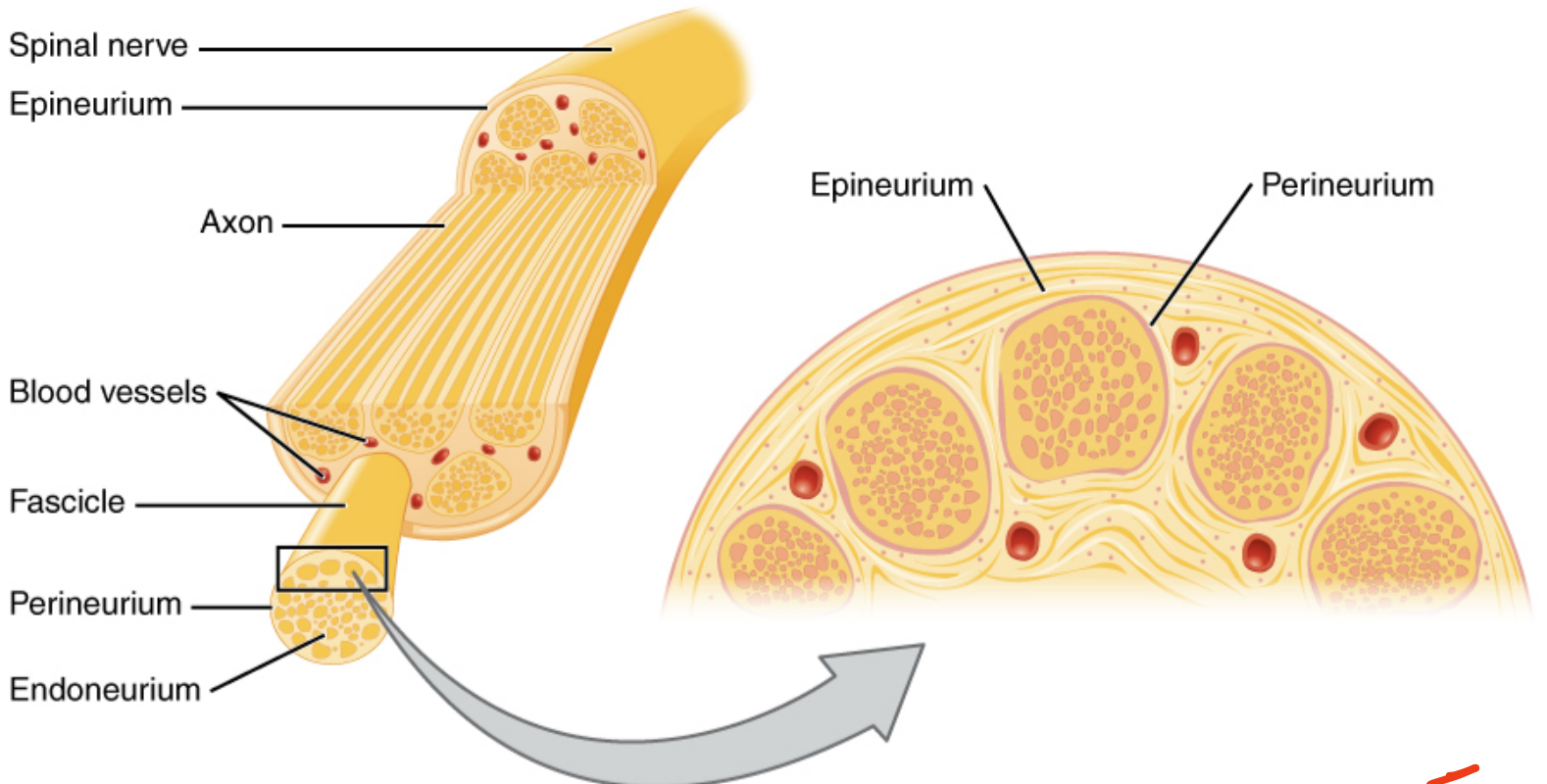
1- Neuron : single nerve cell that transmits electrical impluses. Consist of Cell body /Dendrite and an axon.

The functional unit of the nervous system





2- Nerve : a bundle of many acons (from many neurons) warpped togather in



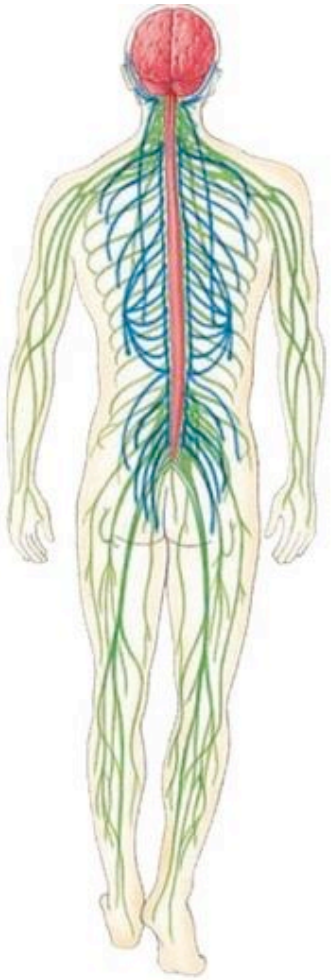
Extra picture

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.

بأمر من



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

inside our body

Somatic nervous system

Voluntary

Autonomic nervous system

(Involuntary)

Stimuli in digestive tract

Motor neurons

Fight or Flight

Sympathetic nervous system

Rest and digest

Parasympathetic nervous system

Enteric nervous system

Skeletal muscles

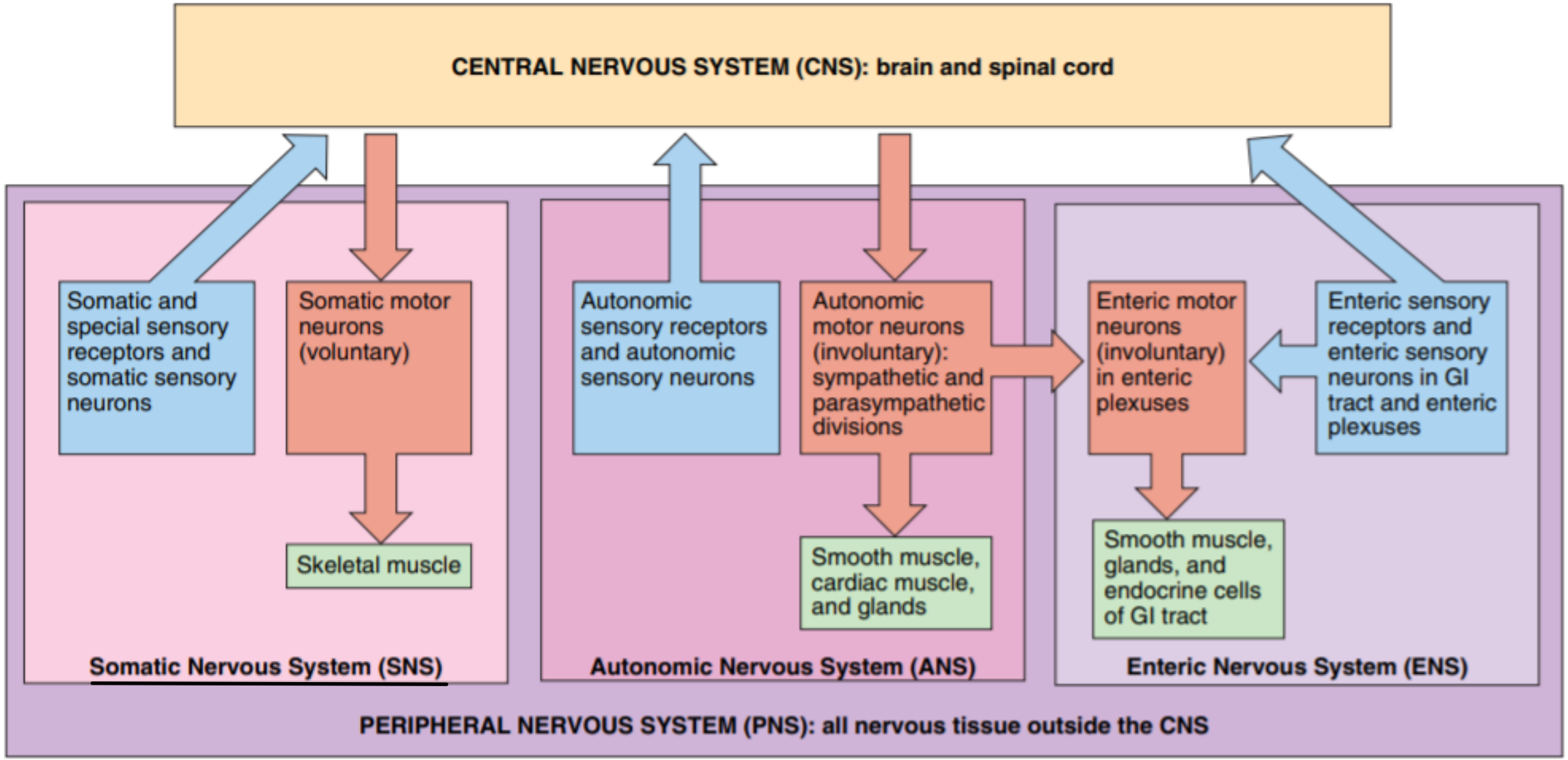
Smooth muscle
Cardiac muscle
Exocrine glands
Some endocrine glands

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*


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

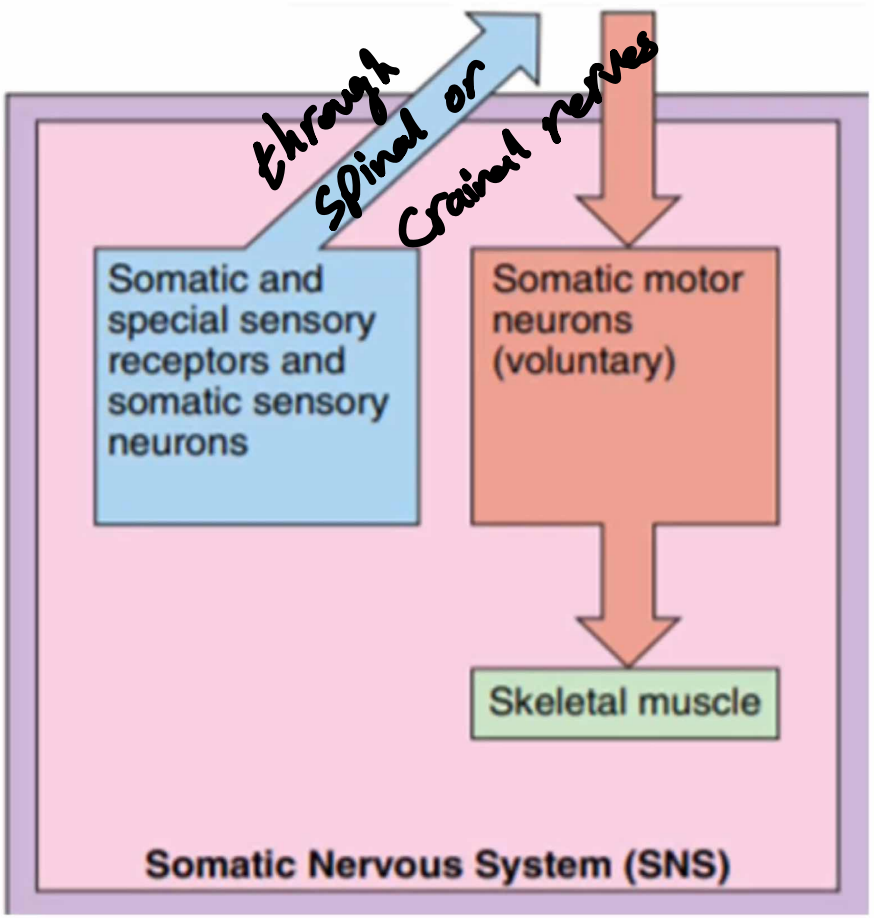
Somatic nervous system

CNS

- **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.

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

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



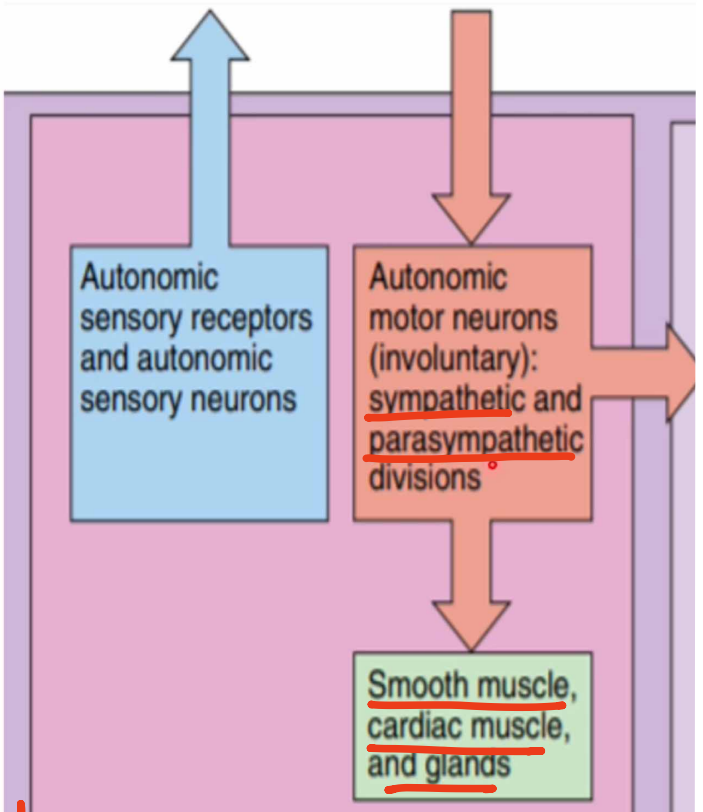
Autonomic nervous system

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

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

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

CNS



fight or flight.

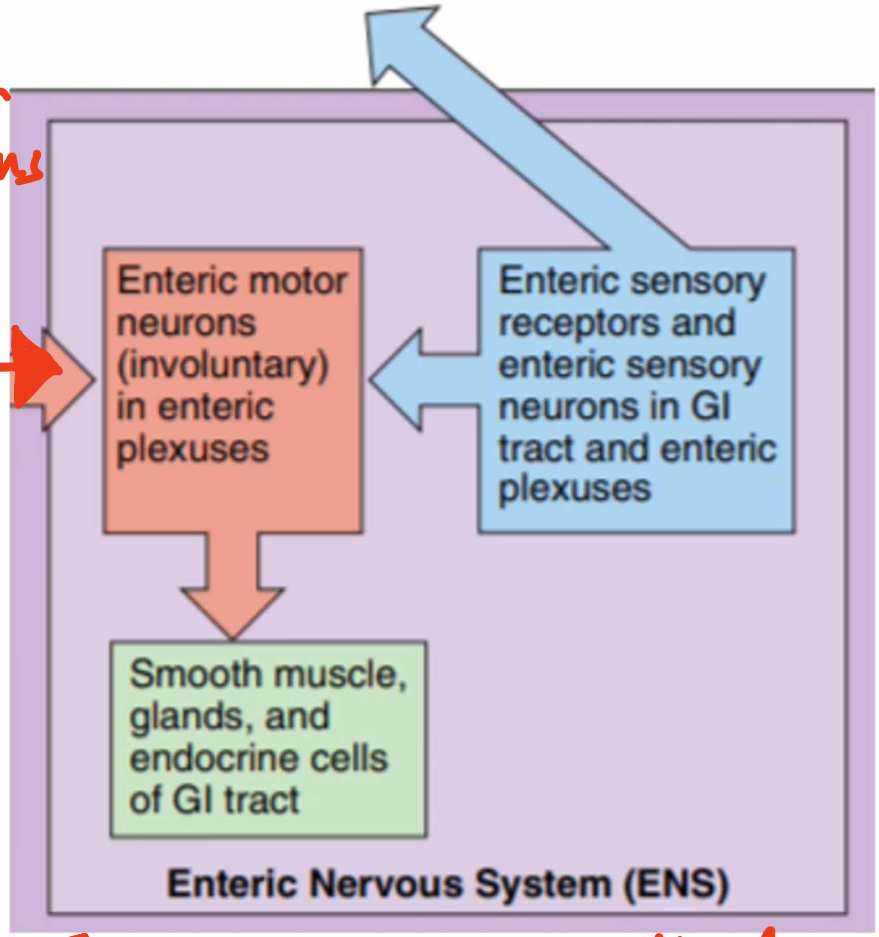
rest and digist

Enteric nervous system

CNS

ANS motor neurons

- **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 <u>involuntary</u>. Many of ENS neurons function independent of ANS or CNS, although they also communicate with the CNS via sympathetic and parasympathetic neurons.



The impluses is not transimted from CNS to the Enteric motor neurons directly rather than that it is transimted to sympathetic and parasympathetic motor neurons

then to the Enteric motor neurons.

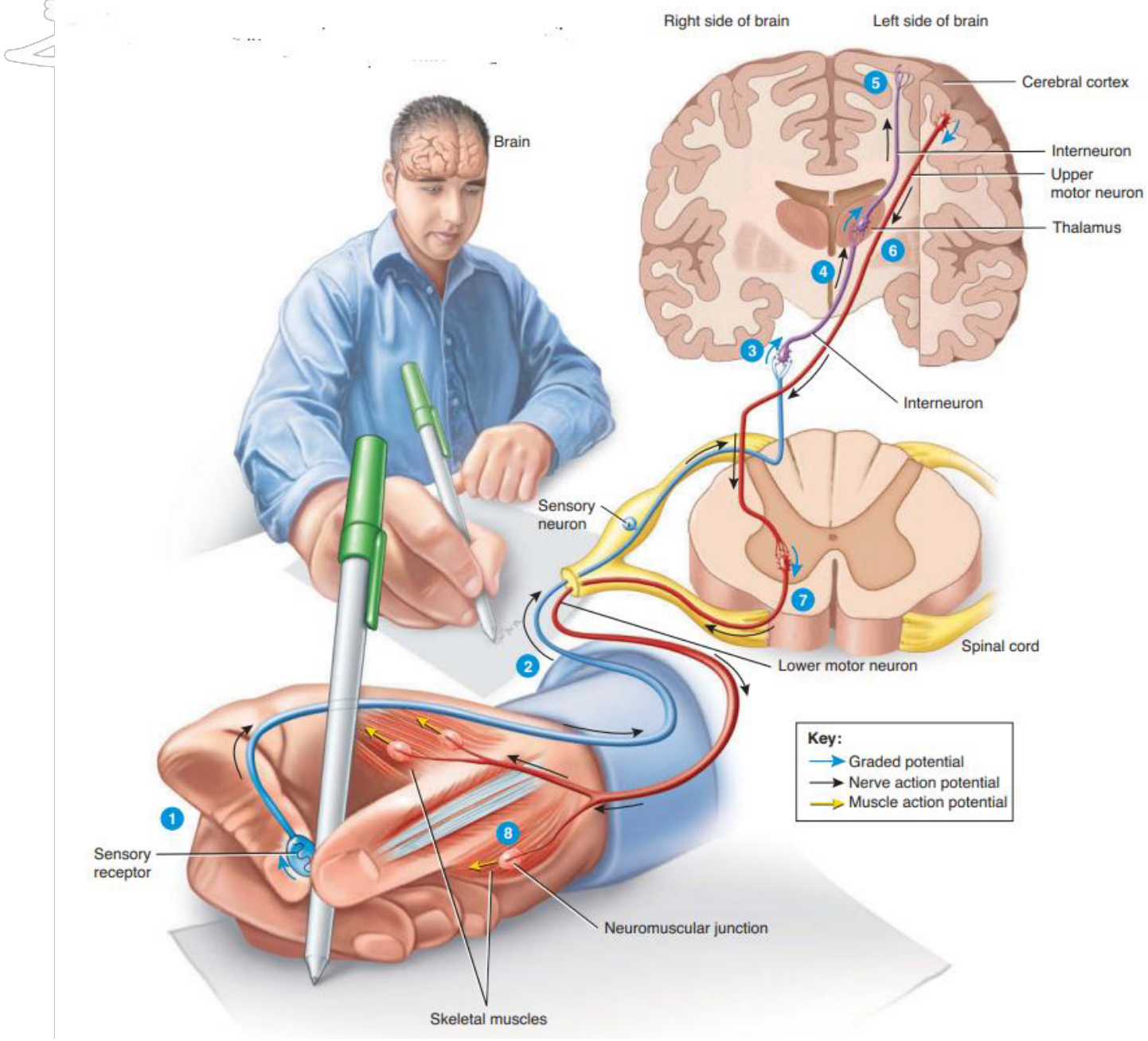
What is the special about the Enteric Nervous System?

That's some signals can be processed and sent to the motor neurons directly without going to the central nervous system.

Sometimes they call it the brain of the gut because it has it can do some of the decisions independent of the central nervous system.

Table From ChatGPT

Enteric Nervous System (ENS)	Autonomic Nervous System (ANS)	Somatic Nervous System (SNS)	Feature
Involuntary	Involuntary	Voluntary	**Control Type**
GI tract and enteric plexuses	Internal organs (e.g., heart, lungs, blood vessels)	Skin, eyes, ears, muscles (special & somatic)	**Sensory Input From** (Extra from Char GPT).
Smooth muscle, glands, endocrine cells of GI tract	Smooth muscle, cardiac muscle, glands	Skeletal muscles	**Motor Output To**
Enteric sensory neurons	Autonomic sensory neurons	Somatic sensory neurons	**Sensory Neurons**
Enteric motor neurons	Autonomic motor neurons	Somatic motor neurons	**Motor Neurons**
None (but can work with or without CNS input)	Sympathetic & Parasympathetic	None	**Divisions/Subsystems**
Can work independently or with CNS and ANS	Works closely with CNS	Direct	**Connection to CNS**
Coordinating digestion, secretion, peristalsis	Regulating heartbeat or digestion	Moving your arm	**Function Example**


Right side of brain
Left side of brain
Cerebral cortex
Brain
Interneuron
Upper motor neuron
Thalamus
5
6
4
3
Interneuron
Sensory neuron
7
Spinal cord
2
Lower motor neuron
Key:
Graded potential
Nerve action potential
Muscle action potential
1
8
Sensory receptor
Neuromuscular junction
Skeletal muscles

1. Stimulus Detection:

You hold the pen, and pressure is applied to the skin of your fingers.

2. Activation of Sensory Receptors:

Specialized sensory receptors (tactile receptors) in your skin detect this pressure/touch (tactile sensation).

3. Transmission via Sensory Neurons (Afferent Pathway):

The sensory receptors send signals through sensory neurons (shown in blue), which carry the information via ascending tracts in the spinal cord.

4. Signal Reaches the Brain:

The signals travel up to the cerebral cortex (the part of the brain responsible for conscious awareness).

5. Sensory Processing & Perception:

The cerebral cortex processes this sensory input, making you consciously aware that you are holding a pen.

6. Decision Making & Integration:

Your brain decides to write. This decision involves the integration centers in the cerebral cortex (e.g., motor planning areas).

7. Sending Motor Commands (Efferent Pathway):

The brain sends instructions via motor neurons (shown in red), traveling through descending pathways.

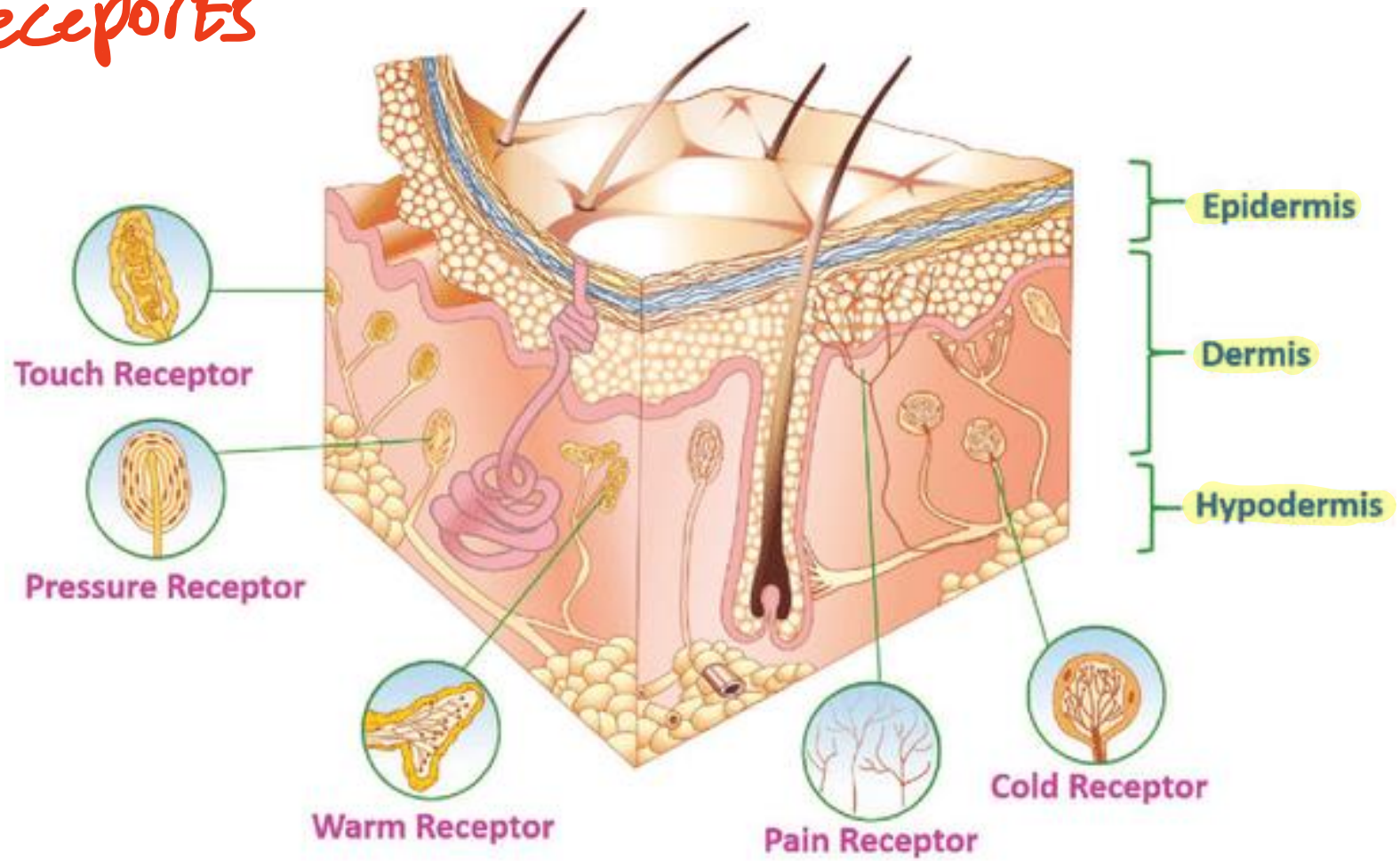
8. Signal Reaches Effectors (Muscles):

The motor neurons activate skeletal muscles in your hand and fingers.

9. Muscle Contraction & Action:

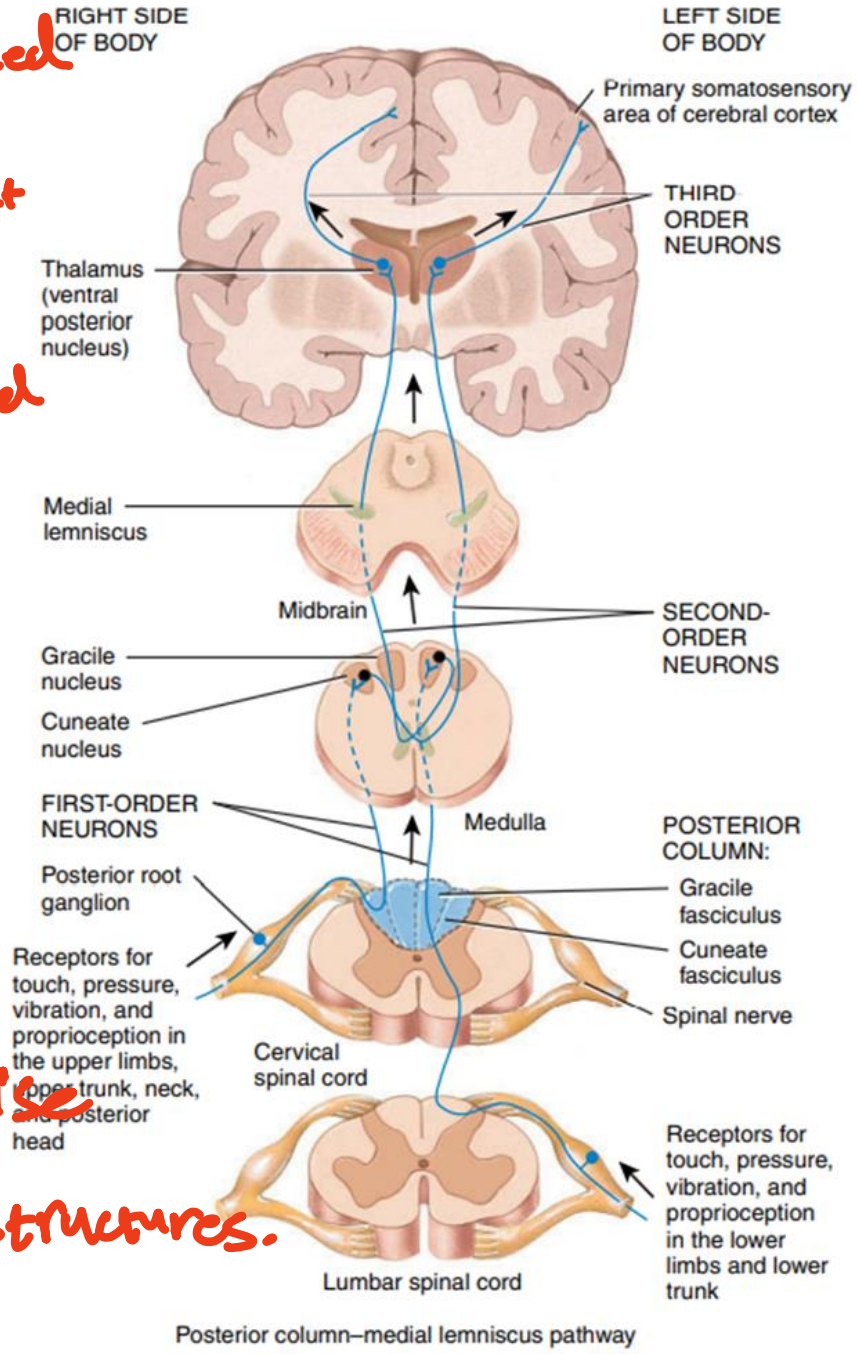
The muscles contract, allowing your fingers to move and the pen to write on the paper.

Sensory receports



- The sensory pathway is called ascending pathway (Afferent Division).
- The motor pathway is called Descending Pathway (Efferent Division).

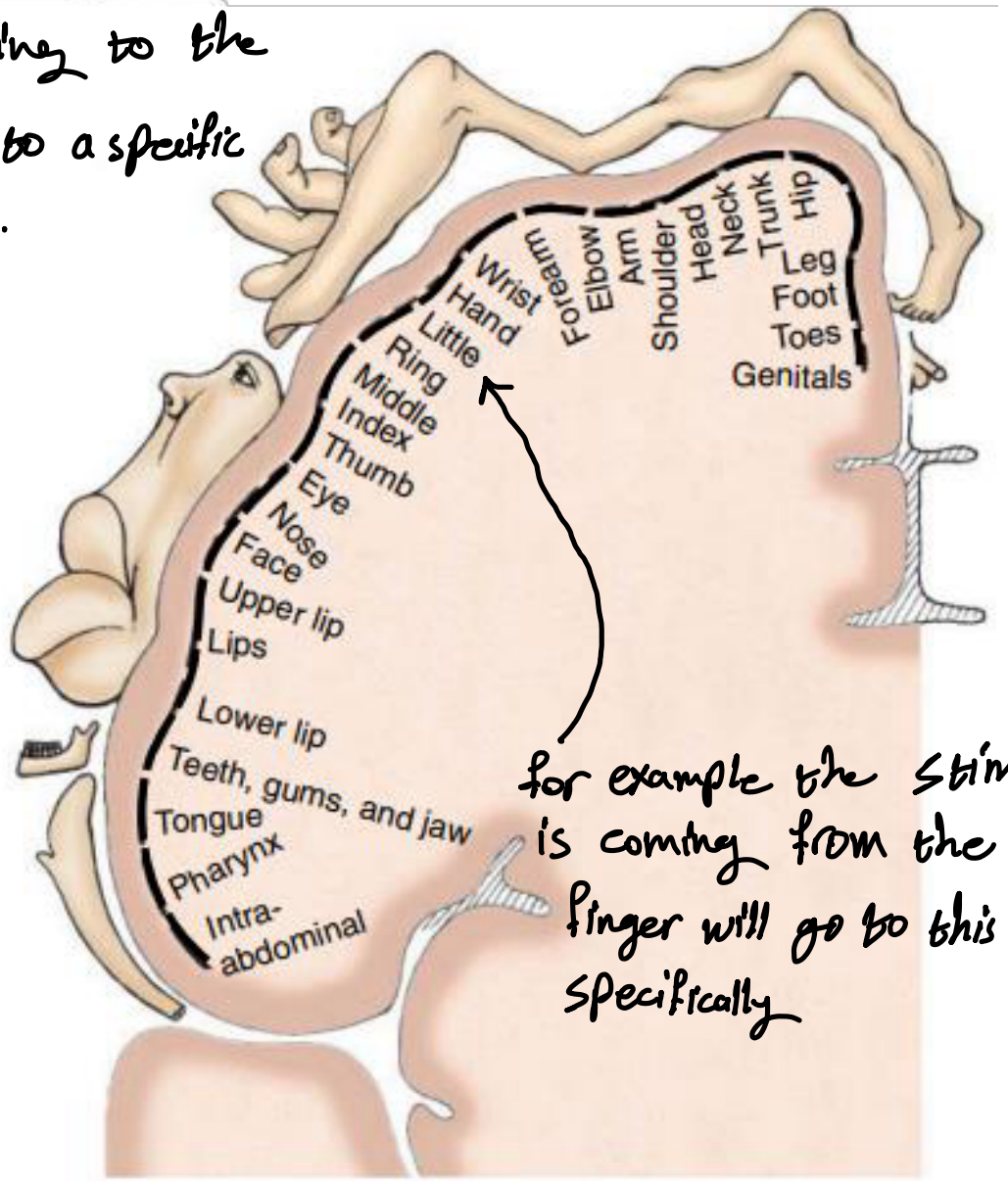
Our Doctor said that you Don't have to memorize the names of detailed structures.



Posterior column–medial lemniscus pathway

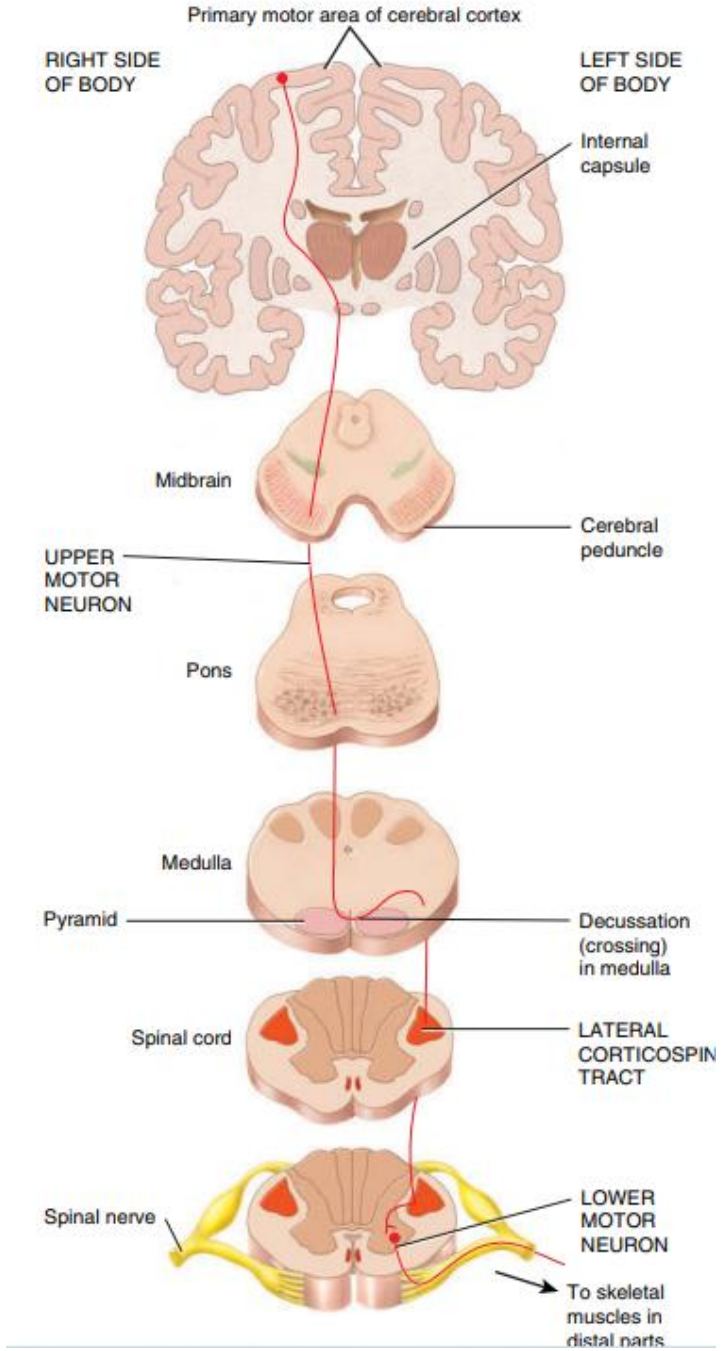
This figure shows you how this specific type of sensory stimulus will pass through a series of sensory neurons in a specific pathway, and they synapse at specific sites in the central nervous system until they reach the ultimate processing center in the cerebral cortex, in this example. So this sensory pathway is called ascending pathway, and it's an afferent neuron.

As the neurons ascending to the cerebral cortex it will go to a specific area of the cerebral cortex.



for example the stimulus that is coming from the little finger will go to this area specifically

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

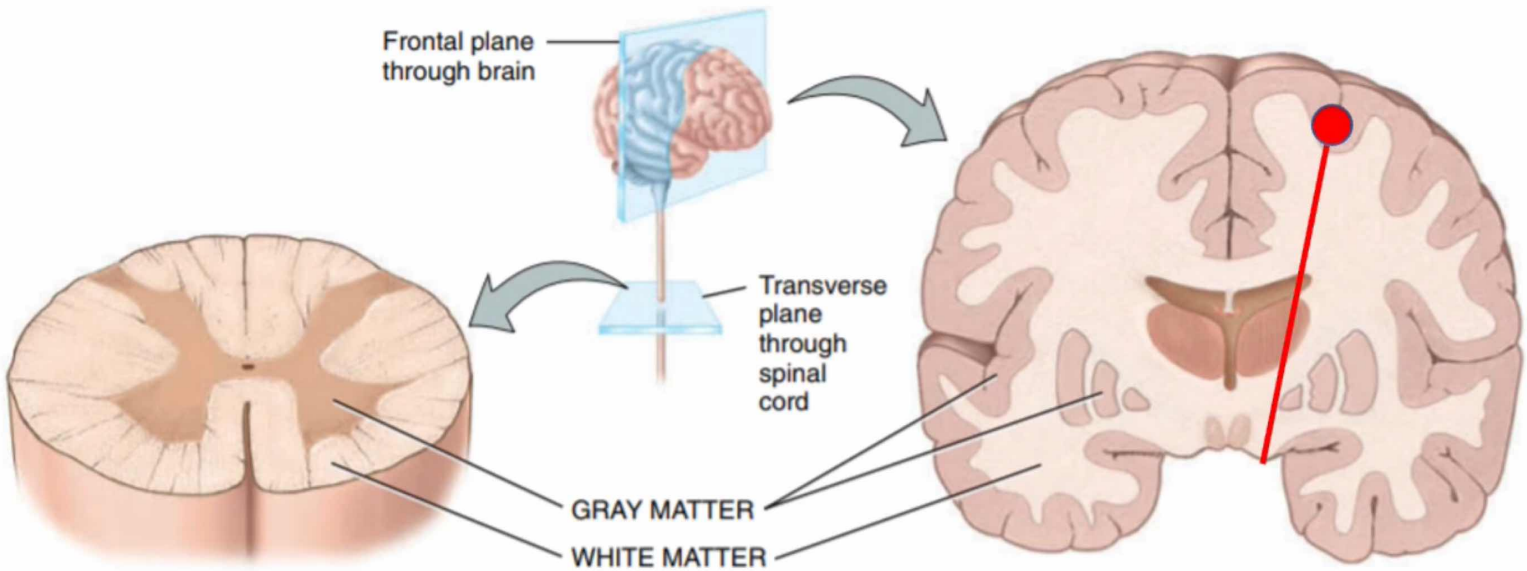


After several processing of the information, it will go to the motor area in the cerebral cortex. Now the decision is made to move or contract these types of muscle, so it will go through specific motor neurons that will communicate together in specific sites that will go through the descending pathways to certain skeletal muscles to cause contraction of these muscles.

White matter

Widespread area of axons in the CNS

not bundled

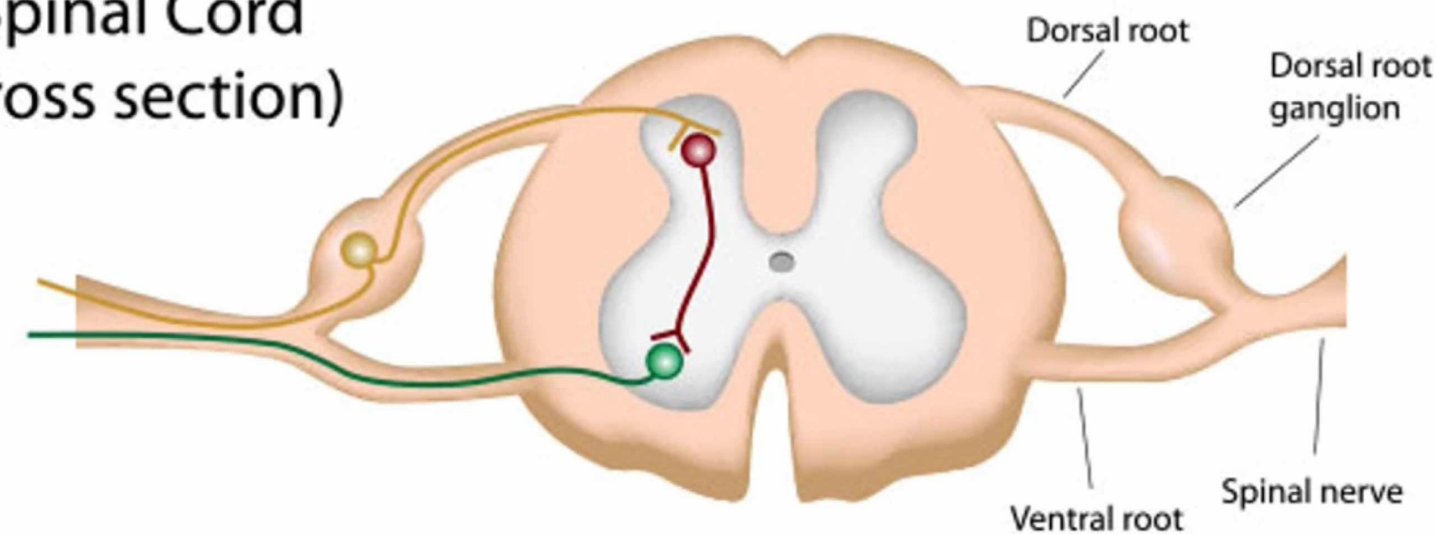


The white matter in the spinal cord is the outer part

The white matter in the brain is the inner part

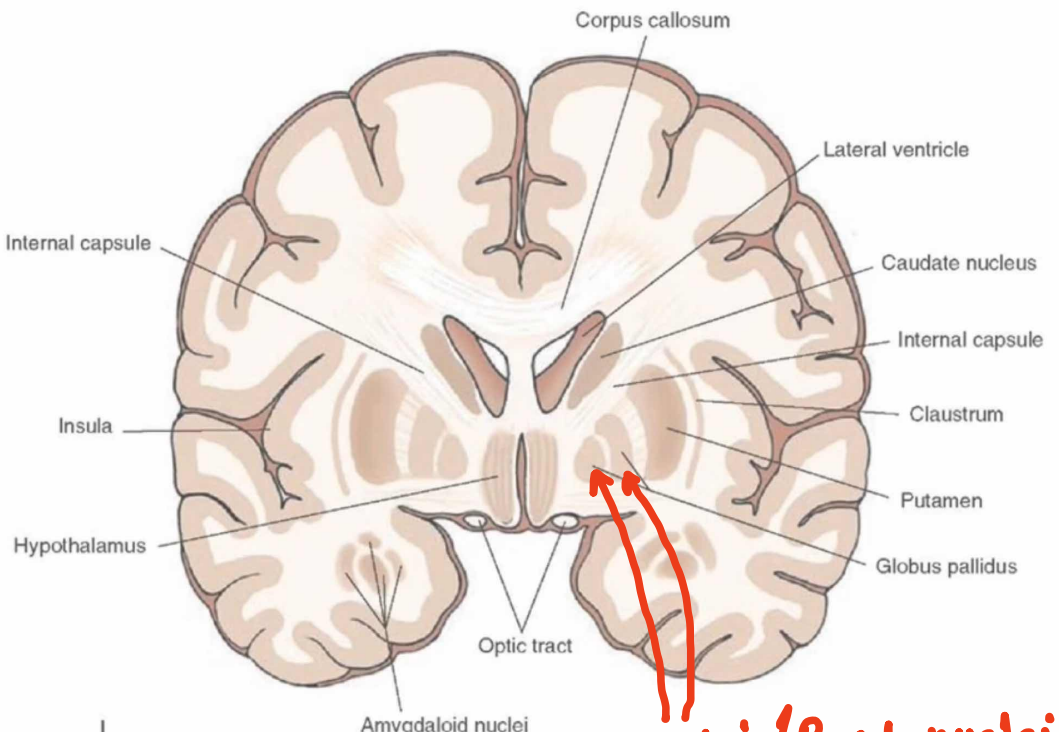
Ganglion: A collection of cell bodies within the PNS (Periphral nervous system).

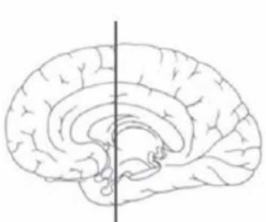
Spinal Cord
(cross section)



https://socratic.org

Nucleus : A collection of cell bodies within the CNS



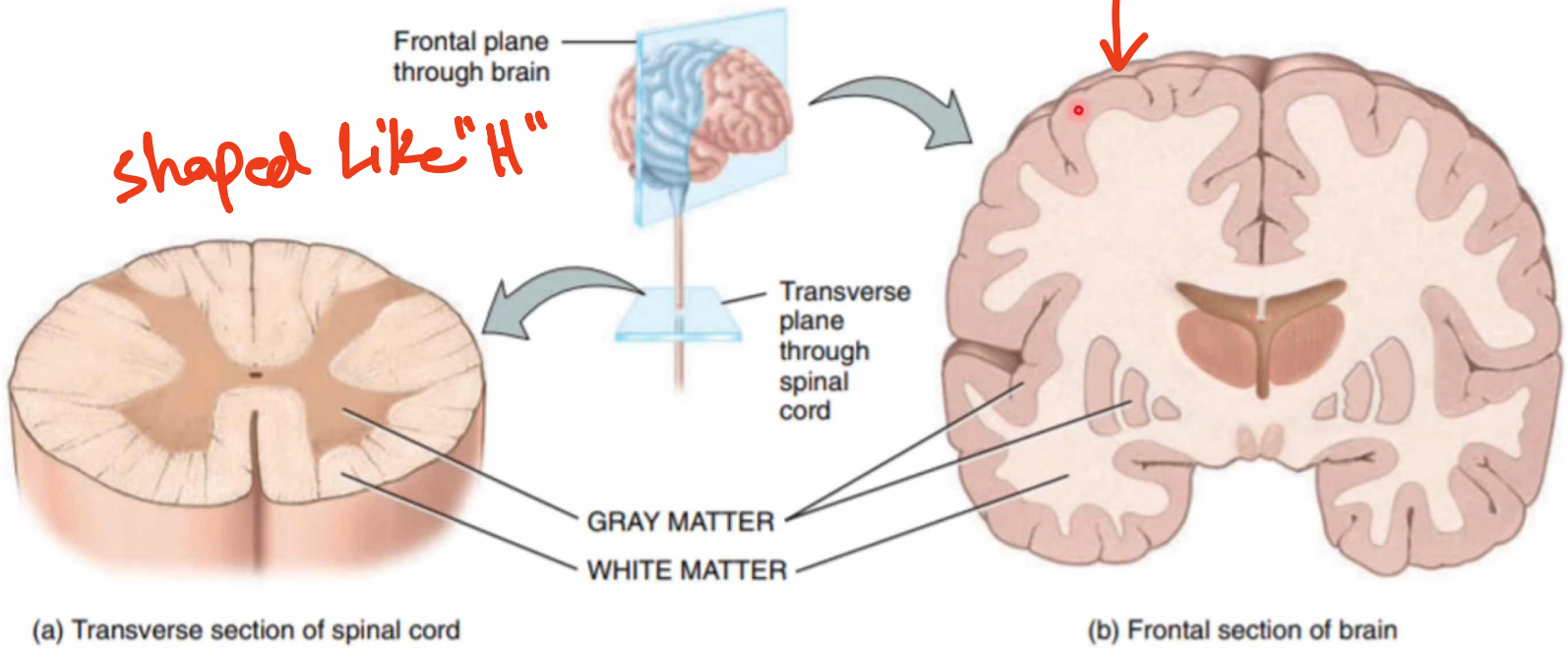


https://what-when-how.com/

← Gray matter

major component of CNS consist mainly of neuron cell bodies, dendrites, unmylinated axon, and glial cells.

Found in the brain in the cerbreal cortex



shaped like "H"

The inner parts in the spinal cord.

The outer part in the Brain