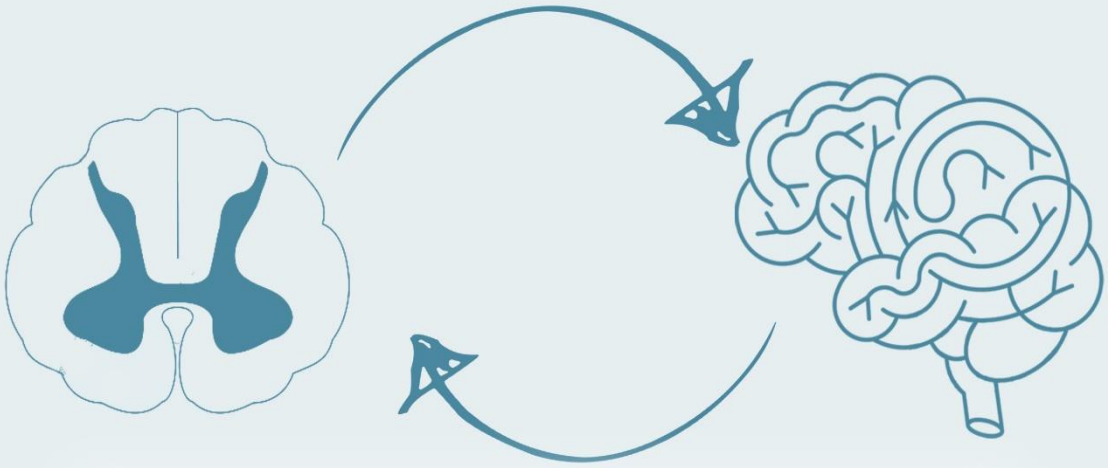

CNS

physiology

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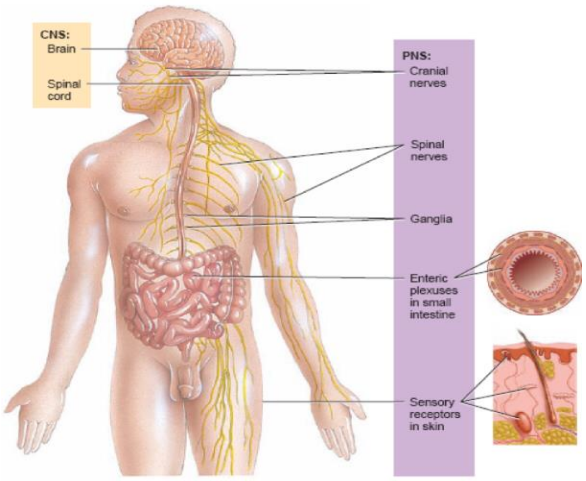
Done by	نور الجايح
Correction	Rahaf AL-Qaryouti
Doctor	Loai Alzgoul

بسم الله الرحمن الرحيم

Today's lecture is an introduction and review for some concepts we took previously.

Nervous system is a system composed of nervous tissue which is highly cellular and composed of two types of cells: **neurons** and supporting cells called **neuroglia**

In general we divide it into **three** big parts :**peripheral** nervous system, **central** nervous system, and **enteric** nervous system.



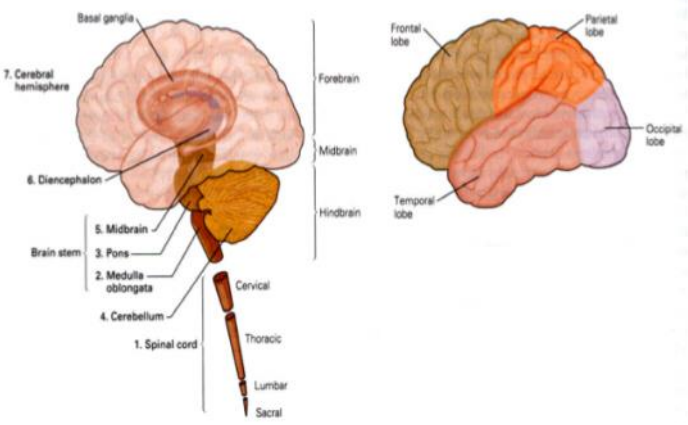
1**) Peripheral nervous system (PNS):** part of the nervous system that is found in the body (legs , hands, trunk , abdomen …) except skull (brain) and spine (spinal cord).

The **main function** of peripheral nervous system is to **conduct information** from external to central nervous system, and **return** back **orders** from central nervous system to effectors either muscles or glands.

2) There is a part of nervous system although it found in the periphery but we consider it as a new division. It is called the **enteric nervous system**, which is found along GI tract. Although it can receive information from CNS, this system is characterized by its capability to work independently of the brain and spinal cord.

3**) Central nervous system (CNS)**: its main function is processing the information in addition to integration and execution.

*Processing can be any changes that occur on input to get information, signals, electrical impulses either by changing their form, speed, value , duration or amount or emit order as an output.



*Divisions of CNS :

A) CNS is divided **anatomically** to many divisions: spinal cord → (cervical & thoracic …) , brain stem →midbrain, Pons, medulla oblongata, thalamus, hypothalamus, cerebellum, basal ganglia,…

B) CNS is divided **functionally** into three divisions :

1)*spinal cord* (spine) : in addition to its function of conducting impulses from periphery of body to higher level of CNS and vice versa, it can also :
- process and analyze the information (processing include : *sorting of information, * deciding which signals are important and deserve to conduct to the higher level and which are not and eliminate them, *changing the signal itself, or* deciding to take decision or order without referring to the higher level.

Example of orders originating from spinal cord without referring to the higher level: spinal **reflexes**, like when we put our hand on something hot, here the spinal cord decide to give order by itself as a **quick response** .
2) *brain stem and subcortical division* : anything between spinal cord & cortex.

Its function is to process the information, which come either from spinal cord or inter it directly, this processing include (changing signal, changing their nature, and take orders). In general ,brain stem & sub-cortex are responsible for control (processing and orders).

It's responsible for **internal reflexes which are unconscious** .
Examples of these activities: breathing (respiration), sleep, dream, heart rate, blood pressure, emotional pattern, feeling , sexual drove, behavior, equilibrium.

3) higher brain (*cerebral cortex*) : it's a part of CNS which is considered the higher order It is a about 3-5 cm surrounding the outer surface of brain & higher end of CNS , and we should know that part of it gives the tortuous structure of the brain.

It's responsible for **conscious voluntarily activities** as memory, thinking, decision making, language, speech , personality & understanding sensations. All these need previous knowledge.

What is the difference between conscious and voluntarily?
Voluntarily →movement
Conscious →explain or interpret information

E.g. if we receive a sensory information, this sensory information will go to the spinal cord to undergo processing and modification then it go to brain stem and undergo another modification and sometimes our brain stem extract an involuntarily orders, but

the process of interpret what's go on in our body and what type of information we have and understand it, it's the function of cortex ☺

*so we can say that our movement is either from spinal cord as reflexes or from brain stem & subcortical division as subconscious involuntary movement or from cortex as conscious voluntary movement ☺

***Note:**

*** the cortex can't make processing to information if it doesn't have previous information or experience to compare with it** → E.g. after we saw Dr. loai alzgoul in the first lecture, consciously now we know him so any time we will face Dr. loai we will remember him

*** the cortex is the only location of somatic memory (large memory storehouse),**which makes sense that perception and conscious processing that need previous knowledge is the function of cortex.

Processing and memory are the two sides of the same coin and they can't be separated from each other→ we don't have processing without memory, also there is no benefit to memory without processing power.

Where is the memory stored inside the cortex ?

→ each type of memory is stored in the area that is responsible for its processing. For example .. the main part of the cortex that makes processing of visual information is inferior & posterior parts → so the memory of vision is stored there.

In addition to that cortex makes processing and conscious information for sensation to interpret it and eventually make a meaning, it's also responsible for **issued conscious voluntary orders** , and also responsible for "**conscious complex order**" which is a complex function that needs multiple processing like language, thoughts, personality.

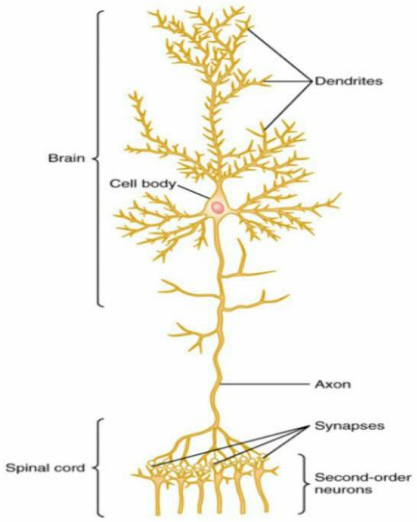
It works as the BIG BOSS which means it's able to control anything below it and also it can prevent them from making their orders

So control can be as the following :

1) sub-cortex like in anger situations .. and the doctor say here that it even can control involuntary order to a certain degree like those individuals that train themselves o stay under water for 3 minutes without breathing ,

2) spinal cord by preventing it from making spinal reflex.. Like when you inject a person by a needle he will not have an aggressive response.

Neuron



It's the most important part of nervous system

Its divided into 4 parts:

1) Dendrites

2) Axon

3) Cell body (Soma or perikaryon)

4) Axon terminal

Synapse : it is where 2 neurons or a neuron with other segment meet each other ,this segment can be other axon, dendrites, or cell body.

-Number of neurons involved in the pathway increases with increasing the complexity of information. It means we need more processing.

Function of neuronal parts:

1) *Axon terminal*: transfers information from first neuron to the next neuron or cell (muscle, gland…).

2) *Axon*: initiates and conducts action potential from the beginning of the axon to the axon terminal.

3) *Cell body*: synthesis and keeping cell alive

4)cell body and *dendrites*: processing:

There are 2 membrane potential changes occurring in neuron:

a) Action potential

b) Graded potential, local potential, potential change.

The differences between them are that graded potential occurs at dendrites and cell body, while action potential occurs at axon.

Q. Does action potential occur at cell body? NO

* action potential follows all or none principle.

*graded potential either can become action potential or turn it off.

So we can conclude that the function of both cell body and dendrites is **processing** because they receive stimulus that form graded potential which in turn either becomes action

potential or not, on the other hand cell body and dendrites will receive hundred of graded potentials , each one of them is different in their value, some are excitatory and the others are inhibitory stimuli , and the result of their summation will either convert to action potential or not.

Types of neurons :

1) Unipolar

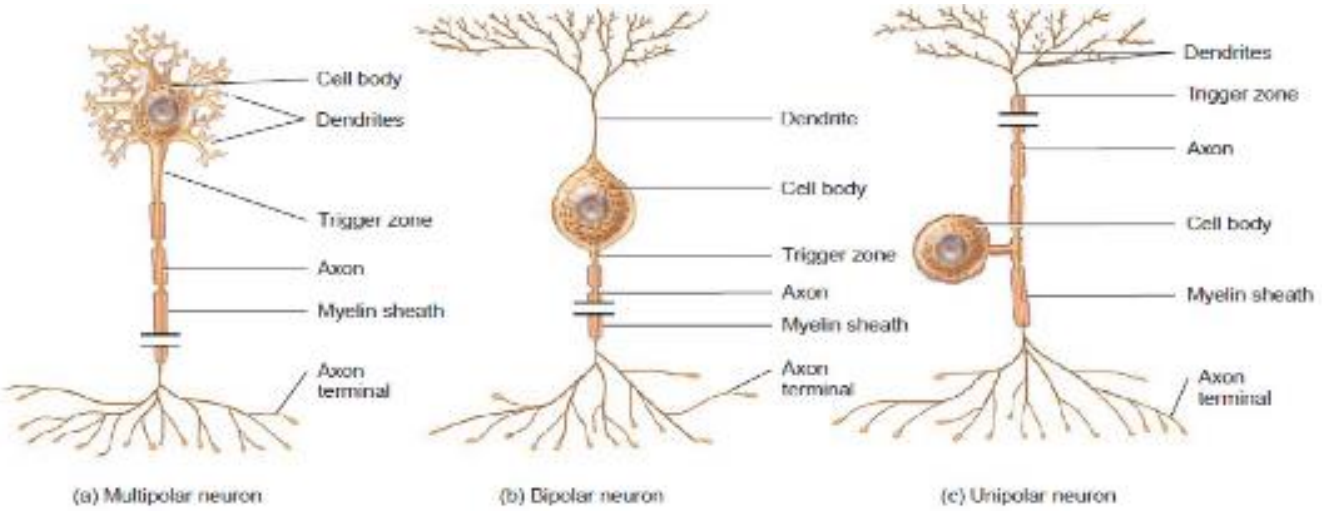
There function is conduction, so it is found in parts of CNS that do not perform processing like : peripheral nervous system especially **sensory** parts.
It's sometimes referred to as pseudo unipolar and it is in the dorsal nerve ganglia.

2) Bipolar

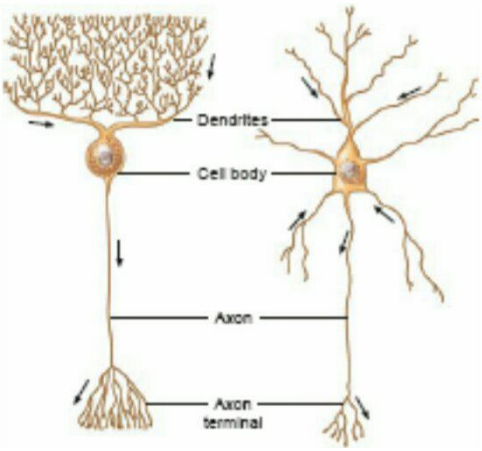
It has a group of dendrites that enter the cell body and exit as one axon (one input & one output)
*they are capable to do processing
*it's not complex
*found in the CNS in limited areas → they are **first order neuron** in most **special sensation** (vision, smelling, hearing…).

3) Multipolar

It's the **most abundant** neuron in our bodies , in this type the cell body has different dendrites.



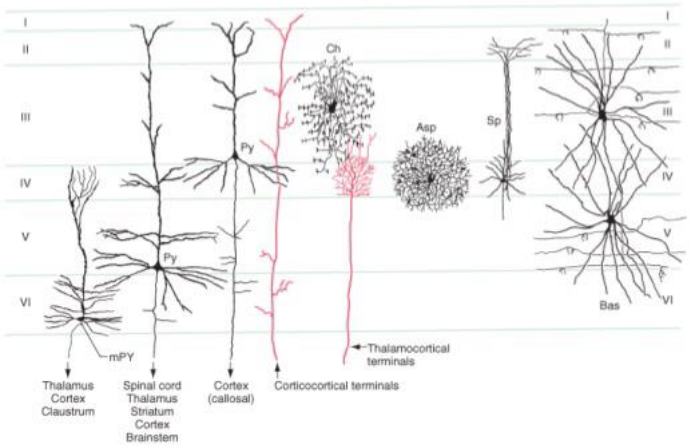
* according to the shape and distribution of dendritic tree, the processing will also differ at any part of CNS in our bodies



This figure shows two different multipolar neurons , and because their dendrites are different in shape and distribution they perform different processing and function.

*In the cortex there is also special shape of neurons (pyramidal, spiny, chandelier) each one of them do different processing → different shape =different processing

*The cortex is divided to different areas according to the shape of neurons they contain, certain area with certain neuron (will have certain processing).



Action potential

Action potential is a series of consequential events, started by opening of voltage gated Na^+ ion channels, allowing the Na^+ to inter the cell, then opening of K^+ ion channels, allowing K^+ to exit the cell.

In other words it is a momentary change in electrical potential on the surface of a neuron or muscle cell. Nerve impulses are action potentials. They either stimulate a change in polarity in another neuron or cause a muscle cell to contract.