no.

Physiology

Doctor 2019 | Medicine | JU

◉ Sheet ○ Slides

Done By

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Contributed in the Scientific Correction

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Contributed in the Grammatical Correction

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Doctor

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Nervous system cells are formed by:

a-Neurons

b-Supportive cells

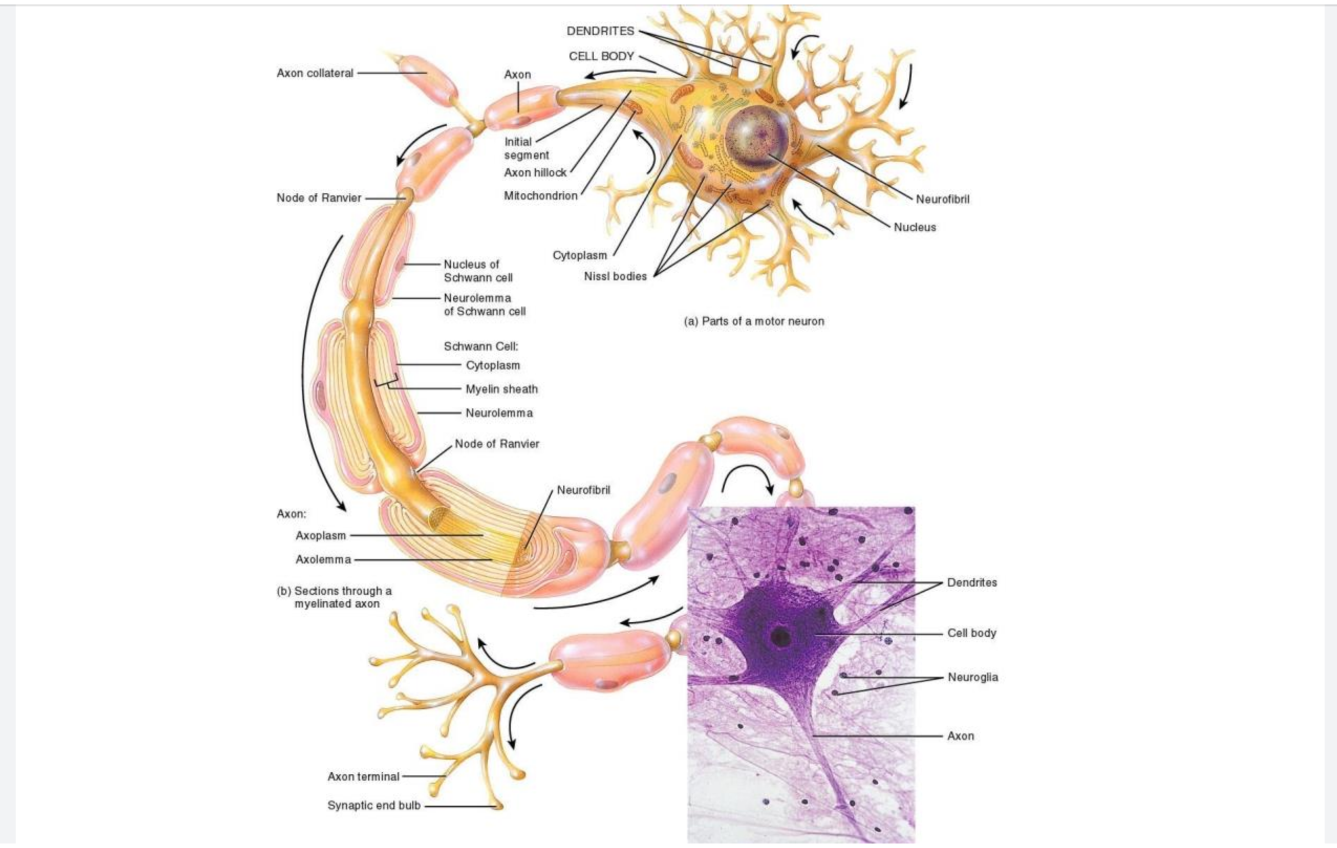
Neurons consist of:

a-Cell body

b-Axons: a long tubular like structure which projects from cone-shaped elevation in the cell body known as axon hillock (means small hill). Axon ends 7 into fine processes called axon terminals>

c-Terminals: Some of these terminals end with a bulb-shape structure called synaptic end bulb (synaptic knob), where neurotransmitter is stored in vesicles and ready for the release

D-Dendrites: short projections from the cell body, which receive inputs from neighboring neurons



The most general function of neural cells is to generate action potential. This action potential is generated at the axon hillock (the junction between the axon and the cell body) and then propagated towards the axon terminals.

Where is the action potential generated?

The impulse begins at the junction between axon hillock and the initial segment of axon

These cells perform the following functions:

*Maintenance of neural environment.

-uptake of K+ and neurotransmitters from the interstitial fluid around the neurons.
*Synthesize and release neurotrophic factors

◊ maintain the survival and protection of neurons

* Other specialized supportive cells are responsible for myelination of axons. In the CNS these cells are oligodendrogliocytes. In the peripheral nervous system, these cells are known as Schwan cells. These cells wrap around axon segments and secrete myelin sheath (a protein lipid complex that insulates nerve fiber). There are gaps in myelin sheaths known as nodes of Ranvier, which appear at intervals along axon. These gaps are used for transmission of impulse along myelinated nerve fiber.

Neurons can be classified depending on the presence of myelinated nerve fibers:

a- Myelinated nerve fibers:

*Have Myelin sheath around the axons.

*Nodes Of Ranvier are exposed to extra cellular fluid so the action potential developed there is then transmitted from one node to another. This type of potential transmission called Saltatory Conduction.

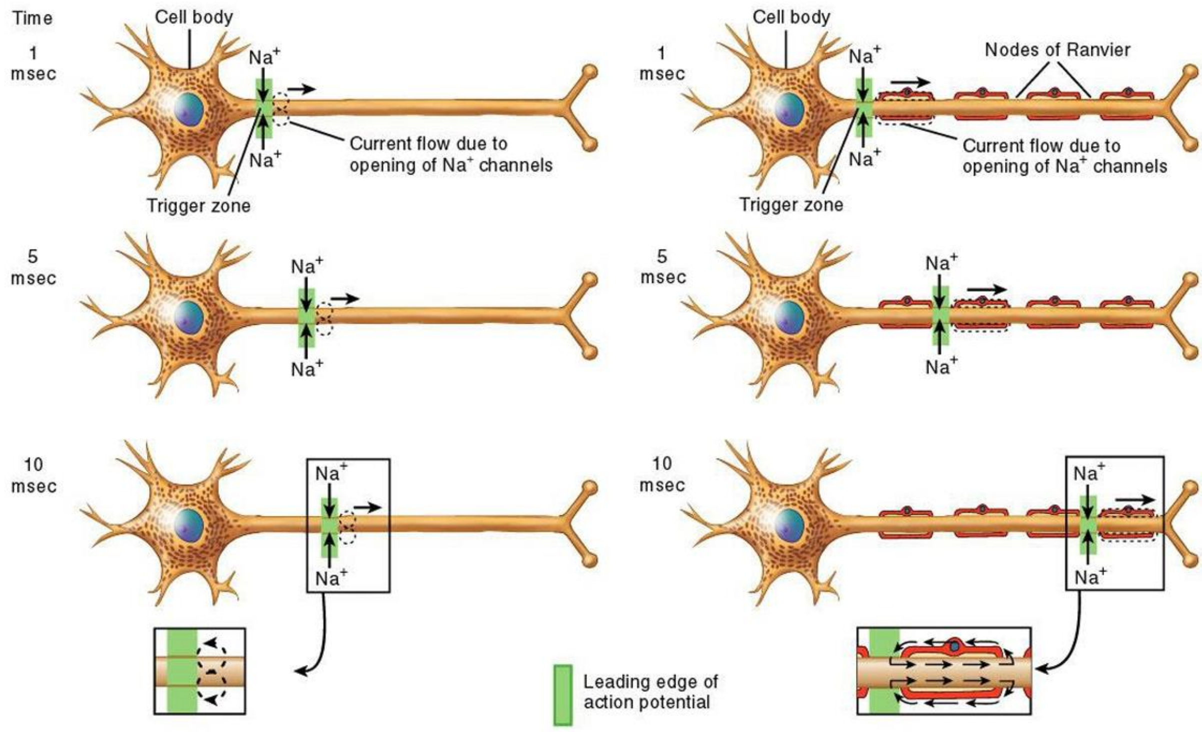
*current flow in Nodes of Ranvier.

b- Unmyelinated nerve fibers :

These neurons have axons that are fully exposed to the extra cellular fluid so the potential developed along the axons and the current flow moves continuously from one area to the next. This type of potential transmission is called Continuous Conduction.

*current flow along the axons.

The picture in the next page shows the difference between the two types of transmission via the two different types of Neurons .



(a) Continuous conduction

(b) Saltatory conduction

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*If we have two different Neurons: one of them has a small diameter while the other has a bigger one, which of them has faster current flow (potential transmission)? and why?

The Neuron with the bigger diameter, due to the less resistance in its cross section area.

*If we have two different Neurons one of them has a myelin sheath around its axon while the other hasn't , which of them has faster current flow (potential transmission) ? and why?

The myelinated one, because we skip a big part of axon between Nodes Of Ranvier .

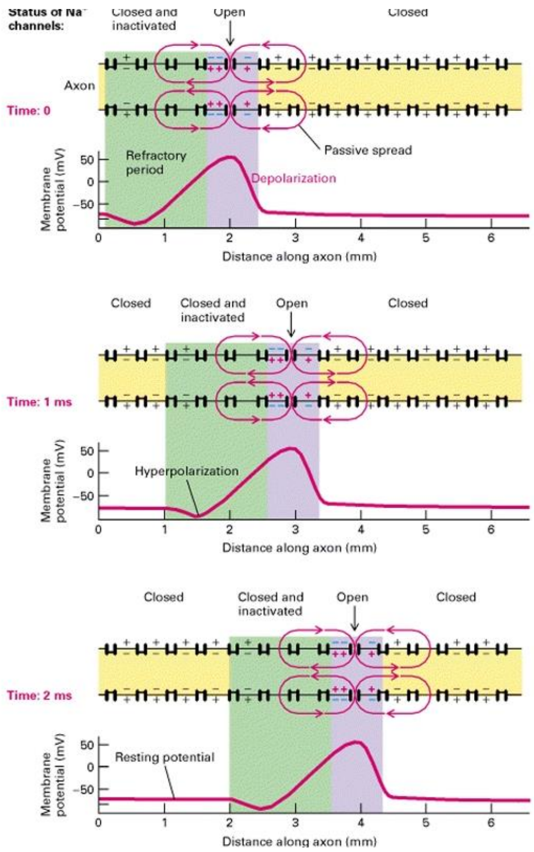
The transmission of action potential:

We assume that the action potential has been generated in the Axon Hillock.

In Unmyelinated nerve fibers:

Local currents flow between the active area, which is at the peak of action potential and inactive area, which is still in resting potential. This flow will cause activation of Na+ channels in inactive area and reduce the 8 membrane potential to the threshold, which triggers an action potential in this area (that was previously inactive). This process is repeated all along the nerve fiber until the impulse has reached nerve terminals.

(The currents depolarize the nearby part of axon to reach the threshold that means we have generated an action potential in that point “as shown in the picture below”.)



- Continuous Conduction in Unmyelinated axons

In Myelinated nerve fibers :

the impulse skips the myelinated regions in the axon and jumps from one node of Ranvier to the adjacent node. This process ensures faster propagation of an action potential along the myelinated axons (50 times faster than in unmyelinated fibers of the same size). The conduction also involves current flow between two adjacent nodes of Ranvier, which results in activation of Na+ channels in the adjacent node, which is still in resting potential. The process is repeated until the impulse activates the axon terminals.

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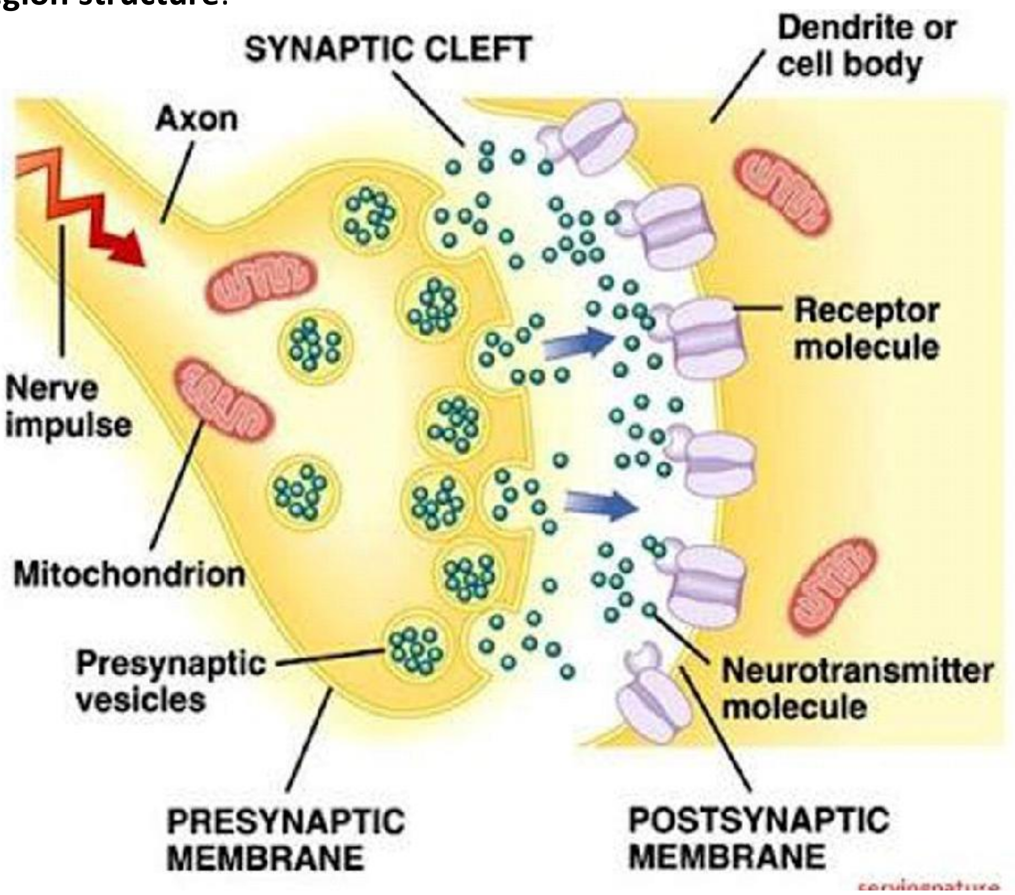
- The potential could go back to the left in the previous picture (toward the side where it was formed) **but** it will not do anything because the region would be in the refractory period "the channels will be closed and not capable to open " .
- The refractory periods ensures the one-way (unidirectional) propagation of action potential

Note: current flow in both types of conduction is from the **positively charged to the negatively charged regions at both sides of the membrane**, and the membrane has high resistance to the passage of current flow across it (**no** current flow can pass through the membrane).

Synaptic region structure:



As shown it has:

a- Postsynaptic neuron.
b- Presynaptic neuron.
c- Synaptic cleft “the space between the pre and the post synaptic neurons”.

How the potential moves in the synaptic region:

Axons of presynaptic neurons continue transmitting the potential toward terminals where the Neurotransmitters are, then release them into the synaptic cleft to be linked with the specific receptors on the postsynaptic neurons .

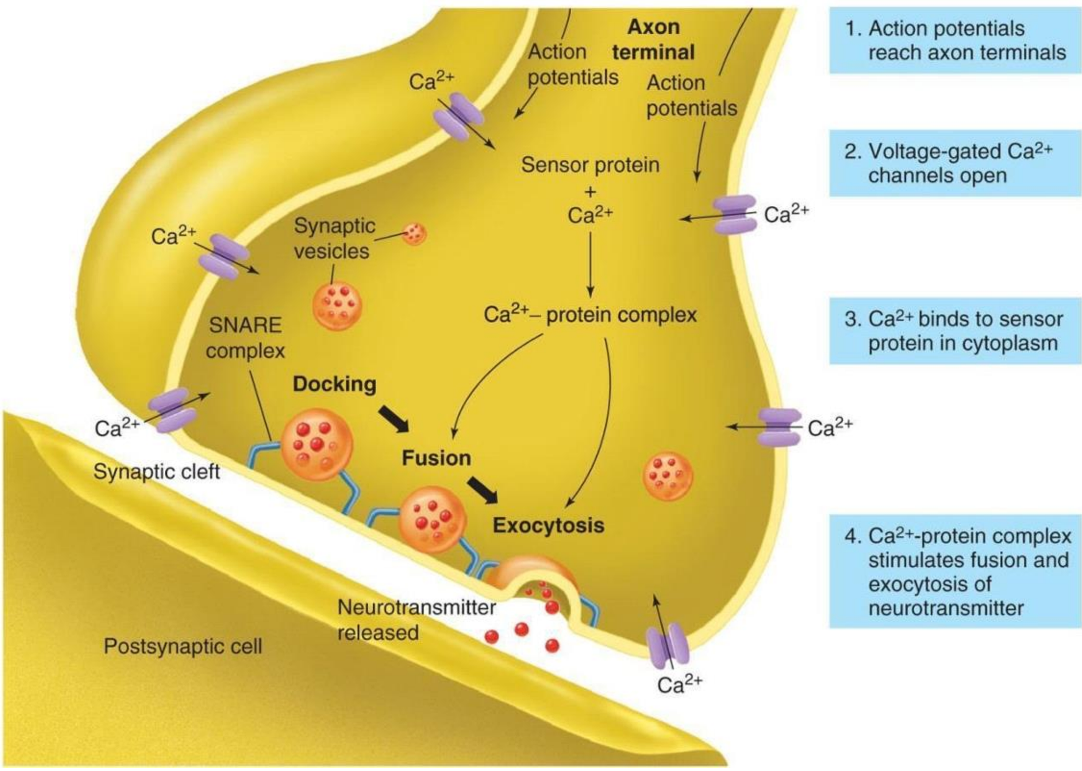
How the neurotransmitters are released ?

When the potential transmitted to the terminals the Ca++ voltage gated channels will be activated so the Ca++ will enter the neuron, the Ca++ concentration will be increased so the repulsion will decrease between the presynaptic vesicles and the membrane so more docking “more exocytosis”.

How to increase exocytosis?

By increasing the Ca++ concentration.

Note: the more Ca++ concentration the more neurotransmissions released the more probability of binding with receptors the more activation of channels.



According to what types of channels have been activated the synaptic input is either inhibitory or excitatory.

Excitatory:

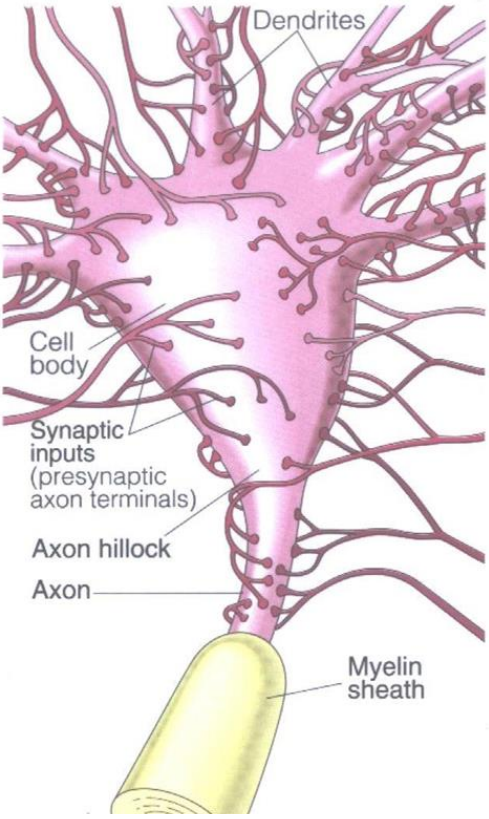
If the neurotransmissions linked to a specific receptor on the Na+ channels in the postsynaptic neuron then this channels will be activated so Na+ will enter this is a **depolarization** (doesn't mean generation an action potential, only shift in the membrane potential).

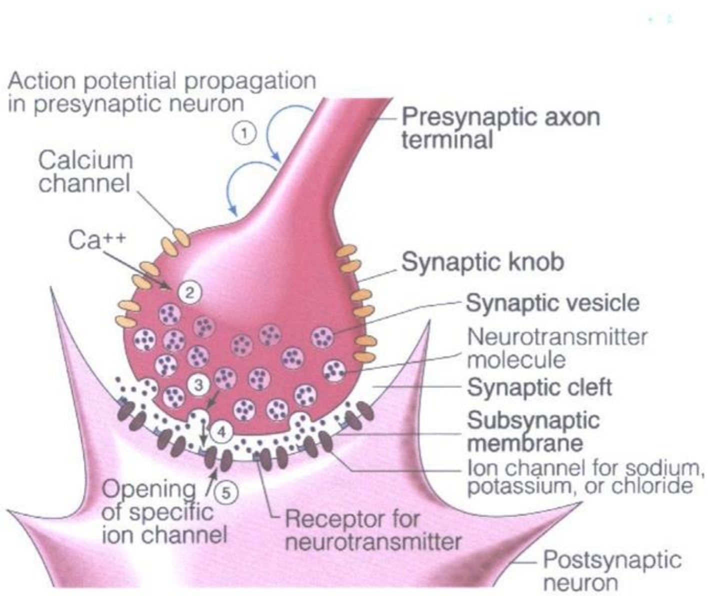
Inhibitory:

If the neurotransmissions linked to a specific receptor on the K+ channels in the postsynaptic neuron, then this channels will be activated so K+ will exit to the synaptic cleft and this is a **hyperpolarization**.

*Remember that depolarization means only shift in the membrane potential while firing state means that we reach the threshold.

Also we have a multi synaptic inputs from different sources as shown, and it may be an inhibitory or excitatory so If the summation of the waves gives a potential that reaches the threshold we will have generated an action potential on the second neuron.





Note:

- **Analog** means the information is divided.
- **Digital** means the information is processing.

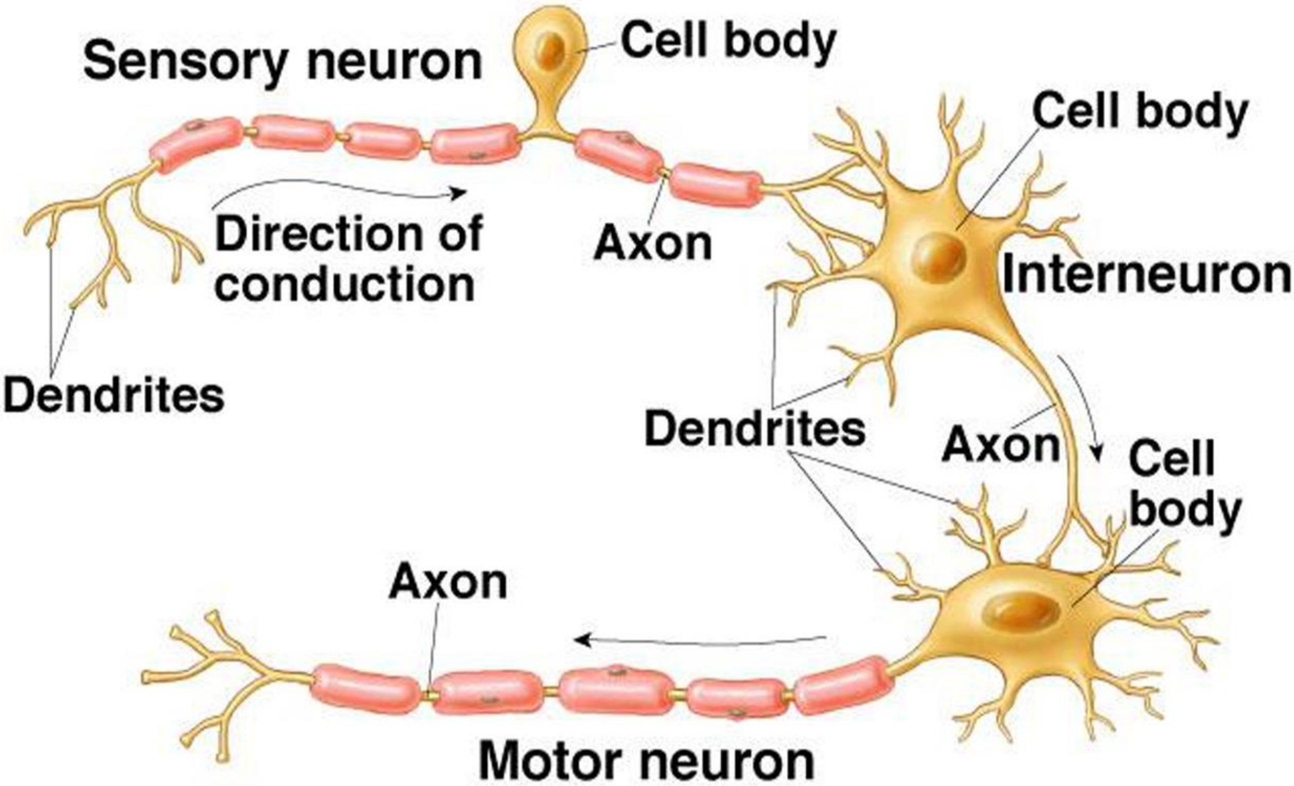
*Analog information can migrate but in different role than the digital information.

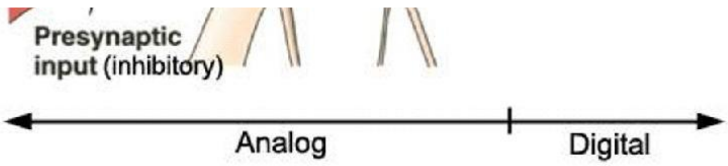
Sensory Neurons:

In sensory neurons we have transmission of the potential toward the central nervous system.

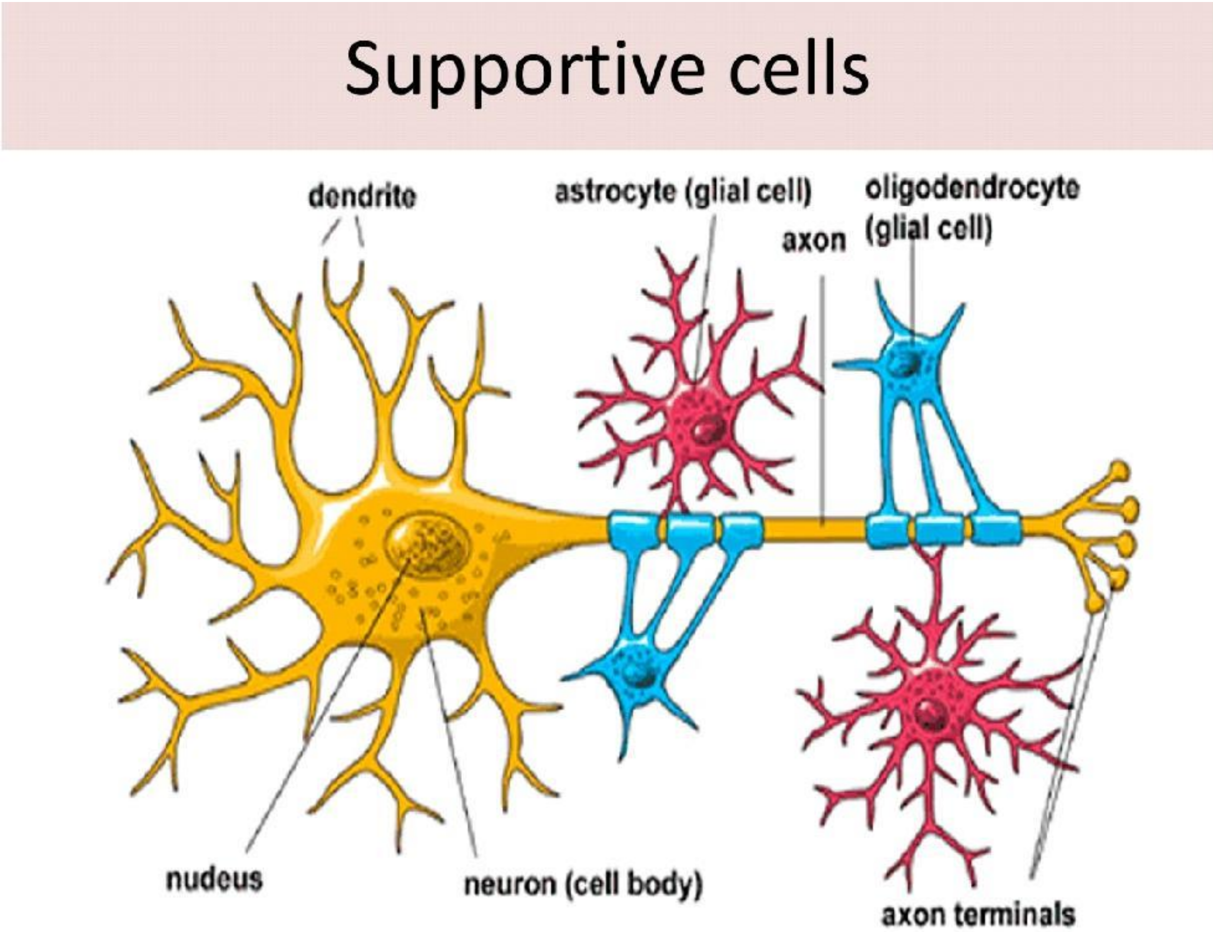
How?

The sensory neuron has a special shape like T letter as shown below .





Supportive cells :



Supportive cells functions :

a- Neurons are not able to divide and to regenerate themselves so there is a type of supportive cells secretion neurotrophic factors keep neurons existence as long as possible.
b- Central isolated from the rest of the body so we have a specific membrane structure called blood brain barrier preventing the passage of any substance from the blood toward the central nervous system.
c- Supportive cells with phagocitic function:

If pathogens enter the nervous system, they will be destroyed by this type of supportive cells because we don’t have immune cells (blood cells)

d- Keeping the medium around neurons clear.
e- Neurons losses alot of neurotransmissions so some of supportive cells capture and destroy them then giving back the substances to the neurons to reproduce new neurotransmission
f- Uptake any amount of high concentration materials around the neurons.

We won’t be asked about each type of cells and their specialized function , we just have to know the supportive cells function in general .

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Sorry to be late , I did my best and I wish this sheet makes your understanding away from distraction .