
◉Sheet ○Slides

Number

**11**

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## Neuronal classification:

Neurons are responsible for transmitting the action potential to the brain.

The speed at which the action potential is transmitted vary between nerve fibers, it can be as fast as **120m/s** or as slow as **0.5m/s**, and **the speed depends on two factors**: the diameter of the neuron, and the myelination of the neuron:

1- **Diameter of the nerve fiber:**
   The **larger** the diameter of the fiber the **smaller** the resistance and the **faster** the rate of transmission.
2- **Myelination of the nerve fiber:**
   The myelinated fibers transmit the action potential **faster;** because of the saltatory conduction, where the action potential is transmitted between the nodes of Ranvier. So , it prevents the dissipation of energy .

## Neurons are classified according to the myelination, or to the diameter of the fibers.

### According to myelination:

1- **Type A neurons:**
   They are found in the sensory nervous system, they are myelinated fibers of varying sizes, and have fast transmission speed. Type A is divided according to the diameter from larger to smaller (α - β - γ - δ) and consequently according to speed because the larger the fiber the faster it is:
   a- Alpha (α): the largest and fastest fiber.
   b- Beta (β)
   c- Gamma (γ)
   d- Delta (δ): the smallest and slowest fiber in type A.
2- **Type B neurons:**
   They are partial myelinated; those fibers are present in the autonomic nervous system.
3- **Type C neurons:**
   They are found in the sensory nervous system along with type A, those fibers are small unmyelinated fibers.

## According to the diameter:

1- Type (I, II, and III) fibers are myelinated and are equivalent to Type A , there is :
10 mins (A α , A β , A γ , A δ)

- ✓ The diameter rate from 1 to 20 micrometer, and the speed rate from 6 to 120 m/sec

2- Type IV fibers are unmyelinated and equivalent to Type C. the diameter is 2 micrometer and the speed is 0.5 to 2 m/s .

- The larger diameter is I , smaller than I is II , ….

Note: Type I isn't the same as Type A (α).

## Classification of neurons depending on the function :

### Sensory neurons ( afferent ):

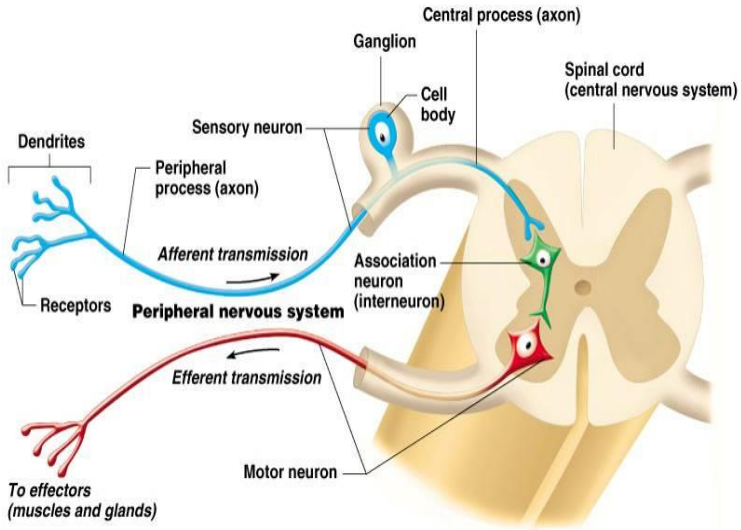
The neurons that transport the impulse from the body to the spinal cord or the brain ( CNS )

### Association neurons (interneuron):

the neurons that connects the sensory neurons to the motor neurons

### Motor neurons (efferent):

the neurons that go from the spinal cord to the effector organs (muscle or gland).




## The neurons are classified structurally into:

1- **Multipolar neurons:**

Those are the most common neurons in the body, in this type of neurons the cell body (soma) gives off many projections (dendrites and an axon).

- ✓ The cell body contain almost all the organelle of the cells , except of the centriole , because they do not divide . It has nucleus, ER, ribosomes (Nissl granule).
- ✓ The axon ends as axonal terminal (knobs or button)
- ✓ Axonal terminals contain chemical (neurotransmitter) to transmit the signal from one neuron to the other.

2- **Bipolar neurons:**

In this type of neurons, the cell body (soma) is present in the middle and has two projections, the dendrites on one side, and an axon on the other. (e.g. visual sensory neurons)

3- **Unipolar neurons:**

In this type of neurons, the cell body (soma) gives off one projection, and that projection divides into other divisions (dendrites and an axon). Found in olfactory system (smell)

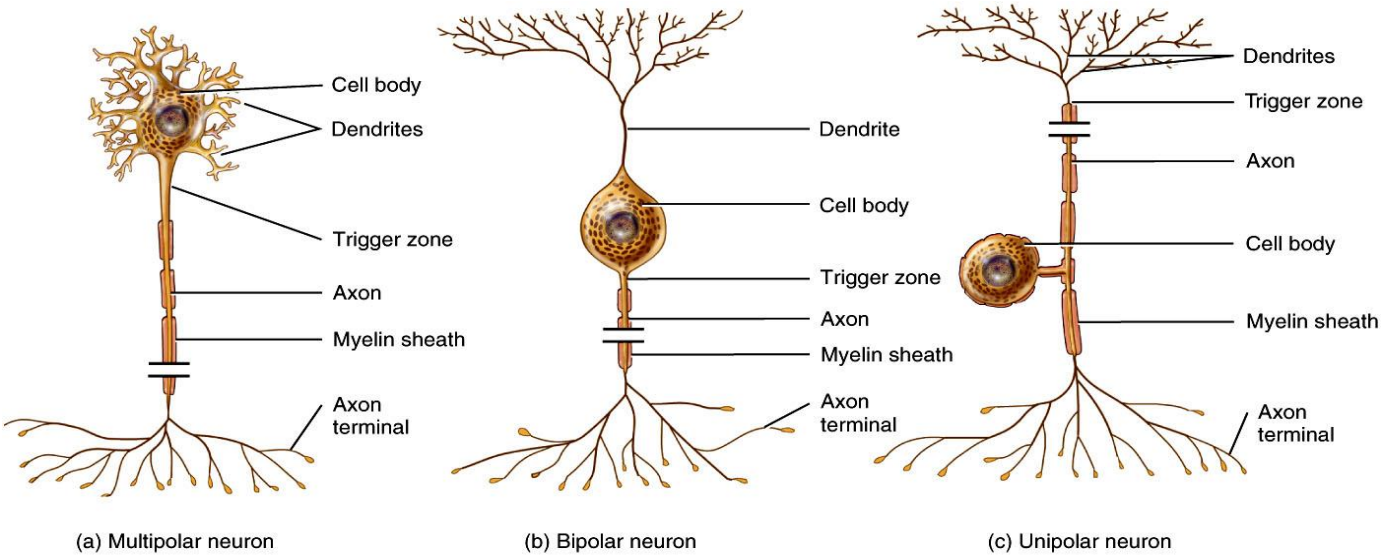



Figure 12.03 Tortora - PAP 12/e


## Neurotransmitters:

**Neurotransmitters are divided into two main categories:**

- ✓ **Rapidly acting small molecules (classical neurotransmitters):**

a- Acetylcholine

b- Amines, derived from amino acids:

Tyrosine based (epinephrine, norepinephrine, dopamine), threonine based (serotonin), histidine based (histamine)

20 mins

c- Amino acids:

Gamma-aminobutyric acid (GABA), glycine, glutamate, aspartate.

d- Gases (they exit the cells quickly because they are lipid-soluble):

Nitric oxide (NO), carbon monoxide (CO)

### Neuropeptides (neuromodulator):

They are peptides that work as neurotransmitters, they are called neuromodulator, because they modulate the action of other neurotransmitters.

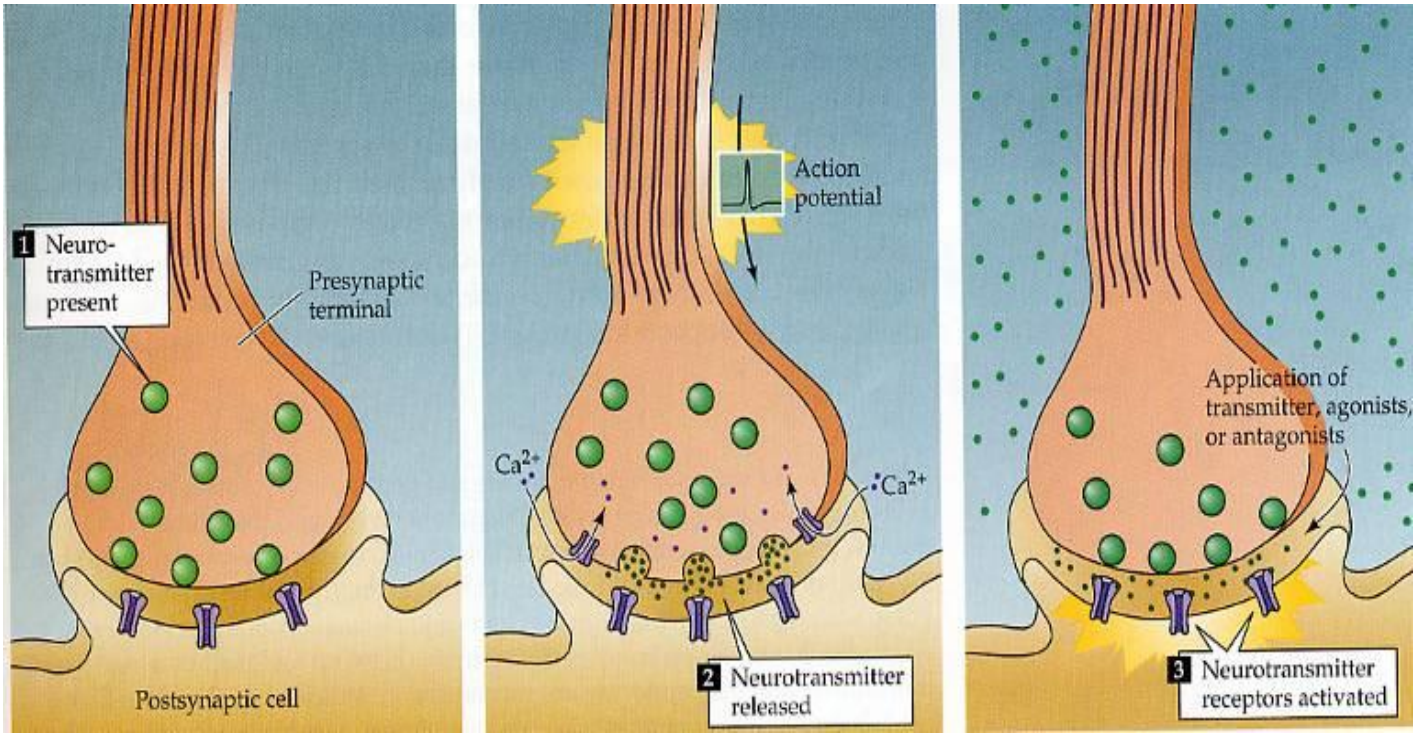
30 mins They are slower than classical neurotransmitters.

- ✓ Neuro because they are found in the nervous system
- ✓ Peptide because they are amino acid chain
- ✓ Any peptide in the brain can act as neurotransmitter in the brain

➢ Go back to slide no. 8 and take a look ^.^

### Neurotransmission mechanism:

When the action potential reaches the axonal terminals (knobs), it stimulates the opening of the voltage gated calcium channels present there, which leads to calcium influx, this influx causes the vesicles containing the neurotransmitters to dock and fuse with the presynaptic membrane and thus releasing the neurotransmitters into the synaptic cleft.



## Comparison between classical neurotransmitters and neuropeptides:

| | Rapidly acting small molecules | Neuropeptides |
|---|---|---|
| **Synthesis** | Synthesised in the axonal terminal. | Synthesised in the soma, in the rER and then transported to the golgi apparatus for packaging, and then slowly transported by vesicles by AXONAL TRANSPORT which is very slow (1-2 millimeters per day) to the axon terminal. |
| **Action / Releasing / longivity** | They are released in large quantities, have short lived action, and act rapidly. | They are released in small quantities, and they act slowly and prolong the action of neurotransmitters. Neuropeptides are co-secreted with small molecules NT. |
| **Vesicles recycling** | Their vesicles are recycled | Their vesicles aren't recycled because are synthesized in the Soma (away from the synapse) . |
| **Number** | Each neuron has one RASM | Each neuron can have one or more neuropeptides. |

40 mins

➢ *Go to slide 9 and take a look ^.^*

## Removal of neurotransmitters:

The neurotransmitters must be removed so that the stimulation of the postsynaptic neuron is not continuous, **and this happens in three ways:**

1- Diffusion of the neurotransmitter into the interstitial fluid outside the synaptic cleft.
2- Enzymatic degradation of the neurotransmitter **(1)**, e.g. ***acetylcholinesterase*** breaks down acetylcholine, and ***peptidases*** break down neuropeptides. ***Monoamine oxidase and Catechol-O-methyltransferase (COMT)*** are enzymes for epinephrine and norepinephrine.
3- Reuptake (active transport) of the neurotransmitter either by the neuron itself **(2)** or by the glial cells surrounding the neuron **(3)**, and this happens via active transport by neurotransmitter transporters.
e.g. when acetylcoline disintegrate to choline and acetyl Co-enzyme , the choline is reuptaken to recycle it and form acetylcholine again .

***Note //*** when we know how the neurotransmitters are broken down or removed , we can think how we treat certain diseases **. e.g.** ***Myasthenia gravis*** disease (weakness of the voluntary muscle groups) it is due to the very fast breakdown of acetylcholine or the receptor is absent , we treat it by prolongation of acetylcholine by inhibition of the enzyme .

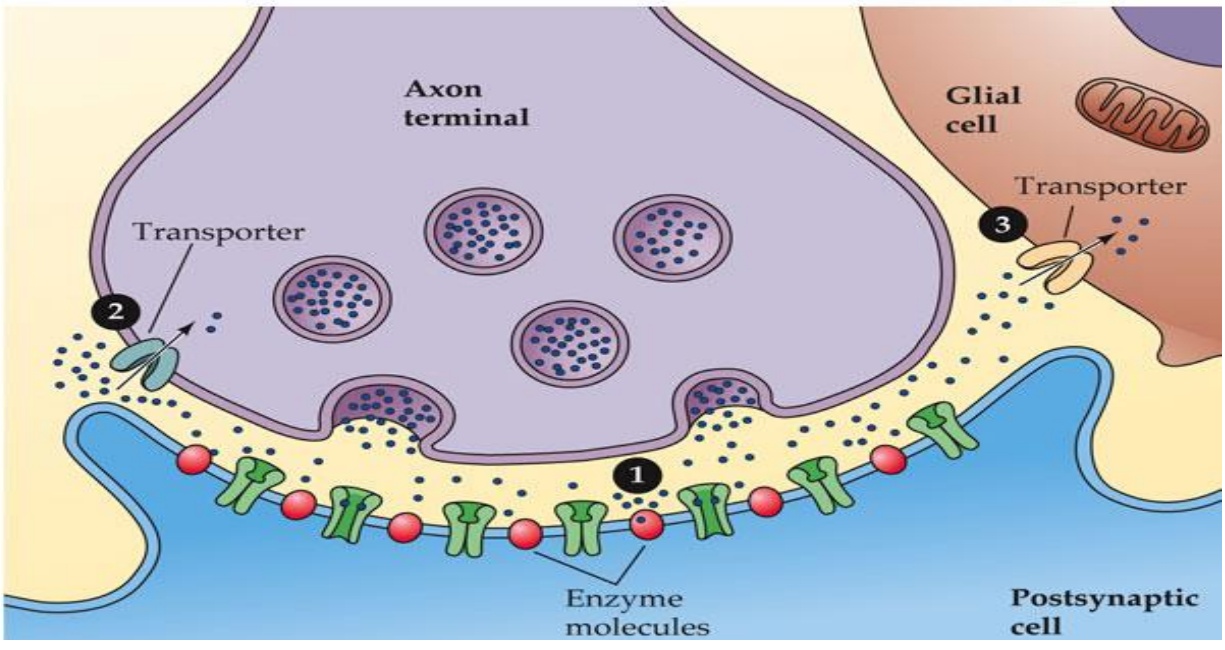
- Prolongation of the neurotransmitter stimulation can be accomplished by stopping either one of those mechanisms, **e.g.** using ***Prozac***, an antidepressant drug, that inhibits serotonin reuptake, or using molecules that inhibit the degrading proteins like acetylcholinesterase.

***Note //*** Acetylcholine decreases the heart rate (inhibitory) and increases the movement of GI (excitatory). ***e.g.*** if a person suffers from a colic (مغص), we treat him by antiacetylcholine, to inhibit the movement of small intestine.

It is inhibitory in the heart because, it is coupled to a receptor that causes opening of K+ channels and the membrane will be more negative (we are away from the threshold) . But in GI it is coupled to Na+ channel (ligand gated) causing the Na+ to enter to the cell (depolarization)

Each neuron has neuroreceptors either on the cell membrane or in the cytoplasm, that could bind to specific neurotransmitter, the properties of the neurotransmitter do not determine its effect on the postsynaptic neuron, ***the properties of the receptor determine whether a transmitter is excitatory*** (e.g. ligand gated sodium channels) or inhibitory (e.g. ligand gated potassium channels).

50 mins



- **Neurotransmitter:** Endogenous signaling molecules that alter the behavior of neurons or effector cells.
- **Neuroreceptor:** Proteins on the cell membrane or in the cytoplasm that could bind with specific neurotransmitters and alter the behavior of neurons of effector cells

•Vast array of molecules serve as neurotransmitters.

•The properties of the transmitter do not determine its effects on the postsynaptic cells

•The properties of the receptor determine whether a transmitter is excitatory or inhibitory.

- **A neurotransmitter must (classical definition):**
  - Be synthesized and released from neurons
  - Be found at the presynaptic terminal
  - Have same effect on target cell when applied externally
  - Be blocked by same drugs that block synaptic transmission
  - Be removed in a specific way

- **Agonist**

  A substance that mimics(simulate) a specific neurotransmitter, is able to attach to that neurotransmitter's receptor and thereby produces **the same action** that the neurotransmitter usually produces.
  - ✓ Drugs are often designed as receptor agonists to treat a variety of diseases and disorders when the original chemical substance is missing or depleted.
- **Antagonist**

  Drugs that bind to but do not activate neuroreceptors
  - ✓ thereby blocking the actions of neurotransmitters or the neuroreceptor agonists.

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