

Physiology202 nerve (lec 1)

The Nervous System

The Nervous system is divided into:

1. Central Nervous System (CNS):

Which is divided into:

- 1) **the brain** (present inside the skull)
- 2) **spinal cord** (present inside the vertebral column)

Functionally, the CNS can be divided into:

Spinal Cord level: concerned with the **simplest** reflex control of automatic function of the body (بيأدي ابسط الوظائف في الجسم و بتكون لإرادية)

Lower Brain Level: (brain stem) concerned with **more complex** reflex control of visceral and postural functions as well as emotional reactions (مسؤول عن وظائف متوسطة في التعقيد)

Higher Brain Level: (brain cortex) concerned with the control of **the most complex** motor activities including voluntary movements, memory, and thinking. (مسؤول عن اكثر الوظائف المعقدة في الجسم زي الحلاكة الارادية و الذاكرة)

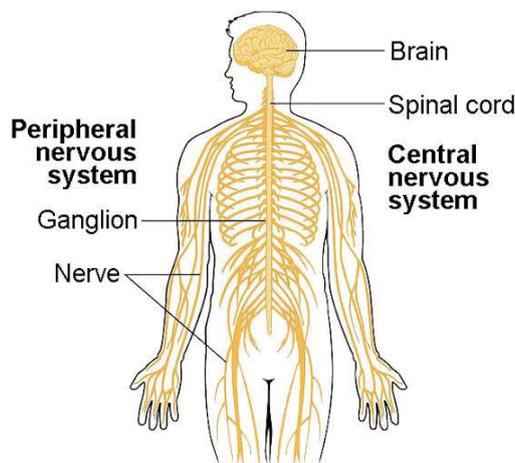
2. Peripheral Nervous System:

divided into:

1- **Afferent (sensory) division:** which consists of the **axons and cell bodies** of **sensory** neurons.

2- **Efferent (motor) division:** which is further divided into:

- **Somatic division:** which consists of the **axons** of **motor** neurons that innervate **skeletal muscle**
- **Autonomic division:** which consists of the **axons** of **motor** neurons that innervate **the viscera**



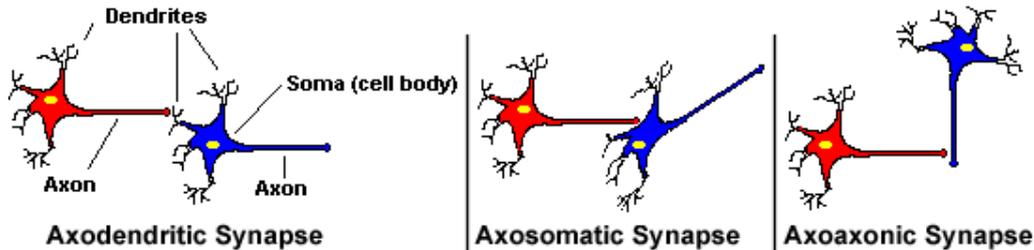
- **The functional unit of the nervous system: the neuron (nerve cell)**
- they are specialized in **production** and **transmission** of action potentials

❖ **Synaptic Transmission:**

Synapse: The area where impulses are transmitted between neurons

هي المناطق الي تنتقل عن طريقها الاشارات بين الخلايا العصبية

there are 3 types of synapses:



1- Axo-dendritic: the axon of presynaptic neuron synapses on the dendrites of postsynaptic neuron

N.B: About 90% of the synapses between neurons are of this type and it is the least excitable type of synapses (اكثر نوع موجود و اقلهم في سهولة الاستثارة)

2- Axo-somatic: where the axon of presynaptic neuron synapses with the cell body (soma) of the postsynaptic neuron

3- Axo-axonic: where the axon of presynaptic neuron synapses with the axon of postsynaptic neuron.

N.B: This type of synapse is the least common and is the most excitable type (اقل نوع موجود و اسهلهم في الاستثارة بسبب قصر المسافة)

❖ **action potential from a neuron can be transmitted to another neuron by two ways:**

1) **Electric transmission:**

- Transmission is by transfer of electric charges directly from presynaptic to postsynaptic neurons along **gap junctions**
- Electric synapses are found in areas of the brain like the **hypothalamus** and **cerebral cortex**
- they are much less common than chemical synapses in humans

في النوع ده الاشارات تنتقل عن طريق ال gap junctions و مش موجود كثير في الجسم

2) **Chemical transmission:**

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In this type of synapse the transmission of signals is by the release of **chemical transmitters** from the presynaptic neuron to affect postsynaptic neurons

في النوع ده الاشارة بتنتقل عن طريق مادة كيميائية

❖ **Anatomy of chemical synapse:** (مكوناته)

1- Presynaptic axonal terminal:

- The terminal end of presynaptic fiber becomes expanded and is known as the synaptic knob (النهايات بتكون منفوخة عشان فيها حويصلات)
- It is rich in **mitochondria** and contains large number of **synaptic vesicles** of chemical transmitter

There are 3 types of vesicles according to the transmitter they contain:

a- Small clear vesicles: contain rapidly (سريعة) acting transmitters such as **acetylcholine** and **glycine**

b- Small granular vesicles: contain **catecholamines**

c- Large granular vesicles: contain slowly (بطيئة) acting **neuropeptides**

2- Synaptic cleft:

This is a space between presynaptic knob and postsynaptic membrane that contains extracellular fluid (المسافة بين الخليتين)

3- Postsynaptic membrane:

The postsynaptic membrane under the synaptic knob is thickened and it contains receptors for the chemical transmitter

❖ **The steps (mechanism) of synaptic transmission:**

1- Release of chemical transmitter:

- Arrival of action potential to synaptic knob opens **Ca²⁺ voltage-gated channels**
- Ca²⁺ enters the synaptic knob according to **concentration** and **electrical gradients**
- Ca²⁺ triggers the **exocytosis** of the transmitter into synaptic cleft
الكالسيوم بيدخل عن طريق القنوات الي بتفتح بالكهرباء و بسبب خروج المادة الكيميائية عن طريق ال exocytosis

2- Binding of chemical transmitter with its receptor:

Which causes opening of ionic channels

3- Generation of postsynaptic potential:

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Binding leads to opening of ligand-gated ionic channels e.g. Na^+ , K^+ , Ca^{2+} or Cl^- channels, which causes changes in postsynaptic potential

المادة الكيميائية تفتتح قنوات الايونات فهتتحرك عبر الغشاء و تغير فرق الجهد

4- Removal of chemical transmitter:

This happens to stop its effect on postsynaptic membrane

بعد ما بيقوم بمهمته بيتشال

This occurs by:

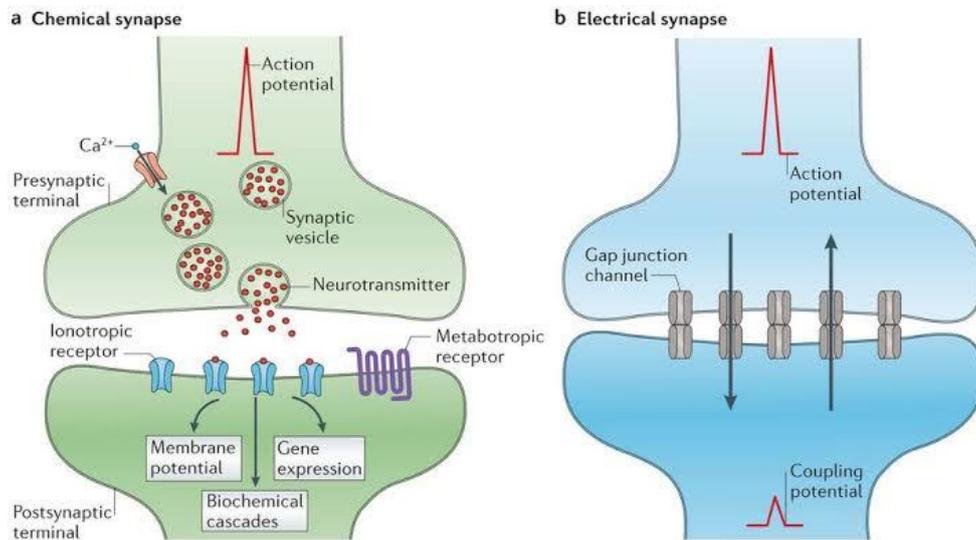
1-Diffusion of the transmitter away from the receptors (ينتشر الى المحيط)

2- Enzymatic inactivation of the transmitter e.g. acetylcholinesterase enzyme hydrolyzes acetylcholine (يتكسر عن طريق انزيم)

3- Removal by **glial cells**

4- Active reuptake of the transmitter back to the synaptic vesicles

(يرجع تاني للخلية الي طلع منها)



Postsynaptic Potential:

As a result of binding of synaptic transmitter to its receptor, postsynaptic membrane potential can *either*:

1- **Decrease** (depolarization) and is called **excitatory postsynaptic potential (EPSP)**. It is accompanied by **increased excitability** of the postsynaptic neuron (ممكن الاشارات تقلل فرق الجهد فتسبب زيادة الاستثارة)

2- **Increase** (hyperpolarization) and is called **inhibitory postsynaptic potential (IPSP)**. It is accompanied by **decreased excitability** of the postsynaptic neuron (ممکن انها تزود فرق الجهد فتقلل الاستثارة)

❖ **Grand Postsynaptic potential (GPSP):**

- The axon of presynaptic neuron branches near its termination into many branches, so the axon of one neuron can synapse with many postsynaptic neurons
- Also, one postsynaptic neuron can receive many presynaptic fibers
- Some presynaptic fibers are excitatory and some are inhibitory
- Hundreds of these presynaptic fibers may be active at the same time
- The net effect of all excitatory and inhibitory presynaptic fibers activity on the postsynaptic neuron is a sum known as **grand postsynaptic potential** (هو مجموع تأثير الاشارات الواصلة للخلية)
- The **magnitude and effect** of the grand postsynaptic potential depends on the **relative balance** between excitatory and inhibitory inputs (تأثيره يعتمد على الفرق بين الاشارات الواصلة المستثيرة و المثبطة)