
PHYSIOLOGY
النادي الطبي
Lec: 15
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# NERVOUS SYSTEM

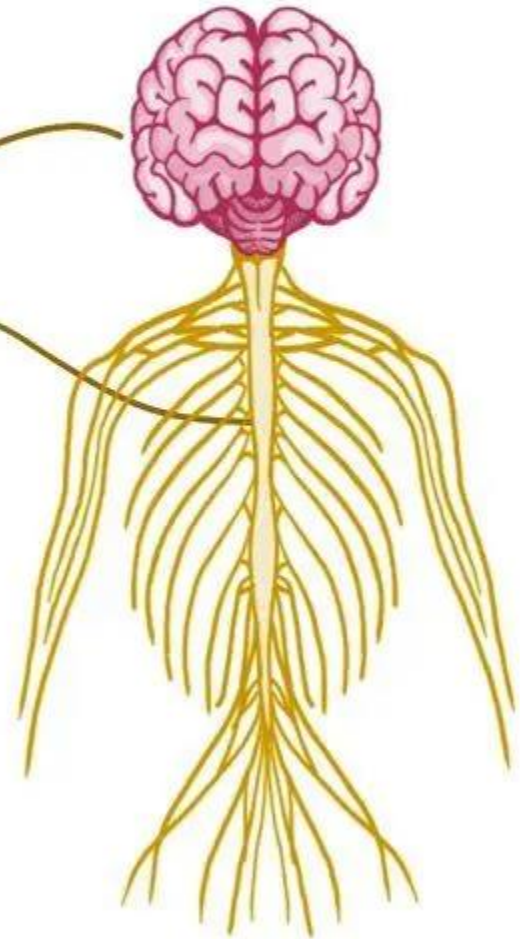
SEE, WALK, TALK

## CENTRAL NERVOUS SYSTEM

- BRAIN
- SPINAL CORD

## PERIPHERAL NERVOUS SYSTEM

- SOMATIC
- AUTONOMIC



## AFFERENT

- SENSORY INFO
- OUTSIDE → CNS
- VISUAL, AUDITORY, CHEMORECEPTORS, & SOMATOSENSORY (TOUCH)

## EFFERENT

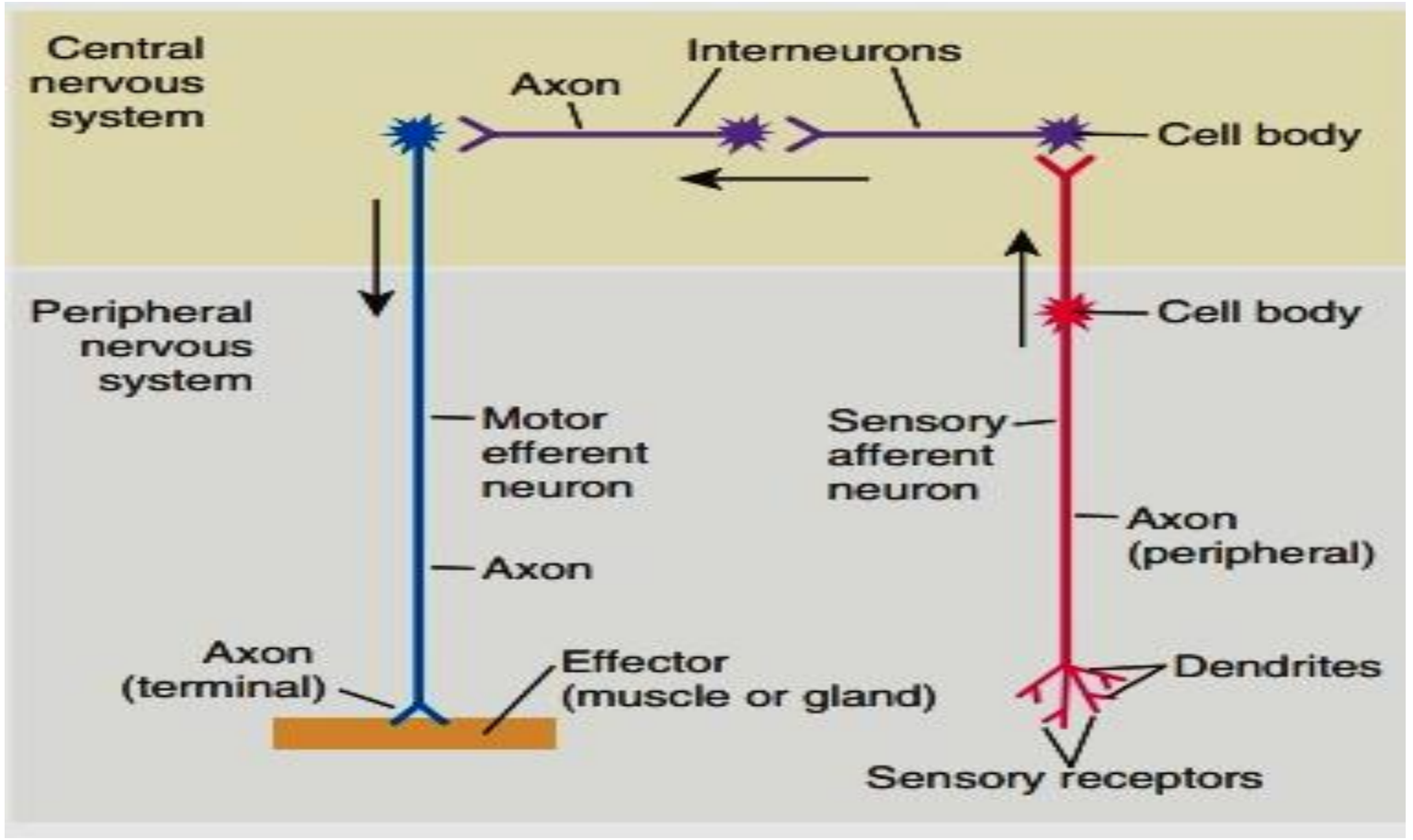
- MOTOR INFO → PERIPHERY
- CONTRACTION OF SKELETAL MUSCLES
  - MOVEMENT THROUGH SOMATIC NS

# تصنيف

# Functional classification of neurons

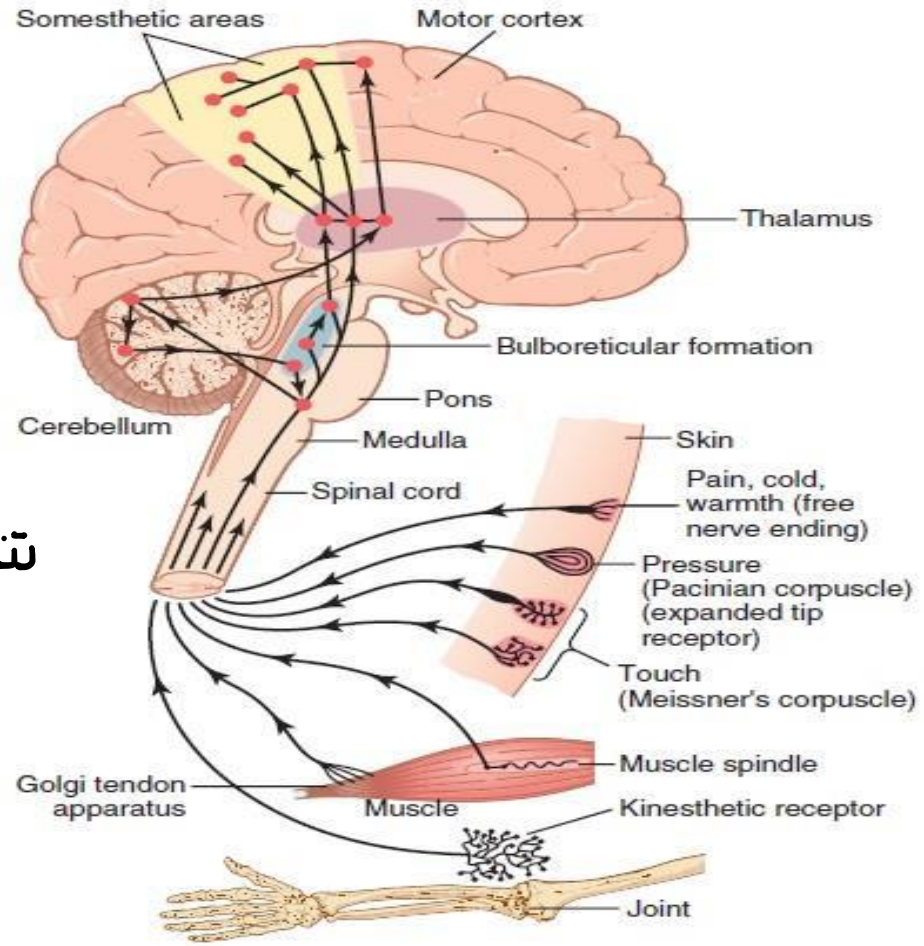
classification of nuerons

- Sensory /affèrent nuerons
- Motor /efférent nuerons
- Inter/association nuerons



# Sensory function of the nervous system

The figure shows an outline of sensory system, which transmits sensory information from
the receptors of the entire body surface and from some deep structures. This information enters the central nervous system through peripheral nerves and is conducted immediately to multiple sensory area he CNS areas via special sensory pathways



Somatosensory axis of the nervous system.

SENSORY NEURONS ARE AFFERENT اي بمعنى تحمل الاشارة العصبية القادمة من الجهاز العصبي الطرفي للجهاز العصبي المركزي

MOTOR NEURONS ARE EFFERENT اي بمعنى الاشارة العصبية تنتقل من الجهاز العصبي المركزي لباقي الجهاز العصبي

# MOTOR PART OF THE NERVOUS SYSTEM—EFFECTORS

*Motor functions* of the nervous system,

(1) contraction of appropriate skeletal muscles throughout the body

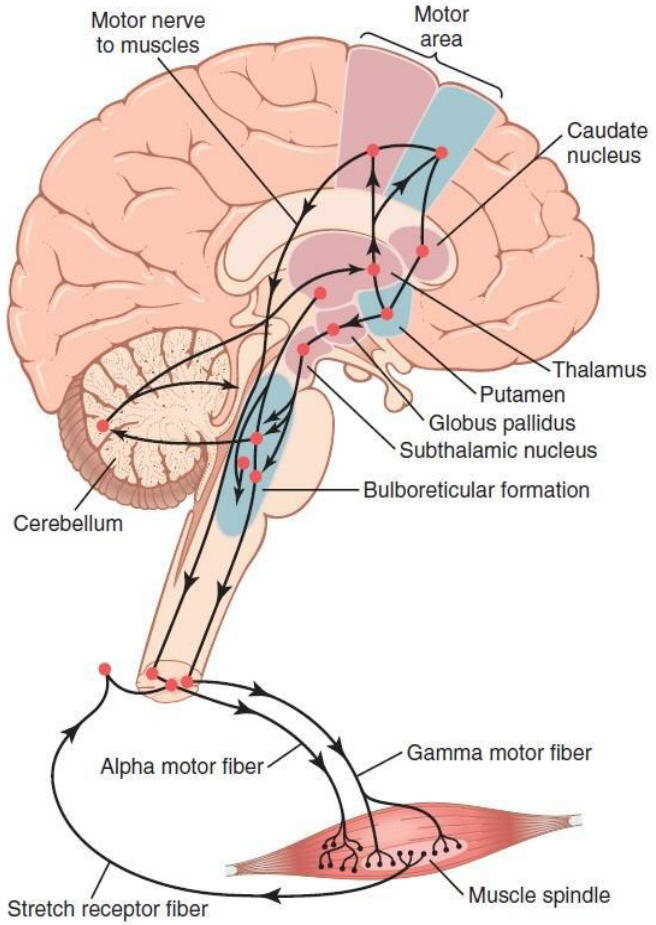
(2) contraction of smooth muscle in the internal organs

(3) Secretion of active chemical substances by both exocrine and endocrine glands in many parts of the body. and the muscles and glands are called *effectors* because

they are the actual anatomical structures that perform the functions dictated by the nerve signals

The motor system consists of voluntary and involuntary part.

- The control of skeletal muscle contraction is mediated by voluntary motor nerves, whereas the **autonomic nervous system** is responsible for the involuntary control of smooth muscle contraction and glandular secretion.




Skeletal motor nerve axis of the nervous system.

ال EFFECTOR هو الجزء اللي انتقله الاشارة العصبية وقام بالوظيفة المحددة من الإشارة

مثال هو الإشارة وصلت عضلة الامعاء إنها تنقبض
في هذه الحالة تعتبر العضلة هي ال effector لأنها قامت بعملية الإنقباض

* EFFECTORS ARE THE ACTUAL ANATOMICAL STRUCTURES THAT PERFORM THE ACTION

ال MOTOR NERVOUS SYSTEM تتكون من اعصاب تكون حركتها إرادية مثل ال MOTOR NERVES المسوولة عن SKELETAL MUSCLE CONTRACTION

او لا إرادية مثل ال AUTONOMIC NERVOUS SYSTEM المسؤولة عن انقباض العضلات الملساء وافراز الغدد

# Neurons and glial cells

انواع الخلايا العصبية

- Nervous tissue is composed of tow types of cells ①②
- Neurons which are excitable and conduct information via nerve impulses and communicate with each through specialized junctions know as synapses
  - There are about 10 billion cells in the CNS ③
  - The basic functional unit of the nervous system is the NEURON. The CNS contains more than 100 billion neurons. Neurons mainly function to *store*, *communicate*, and *integrate information*

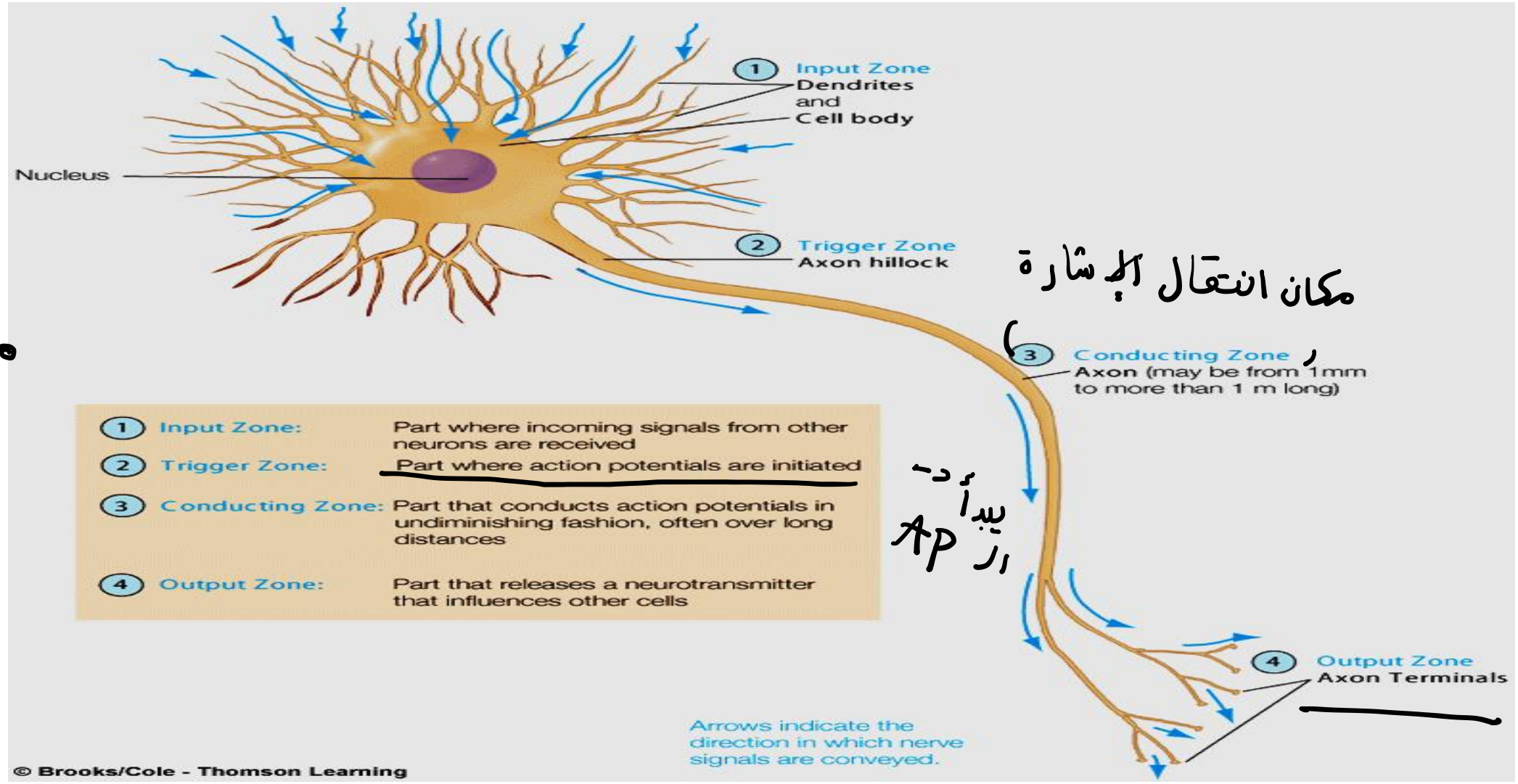
الخلايا الغرائية مثل ال SCHWANN CELLS تقوم بتكوين ال MYELIN حول ال NEURONS

- Glial cells :which perform a variety of nonsignaling functions such as forming myelin to provide support and insulation between neurons, phagocytosing and removing cellular debris, removing excess neurotransmitters, and forming the blood-brain barrier

بقايا الخلايا ← الفائض

شرح مبسط ← semi membrane between blood and brain fluids

# Functional component of a neuron




مطلوبة

مكان انتقال الإشارة

يبدأ د AP

# Synapses and Signal Transmission

- A synapse is the junction between neurons or between a neuron and an effector like skeletal muscles

- Types of synapse
  - Electrical Synapse
  - Gap junctions connect cells and allow the transfer of electrical activity and to synchronize the activity of a group of cells
  - Chemical Synapse
  - One-way transfer of information from a presynaptic neuron to a postsynaptic neuron
  - The primary type of synapses in the nervous system

two ways

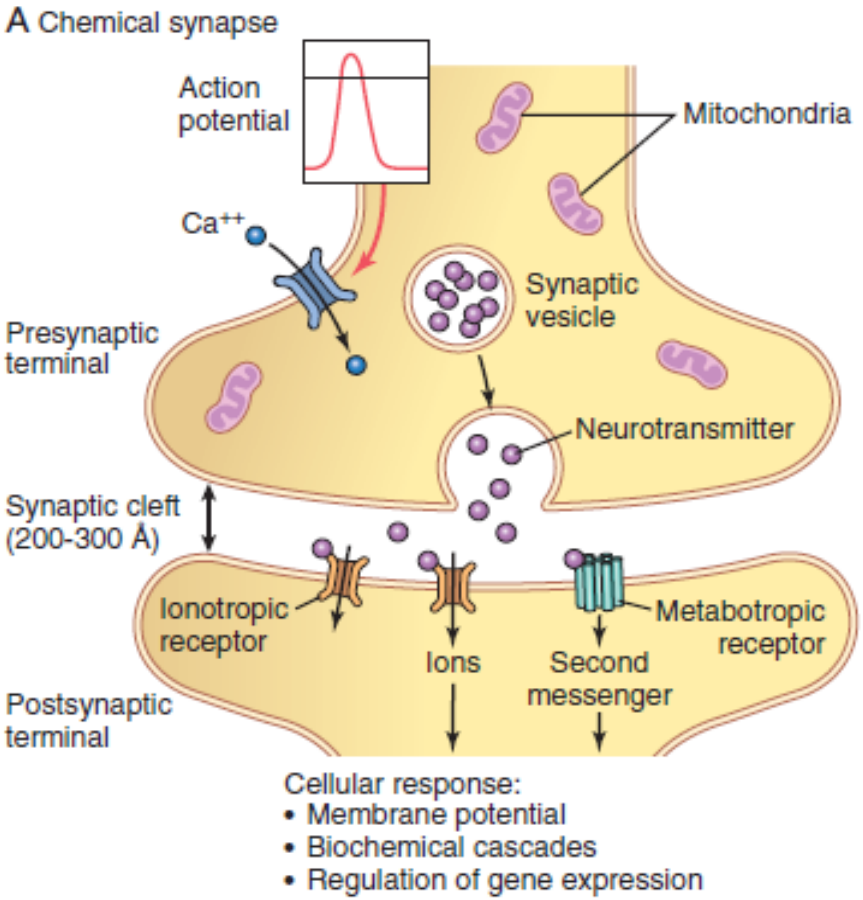
one way

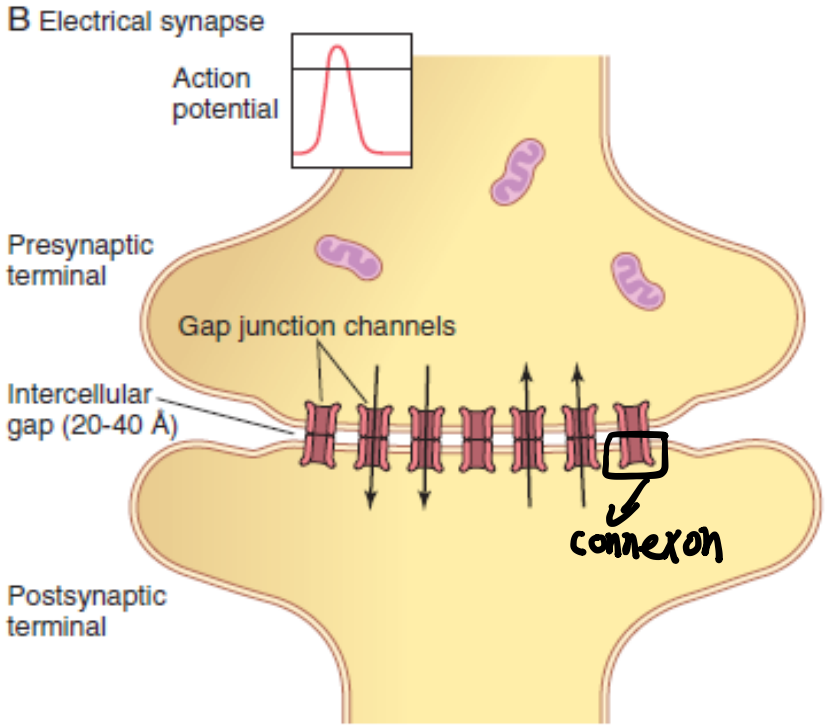
غالبًا ما يحدث

# Types of Synapses
# Electrical synapses and chemical synapses
# Functional anatomy

**Synaptic cleft**

**synaptic delay**



# Electrical synapses

*response is immediate, no delay

1. Electrical synapses are a physical connection between two neurons. cell membrane proteins called connexons form gap junctions between the neurons.
2. The gap junctions form pores (ثقوب) that allow ions to flow between neurons, so as an action potential propagates in the presynaptic neuron, the influx of sodium can move directly into the postsynaptic neuron and depolarize the cell.
3. The response in the postsynaptic cell is almost immediate, with little to no delay between signaling in the pre- and postsynaptic neurons.
4. Electrical synapses play an important role in the development (تطوير) of the nervous system but are also present throughout the developed (متطورة) nervous system, although in much smaller numbers compared chemical synapses.
   - Compared to chemical synapses, electrical synapses conduct nerve impulses faster (almost no delay).

*electrical synapses is faster that chemical synapses

*electrical synapses is smaller in number compared to chemical synapses (in developed NS)

## شرح نقطة رقم 2:

يعني لو صار ACTION POTENTIAL في ال PRESYNAPTIC NEURON
واللي هو عبارة عن DEPOLARIZATION بسبب ايونات الصوديوم ،
ايونات الصوديوم هاي قادرة انها توصل لل POSTSYNAPTIC
NEURON عن طريق الثقوب ورح تحدث DEPOLARIZATION

# Electrical synapses

HYPERPOLARIZATION IN PRE-SYNAPTIC CELL MEANS HYPERPOLARIZATION AND POSTSYNAPTIC CELL

DEPOLARIZATION IN PRE-SYNAPTIC CELL MEANS DEPOLARIZATION AND POSTSYNAPTIC CELL

- The response is always the same sign as the source. For example, depolarization of the pre-synaptic membrane will always induce a depolarization in the post-synaptic membrane, and vice versa for hyperpolarization.
- Also, the response in the postsynaptic neuron is in general smaller in amplitude than the source.
- The relative speed of electrical synapses allows for many neurons to fire synchronously (at the same time). For example, certain hormone-secreting neurons within the hypothalamus are connected by electrical synapses, thus facilitating a burst of hormone secretion into the circulation
- Gap junctions are present in cardiac muscles and visceral (single unit smooth muscles )

حسيتهم مهمين بما انه الدكتور ذكرهم

# Chemical synapses

- Most synapses in Nervous system are chemicals synapses and the transmission of signal from presynaptic to postsynaptic cell occurs via the release of chemicals know as neurotransmitters
- Transmission is one direction ( from presynaptic to postsynaptic neuron )
- Synaptic cleft : space between presynaptic and postsynaptic neurons
- Synaptic delay Time is needed for signal transmission from presynaptic to postsynaptic neuros

# Function of chemical nervous system synapses

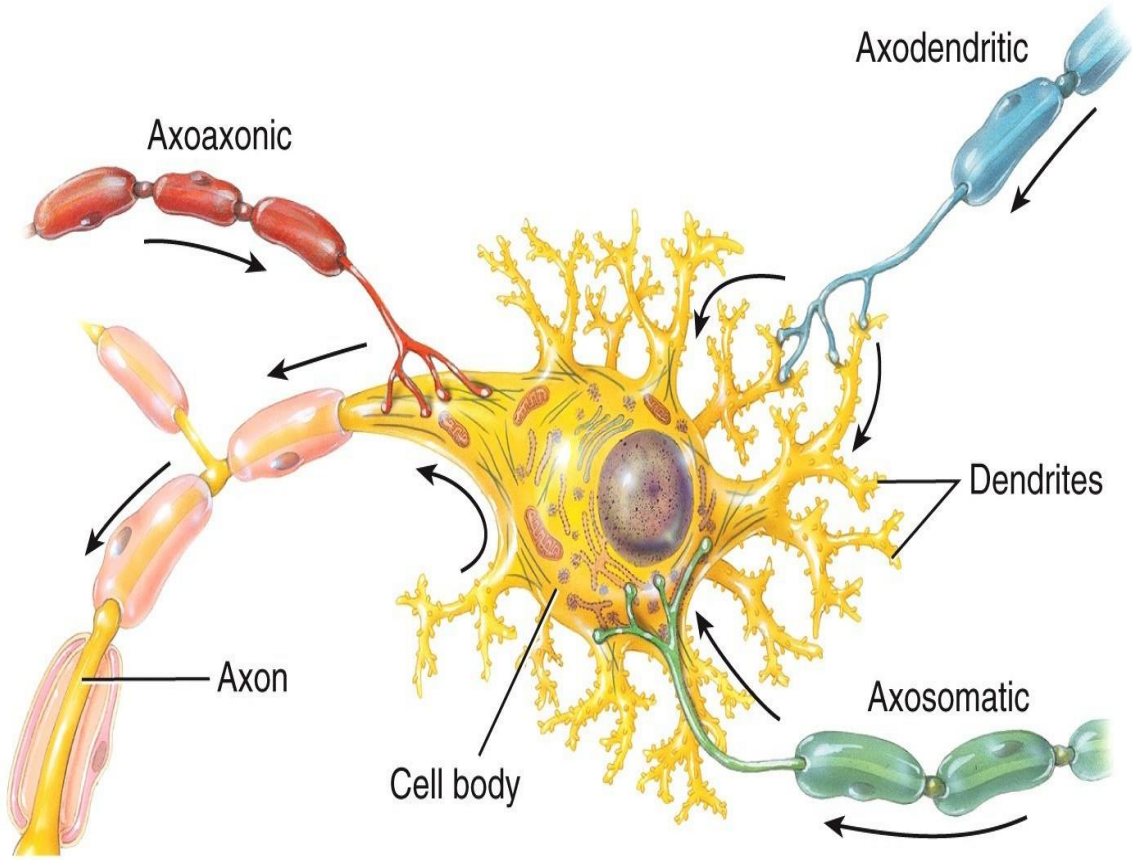
- Synapses determine the directions that the nervous signals will spread through the nervous system.
- Changing the impulse from a single into repetitive impulses (Signal amplification)
- *Facilitatory* and *inhibitory* signals from other areas in the nervous system can control synaptic transmission, sometimes opening the synapses for transmission and, at other times, closing them
- Some postsynaptic neurons respond with large numbers of output impulses ,and others respond with only a few. Thus, the synapses perform a selective action, often blocking weak signals while allowing strong signals to pass but, at other times, selecting and amplifying certain weak signals and often channeling these signals in many directions rather than in only one direction.
- Synapses also are important for storage of information is the process we call *memory*

للي دارس المحاضرات اللي قدام رح يفهم النقاط

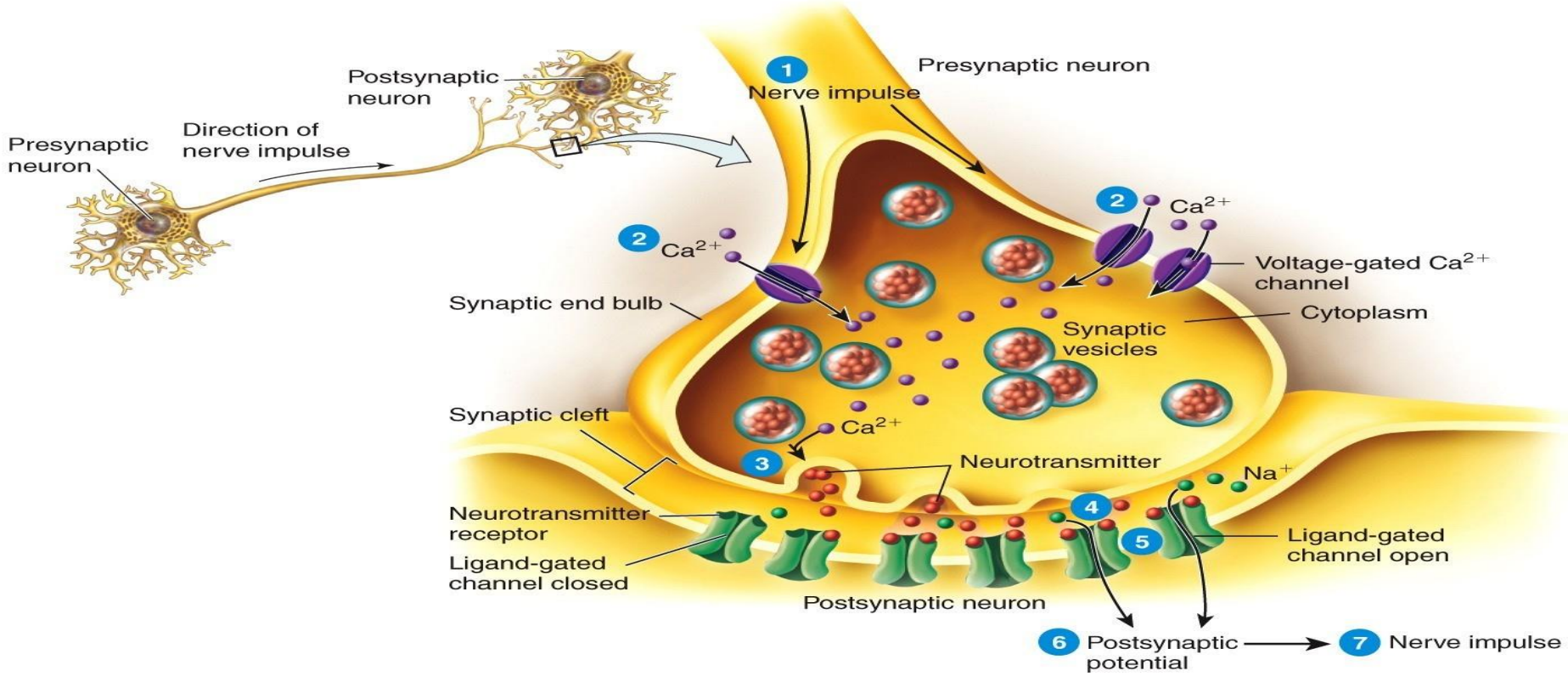
حكاها الدكتور

# Structure of a chemical synapse and types of different pattern of synaptic connection in nervous system

- A synapse involves a junction between an axon terminal of one neuron, known as the **presynaptic neuron**, and the dendrites or cell body of a second neuron, known as the **postsynaptic neuron**.
- This junction allows the transmission of nerve action potential (or nerve impulse) from one neuron to the next.
- There are different types of chemical synapses depending on the site of contact between presynaptic terminal and post synaptic cell
  - Axodendritic → very common
  - Axosomatic
  - Axoaxonic → rare



# Steps of synaptic transmission and signal transmission at a Chemical synapses




The neurotransmitters (Small molecules) are synthesized and stored in vesicles in presynaptic terminal Can be Excitatory neurotransmitters or Inhibitory neurotransmitters depending on the receptor and its interaction with neurotransmitter

تفاعله

المستقبل

* EXCITATORY NEUROTRANSMITTERS WILL CAUSE AN INCREASE IN SODIUM IONS PERMEABILITY IN THE POST SYNAPTIC NEURON WHICH WILL CAUSE A DEPOLARIZATION IN THE POST SYNAPTIC NEURON AND IF THIS DEPOLARIZATION WAS SUFFICIENT, IT WILL CAUSE AN INITIATION OF AN ACTION POTENTIAL

excitatory synapses

* THE INHIBITORY NEUROTRANSMITTER INCREASES ABILITY TO CHLORIDE IONS OR POTASSIUM IONS A HYPERPOLARIZATION WILL HAPPEN IN THE POST SYNAPTIC NEURON AN ACTION POTENTIAL OCCURING WILL BE HARDER

inhibitory synapses

شرح مختصر
للسلايد القادمة:

ال DEPOLARIZATION يؤدي إلى فتح قنوات الكالسيوم
وعند زيادة تركيز ايونات الكالسيوم رح تتحفز بروتينات ملتصقة بال SYNAPTIC VESICLES ورح تندمج ال
VESICLES بال MEMBRANE بحيث يخرجوا عن طريق ال EXOCYTOSIS

ارتباط الNEUROTRANSMITTERS بال
POSTSYNAPTIC RECEPTORS

AP in presynaptic neuron
reaches the terminal
increase the permability of $Ca^{+2}$ ions by voltage gated channels
which fuses the vesicles with the membrane and exocytosis happens for NT

# Basic Steps in chemical synaptic transmission

- Basic Steps
  - Neurotransmitter synthesis
  - Load neurotransmitter into synaptic vesicles
  - Depolarization opens voltage-sensitive Ca2 + channels in the presynaptic nerve terminal
  - Vesicles fuse to presynaptic terminal and release of NT by exocytosis
  - Neurotransmitter spills into synaptic cleft
  - Binds to postsynaptic receptors
  - Biochemical/Electrical response elicited in postsynaptic cell
  - Removal of neurotransmitter from synaptic cleft
  - Recycling of synaptic vesicles back into presynaptic terminals also occurs via clathrin mediated endocytosis .

L> neurotransmitters

لي ماركن
عليه الكتور

# Termination of action of neurotransmitters (Removal of Neurotransmitter)

التخلص من النواقل العصبية

There are four ways three ways by which neurotransmitters are cleared from the cleft:

1. Diffusion → exits the synaptic cleft
2. Enzymatic degradation (تحطيم) Example Acetylcholine esterase at cholinergic synapses and MAO (Mono amino oxidase) in adrenergic synapses
3. Reuptake into the nerve terminal by transport protein coupled to the $Na^+$ gradient, for example, dopamine, norepinephrine, glutamate and GABA;
4. Uptake and metabolism by glial cells (glutamate)

MONOAMINE NEUROTRANSMITTERS INCLUDE ADRELANINE

by presynaptic cell

ACETYLCHOLINE يكون الناقل العصبي فيه ال SYNAPSES نوع من ال

MAO ALSO DEGRADES NOREPINEPHRINE مهم