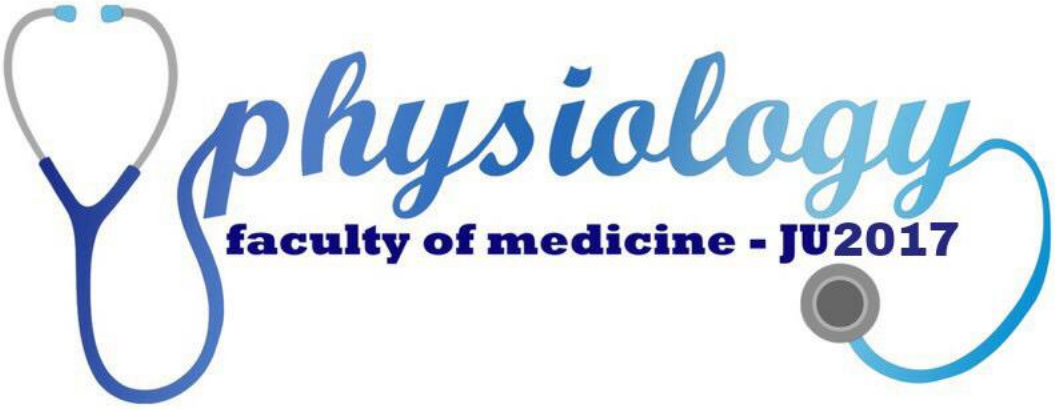

◉Sheet ○Slides

Number

15

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Neuron types and neurotransmitters

Things to remember

- Types of synapse:

When it happens between an axon and dendrites it is called ⟶ axodendritic synapse
when it is between axon and cell body (soma) it is called ⟶ axosomatic synapse
when it is between axon and axon it is then called ⟶ axoaxonic synapse.

- The first part of the axon is called axonal hillock (trigger zone), it has the lowest threshold for action potential meaning (that the density of voltage gated Na+ channels is the highest).
- If there are only ligand gated Na+ channels, no action potential will be produced instead, there is local potential.
- Action potential is all or non-principle as long as you reach the threshold.
- Local potential depends on the strength of the stimulus (the higher the stimulus the higher the potential).
- If the stimulus is higher than the threshold you can stimulate the neuron during the relative refractory period, you can stimulate the neuron earlier and earlier increasing the rate of action potential until you reach the absolute refractory period ⟶ once you reach the absolute refractory period you get the maximum rate of action potential.

Example:

If the stimulus= threshold the rate of action potential is every 10 milliseconds.

If stimulus is higher than the threshold rate of action potential can be 8 milliseconds and so on.

- Absolute refractory period limits the maximal rate of action potential in the neuron we can't pass the absolute refractory period.
- Neuropeptides and neuromodulators are considered neurotransmitters because they are secreted form neurons.
- The axonal terminals are sometimes called buttons or knobs and Neurotransmitters are found there.
- If the amino acid sequence is more than 100 amino acid we call it protein Less than 100 we call it peptide.

- Neurotransmitter: signaling molecules that alter the behavior of neurons or effector cells they have to be Endogenous meaning they exist naturally within the body like Endogenous pain suppressors (endorphins) ➟ (If you have the receptor to any NT, then this NT is made inside the body) pain killers mimic the shape of endorphins so they can bind on receptors in the brain.
- Receptor: Proteins on the cell membrane or in the cytoplasm that could bind with specific neurotransmitters and alter the behavior of neurons or effector cells.

The rate of transmission of the signal from the receptor to the brain depends on:

1-Nerve fiber diameter: the larger the diameter (less resistance), the faster the rate.

2- Myelinated or Unmyelinated: the propagation in the myelinated is faster (120m/s) , the myelin sheath work as insulator, in unmyelinated there is a continuous conduction that's why it's slower (0.5m/s).

Nerve fiber classification:

"General Classification"

1- Type A (myelinated, fast transmission speed,(it can reach 120m/s) subdivided according to diameter from larger to smaller (α - β - γ - δ) and consequently according to speed because the larger the fiber the faster it is.

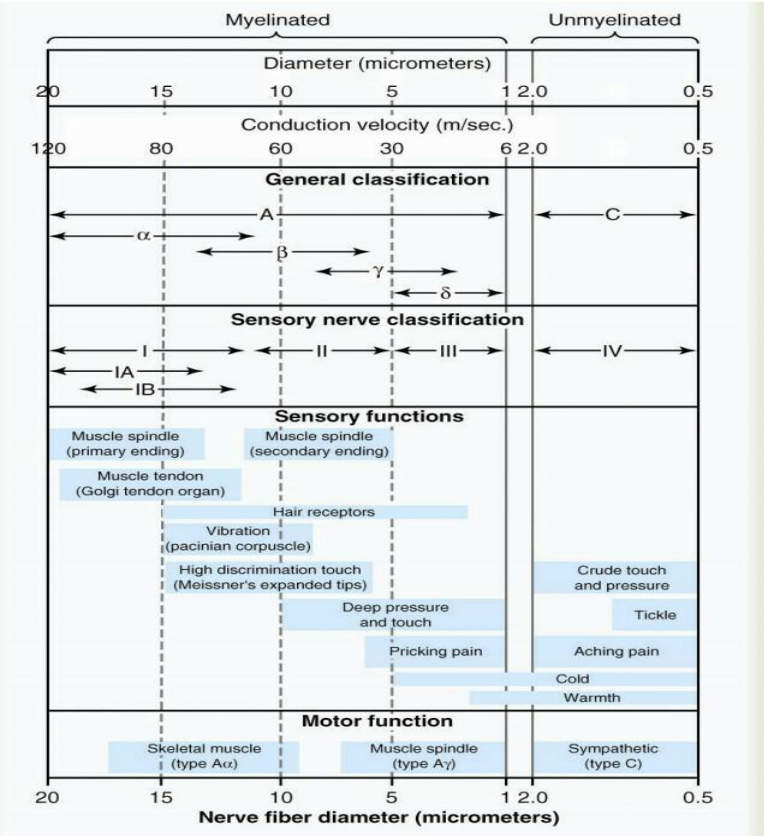
!!Details:

-Most of the motor neuron are A-α, they are very fast.

-Pain transmitters are slower A-γ or A-δ

2- Type B (partially myelinated) usually found in the autonomic nervous system (preganglionic).

3- Type C (unmyelinated, slow transmission speed it can be 0.5m/s).



-they get slower and slower as the diameter gets smaller

*Classification according to Roman numbers:

"Sensory nerve classification"

1-Type (I, II,III) are myelinated fibers, they are the same as type A in general classification.

^^don't memorize the numbers^^

2-Type (IV) are unmyelinated fibers, they are the same as type C.

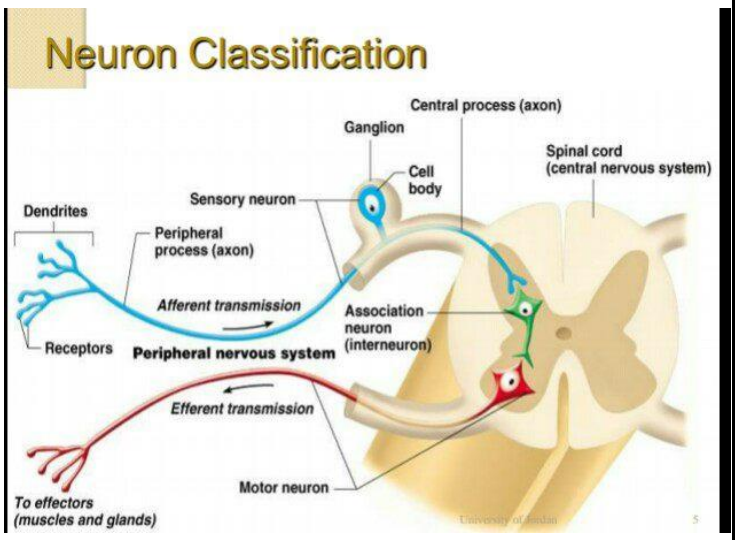
*classification according to morphology:

1- Sensory neuron (afferent): impulses from outside (skin, muscle, receptor) to the spinal cord.

2-Inter neuron (Association): connects the sensory to the motor.

3-Motor neuron (efferent):

Impulses from the spinal cord to the effectors (muscles or glands).

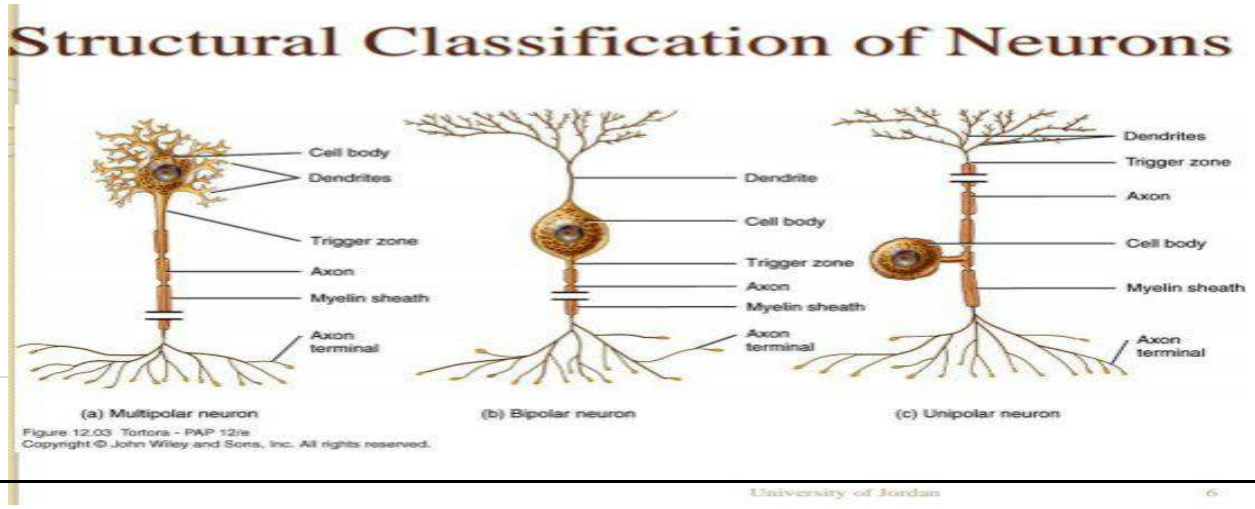


*Structural classification of neurons:

1- Multipolar neuron (classical) : like the palm of the hand (the hand is the cell body the fingers are the dendrites, and the arm is the axon)the most common.

2-Bipolar neuron: it has two poles and found in certain areas in the CNS.

3- Unipolar neuron: found in olfactory system (smell).



*The neurotransmitters:

There are two major types

1-The classical neurotransmitters:

Small molecules rapidly acting neurotransmitters, they have short duration and less potent.

Classes and examples:-

- Class I: acetylcholine.
- Class II (Amines): like norepinephrine, epinephrine, dopamine, serotonin and histamine -derived from amino acids (mainly Tyrosine).
- Class III (amino acids): GABA, glycine, glutamate and aspartate.
- Class IV (gasses): NO and CO.

*Class IV don't need receptors and pass very fast through the membrane by simple diffusion because they are lipid soluble.

2-Neuropeptides/neuromodulators:

(Slowly acting or growth factors), more potent and longer duration.

-Anywhere in the brain there is neuropeptides it might act as neurotransmitters.

Examples:-

Endorphins, enkephalins, VIP, hypothalamic- releasing hormone, TRH, LHRH, pituitary peptides, GnRH, ACTH, prolactin, vasopressin…

*You can find the complete list in the slides.

*Comparison between Small molecules and Neuropeptides Neurotransmitters:-

1-Small molecules NT are synthesized in the **presynaptic terminal** (their enzyme is found there) and they are found in vesicles.

They are released by exocytosis into the synaptic cleft.

Neuropeptides are synthesized in the ribosomes (Rough Endoplasmic Reticulum) **in the SOMA**, packaged and modified in the Golgi apparatus and then transported (by vesicles)

by AXONAL TRANSPORT which is very slow (1-2millimeters per day) to the axon terminal.

2-Neuron <u>has only one NT</u> - but may have one or more Neuropeptides.

3-Small molecules NT have short lived action - Neuropeptides have prolonged time of action.

4-Small molecules NT are excreted in large amounts compared to - smaller quantities of Neuropeptides (NP), we consider NP precious and very important.

6-Small molecules NT vesicles are recycled (used again) (because they are near the synapse) unlike - NP which are synthesized in the Soma (away from the synapse).

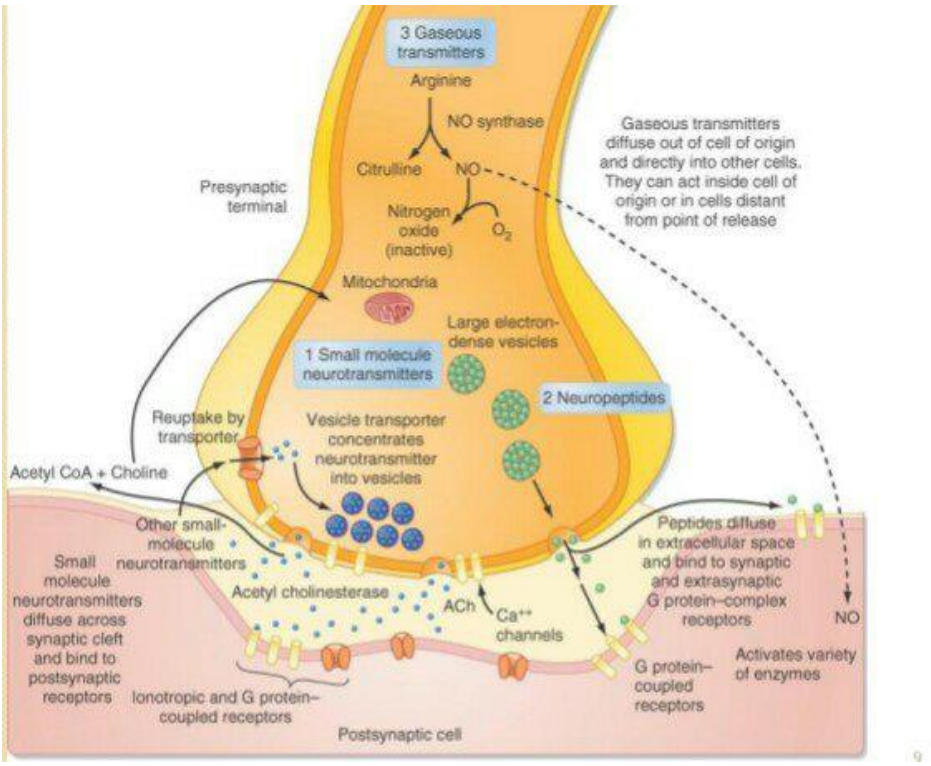
7-Neuropeptides are co-secreted with small molecules NT.

*You should know the mechanism from earlier lectures.

AS you can see:-

The fast diffusion of gases without receptors.

Notice the degradation of ACH to Acetyl Coa and Choline and then reuptake them.



The receptor acts directly to open ion channels so we call it **IONOTROPIC,** another type is **INOTROPIC**, which is found in the cardiac for contractility.

NP the receptors are usually on the cell membrane and work through activation of G-proteins which consists of 3 subunits (Alfa, Beta and Gama), after binding and activate G-protein the Alfa subunit dissociate and cause activation inside.

NT is called first messenger, there could be second messenger (Camp, Cgmp, IP3, CA, phospholipids …).

*Removal of Neurotransmitters :-

The NT doesn't stay forever; there are 3 ways to remove it:

1- Diffusion to interstitial fluid by concentration gradient.

2- Enzymatic degradation like Acetyl cholinesterase for ACH and Peptidases for NP and monoamine oxidase for epinephrine.

3- Reuptake by neurons or glia cells.

Drugs are made to inhibit reabsorption, which prolongs its action.

Example: PROZAC =serotonin reuptake inhibitor (for psychiatric patient).

Drugs that inhibit cholinesterase so acetylcholine action is prolonged.