

Autonomic nervous system (2)

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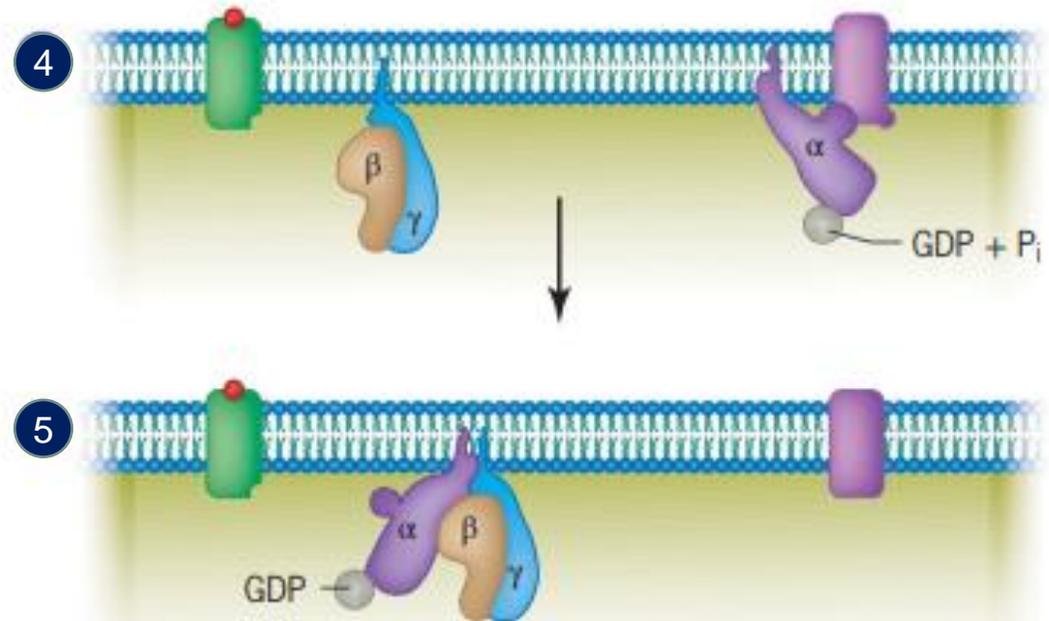
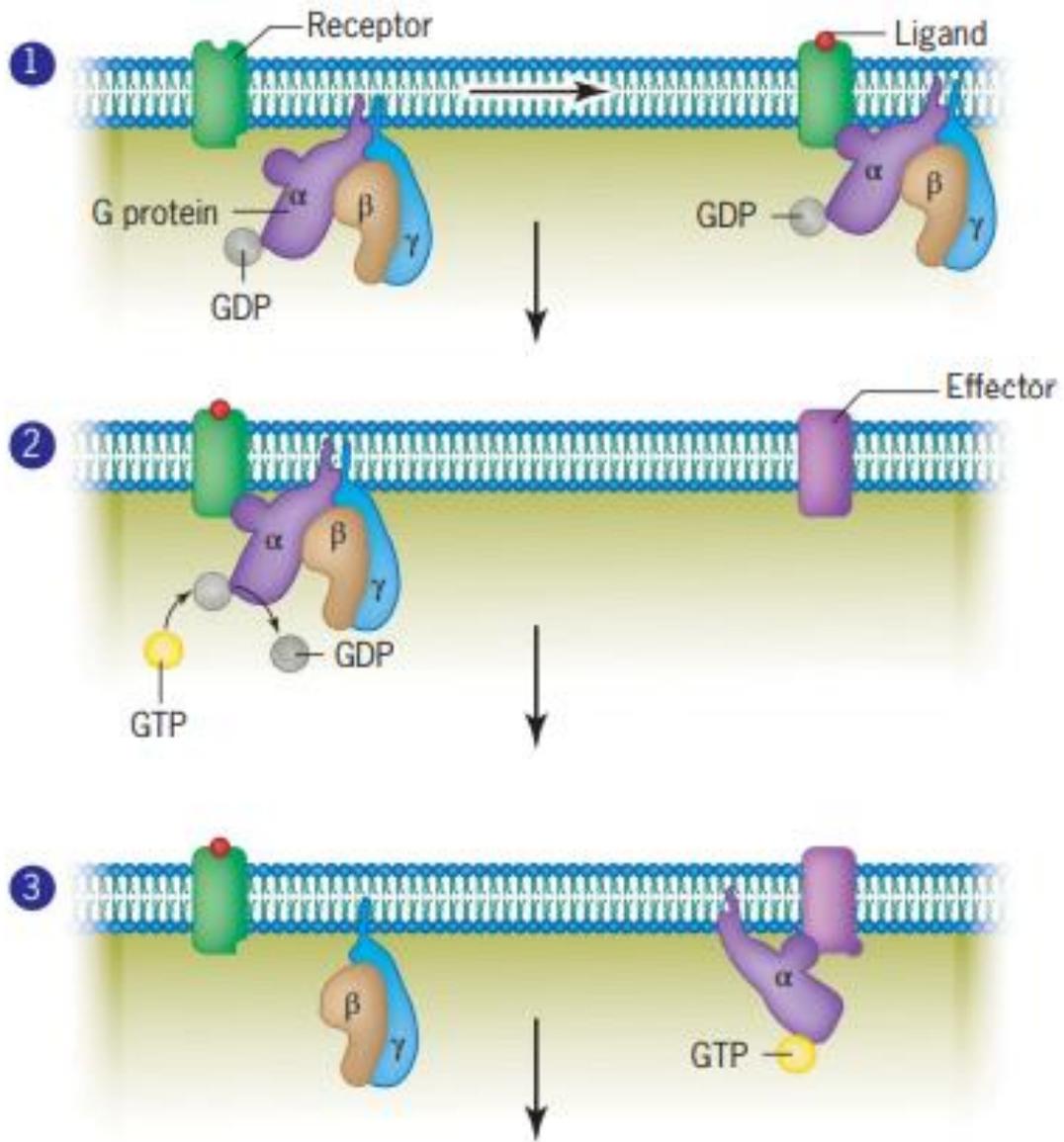
فورم التسجيل في دورات الفسيو، الامبريو
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Topics of this lecture

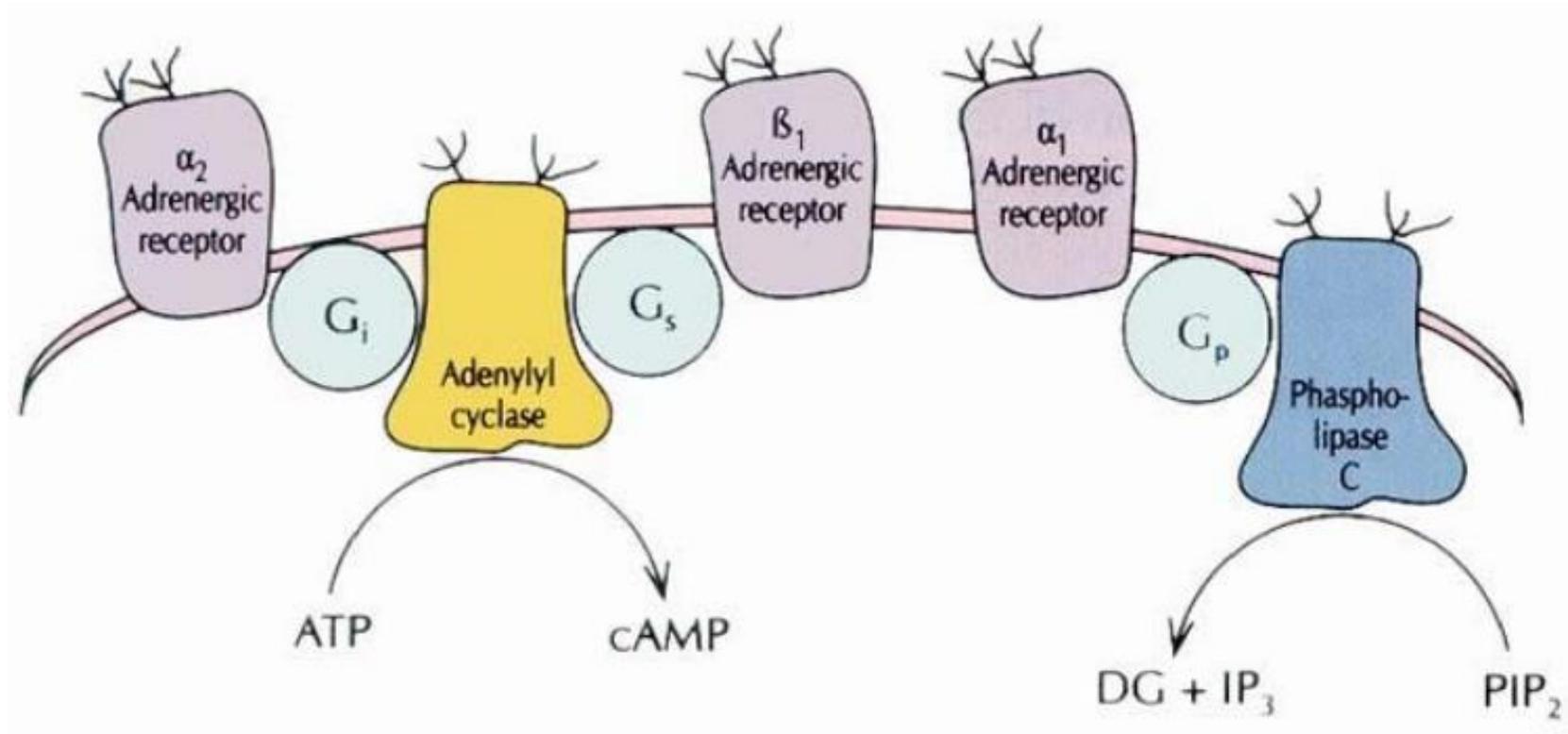
- 1- Remember
- 2- Neurotransmitters released in ANS
- 3- Types of receptors
- 4- Receptors at ganglion (nicotinic receptor)
- 5- muscarinic receptors
- 6- Adrenergic receptors



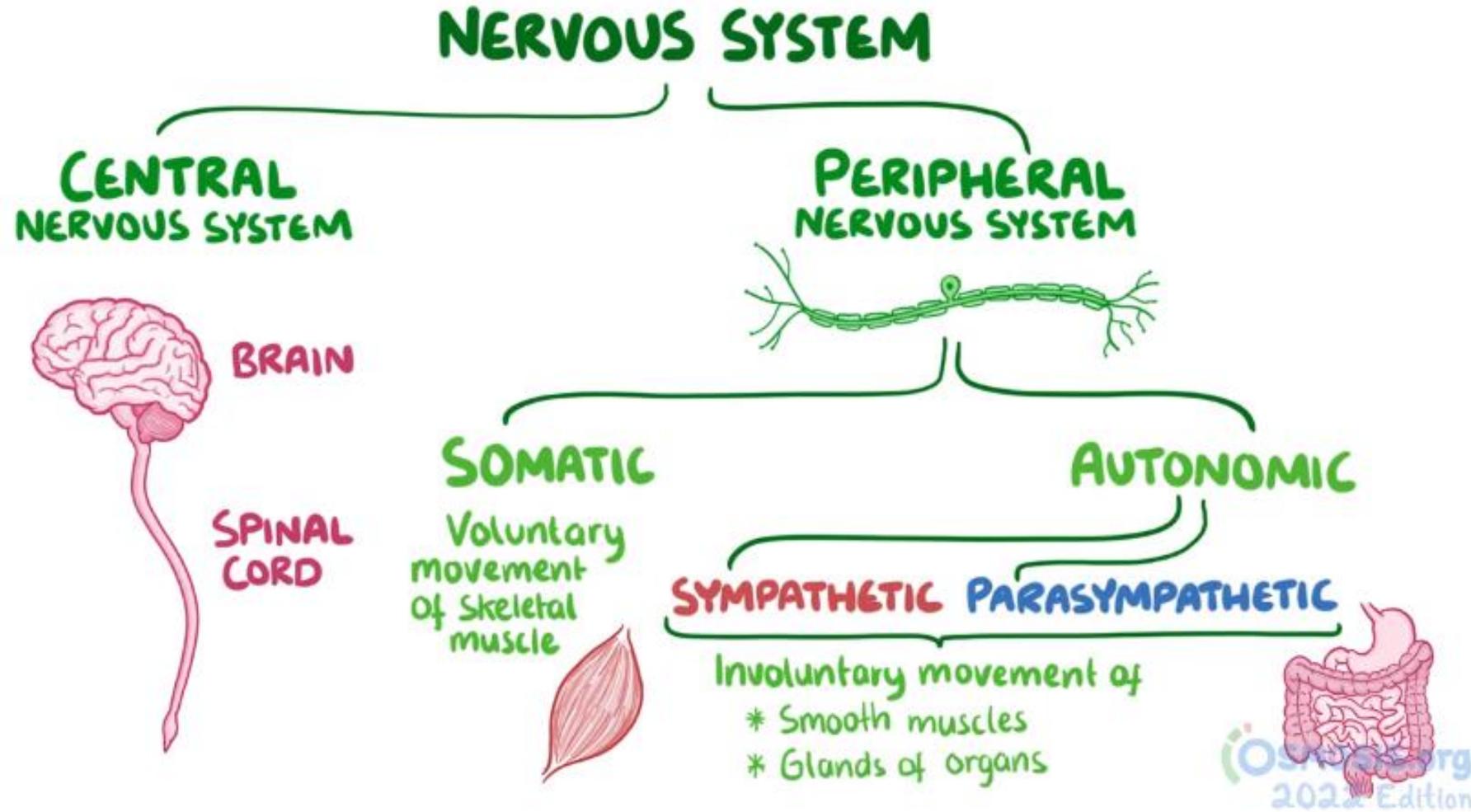
1- Remember

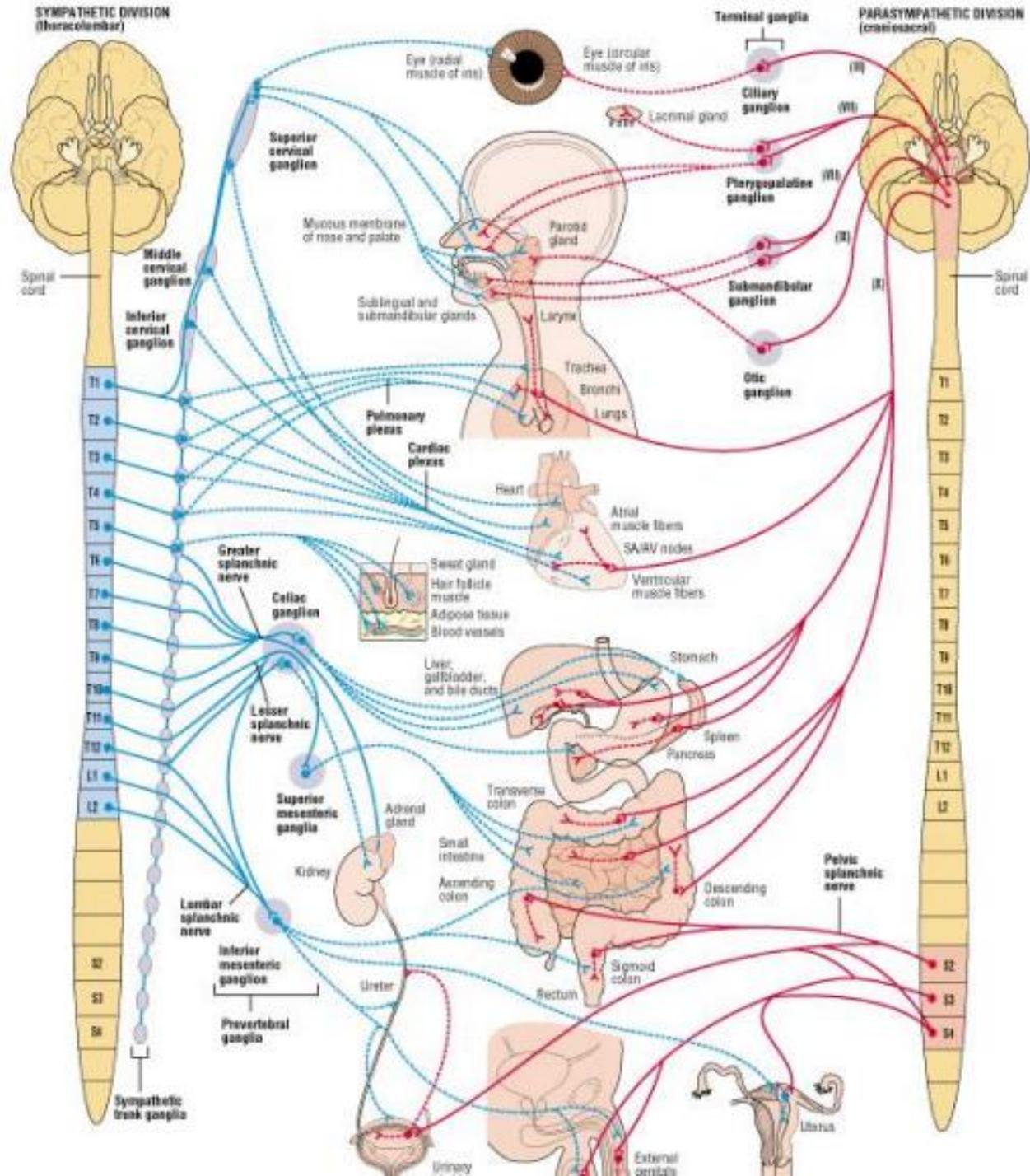


1- Remember

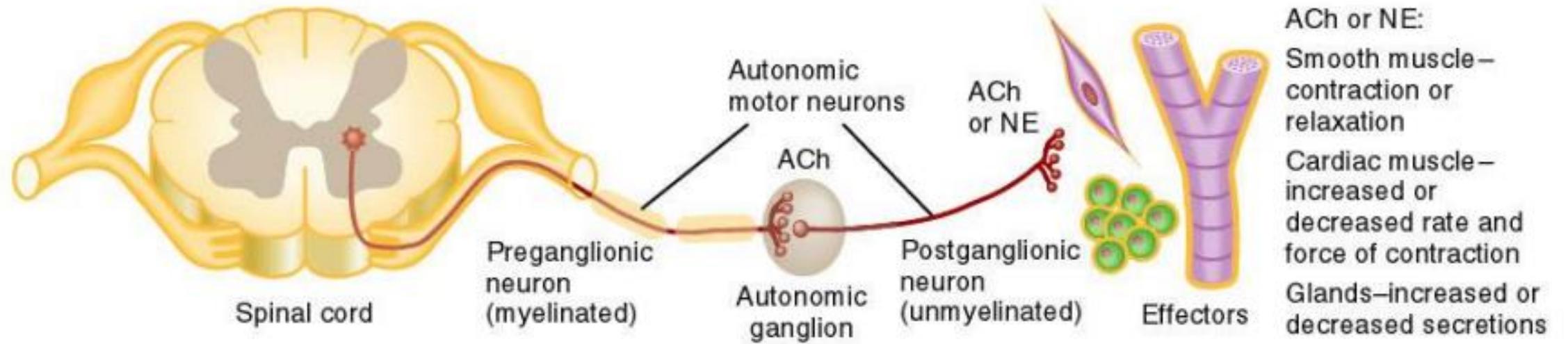


1- Remember





1- Remember

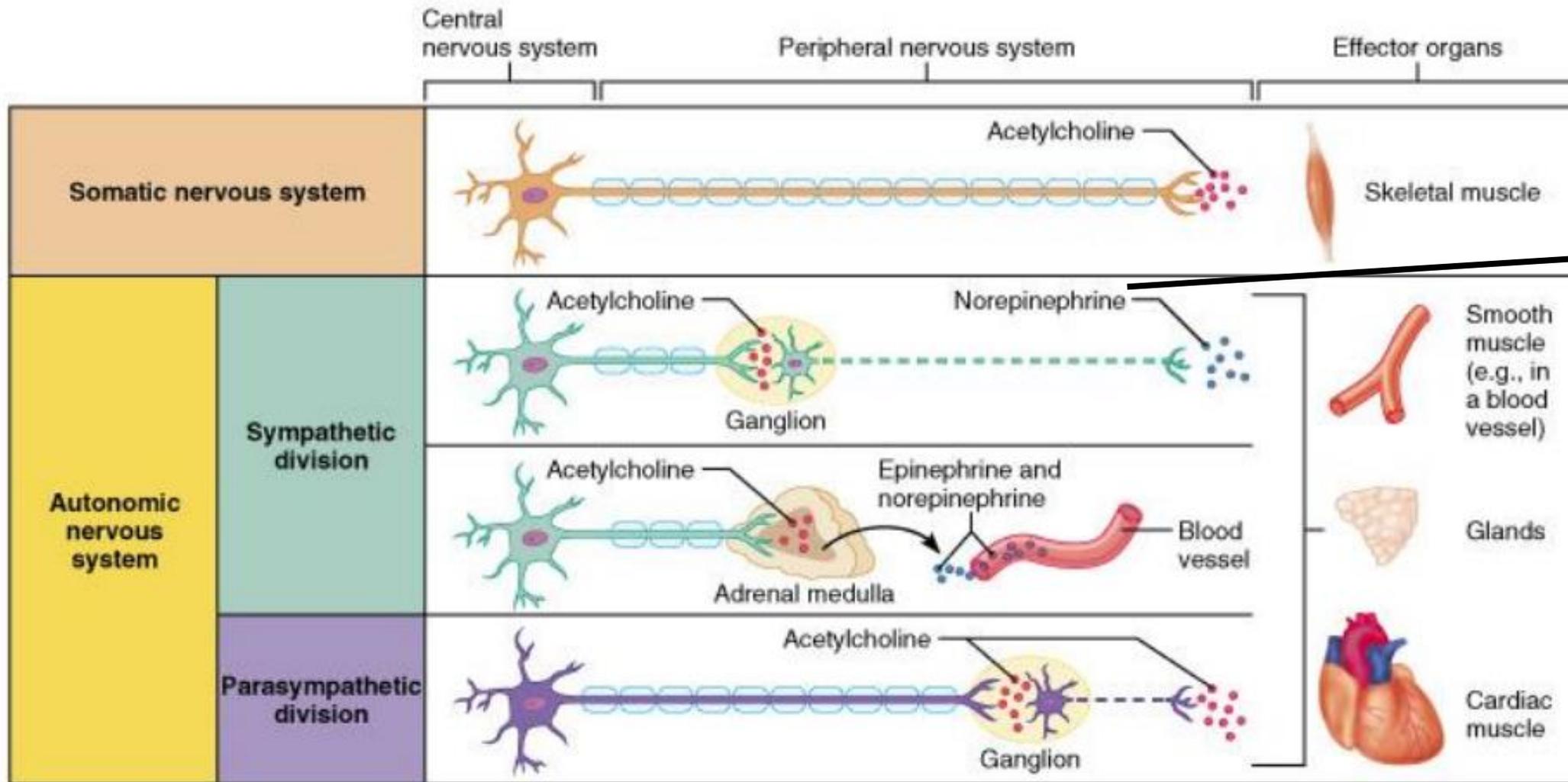


(b) Autonomic nervous system

17.01



2- Neurotransmitters released in ANS



An exception for sympathetic nerves to sweat glands, which release acetylcholine (Ach).

Key:

- = Preganglionic axons (sympathetic)
- - - = Postganglionic axons (sympathetic)
- = Preganglionic axons (parasympathetic)
- - - = Postganglionic axons (parasympathetic)
- = Myelination



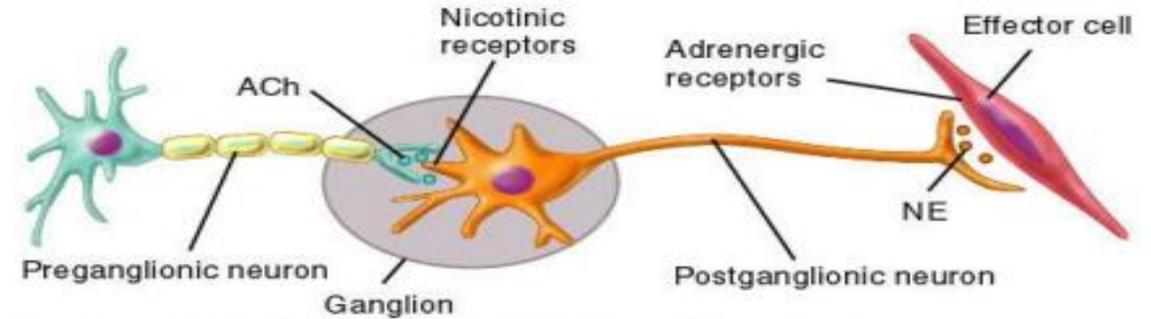
2- Neurotransmitters released in ANS

- At ganglion: preganglionic neurons of both sympathetic and parasympathetic release acetylcholine (Ach).
- At effector organs:
 - Post ganglionic terminals of parasympathetic fibers release acetylcholine.
 - Post ganglionic terminals of sympathetic fibers release norepinephrine. An exception for sympathetic nerves to sweat glands, which release acetylcholine (Ach).
- Note: The released Ach by parasympathetic system is inactivated by breakdown by acetylcholinesterase. Epinephrine is inactivated by recapture by postganglionic nerve varicosities.

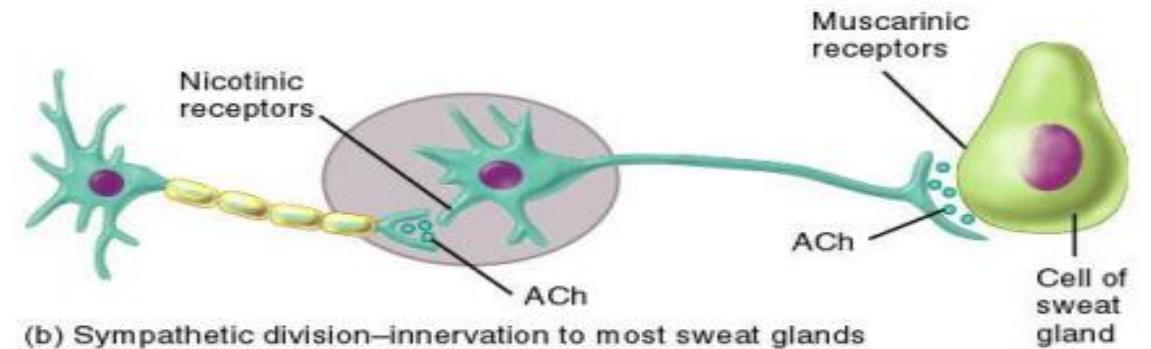


3- Types of receptors

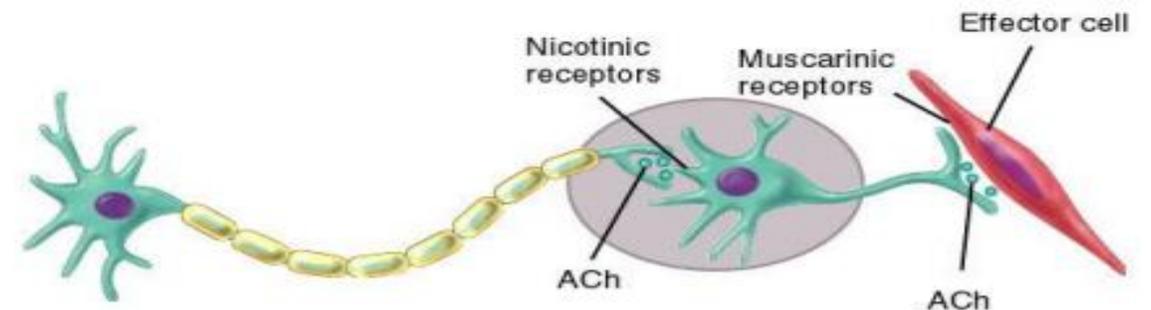
- At ganglia: sympathetic and parasympathetic have nicotinic receptors at the post synaptic membrane
- on effector cells:
 - Muscarinic receptors for ACh in both sympathetic & parasympathetic
 - Adrenergic receptors for NE & Epi



(a) Sympathetic division—innervation to most effector tissues



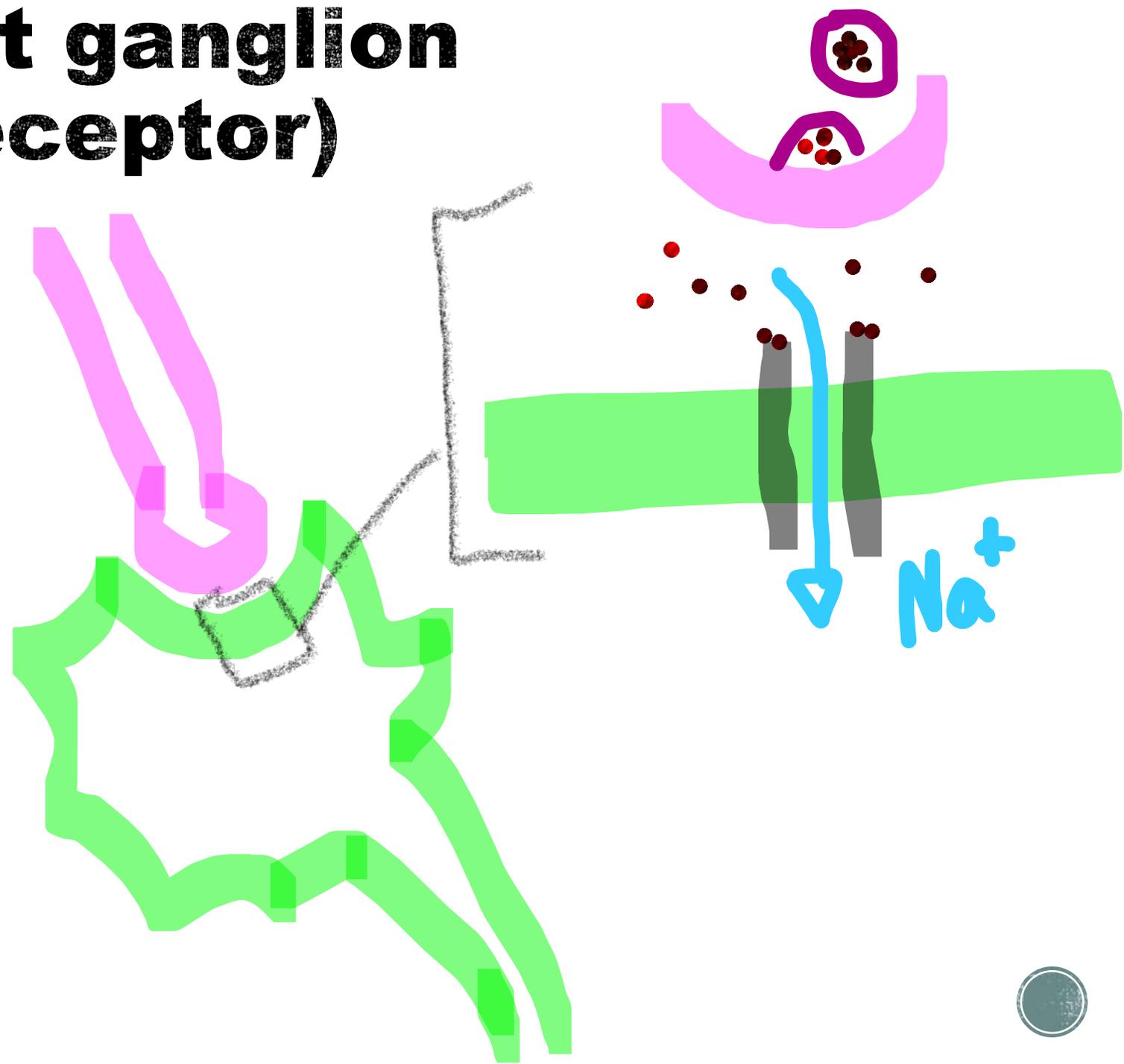
(b) Sympathetic division—innervation to most sweat glands



(c) Parasympathetic division

4- Receptors at ganglion (nicotinic receptor)

- On post synaptic membrane of sympathetic and parasympathetic there are nicotinic receptors. These receptors are excited by acetylcholine.
- This receptor is similar but not identical (they have different subunit structures) to nicotinic receptor of the neuromuscular junction.
- This receptor gates ligand gated Na^+ channel. Activation of this receptor will cause depolarization on postsynaptic membrane.
- The drug nicotine can also stimulate these receptors.



5- muscarinic receptors

- These cholinergic receptors lie on effector cells of parasympathetic neuro-effector junctions. (and sometimes on sympathetic as well)
- Many muscarinic receptors have been known (M1-M5) at these junctions. All these receptors are coupled to G protein.
- M2 receptor is considered an inhibitory receptor, we have also another sub-types that are excitatory receptors which are (M1,M3,M5) receptors, they are bound to Gq α
- M2 receptors can be:
 - bound to Gi α that inhibits adenylyl cyclase and decreases cAMP
 - The inhibitory receptor that is found in the heart (M2) is coupled via G protein to K⁺ channels. Activation of this receptor will slow the rate of depolarization.
- The excitatory receptors (M1, M3, M5) found on smooth muscle and glands are coupled via Gq protein to phospholipase C. This enzyme increases production of inositol-1,4,5-trisphosphate (IP3). IP3 causes release of Ca⁺⁺ from internal stores in muscle or glands, causing contraction or secretion.

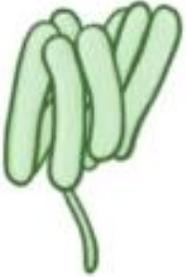
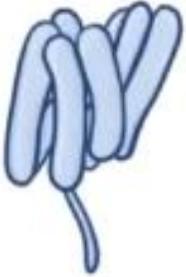
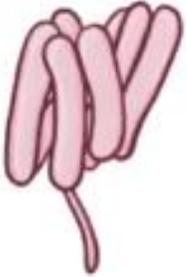


5- muscarinic receptors

- These receptors are activated by muscarine and inhibited by atropine.
- The targets of muscarinic receptors' stimulation are illustrated by muscarine poisoning. These effects include:
 - stimulation of secretory activity: salivation, tearing, sweating, nasal and bronchial secretion.
 - Increase gastrointestinal tract motility
 - vomiting and diarrhea.
 - Contraction of urinary bladder
 - urination.
 - Slowing of the heart
 - Bradycardia.
- These receptors are blocked by atropine from a plant atropa belladonna which induces reversal effects of muscarinic poisoning. Effects of atropine include:
 - Inhibition of glandular secretions
 - dry mouth, dry eyes, and dry nasal passages.
 - Tachycardia. (increase heart rate).
 - Loss of pupillary light reflex.
 - Loss of ability to focus the lens for near vision.



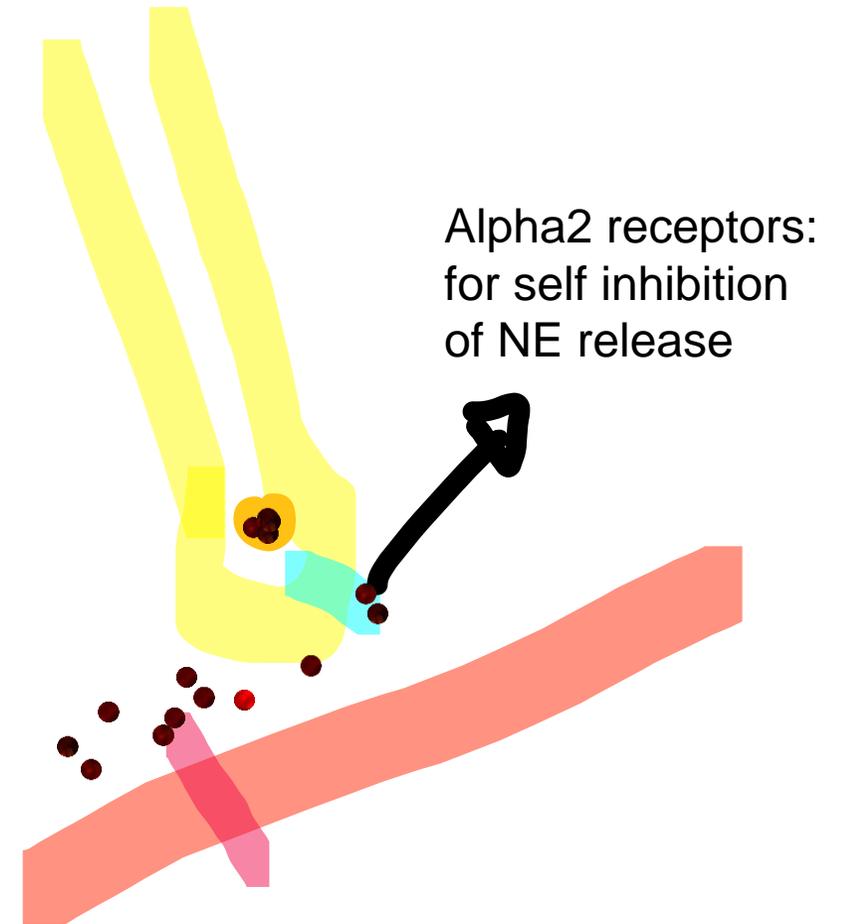
6- Adrenergic receptors

				
ALPHA 1	ALPHA 2	BETA 1	BETA 2	BETA 3
				
G _q	G _i	G _s	G _s	G _s
				
NORADRENALINE (NOREPINEPHRINE)				
				
ADRENALINE (EPINEPHRINE)				



6- Adrenergic receptors

- These receptors respond to catecholamines (epinephrine (EP) and norepinephrine (NE)).
- Two types of receptors are known alpha and beta receptors.
- Alpha receptors: The alpha receptors are subdivided into $\alpha 1$ and $\alpha 2$ receptors.
- The alpha 1 receptor is widely distributed on smooth muscles with the exception of bronchial muscle. NE and EPI are about equally effective on these receptors. Stimulation of this receptor produces excitation. This effect involves IP3 production and release of Ca^{++} from intracellular stores. Some $\alpha 1$ are coupled to Ca^{++} gated channels).
- Alpha2 receptors: are found on sympathetic postganglionic nerve terminals. These receptors are important for self inhibition of NE release.
- Similar receptors are found on non-adrenergic terminals are called Alpha2 heteroreceptors. These receptors are negatively coupled to adenylyl cyclase via Gi protein and decrease c-AMP production.



6- Adrenergic receptors

- Beta receptors: These receptors are subdivided into beta1 ($\beta 1$) and beta 2 ($\beta 2$) receptors. Both of them are more sensitive to catecholamines than alpha receptors (catecholamines stimulate these receptors at much lower concentration than stimulation of alpha receptors).
- Beta 1 ($\beta 1$) receptors: found on heart and produces excitation in the heart.
- Beta 2 ($\beta 2$) receptors: found on tracheal and bronchial smooth muscle, in the gastrointestinal tract, and on smooth muscles of blood vessels supplying skeletal muscles (occurs along with alpha 1 receptors).
- The $\beta 2$ receptors are preferentially activated by EPI rather than NE.
- Both receptors are positively coupled to adenylyl cyclase via Gs protein, and increase c-AMP. This will result in subsequent activation of protein kinase and phosphorylation of one or more proteins. The response elicited depends on the role of phosphorylated proteins.
- All subclasses of adrenergic receptors can be blocked by specific blocking agents (antagonists). $\beta 1$ blockers are useful as antiarrhythmic drugs. $\beta 2$ selective agonist (produce activation of $\beta 2$ receptor) will dilate bronchi. This agonist is useful in asthma.

