



**Physiology Team**



## ***LECTURE : 5***

# **The neurotransmitters & receptors of Autonomic NS**

**Done By: Fay Al-Ruwais**

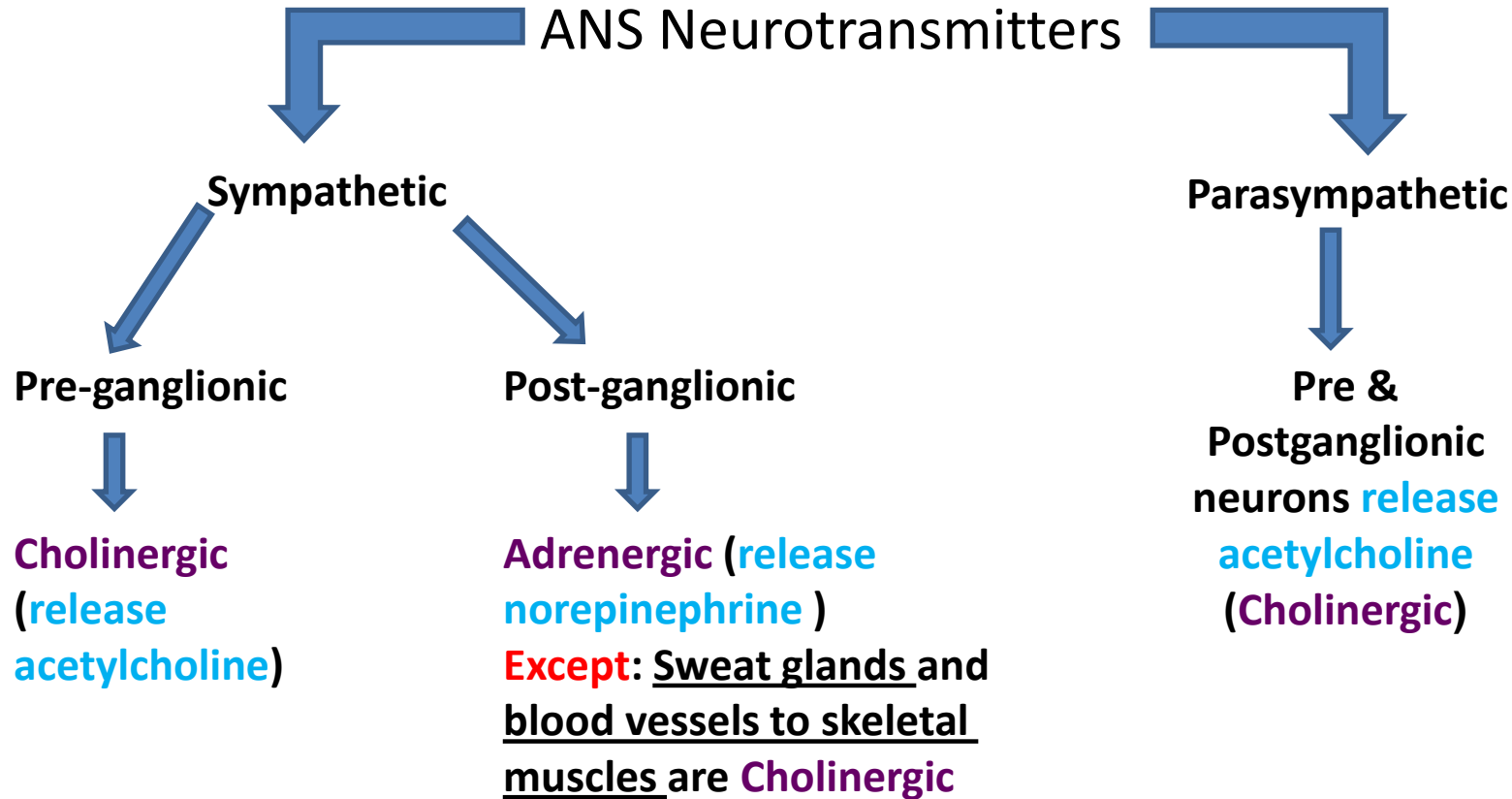
**Reviewed By: Abdulrahman Al-Akeel**

# OBJECTIVES

**At the end of this lecture, student should be able to describe:**

- Describe neurotransmitters that can release at pre and post ganglionic of Autonomic NS.
- Describe Autonomic NS receptors.

# MIND MAP



**\*Note: this slide from boy's slides.**



**Acetylcholine activates**  
mainly 2 types of receptors



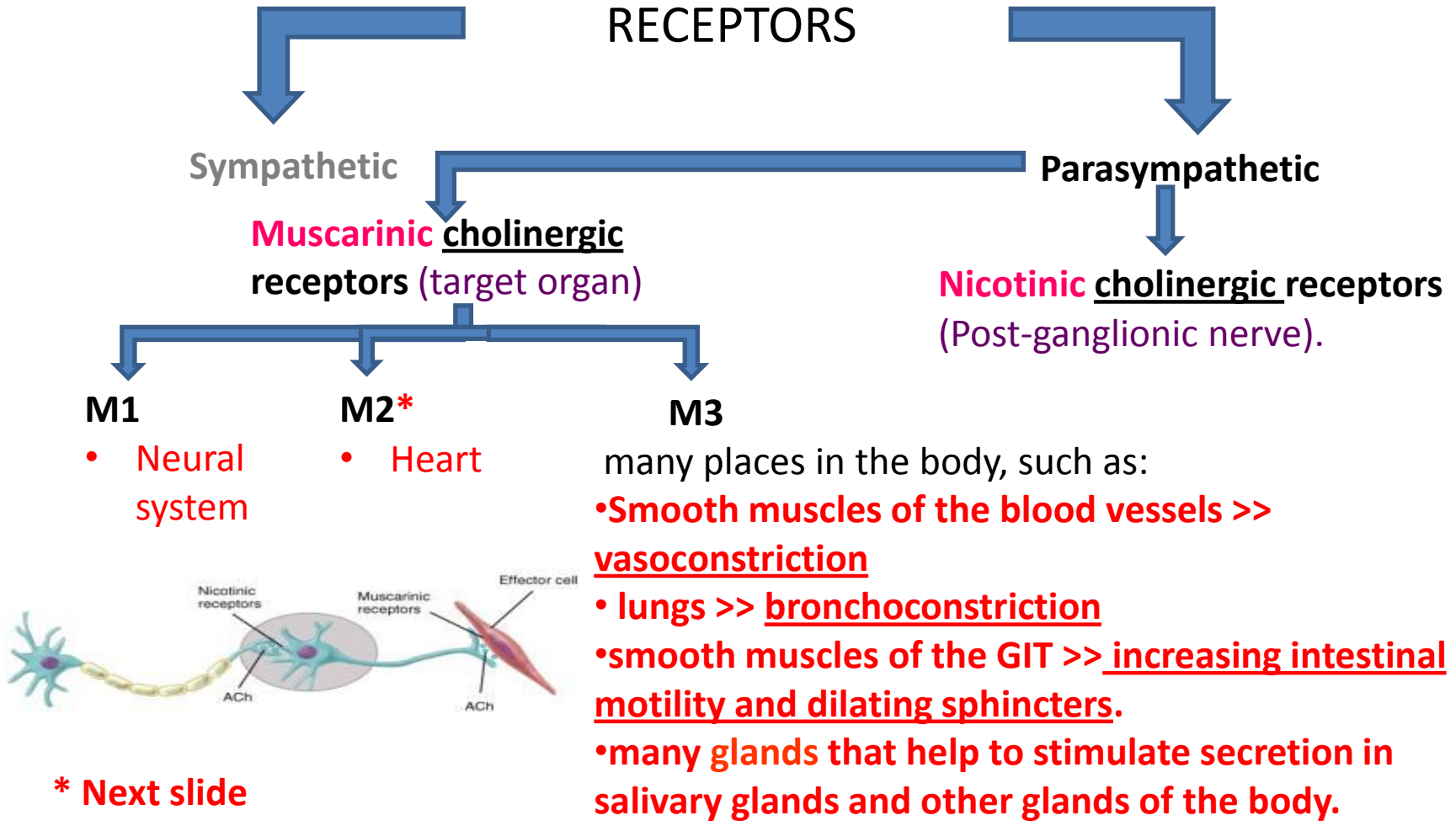
### **Muscarinic receptors**

- Are found on all effector cells that are stimulated by the postganglionic cholinergic neurons of either the parasympathetic nervous system or the sympathetic system.
- Also, it activated by **muscarine**.

### **Nicotinic receptors**

- Are found in the autonomic ganglia at the synapses between the preganglionic and postganglionic neurons of both the sympathetic and parasympathetic systems.
- Also, it activated by **nicotine**.

# MIND MAP



■ **Slides**

■ **Important**

■ **Doctor's Notes**

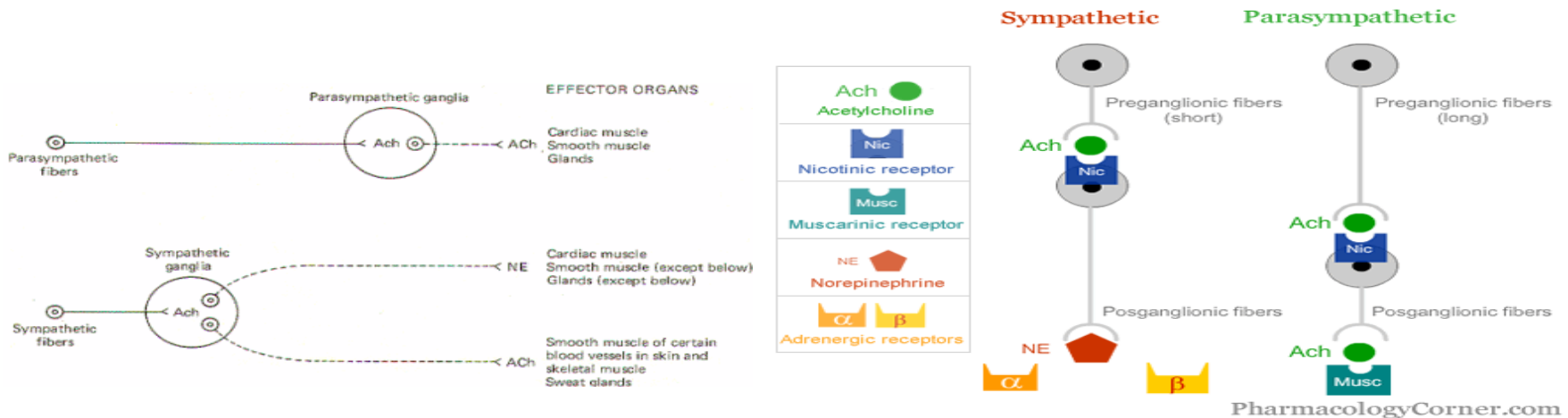
■ **Explanation**

■ **Boy's Slides**

**\* M2 Muscarinic cholinergic receptors:**

Act to bring the heart back to normal after the actions of the sympathetic nervous system: slowing down the heart rate, reducing contractile forces of the atrial cardiac muscle, and reducing conduction velocity of the SA and AV node.

**Note, they have no effect on the contractile forces of the ventricular muscle.**



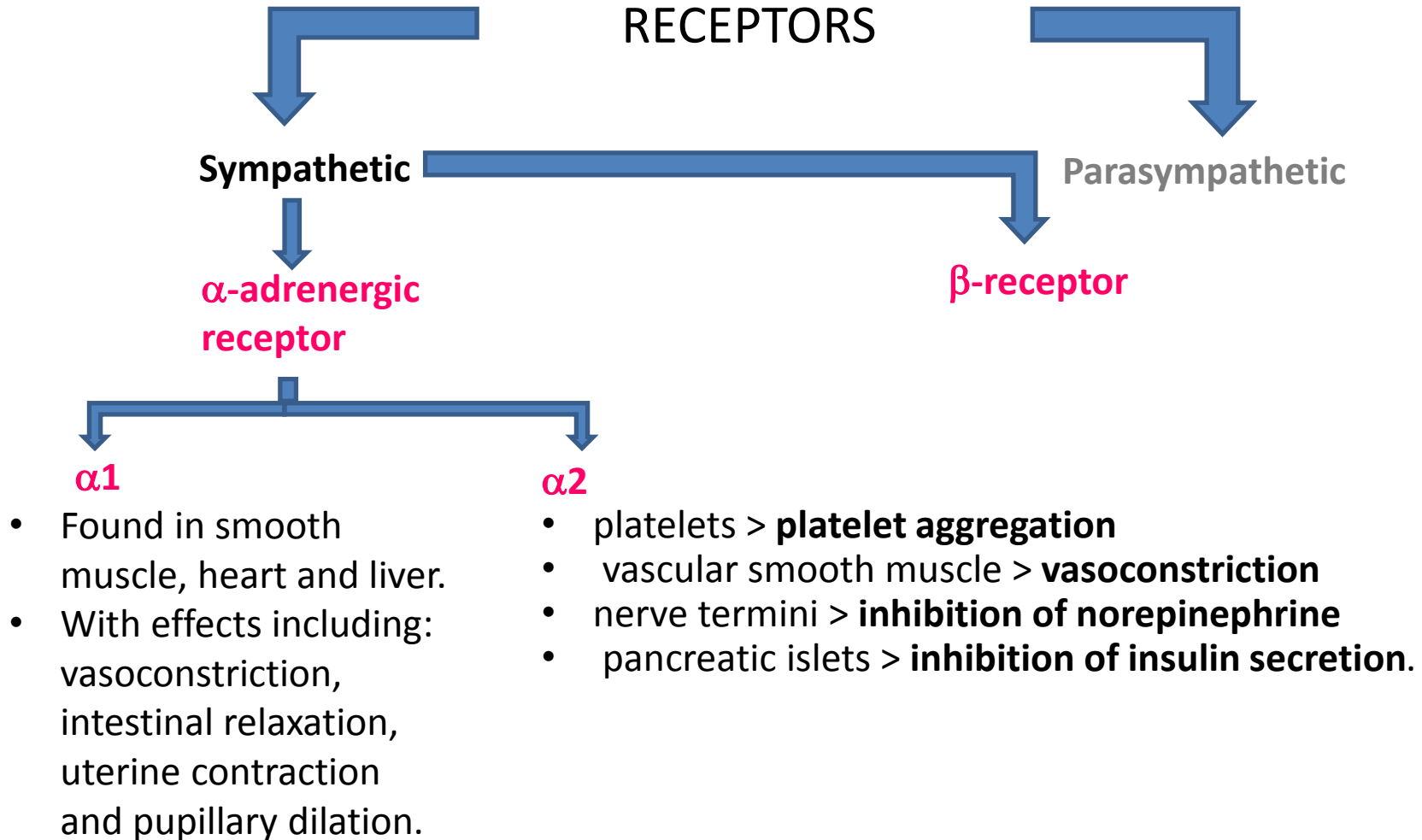
■ **Slides**

■ **Important**

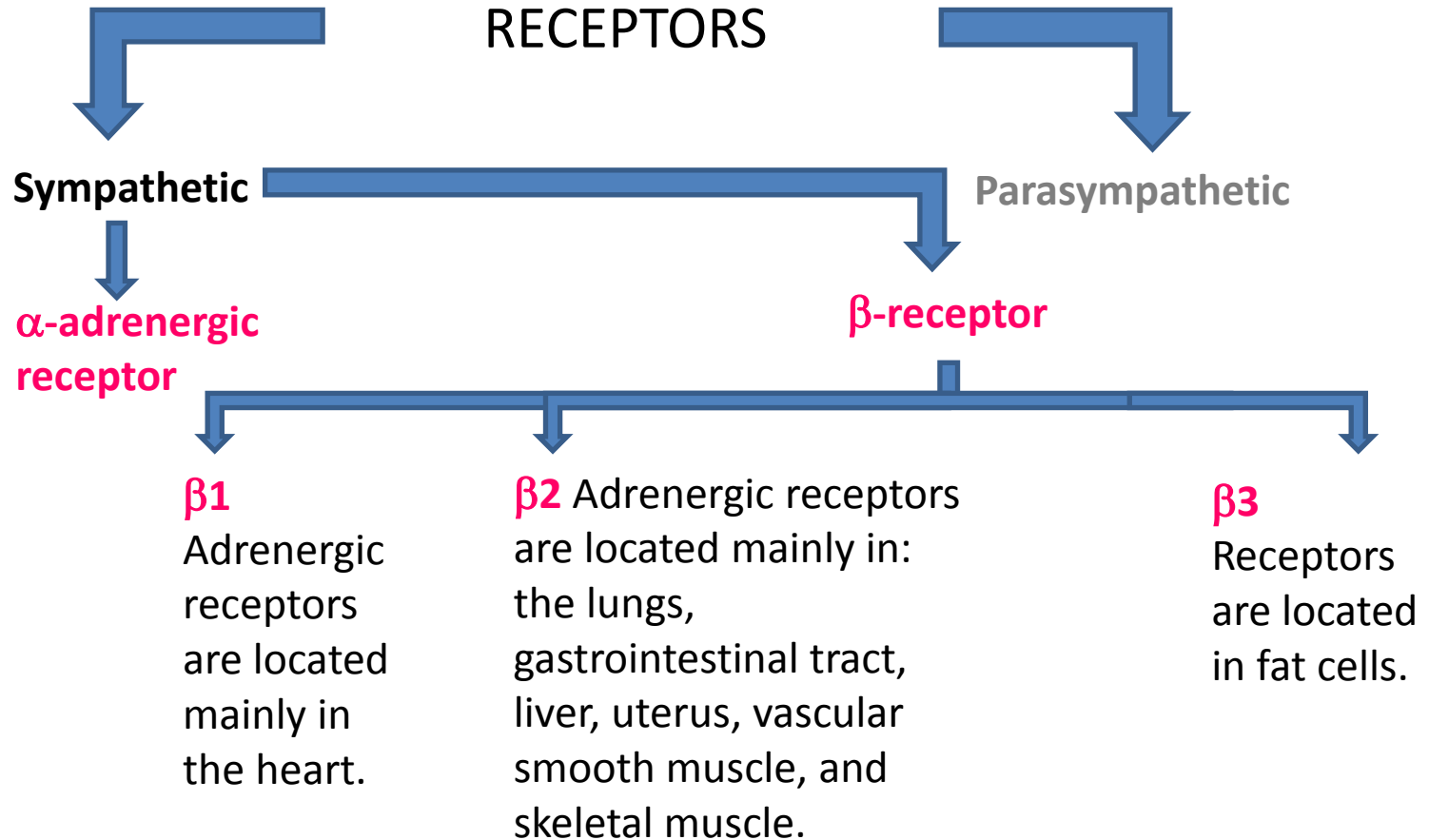
■ **Doctor's Notes**

■ **Explanation**

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# MIND MAP





# Remember

**$\alpha$ -adrenergic receptors** > respond to [norepinephrine](#)

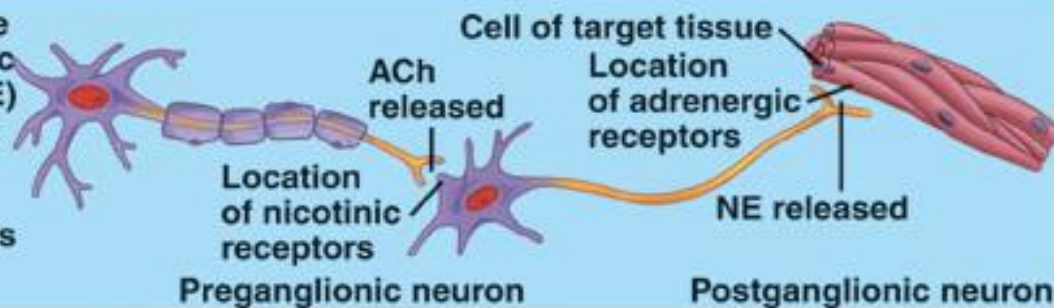
**$\beta$ -adrenergic receptors** > respond to [epinephrine](#) (particularly).

**$\alpha$ -adrenergic receptors** > respond to blocking agents as [phenoxybenzamine](#).

**$\beta$ -adrenergic receptors** > respond to blocking agents as [propranolol](#).

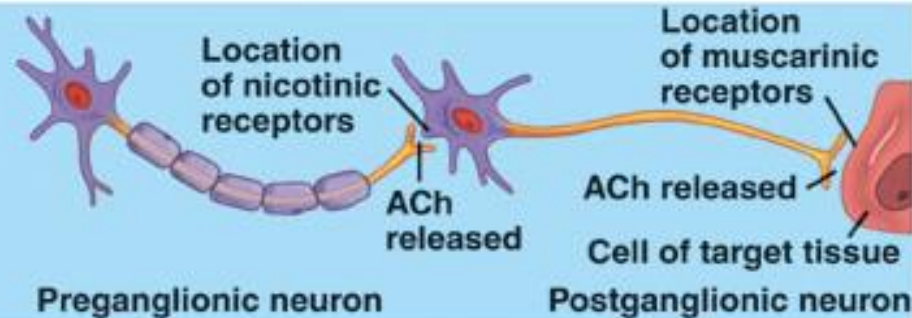
## Sympathetic division

Most target tissues innervated by the sympathetic division have adrenergic receptors. When norepinephrine (NE) binds to adrenergic receptors, some target tissues are stimulated, and others are inhibited. For example, smooth muscle cells in blood vessels are stimulated to constrict, and stomach glands are inhibited.



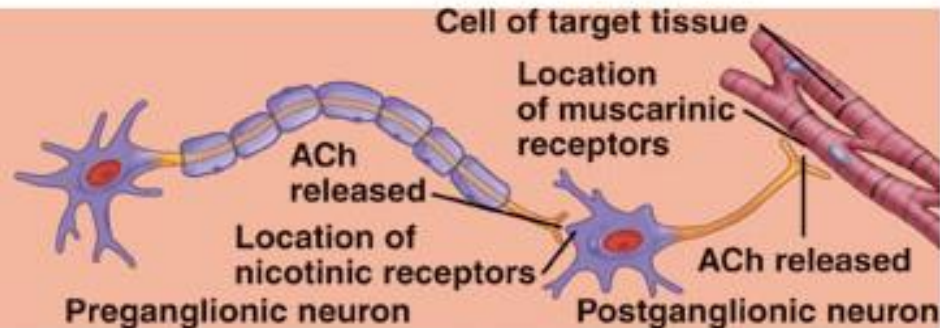
## Sympathetic division

Some sympathetic target tissues, such as sweat glands, have muscarinic receptors, which respond to acetylcholine (ACh). Stimulation of sweat glands results in increased sweat production.



## Parasympathetic division

All parasympathetic target tissues have muscarinic receptors. The general response to ACh is excitatory, but some target tissues, such as the heart, are inhibited.



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Vascular constriction = according to the structure, there will be a different receptor

## circulatory system

	Sympathetic (adrenergic receptors, <i>with exceptions</i> )	Parasympathetic (muscarinic receptors)
<b>cardiac output</b>	( <i>not known yet</i> ) increases	M2: decreases
<b>SA node: heart rate (chronotropic)</b>	$\beta 1, \beta 2$ : increases	M2: decreases
<b>cardiac muscle: contractility (inotropic)</b>	$\beta 1, \beta 2$ : increases	M2: decreases ( <b>atria only</b> )
<b>conduction at AV node</b>	$\beta 1$ : increases	M2: decreases
<b>vascular smooth muscle</b>	M3: contracts; $\alpha$ ( <i>in skin</i> ) = contracts; $\beta 2$ ( <i>in Blood vessels of skeletal muscles</i> ) = relaxes	---
<b>platelets</b>	$\alpha 2$ : aggregates	---
<b>mast cells - histamine</b>	$\beta 2$ : inhibits	---

■ Slides

■ Important

■ Doctor's Notes

■ Explanation

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## respiratory system

Sympathetic (adrenergic)

Parasympathetic  
(muscarinic)

smooth muscles of  
bronchioles

$\beta 2$ : relaxes (major contribution);  
 $\alpha 1$ : contracts (minor contribution)

**M3**: contracts

## nervous system

pupil of eye

$\alpha 1$ : relaxes

**M3**: contracts

ciliary muscle

$\beta 2$ : relaxes

**M3**: contracts

## digestive system

	Sympathetic (adrenergic, <i>with exceptions</i> )	Parasympathetic (muscarinic)
salivary glands: secretions	$\beta$ : stimulates viscous, amylase secretions; $\alpha 1$ = stimulates potassium cation	stimulates watery secretions
lacrimal glands (tears)	decreases	<b>M3</b> : increases
kidney (renin)	secretes	---
parietal cells	---	<b>M1</b> : secretion
liver	$\alpha 1$ , $\beta 2$ : glycogenolysis, gluconeogenesis	---
adipose cells	$\beta 3$ : stimulates lipolysis	---
GI tract motility	decreases	<b>M1, M3</b> : increases
smooth muscles of GI tract	$\alpha$ , $\beta 2$ : relaxes	<b>M3</b> : contracts
sphincters of GI tract	$\alpha 1$ : contracts	<b>M3</b> : relaxes
glands of GI tract	inhibits	<b>M3</b> : secretes



<b>endocrine system</b>		
	<b>Sympathetic (adrenergic)</b>	<b>Parasympathetic (muscarinic)</b>
<b>pancreas (islets)</b>	$\alpha$ 2: decreases secretion	---
<b>adrenal medulla</b>	N: secretes epinephrine	---
<b>urinary system</b>		
<b>bladder wall</b>	$\beta$ 2: relaxes	contracts
<b>ureter</b>	$\alpha$ 1: contracts	relaxes
<b>sphincter</b>	$\alpha$ 1: contracts; $\beta$ 2 relaxes	relaxes
<b>reproductive system</b>		
<b>uterus</b>	$\alpha$ 1: contracts; $\beta$ 2: relaxes	---
<b>genitalia</b>	$\alpha$ : contracts	M3: erection
<b>sweat gland secretions</b>	M: stimulates (major contribution); $\alpha$ 1: stimulates (minor contribution)	---
<b>arrector pili</b>	$\alpha$ 1: stimulates	---

■ [Slides](#)

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# SUMMARY

- Activation of  $\alpha$  receptors leads to smooth muscle contraction
- Activation of  $\beta$ 2 receptors leads to smooth muscle relaxation
- Activation of  $\beta$ 1 receptors leads to smooth muscle contraction (especially in heart)

- Cholinergic Receptors

The two types of receptors that bind ACh are nicotinic and muscarinic  
These are named after drugs that bind to them and mimic ACh effects

- Nicotinic Receptors

Nicotinic receptors are found on:

- Motor end plates (somatic targets)
- All ganglionic neurons of both sympathetic and parasympathetic divisions
- The hormone-producing cells of the adrenal medulla

The effect of ACh binding to nicotinic receptors is always stimulatory

# SUMMARY

- Muscarinic Receptors

**Muscarinic receptors occur on all effector cells stimulated by postganglionic cholinergic fibers**

The effect of ACh binding:

- **Can be either inhibitory or excitatory**
- **Depends on the receptor type of the target organ**

- Adrenergic Receptors

The two types of adrenergic receptors are alpha and beta

Effects of NE binding to:

**$\alpha$  receptors is generally stimulatory**

**$\beta$  receptors is generally inhibitory**

**A notable exception – NE binding to  $\beta$  receptors of the heart is stimulatory**

- Dual Innervation

**Most of viscera receive nerve fibers from both parasympathetic and sympathetic divisions**

**Both divisions do not normally innervate an organ equally**



# QUESTIONS

- **What's the neurotransmitter of the sympathetic system ?**

## Norepinephrine

\* Is asked by Dr. Fawzia

\*If they didn't define the location where the neurotransmitter works ( post or pre ganglionic) then we choose the answer according to its post ganglionic location, because pre ganglionic neurotransmitter is always Ach.

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### Complete :

1- M3 muscarinic receptor will \_\_\_\_\_ sphincters of GI tract.

### (True/False):

2- M2 muscarinic receptor decreases the contractility of both atria and ventricles .

3- Sympathetic Post-ganglionic neurotransmitters are all Adrenergic.

### Answers :

1- Relaxes.    2- False (only atria).

3- False (Sweat glands blood vessels to skeletal muscles are Cholinergic).

**THE END**

**If there are any Problems or Suggestions,  
Feel free to contact:**

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**THANK YOU**