LECTUR (2)

The neurotransmitters & receptors of Autonomic NS

INTRODUCTION

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- It is the balance between the sympathetic and parasympathetic nervous system that keeps our automated body functions working properly
- The autonomic nervous system receptors act as on/off buttons that control the various sympathetic and parasympathetic effects in the body. When these buttons are turned on or off, things happen in your body. If you learn about these receptors and their actions described below, you will be able to understand what a beta-blocker does or what to expect from an alpha agonist medication .

OBJECTIVES

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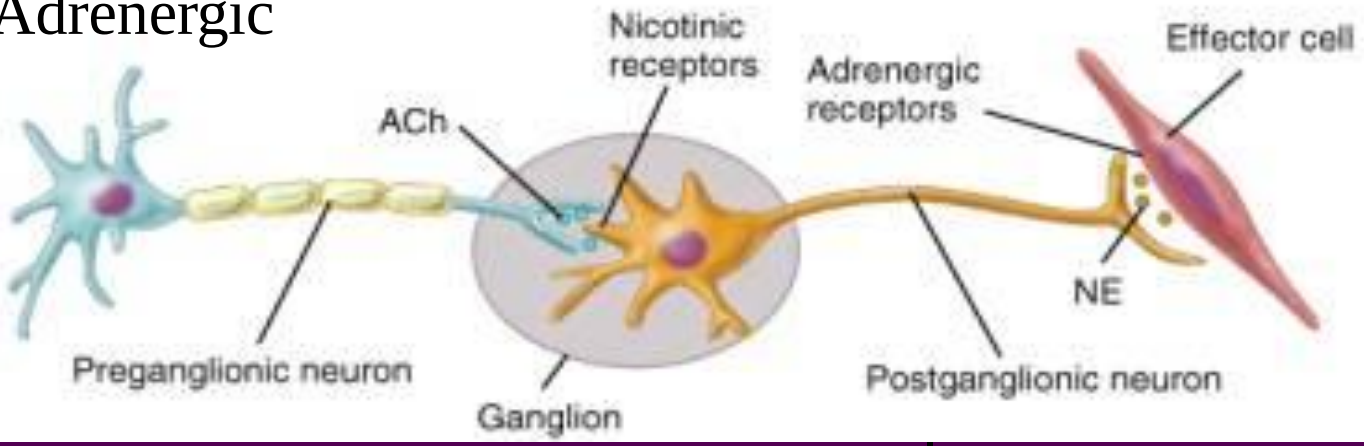
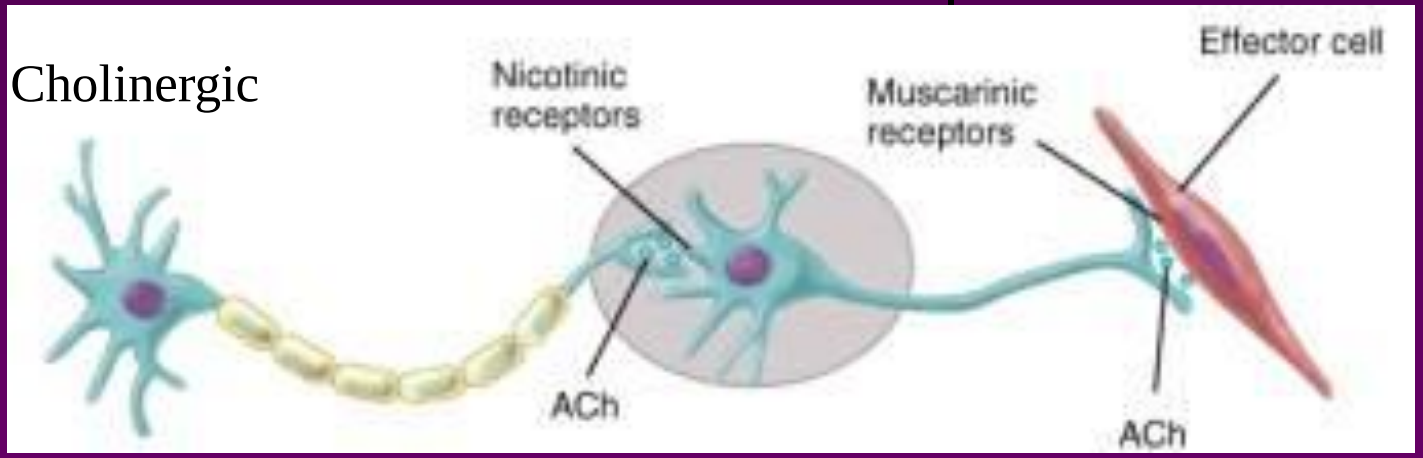
- describe neurotransmitters that can release at pre and post ganglionic of Autonomic NS.
- Describe Autonomic NS receptors.

ANS Neurotransmitters: Classified as either cholinergic or adrenergic neurons based upon the neurotransmitter released at postganglionic neurons

Adrenergic

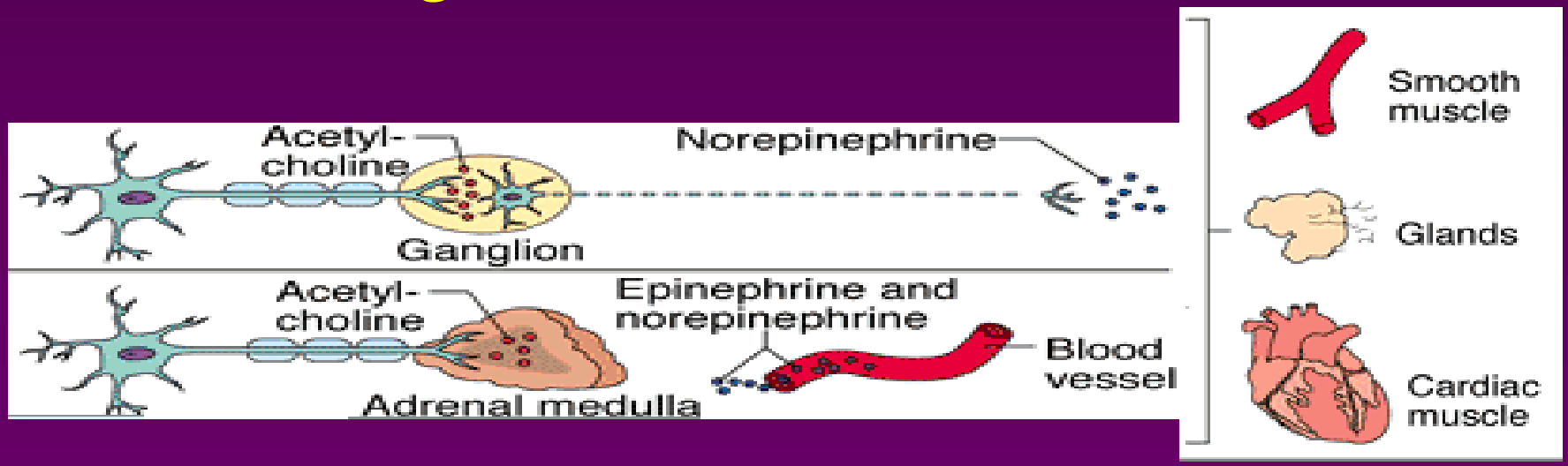


Cholinergic



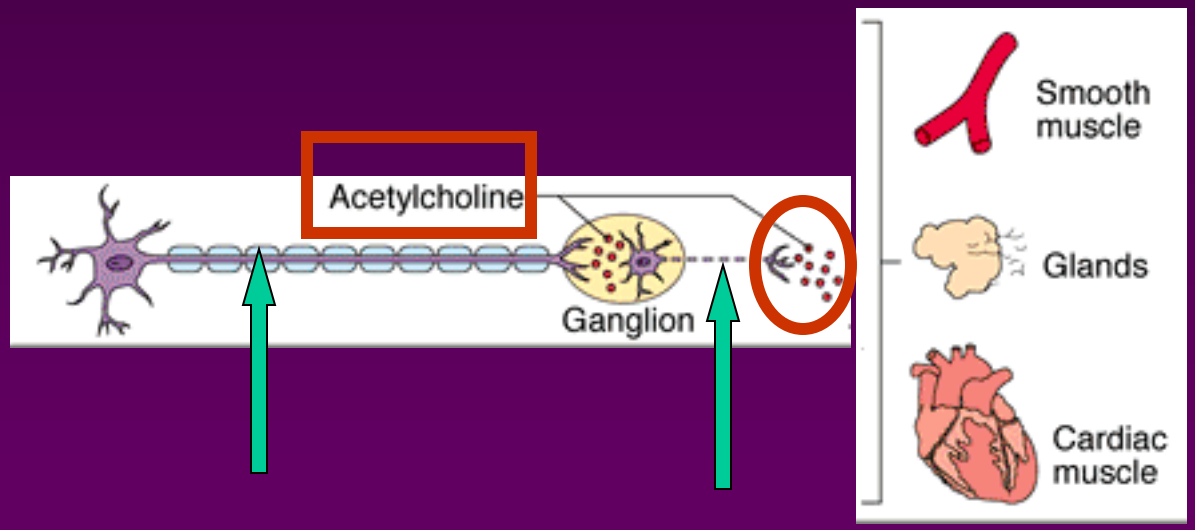
Sympathetic Neurotransmitters

- Preganglionic neurons - Cholinergic = (release acetylcholine)
- Postganglionic neurons:
  - release norepinepherine at target organs
  - ie. Adrenergic



Parasympathetic Neurotransmitters

- Pre & Postganglionic neurons release acetylcholine = Cholinergic



Chemical or neural transmitter

- All **preganglionic** fibers release **acetylcholin (Ach).**
- All **parasympathetic postganglionic** release **Ach.**
- All **sympathetic postganglionic** release **noradrenalin except sweat glands & blood vessels to skeletal muscles**

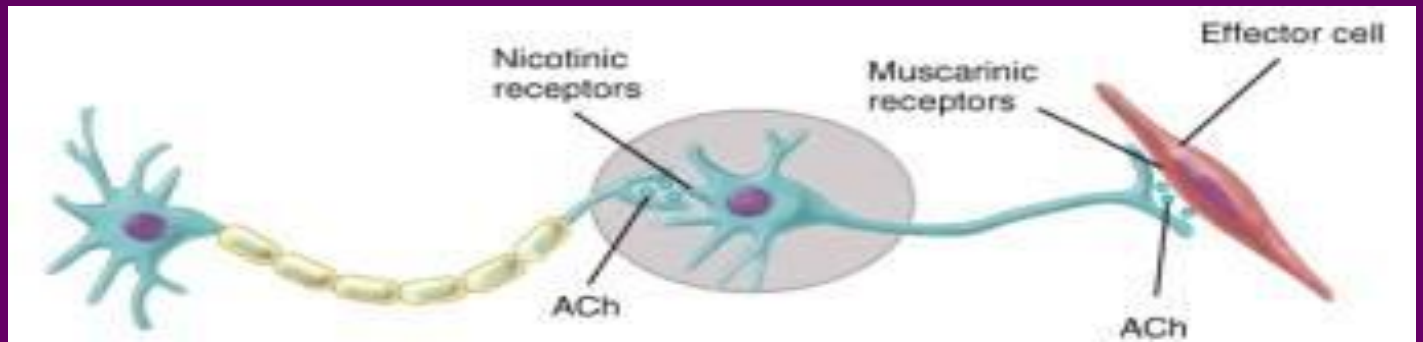
RECEPTORS

- **Parasympathetic nervous system**

acts on two types of receptors:

muscarinic and nicotonic choloinergic receptors.

- **Most transmissions occur in two stages: When stimulated, the preganglionic nerve releases ACh at the ganglion, which acts on nicotinic receptors of the postganglionic nerve.**
- **The postganglionic nerve then releases ACh to stimulate the muscarinic receptors of the target organ.**



TYPES OF MUSCARINIC RECEPTORS

Three main types of muscarinic receptors:M1,M2&M3

- **M1 at neural system.**
- **M2 at heart .**
- **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.**

TYPES OF MUSCARINIC RECEPTORS

- **M3 at many places in the body, such as**
- **smooth muscles of the blood vessels> cause vasoconstriction**
- **lungs> cause bronchioconstriction**
- **smooth muscles of the GIT > help in increasing intestinal motility and dilating sphincters.**
- **many glands that help to stimulate secretion in salivary glands and other glands of the body.**

- **The Sympathetic NS Acts on tow types of receptors :**
  - α and β.

Types of α-adrenergic receptor

- Two types:

- **α1**, found in smooth muscle, heart, and liver, with effects including vasoconstriction, intestinal relaxation, uterine contraction and pupillary dilation,

- **α2**

- platelets >platelet aggregation
- vascular smooth muscle > vasoconstriction
- nerve termini > inhibition of norepinephrine
- pancreatic islets > inhibition of insulin secretion.

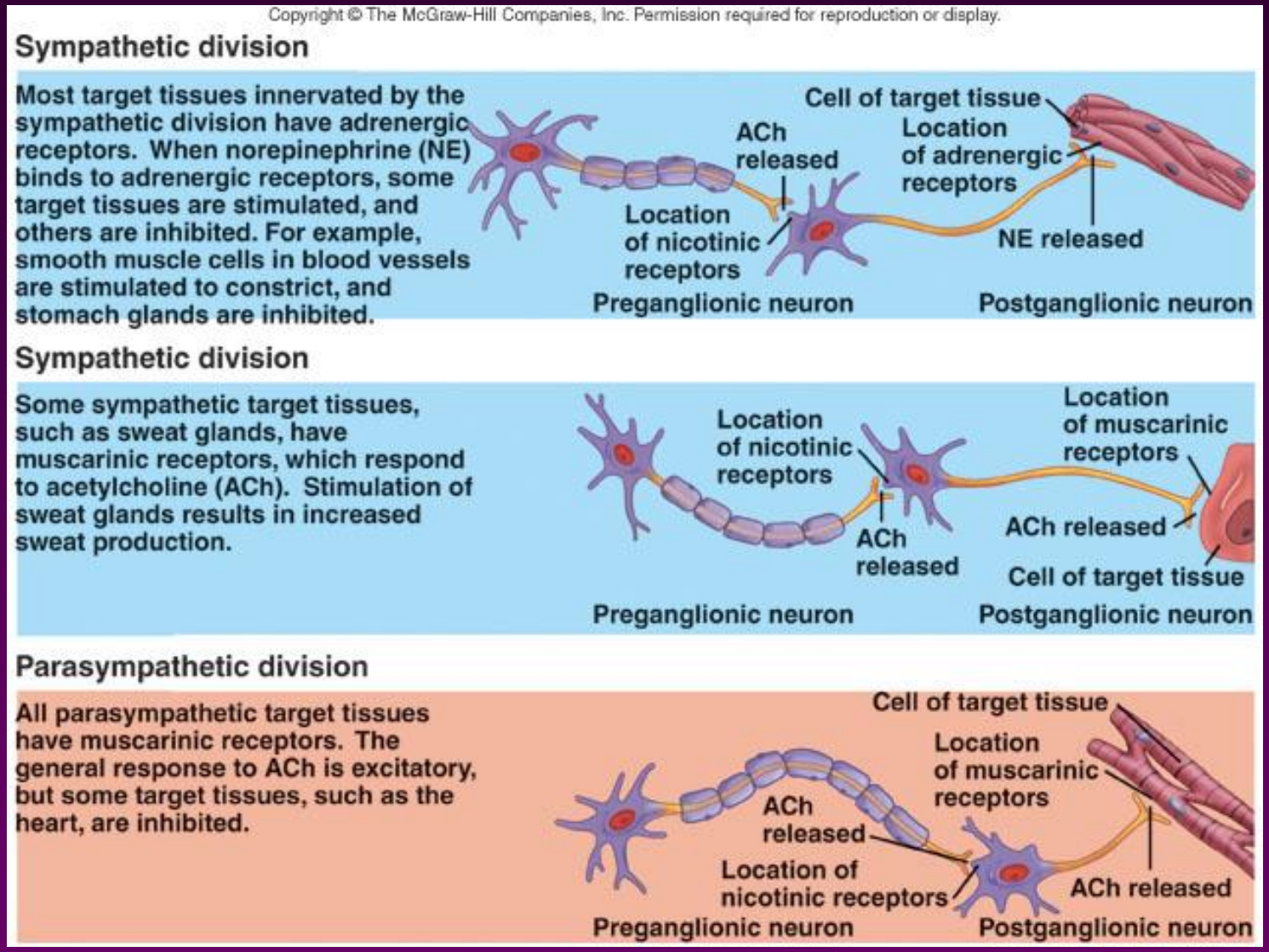
- **α-adrenergic receptors** >respond to norepinephrine and to blocking agents as phenoxybenzamine.

β-receptor types

- There are three known types of beta receptor, designated β_1, β_2 and β_3.
- β_1-Adrenergic receptors are located mainly in the heart.
- β_2-Adrenergic receptors are located mainly in the lungs, gastrointestinal tract, liver, uterus, vascular smooth muscle, and skeletal muscle.
- β_3-receptors are located in fat cells.

β-adrenergic receptors respond particularly to epinephrine and to such blocking agents as propranolol.

Neurotransmitters and Receptors



	Sympathetic (adrenergic,	Parasympathetic (muscarinic)
circulatory system		
cardiac output	increases	M2: decreases
SA node: heart rate (chronotropic)	β1, β2: increases	M2: decreases
cardiac muscle: contractility (inotropic)	β1, β2: increases	M2: decreases (atria only)
conduction at AV node	β1: increases	M2: decreases
vascular smooth muscle	M3: contracts; α = contracts; β2 = relaxes	---
platelets	α2: aggregates	---
mast cells - histamine	β2: inhibits	---

	Sympathetic (adrenergic,	Parasympathetic (muscarinic)
respiratory system		
smooth muscles of bronchioles	β2: relaxes (major contribution); α1: contracts (minor contribution)	M3: contracts
nervous system		
pupil of eye	α1: relaxes	M3: contracts
ciliary muscle	β2: relaxes	M3: contracts

	Sympathetic (adrenergic,	Parasympathetic (muscarinic)
digestive system		
salivary glands: secretions	β: stimulates viscous, amylase secretions; α1 = stimulates potassium	stimulates watery secretions
lacrimal glands (tears)	decreases	M3: increases
kidney (renin)	secretes	---
parietal cells	---	M1: secretion
liver	α1, β2: glycogenolysis, gluconeogenesis	---
adipose cells	β3: stimulates lipolysis	---
GI tract motility	decreases	M1, M3: increases
smooth muscles of GI tract	α, β2: relaxes	M3: contracts
sphincters of GI tract	α1: contracts	M3: relaxes
glands of GI tract	inhibits	M3: secretes

	Sympathetic (adrenergic,	Parasympathetic (muscarinic)
ENDOCRINE		
pancreas (islets)	α2: decreases secretion	---
adrenal medulla	secretes epinephrine	---
urinary system		
bladder wall	β2: relaxes	contracts
ureter	α1: contracts	relaxes
sphincter	α1: contracts; β2 relaxes	relaxes
reproductive system		
uterus	α1: contracts; β2: relaxes	---
genitalia	α: contracts	M3: erection
sweat gland secretions	M: stimulates (major contribution); α1: stimulates (minor contribution)	---
arrector pili	α1: stimulates	---

Summary

Activation of **α receptors** leads to smooth muscle contraction

Activation of **β_2 receptors** leads to smooth muscle relaxation

Activation of **β_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

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:
  - α receptors is generally stimulatory
  - β receptors is generally inhibitory
- A notable exception – NE binding to β 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

THANK YOU