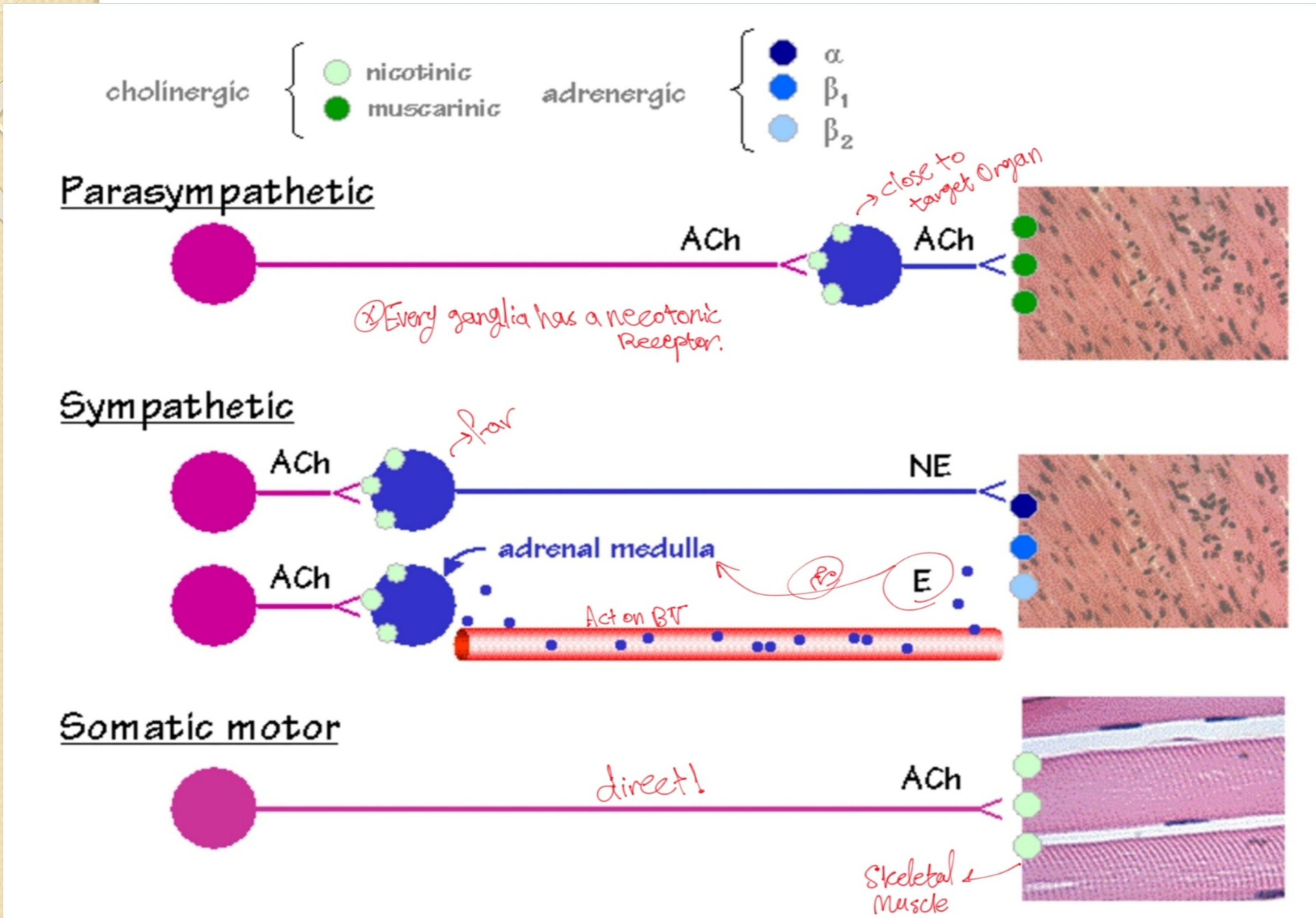
Autonomic Nervous System



cholinergic
nicotinic
muscarinic
adrenergic
α
β1
β2
Parasympathetic
ACh
ACh
close to target Organ
Every ganglia has a neeotonic Receptor.
Sympathetic
ACh
far
NE
ACh
adrenal medulla
E
Act on BV
Somatic motor
direct!
ACh
Skeletal Muscle

Lecture-5 :Topics

- Functions of ANS
- Effect of Sympathetic & Parasympathetic stimulation
- Overall difference between 2 divisions of ANS

Learning Objectives

- Effects of sympathetic and parasympathetic neurotransmitters on target organs and tissues.

trigger / stimulates / signal

• Most of the organs are dual innervated (by P, S).

Sympathetic Effects

- Fight, Fright or flight response
- Release of Neurotransmitters (NT)-
  - Norepinephrine (NT) from postganglionic fibers
  - Epinephrine (NT) from adrenal medulla

Exception

⇒ Main Neurotransmitter in the Sympathetic NS is the Nor-Epinephrine

Sympathetic Effects

- Mass activation prepares for intense activity ⇒ High Maintenance Activity.
  - [redacted] (HR) [redacted] ⇒ Ex -> during Running the HR ↑
  - [redacted] ⇒ for Better Breathing during Running
  - [redacted] [glucose] [redacted]
    - Brain is feeding on it

Sympathetic Effects

↳ Fight + Flight

- [redacted] ⇒ During the fight/flight we don't need the GI that much! I'm paying attention somewhere else!
- [redacted] ↳ Better pumping for the Heart
- [redacted]
  - [redacted] ⇒ Outward muscle in the urinary bladder.
  - [redacted]
- [redacted] ⇒ اتساع بؤبؤ العين

Parasympathetic Effects

- Normally not activated as a whole
  - Stimulation of separate parasympathetic nerves.
- Release ACh as NT
- Relaxing effects-
  - Decreases HR. ⇒ Relaxing
  - Dilates visceral blood vessels.
  - Increases digestive activity. ⇒ Mostly GI motility increases ⇒ So

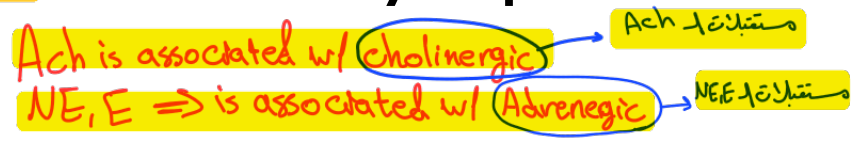
Parasympathetic Effects

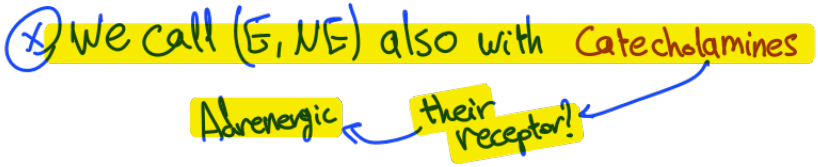
Relaxation Mode be like:

- [redacted]
- [redacted]
- [redacted]
- [redacted] of
  - [redacted]
  - [redacted]
- [redacted] ⇒ البوبو حاد

Adrenergic and Cholinergic Synaptic Transmission

- [redacted] is [redacted] for [redacted]
  - Sympathetic fibers
  - Parasympathetic fibers
- [redacted] at [redacted] is termed [redacted]
- [redacted] fibers [redacted] in [redacted]





Adrenergic and Cholinergic Synaptic Transmission

- [redacted] is NT released by -
  - [redacted] parasympathetic fibers
  - [redacted] fibers
- [redacted] the [redacted] / Targent Organ

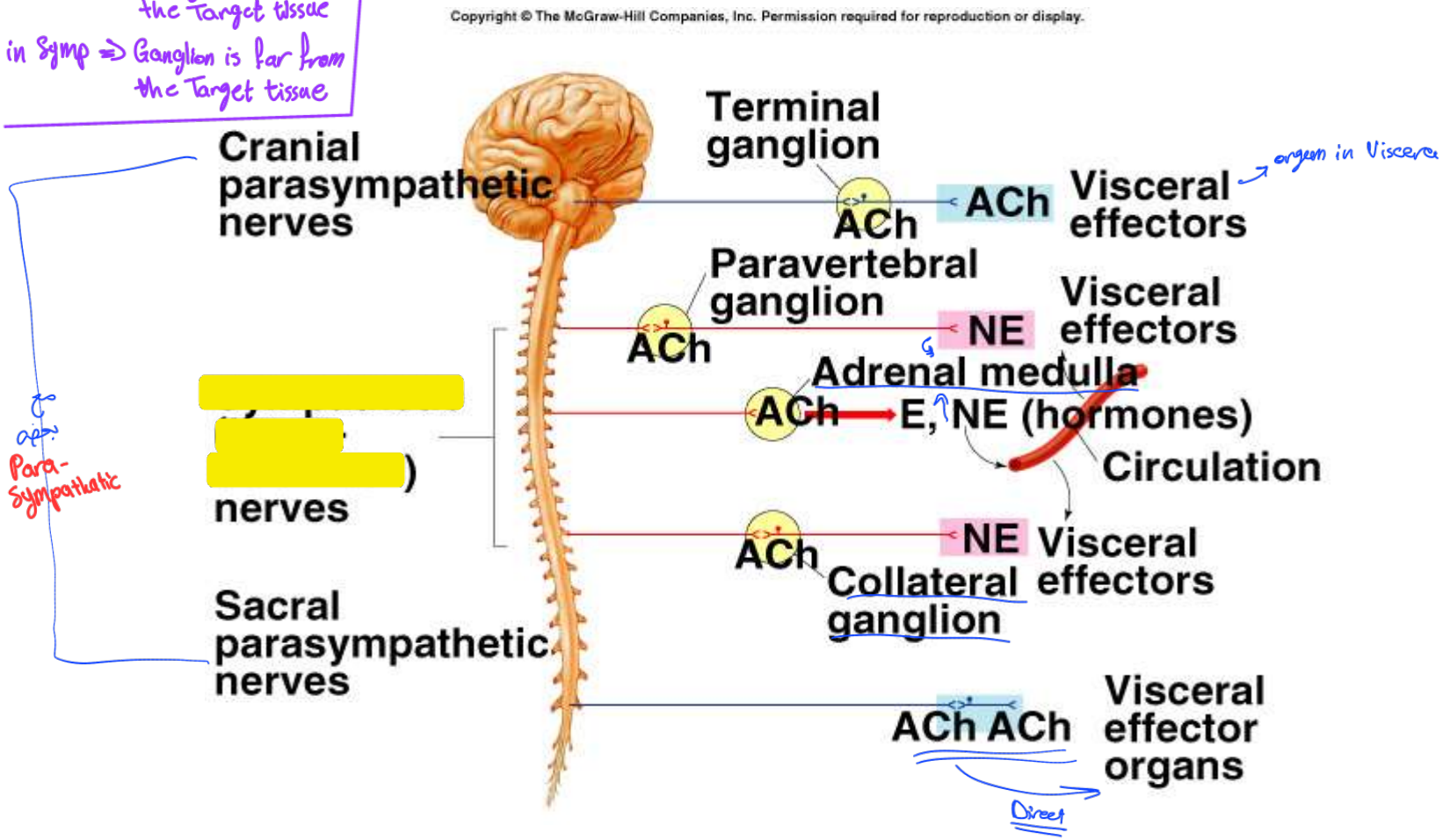
Adrenergic and Cholinergic Synaptic Transmission

Some organs has dual innervation from P + S

Remember

- in Para ⇒ Ganglion is near the Target tissue

in Symp ⇒ Ganglion is far from the Target tissue



Adrenergic Synaptic Transmission

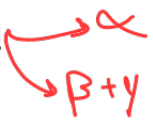
(continued)

- Transmission at these synapses is called adrenergic:
  - Norepinephrine
    - released by most postganglionic sympathetic nerve fibers.
  - Epinephrine,
    - released by the adrenal medulla
- Collectively called Catecholamines

(+ Ach, ⇒ Cholinergic)

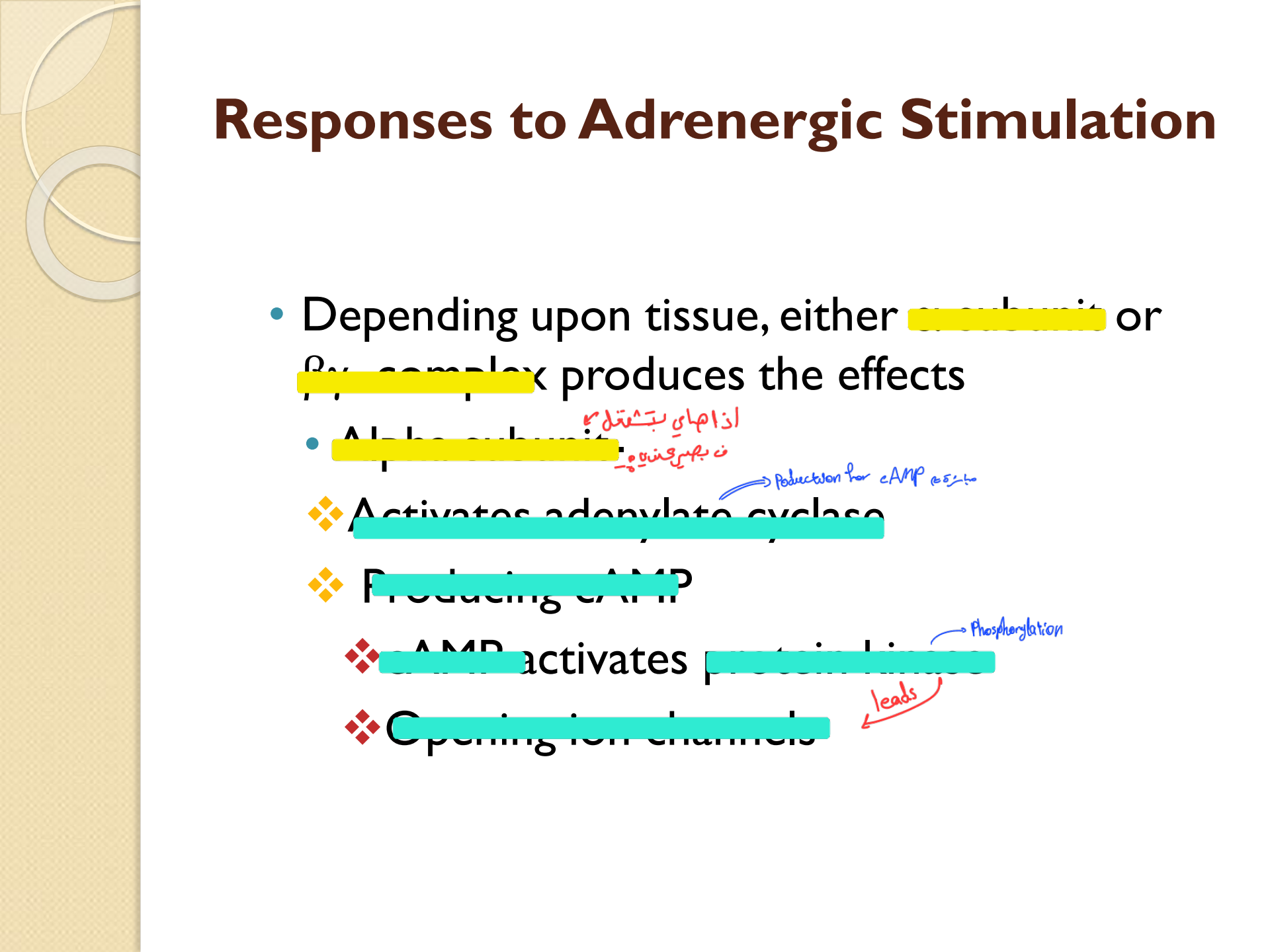
Responses to Adrenergic Stimulation

- [redacted] receptors:
  - [redacted]
  - [redacted]
  - [redacted]



Responses to Adrenergic Stimulation

- Depending upon tissue, either [redacted] or [redacted] produces the effects
  - [redacted]
    - [redacted]
    - [redacted]
      - [redacted] activates [redacted]
      - [redacted]



Responses to Adrenergic Stimulation
(continued)

(α one)

- **Alpha$_1$ adrenergic receptors:**
  - Produces their effects by the production of IP_3 and DAG
  - Epi binds to receptor
  - Ca^{2+} binds to calmodulin → Protein that binds w/ Calcium
  - Calmodulin activates protein kinase, modifying cell function ⇒ Response only By α_1

Responses to Adrenergic Stimulation
(continued)

- **Alpha adrenergic receptors**:
  1. Located on P
     - D
       - Negative feedback control ⇒ لما نزيد عن حده بروح يطفي حاله
  2. Located on
     - When , produces vasoconstriction

Q) If I have a patient w/ a hypertension, on what type of Receptors should the drug acts on? or what would be target tissue of the drug?

Responses to Adrenergic Stimulation
(continued)

- Has both [redacted] and [redacted] effects.
- Responses due to different membrane receptor proteins. ⊛ Major Mechanisms ⊛
  - [redacted]: constricts (visceral) smooth muscles.
  - [redacted]: contraction of smooth muscle.
  - [redacted]: increases HR and force of contraction.
  - [redacted]: relaxes bronchial smooth muscles.
  - [redacted]: adipose tissue, function unknown

تقريباً كلشي بعرفه!

In asthama ⇒ we give β2 specified drugs.

Responses to Cholinergic Stimulation

Adrenergic => NE, EPIN

- [redacted] fibers-.
  - Release [redacted] as NT
    - [redacted] (Voluntary)
    - [redacted]
    - [redacted] neurons
    - [redacted] neurons

Responses to Cholinergic Stimulation (continued)

- Somatic motor neurons ⇒ Excitatory
- All preganglionic autonomic neurons ⇒ Excitatory
- Postganglionic axons ⇒ Excitatory or Inhibitory

Responses to Cholinergic Stimulation (continued)

- [redacted]
  - [redacted]
  - [redacted]
  - [redacted] affects-
    - [redacted] a channel or
    - [redacted] a channel or
    - [redacted]

Responses to Cholinergic Stimulation (continued)

- Nicotinic receptors (ligand-gated)
  - ACh binds to 2 nicotinic receptor binding sites.
  - Causes ion channel to open within the receptor protein.
    - Opens a Na^+ channel.
- Always excitatory ⇒ For Muscle Contraction

Pre Ganglionic — ganglia (S ↖ ↗ P) — post ganglionic

↓

it has Nicotonic Receptors → whatever its type is stimulated by Ach

Responses to Cholinergic Stimulation (continued)

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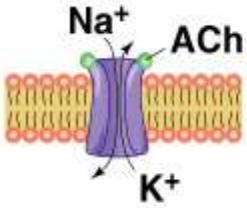
Nicotinic ACh receptors

Postsynaptic membrane of
- All autonomic ganglia
- All neuromuscular junctions
- Some CNS pathways



Ligand-gated channels (ion channels are part of receptor)

Depolarization

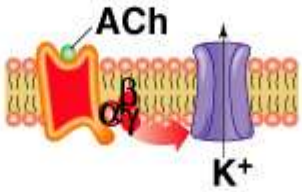
↓

Excitation

↳ Action Potential ↳ caused by movement of charged particles inside.

Muscarinic ACh receptors

- Produces parasympathetic nerve effects in the heart, smooth muscles, and glands
- G-protein-coupled receptors (receptors influence ion channels by means of G-proteins)

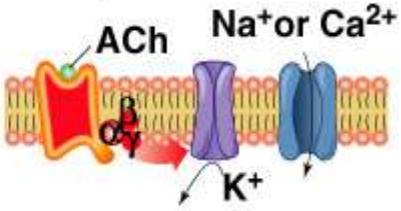


Hyperpolarization

↓ (K^+ channels opened)

Inhibition

Produces slower heart rate



Depolarization

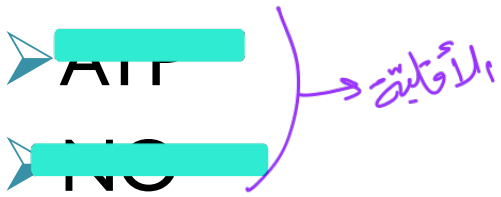
↓ (K^+ channels closed)

Excitation

Causes smooth muscles of the digestive tract to contract

Other Autonomic NTs

- Certain [redacted] their effects through other NTs
  - [redacted]
  - [redacted]



Organs With Dual Innervations

- [redacted]
  - Innervations by both
    - [redacted]
    - [redacted]
- [redacted]
- Effects of dual innervations
  - [redacted] ⇒ عكس بعضهن
  - [redacted] ⇒ متكملين لبعضهن
  - [redacted] ⇒ متعاونين

Organs With Dual Innervations

- Antagonistic :
  - Sympathetic and parasympathetic fibers innervate the same cells.
    - Actions counteract each other.
      - Heart rate.
- Complementary:
  - Sympathetic and parasympathetic stimulation produces similar effects.
    - Salivary gland secretion. No Inhibition
- Cooperative:
  - Sympathetic and parasympathetic stimulation produce different effects that work together to produce desired effect.
    - Micturition.

التبوّل

التعاون بينه
اجهاز اي يسيطر
على sphincter والآخر
Muscle

Organs Without Dual Innervations

- Regulation achieved by [redacted] or [redacted] firing rate.
- Organs that receive [redacted] innervations-
  - [redacted] / Suprarenal
  - [redacted]
  - [redacted]
  - [redacted].

Q What are the

All the following Except?

Applied

Horner's syndrome

- Characterized by- Symptoms?
  - Constriction of the pupil
  - Enophthalmos ⇒ العين داخلة لجوا / لبرا ← Exo
  - Drooping of eye lid ⇒ سايح
  - Anhydrosis on affected side of face ⇒ No Sweat
- Occurs due to-
  - Damage of stellate ganglia ← Huge Nerves Present in the Neck
  - Paralysis of Cervical Sympathetic nerve trunk

Horner's syndrome

Figure 1: Left pupillary miosis, marked hypochromia of the left iris, ipsilateral mild ptosis and left hemifacial anhidrosis

Drugs acting on autonomic ganglia

Increases activity

- Direct effect
  - Acetylcholine
  - Nicotine (Low doses)
- Indirect effect (ACE inhibitors)
  - Physostigmine
  - Neostgmine
  - Parathion
  - DFP

Decreases activity

- Ganglion blockers-
  - Hexamethonium
  - Macamylmamine
  - Pentolinum
  - Trymethaphan

Drugs acting on Postganglionic sympathetic nerve endings

Increases activity

- Release NE (TEA)
  - Tyramine
  - Ephedrine
  - Amphetamine

Decreases activity

- Block NE Synthesis
  - Metyrosine
- Block Storage
  - Reserpine
  - Guanethidine
- Prevent Release
  - Bretylium
- False transmitters
- Methyldopa

Drugs acting on Muscarinic receptors

Increases activity

- Acetylcholine

Decreases activity

- Atropine ⇒ Parasympathetic
- scopolamine

Drugs acting on Beta adrenergic receptor

Increases activity

- **β stimulators**
  - Isoproterenol
- **$\beta_2$stimulators**
  - Salbutamol
  - Terbutaline

- Decreases activity
- **β blockers**
  - Propranolol ⇒ Regulates HR
  - Metaprolol
- **β_1 blockers**
  - Atenolol
- **β_2 blockers**
  - Butoxamine

Drugs acting on Alpha adrenergic receptors

Increases activity

(α_1 stimulators)

- Methoxamine
- Phenylepinephrine

Decreases activity

(α blockers)

- Phenoxybenzamine
- Phentolamine
- Prazocin (α_1 blockers)
- Yohimbine ($\alpha_2$blockers)

Thank You!!!