437

PHYSIOLOGY TEAM

MED437

KING SAUD UNIVERSITY

PHYSIOLOGY

- Females & Males Slides
- Only Found in Males' slides
- Only Found in Females' slides
- Very Important Notes
- Notes
- Extra Information

غيـــداء آل مصـــمع
عبدالرحمن الحيسوني

Revised by

AUTONOMIC NERVOUS SYSTEM

Objectives

At the end of this session, the students should be able to:

1) Organization of the Autonomic Nervous System.
2) Terminology.
3) Sympathetic Nervous System (SNS).
4) Neurotransmitters and Types of Receptors.
5) Parasympathetic Nervous System.
6) Autonomic Receptors:
7) A) Adrenoreceptors.
8) B) Cholinorecptors.
9) Prototypes of Agonists and Antagonists to Autonomic Receptors.
10) Sympathetic and Parasympathetic Tone.
11) Function of Adrenal Gland.
12) Examples of The Effects of Sympathetic and Parasympathetic.
13) Anatomy and physiology of Autonomic Nervous System.
14) appreciate the anatomy of sympathetic& parasympathetic nervous system.
15) explain physiological functions of Sympathetic &parasympathetic nerves in head &neck, chest, abdomen and pelvis.

THE NERVOUS SYSTEM

INTRODUCTION:

- The nervous system monitors and controls almost every organ / system through a series of positive and negative feedback loops.
- The Central Nervous System (CNS): Includes the brain and spinal cord.
- The Peripheral Nervous System (PNS): Formed by neurons & their process present in all the regions of the body.
- It consists of cranial nerves arising from the brain & spinal nerves arising from the spinal cord.
- The peripheral NS is divided into:
  - A) Somatic Nervous system.
  - B) Autonomic nervous system.

*سلايد كامل من البنات

SOMATIC AND AUTONOMIC NERVOUS SYSTEM

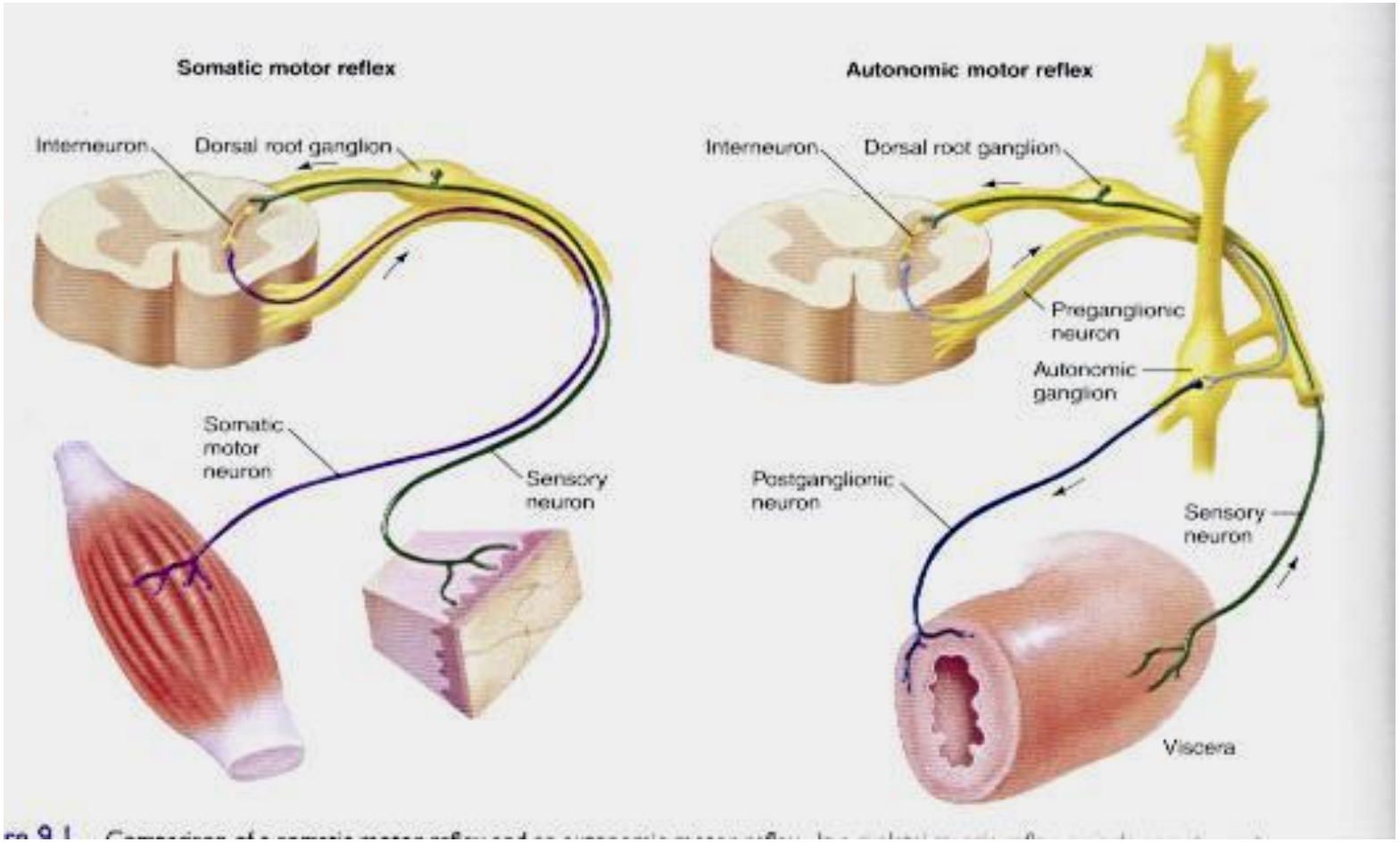
The motor efferent nervous system has two components:

A) Somatic.
B) Autonomic.

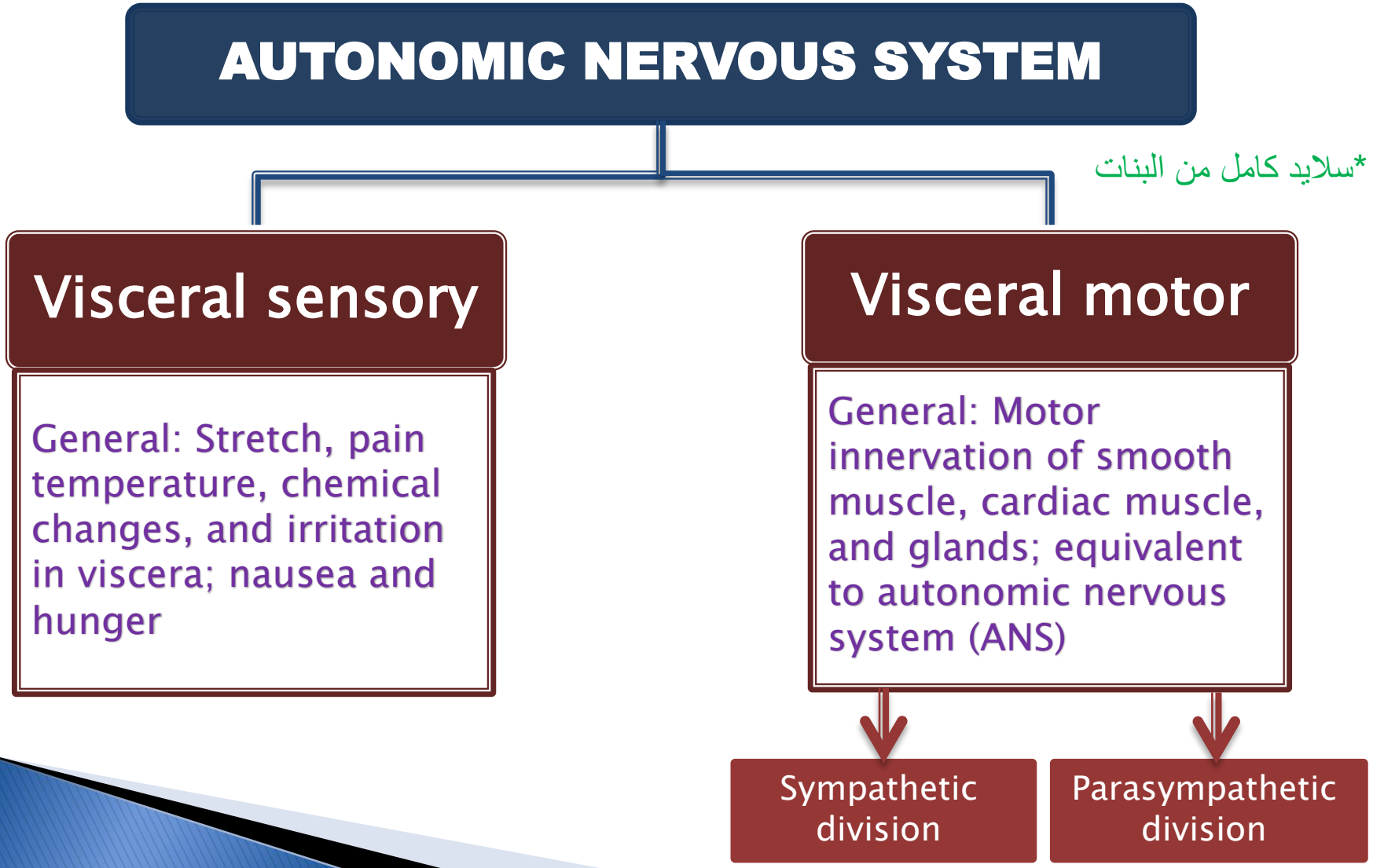
Somatic Nervous System:

- a voluntary nervous system under conscious control.
- consists of a single motoneuron and skeletal muscle fibers.
- Cell bodies of motor neurons reside in CNS (brain or spinal cord).
- Their axons (sheathed in spinal nerves) extend all the way to their skeletal muscles.

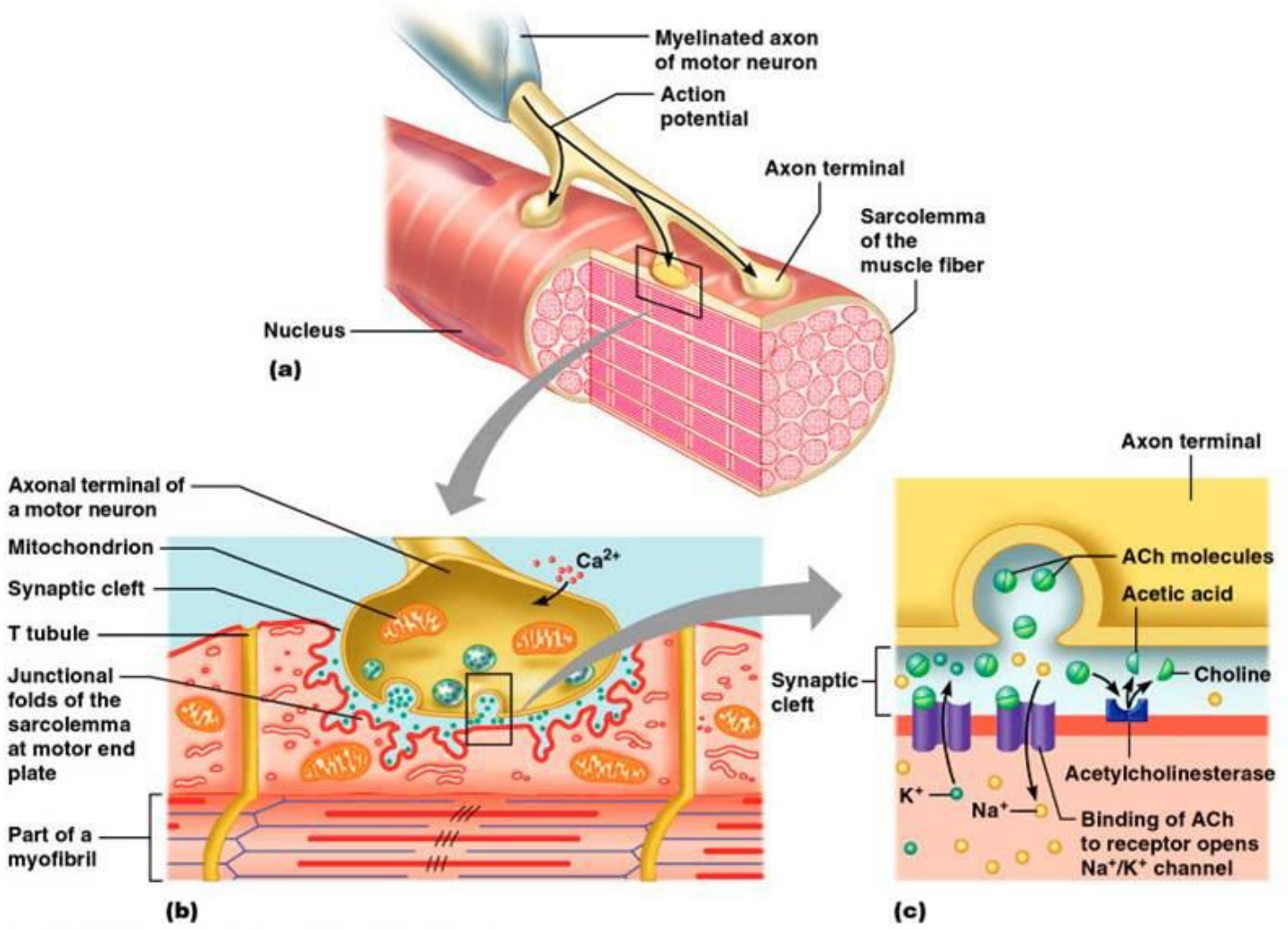
Organization of the Autonomic Nervous System



THE AUTONOMIC NERVOUS SYSTEM

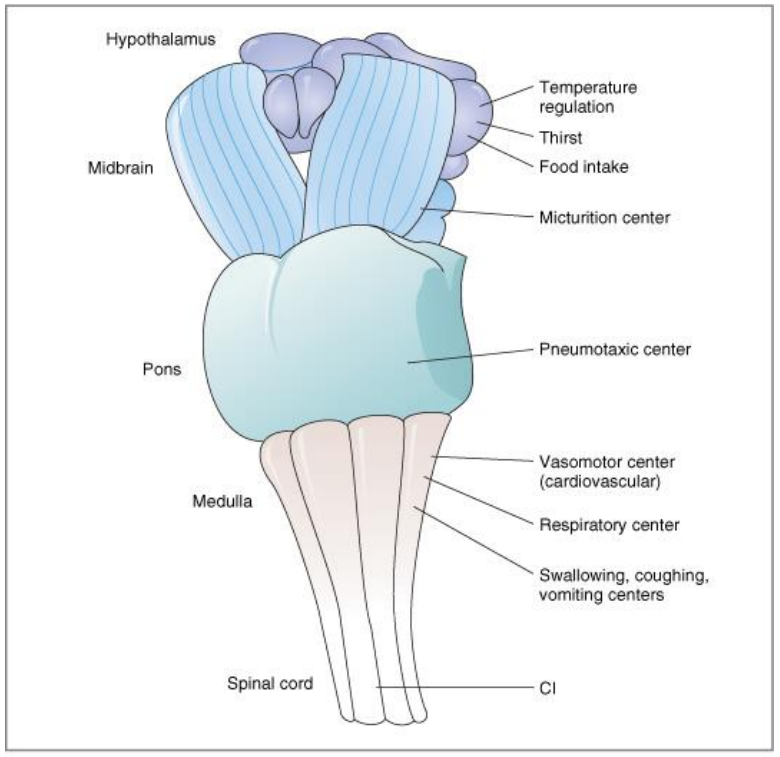


Somatic Nervous System



Organization of the Autonomic Nervous System

- An involuntary nervous system that modulates and controls the function of visceral organs.
- Autonomic nervous system (ANS) consists of two major divisions:
  - A) Sympathetic.
  - B) Parasympathetic.
- ANS is activated by centers in spinal cord, brain stem and hypothalamus.
- ANS is operated by visceral reflex. (المنعكسات العصبية)



Autonomic Nervous System (ANS)

- Organization of autonomic nervous system motor pathway consists of two neurons:
  A) Preganglionic neuron (cell body in brain or spinal cord)
  B) Postganglionic neuron (cell body in ganglion outside CNS)
    - Slower because lightly myelinated or unmyelinated

- All preganglionic neurons release Acetylcholine (Ach).
- Ach is a nurotransmiter released by cholinergic.
- Postganglionic neurons release either Ach, or norepinephrine.
- Norepinephrine is a nurotransmiter released by adrenergic neurons.

Terminology

- Sympathetic and parasympathetic are anatomic terms and refer to anatomic origin of preganglionic neurons in the central nervous system (CNS).
- Adrenergic and Cholinergic terms are used to describe neurons of either division, according to which neurotransmitter they synthesize and release.
- Adrenergic neurons release nor-epinephrine and the receptor is adrenoreceptor.
- Cholinergic neurons release Ach and the receptor is cholinergic.

Sympathetic Nervous System (SNS)

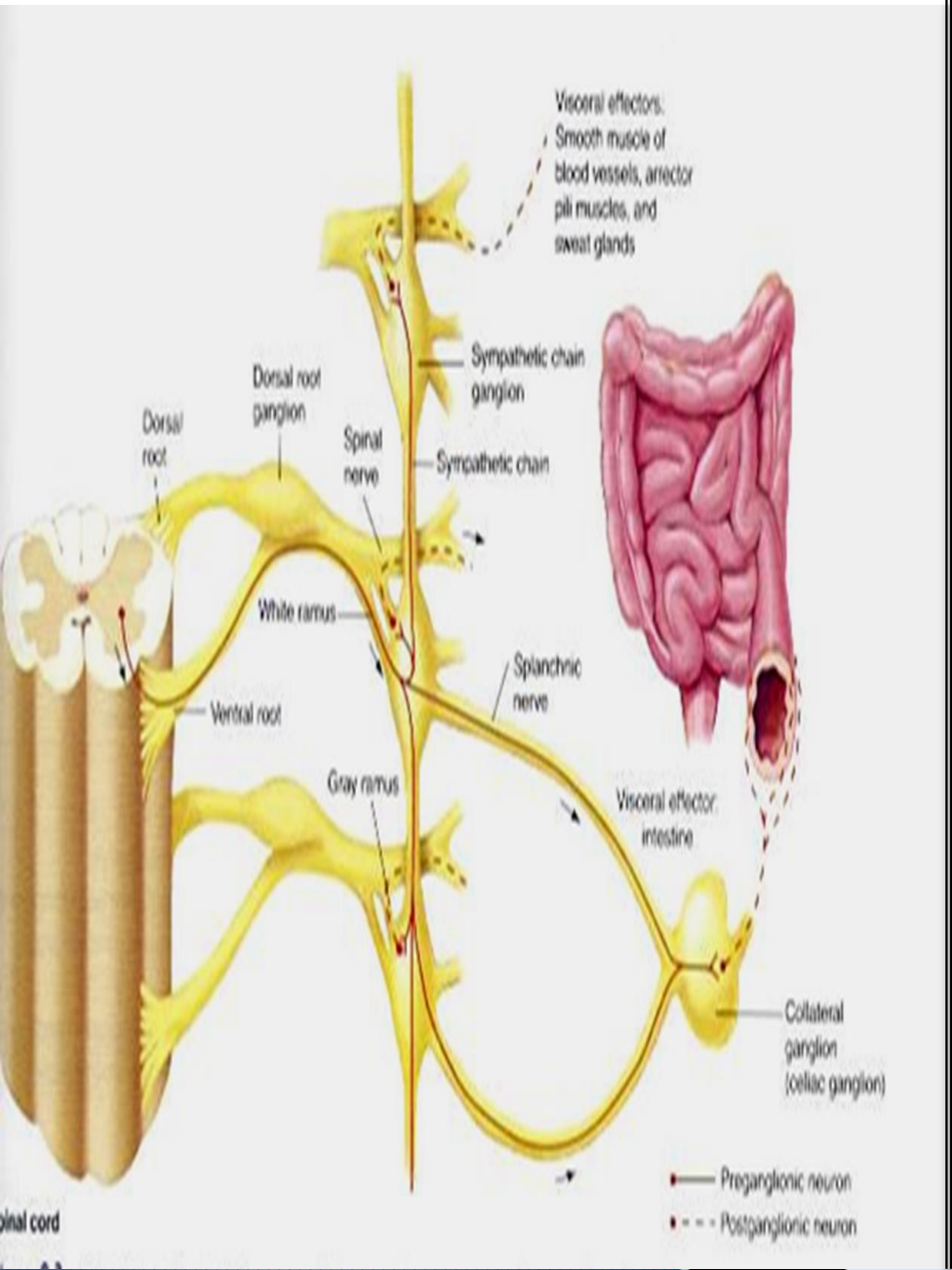
- Operates continuously to modulate the functions of many organ systems e.g; heart, blood vessels, gastrointestinal tract, bronchi and sweat glands.

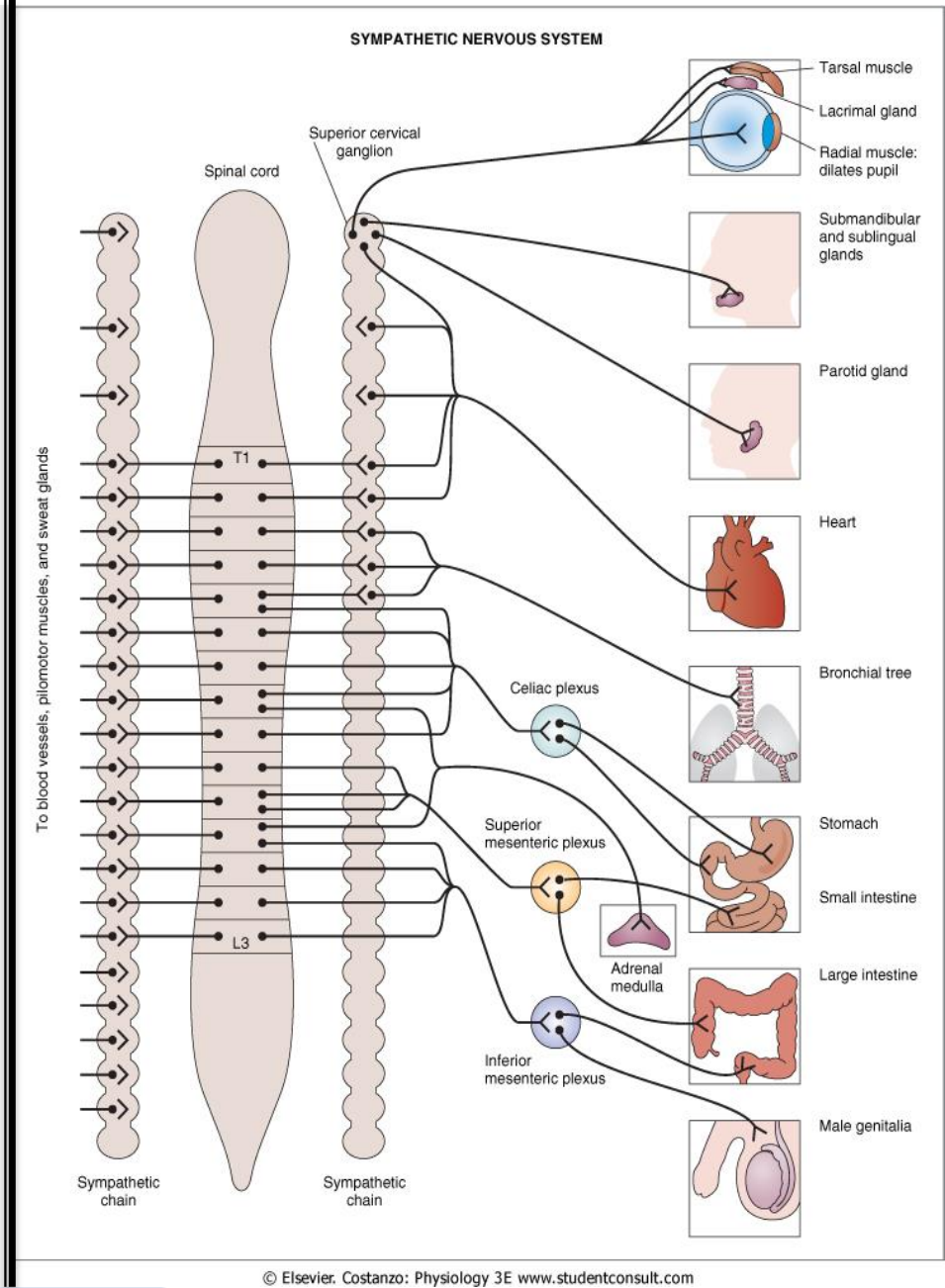
- Stressful stimulation activates SNS enables the body to be prepared for fear, flight or fight. And leads to a response known as “fight or flight” Which causes :increased arterial pressure, blood flow, blood glucose, metabolic rate , mental activity , heart rate, blood pressure ,cardiac output.
- diversion of blood flow from the skin and splanchnic vessels to those supplying skeletal muscle.
- Bronchioles dilate, which allows for greater alveolar oxygen exchange.
- -The tone increases in case of stress.

Sympathetic Nervous System (SNS)

- Sympathetic preganglionic neurons originate from thoracolumbar spinal cord (T1-L3) (lateral horns of the spinal segments).
- SNS ganglia are located near the spinal cord either in the paravertebral ganglia (sympathetic chain) (Trunk (chain) ganglia near vertebral bodies).
- or in the prevertebral ganglia near large blood vessel in gut :celiac ,superior mesenteric & inferior mesenteric .
  -Ganglia are in 2 regions :1-paravertebral,2- prevertebral
- Preganglionic neurons are short and lightly myelinated.
- The post ganglionic neurons are long and unmyelinated.
- Ganglia close to spinal cord .

Sympathetic Nervous System (cont.)



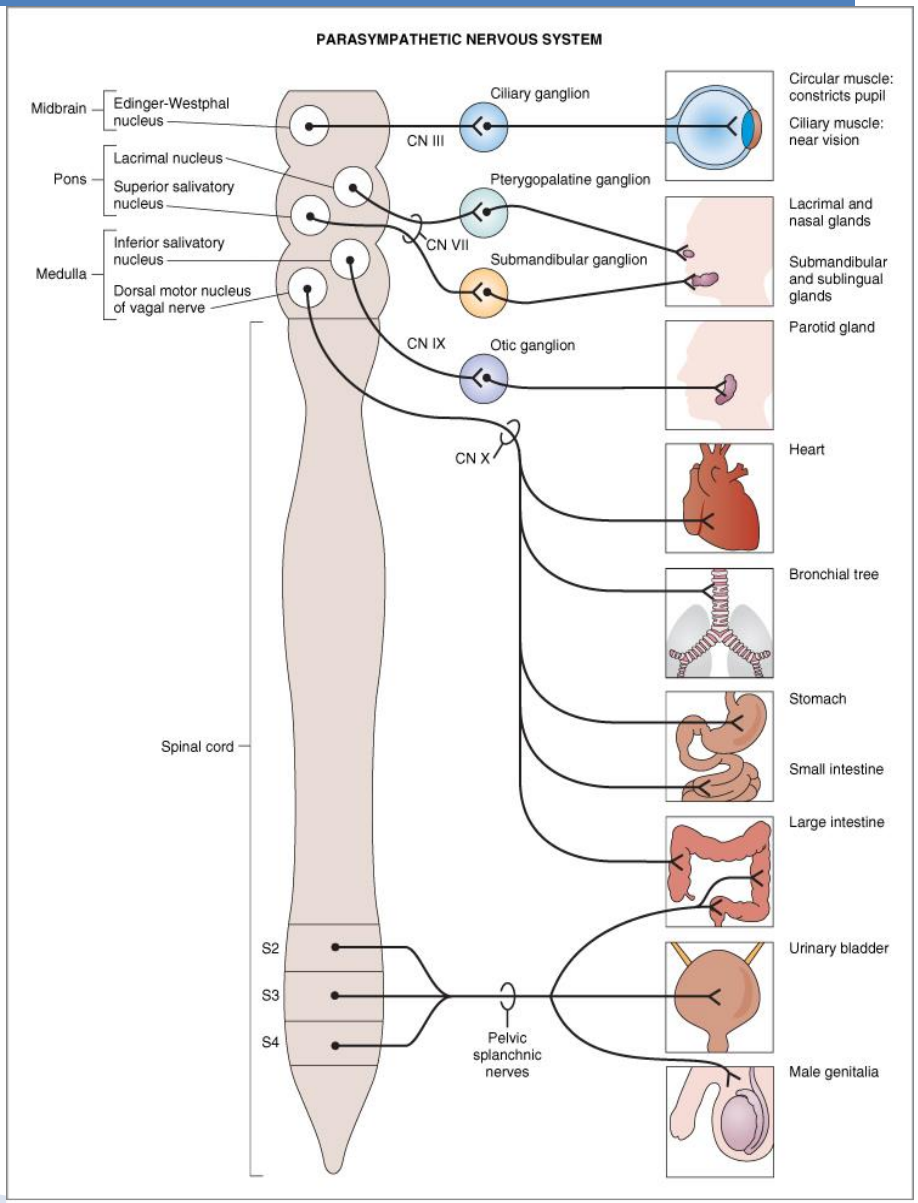


Neurotransmitters and Types of Receptors of SNS

- Preganglionic neurons are always cholinergic.
- Release Ach (acetylcholine), interacts with nicotinic receptors(N) on the cell body of postganglionic neurons.
- Postganglionic neurons are adrenergic (release noradrenalin) except in thermoregulatory sweat glands (muscarinic(M) cholinergic) and blood vessels to skeletal muscles .
- Adrenergic neurons affect adrenoreceptors: $alpha_1$, $alpha_2$, $beta_1$, $beta_2$

Parasympathetic Nervous System

- Preganglionic fibers originate from cranial nuclei (the motor nuclei of the cranial nerves III, VII, IX and X) in brain stem (mid brain, pons, medulla) and in sacral segments (S_2–S_4) (Craniosacral)
- Parasympathetic ganglia are located on or in the affected organs
- Preganglionic neuron has long axon and postganglionic neuron has short axon
- –Ganglia of parasympathetic : terminal ganglia, on the affected organ (عليه بالضبط)



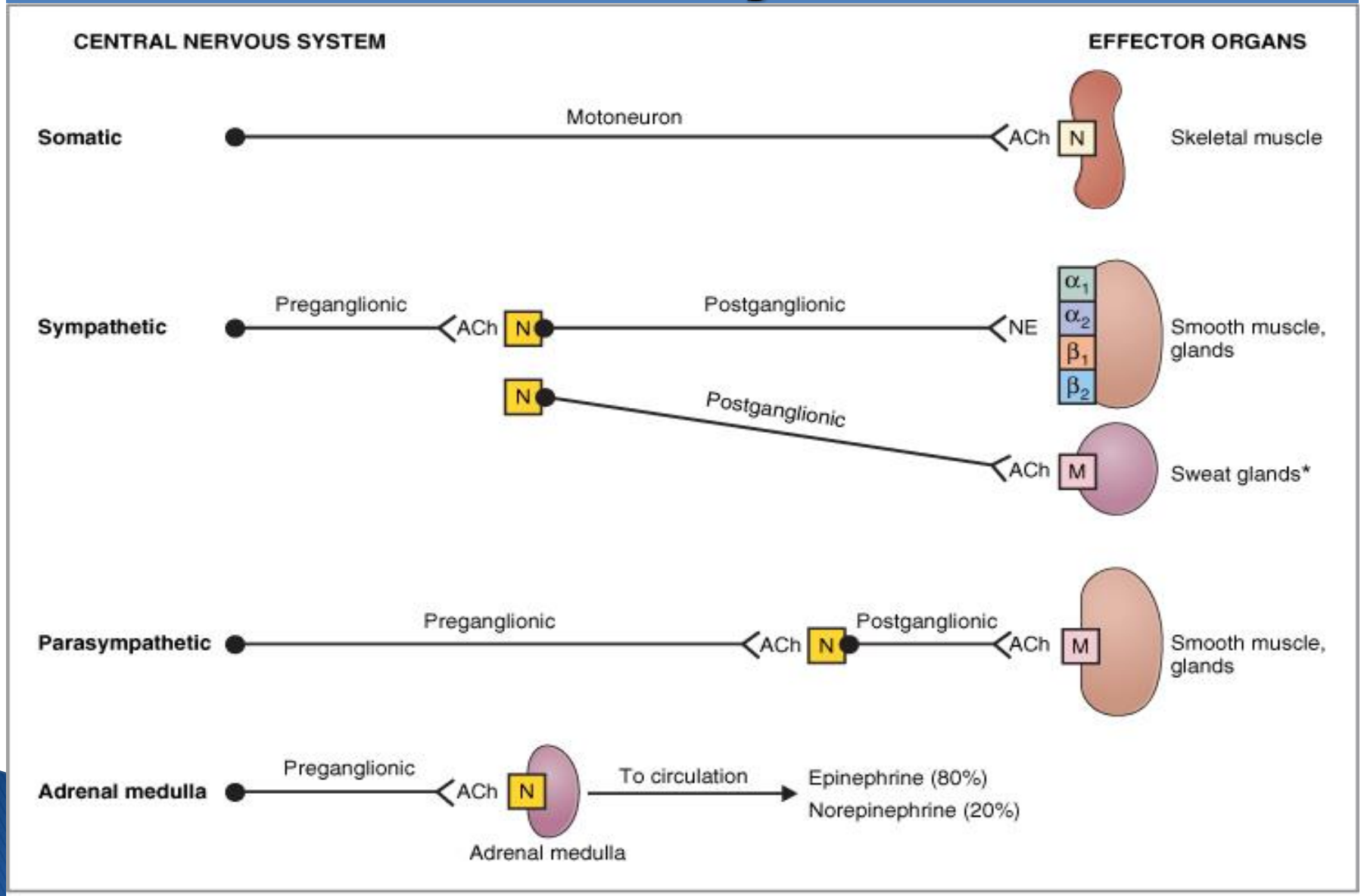
Parasympathetic Nervous System

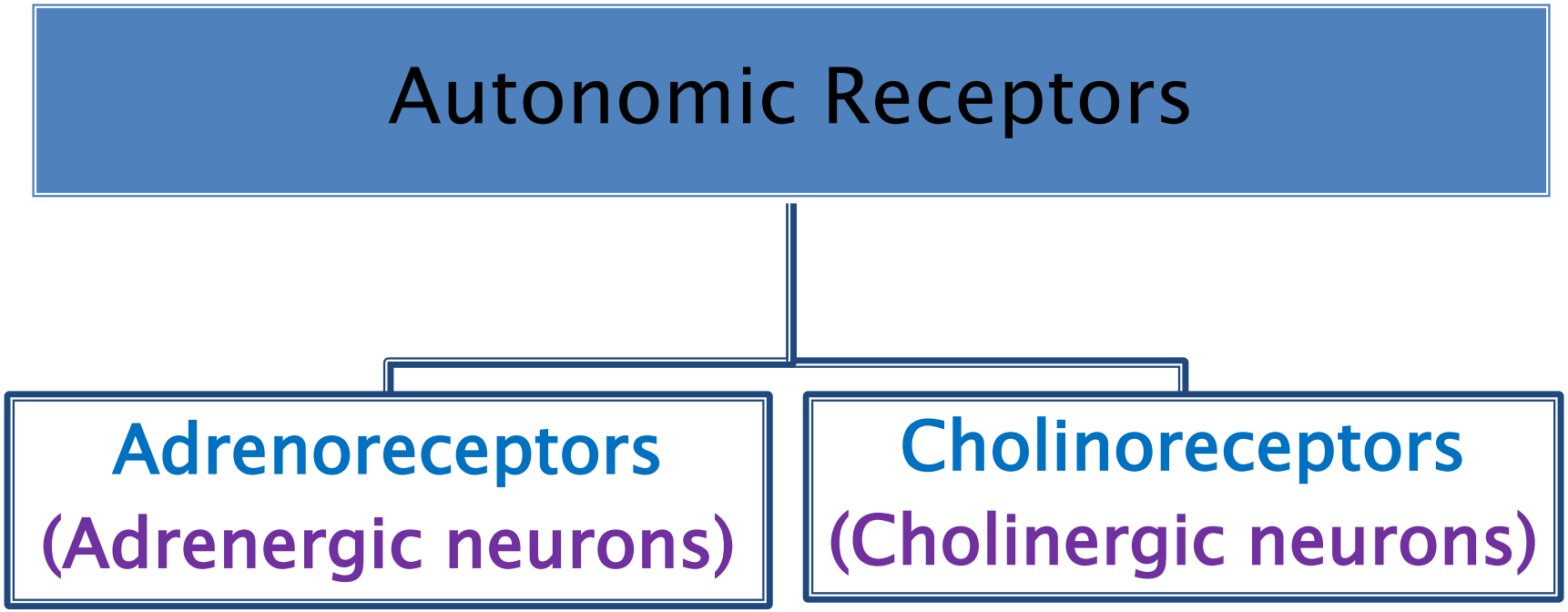
- The cranial nerves III, VII and IX affect the pupil and salivary gland secretion
- Vagus nerve (X) carries fibres to the heart, lungs, stomach, upper intestine and ureter
- The sacral fibres form pelvic plexuses which innervate the distal colon, rectum, bladder and reproductive organs.

Neurotransmitters and types of receptors

- All preganglionic neurons are cholinergic, release Ach which interacts with nicotinic receptors
- Cholinergic receptors are : nicotinic (N) and muscarinic(M)
- Postganglionic neurons are cholinergic, release Ach which interacts with muscarinic receptors

Organization of the Autonomic Nervous System

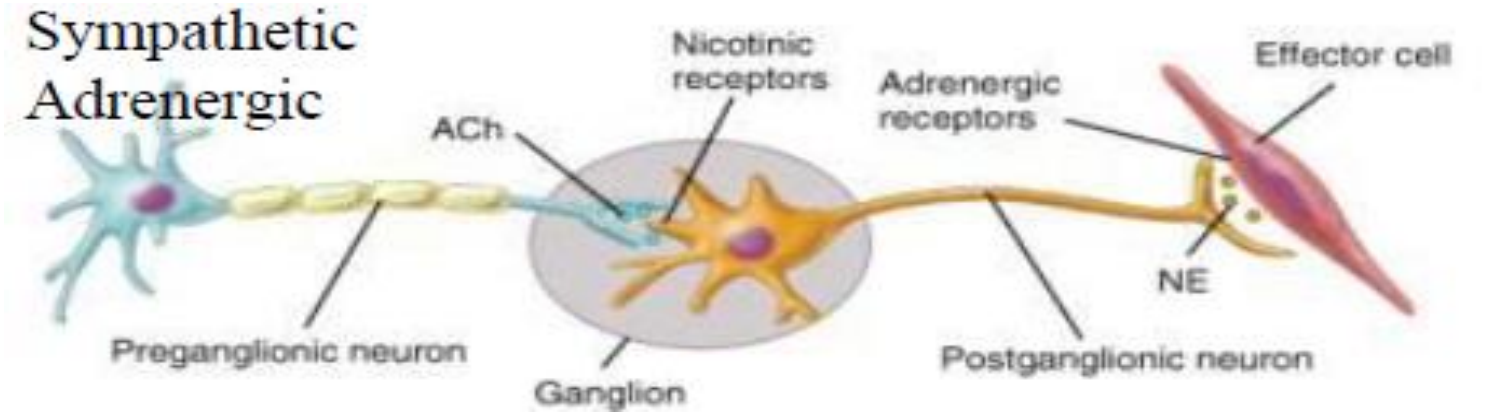


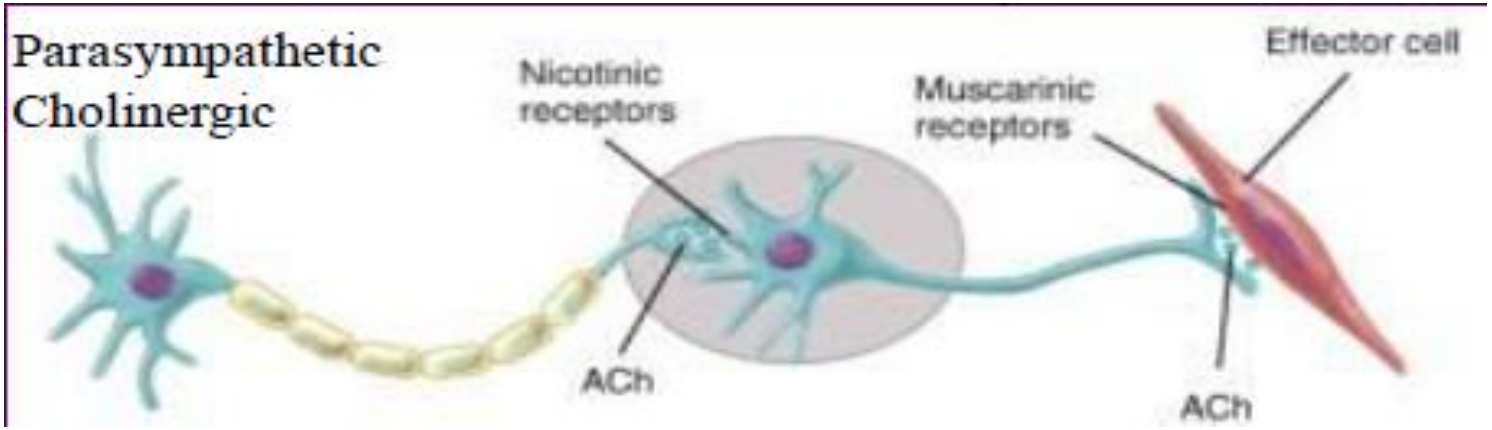

Autonomic Receptors
Adrenoreceptors
(Adrenergic neurons)
Cholinoreceptors
(Cholinergic neurons)

Receptors

- The parasympathetic nervous system uses only acetylcholine (ACh) as its neurotransmitter.
- The ACh acts on two types of receptors, the muscarinic and nicotinic cholinergic receptors.
- Most transmitions occur in two stages: When stimulated, the preganglionic nerve release ACh at the ganglion, which acts on nicotinic receptors of the postganglionic nerve.
- The post ganglionic nerve then releases ACh to stimulate the muscarinic receptors of the target organ.

ANS Receptors: Classified as either parasympathetic or sympathetic





Adrenoreceptors

The Sympathetic NS acts on two types of receptors: α and β

1) α1 receptor: found in vascular smooth muscle, gastrointestinal (GI) sphincters and bladder, radial muscle of iris:

- Activation of α1 ⟶ ↑ contraction (Vasoconstriction).
- Activation of α1 ⟶ Dilatation of pupil.
- Activation of α1 ⟶ Intestinal relaxation.
- Activation of α1 ⟶ Bladder sphincter contraction.

2) β1 receptor: is found in the following tissues:

- S.A node ⟶ ↑heart rate.
- AV node ⟶ ↑conduction velocity.
- Ventricular muscle ⟶ ↑contractility (force of contraction)
- Salivary gland ⟶ ↑salivary secretions, (but enzymes production)
- Lipolysis (blocked by atenolol in hypertension).

Adrenoreceptors

3) β2 receptors:

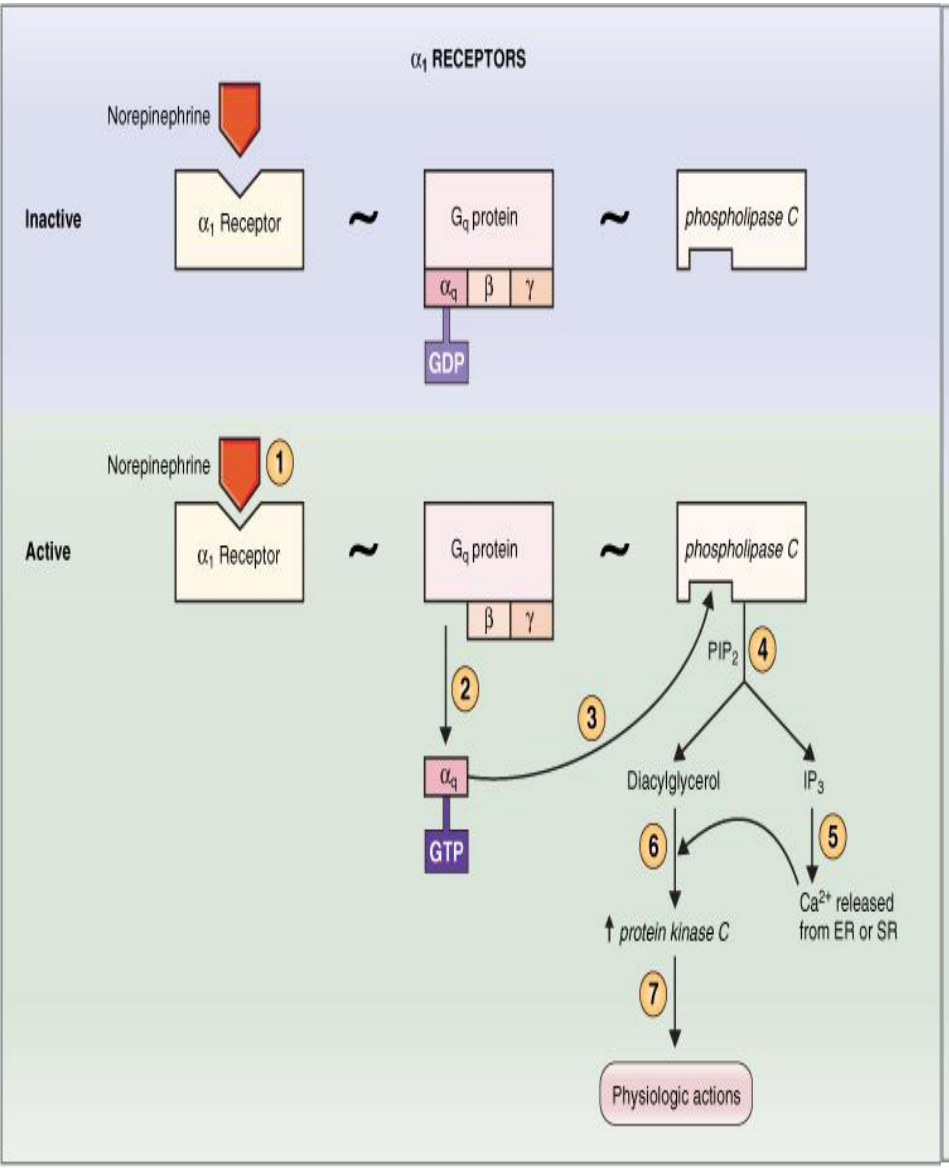
found in vascular smooth muscle wall of bladder, bronchial tract ,uterus and wall (smooth muscles) of GI.

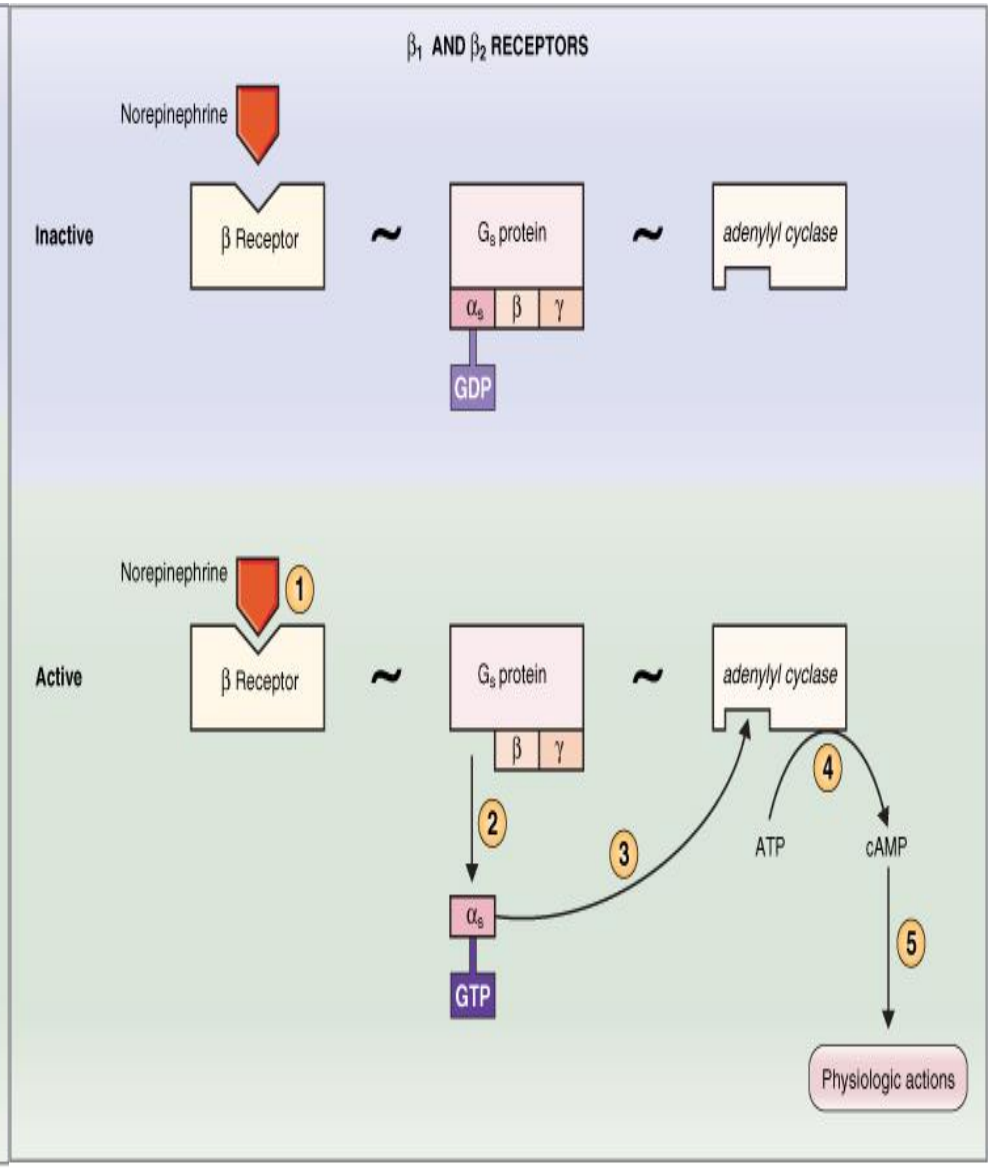
- Activation of β2 ⟶ relaxation (Intestinal and bladder wall relaxation)
- Vasodilatation.
- Bronchodilatation.
- Bladder wall relaxation.
- β2 more sensitive to Epinephrine than Nor-epinephrine.

- alpha 2 has the same function as alpha 1 but is rarely found in the human body

α1 receptor

β1, β2 receptors

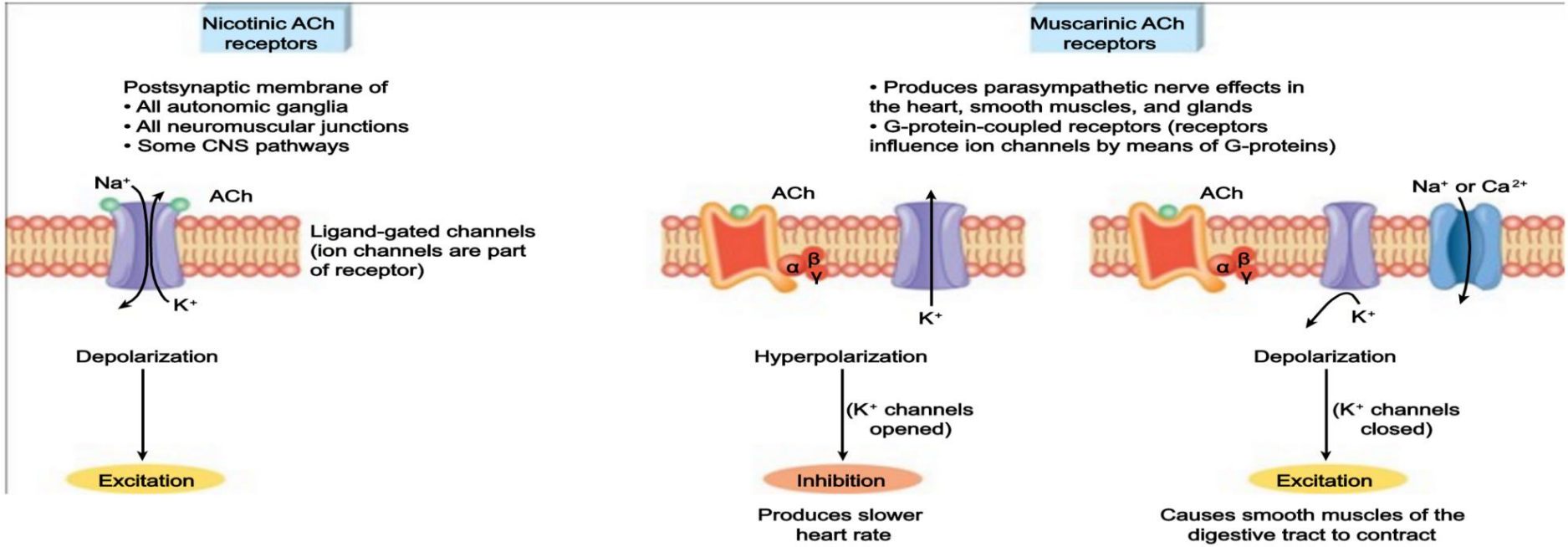




Cholinorecepters

- Nicotinic receptor
  - an ion channel for Na+ and K+
  - in all postganglionic neurons, motor end plate at skeletal muscle and chromaffin cells

- Muscurinic Receptor
  - Works either like α1 adrenoreceptor via PKC, DAC and IP3 or via G protein which has α1 subunit that binds K+ channel and open it



IP3 (Inositol trisphosphate) / DAG (Diacylglycerol) / PKC (Protein kinase C)

Autonomic Receptors (in summary)

- The type of receptor and its mechanism of action determine the physiologic response (inhibition،excitation) e.g. β1 receptor in SA node and in ventricular muscle:

SA node: activation of SA node by the agonist (nor-epinephrine) ⟶ ↑heart rate

ventricular muscles ⟶ ↑contractility

- What do receptors do?

a) Activation of α receptors leads to smooth muscles contraction
b) Activation of β2 receptors leads to smooth muscles relaxation
c) Activation of β1 receptors leads to smooth muscles contraction (especially in heart)

Prototypes of Agonists and Antagonists to Autonomic Receptors

Receptor	Agonists	Antagonists
Adrenoreceptors		
α_1	Norepinephrine	Phenoxybenzamine
	Phenylephrine	Prazosin
α_2	Clonidine	Yohimbine
β_1	Norepinephrine	Propranolol
	Isoproterenol	Metoprolol
β_2	Epinephrine	Propranolol
	Isoproterenol	Butoxamine
	Albuterol	
Cholino receptors		
Nicotinic	ACh	Curare
	Nicotine Carbachol	Hexamethonium (blocks ganglionic receptor but not neuromuscular junction)
Muscarinic	ACh	Atropine
	Muscarine	
	Carbachol	

Sympathetic and Parasympathetic Tone

- The role of them is to keep the stimulated organs in normal stage

- Examples:

a) sympathetic always keeps the blood vessel constricted ½ of its normal diameter.

b) removal of vagus (Parasympathetic nerve) nerve atony loss of peristalsis (contraction of small intestine) constipation.

Effect of loss of sympathetic and parasympathetic tone after denervation

Loss of sympathetic tone in blood vessel causes severe vasodilatation but after sometime, intrinsic tone increases by chemical adaptation

Function of Adrenal Gland

- Stimulation of sympathetic nerves causes large quantities of Epinephrine and Nor-epinephrine to be secreted in blood.

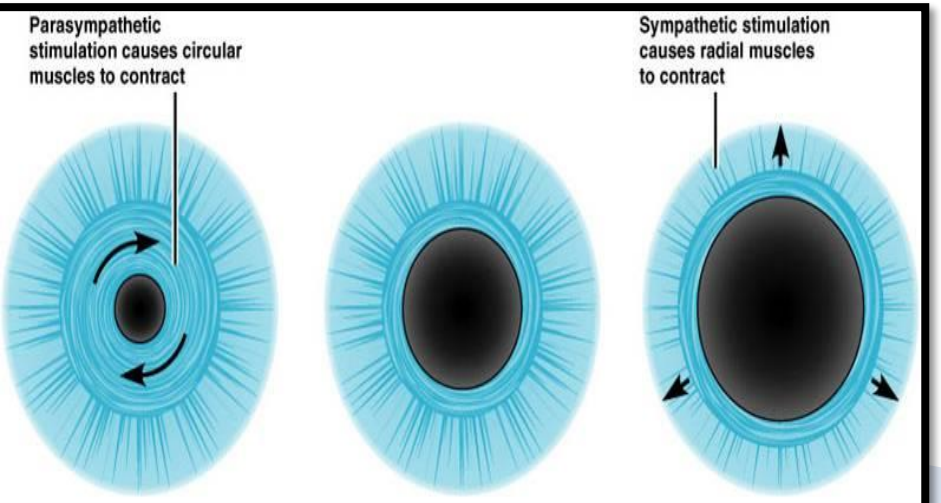
- The effect of Epinephrine & Nor-epinephrine lasts 5-10 times more than the ones which secreted from sympathetic.

Examples of The Effects of Sympathetic and Parasympathetic

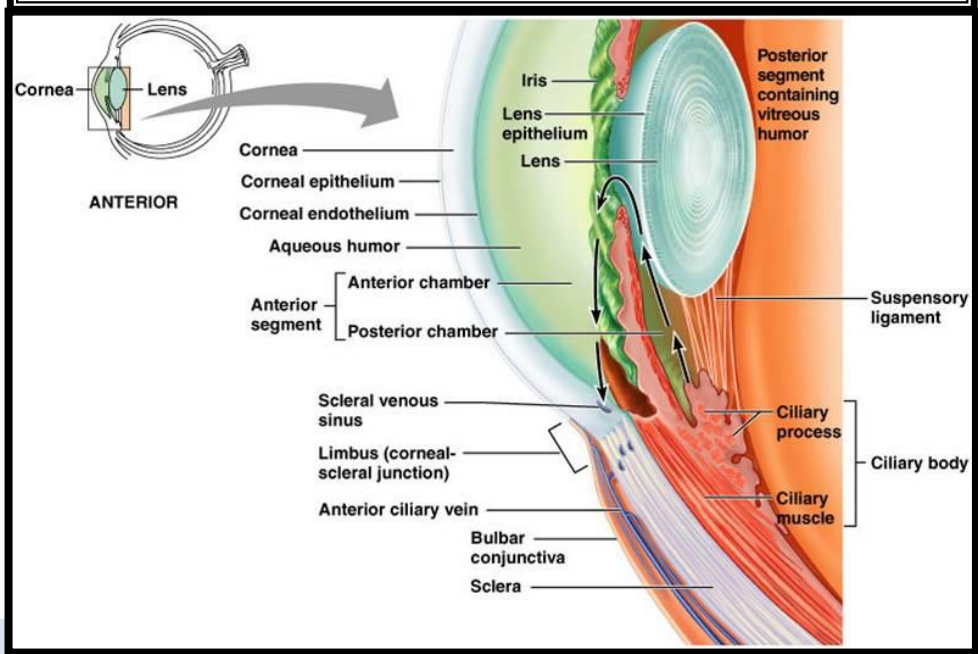
A) The Eyes:

- Sympathetic stimulation contracts the meridional fibers of the iris to dilate the pupil.
- Parasympathetic stimulation contracts the circular muscle of the iris to constrict the pupil.
- Focusing of the lens is controlled by parasympathetic through contraction of ciliary muscle.
- Sympathetic nerve dilate the pupil and relax the lens ,allowing more light to enter the eye.
- Bronchiolar dialation ,contraction of sphincters and metabolic changes such as the mobilization of fat and glycogen.

Pupil Dilation and Constriction



Structure of The Eye



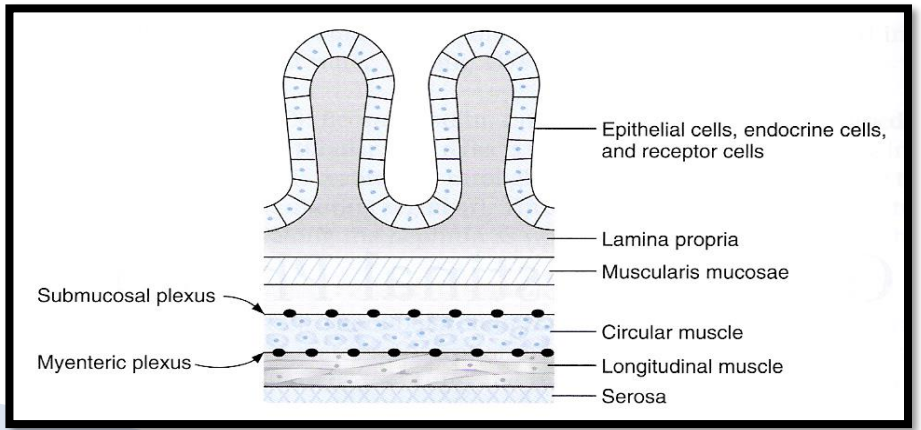
B) The Glands:

- Controlled by parasympathetic ⟶ ↑ their secretions
- Sympathetic causes vasoconstriction of the blood vessels to the glands which causes reduction in in their secretion

Sweat glands secretion: increased by sympathetic stimulation.

C) The Gastrointestinal tract (GI)

- Enteric nervous system
- Parasympathetic nervous system increases the activity of GI tract (increases peristaltic contraction, and sphincter relaxation).
- Sympathetic decreases the activity of GI.



D) The Heart:

- Sympathetic stimulation ⟶ ↑activity of the heart.
- Parasympathetic stimulation doing the opposite.

E) Systemic Blood Vessels:

- Constricted by stimulation of sympathetic.
  - No effect of the parasympathetic except in certain areas, such as blushing of the face.

F) Arterial Pressure:

- Sympathetic stimulation ⟶ ↑the cardiac output and ↑resistance to the blood flow and blood pressure.
- Parasympathetic ⟶ ↑cardiac output and has no effect on blood vessels.

Structure	Sympathetic Stimulation	Parasympathetic Stimulation
Iris (eye muscle)	Pupil dilation	Pupil constriction
Salivary Glands	Saliva production reduced	Saliva production increased
Oral/Na sal Mucosa	Mucus production reduced	Mucus production increased
Heart	Heart rate and force increased	Heart rate and force decreased
Lung	Bronchial muscle relaxed	Bronchial muscle contracted

Structure	Sympathetic Stimulation	Parasympathetic Stimulation
Stomach	Peristalsis reduced	motility secreted; Gastric juice increased
Small Intes	Motility reduced	Digestion increased
Large Intes	Motility reduced	Secretions and motility increased
Liver	Increased conversion of glycogen to glucose	
Kidney	Decreased urine secretion	Increased urine secretion
Adrenal medulla	Norepinephrine and epinephrine secreted	
Bladder	Wall relaxed Sphincter closed	Wall contracted Sphincter relaxed

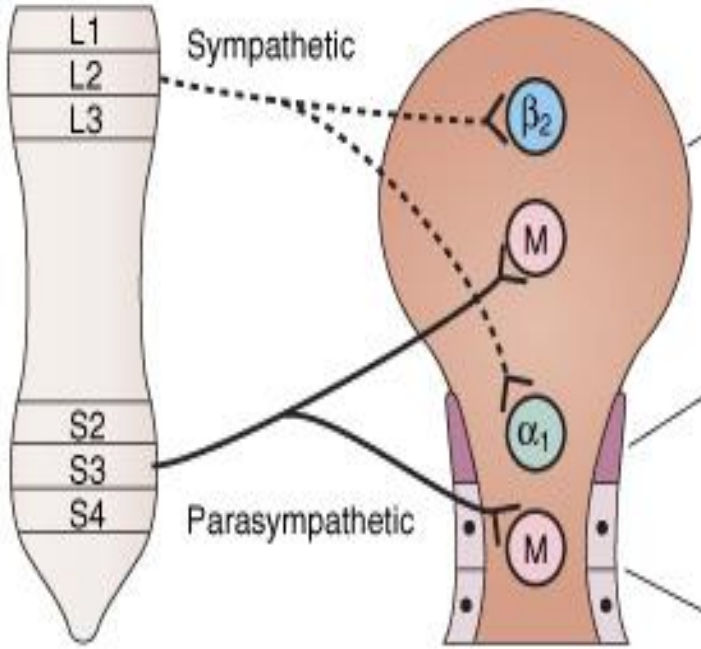
Autonomic Reflexes

Most of the visceral functions of the body are regulated by autonomic reflexes

- **Cardiovascular:**
  - baroreceptor reflex:

  It is stretch reflex in the main arteries such as carotid artery to detect the blood pressure.
- **Gastrointestinal:**
  The receptors in the nose and mouth send a signal to parasympathetic to notify the glands of mouth & stomach to secrete the digestive juices.
- **Urinary Bladder:**
  - Initiate the micturition (urination) by parasympathetic innervations.
- **Sexual reflexes:**
  - erection by parasympathetic
  - ejaculation by sympathetic

Urinary Bladder



Muscle	Filling of Bladder		Emptying of Bladder	
	State	Control Mechanism	State	Control Mechanism
Detrusor muscle	Relaxed	Sympathetic (β_2)	Contracted	Parasympathetic (M)
Internal sphincter	Contracted	Sympathetic (α_1)	Relaxed	Parasympathetic (M)
External sphincter	Contracted	Voluntary	Relaxed	Voluntary

Autonomic Reflexes

- Sympathetic activation could occur in isolated portions such as:
  - heart regulation.
  - many sympathetic reflexes that regulate G.I. functions.

- The parasympathetic usually causes specific localized responses:
- The effect of parasympathetic usually specifies to certain organ , but sometimes there is a common effect of parasympathetic activity by affecting the functions of some organs together such as rectal emptying and bladder emptying, salivary secretion and gastric secretion.

- Sympathetic can deal with every single organ alone.

- Parasympathetic can do that, but sometimes not, should be two processes together.

Quiz

(Fill the boxes)

1)The ---Nervous System : Formed by neurons & their process present in all the regions of the body.

A)Peripheral B)Central C)Body D)somatic

2)----nervous system axons extend all the way to their skeletal muscles

A) Autonomic B) Somatic C) All D) Viscera

3)ANS is activated by centers in

A)spinal cord B)brain stem C)hypothalamus D)All of the above

4)---is a neurotransmitter released by cholinergic

A)Ash B)Adrenaline C)Noradrenaline D)Acetylcholine

5)---are in 2 regions :1-paravertebral, 2- prevertebral

A)Neurons B)Nerves C)Ganglias D)Neurotransmitters

6)In SNS Postganglionic neurons are adrenergic (release noradrenalin) except in---(muscarinic (M) cholinergic)

A)Glands B)heart C)Sweat glands D)All of these

7) Sympathetic stimulation contracts meridional fibers to:

A)No effect on pupil B)Constrict pupil C)Dilate pupilT
D)Increase Aqueous Humor secretion

8) A nicotinic receptor is an ion channel for:

A)K+ B)Na+ C)Ca2+ D)K+ and Na+ T

9) β2 receptors are:

A) More sensitive to Norepinephrine than epinephrine
B) More sensitive to Epinephrine than norepinephrine T
C) Equally sensitive to both
D) Insensitive to both

10) Stimulation of _____ Nerves causes large quantities of Epinephrine and norepinephrine to be secreted in blood

A) Sympathetic T B)Parasympathetic C)Vagus D)None of the above

11) Secretion of sweat glands is:

A) Increased by Sympathetic nervous system

B) Increased by Parasympathetic nervous system

C) Not affected by Autonomic nervous system

D) Increased by both Parasympathetic and Sympathetic nervous system

12) The parasympathetic nervous system uses _____ as its neuro transmitter/s:

A) Norepinephrine

B) Acetylcholine (ACh)

C) Both Acetylcholine and Norepinephrine

D) Noradrenaline

Answers

Question	answer	Slide number
1	A	4
2	B	5
3	D	9
4	D	10
5	C	14
6	C	17
7	C	35
8	D	30
9	B	28
10	A	34
11	A	36
12	B	25

Thank you & good luck

Girls team members:

- مها العمري
- هديل عورتاني
- ريما العنزي
- روتانا خطيب
- لجين عزيز الرحمن
- العنود المفرج
- ريم القرني
- عهد
- مها النهدي
- بلقيس الراجحي
- سارة البليهد
- ميعاد النفيعي
- نورة البسام
- عبير العبدالجبار
- وجدان الشامري
- الجوهرة الشنيفي

Boys team members:

- هشام الشايع
- محمد الحسن
- محمد الصويغ
- محمد المنجومي
- معاذ الحمود
- خالد العقيلي
- عبدالجبار اليماني
- عمر الفوزان
- فهد الحسين
- سعد الهداب
- نواف اللويمي
- انس السيف
- سيف المشاري
- سعود العطوي
- نايف المطيري
- عبدالرحمن العقيل

Team Leaders:

-مها بركة -طارق العميم