

A close-up photograph of several vibrant pink roses in full bloom, set against a background of green leaves and some blurred blue flowers. The roses are the central focus, with their petals showing various shades of pink and red. The overall image has a soft, natural feel.

# **Autonomic Nervous System**

**Assess Prof. Fawzia Al-Rouq**

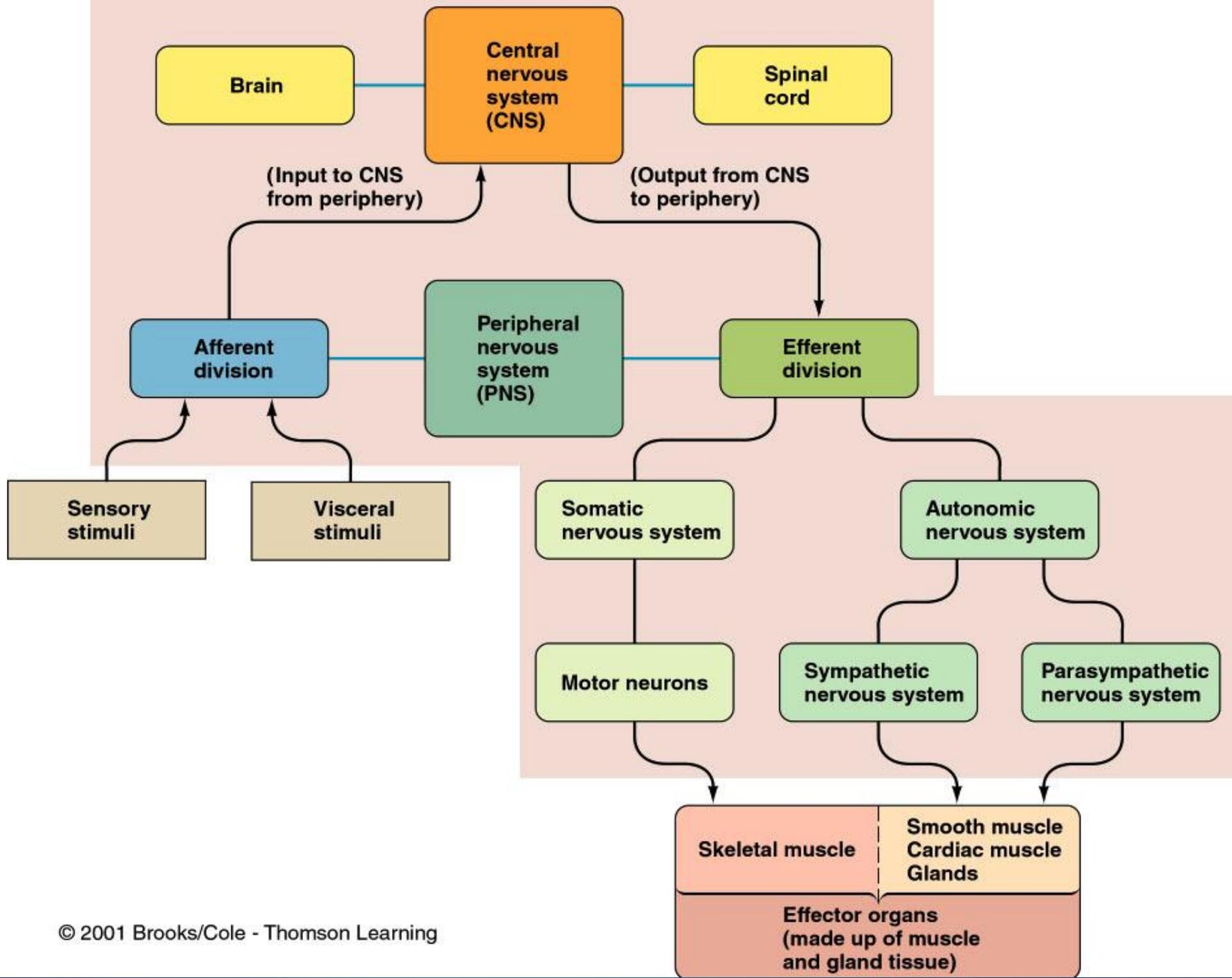
**Department of Physiology**

**College of Medicine**

**King Saud University**

# INTRODUCTION





# 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** arises from the brain & **spinal nerves** arising from the spinal cord.
- The peripheral NS is divided into
  - Somatic Nervous system**
  - Autonomic nervous system**

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# Functional Anatomy & Physiology of Autonomic NS

# OBJECTIVES

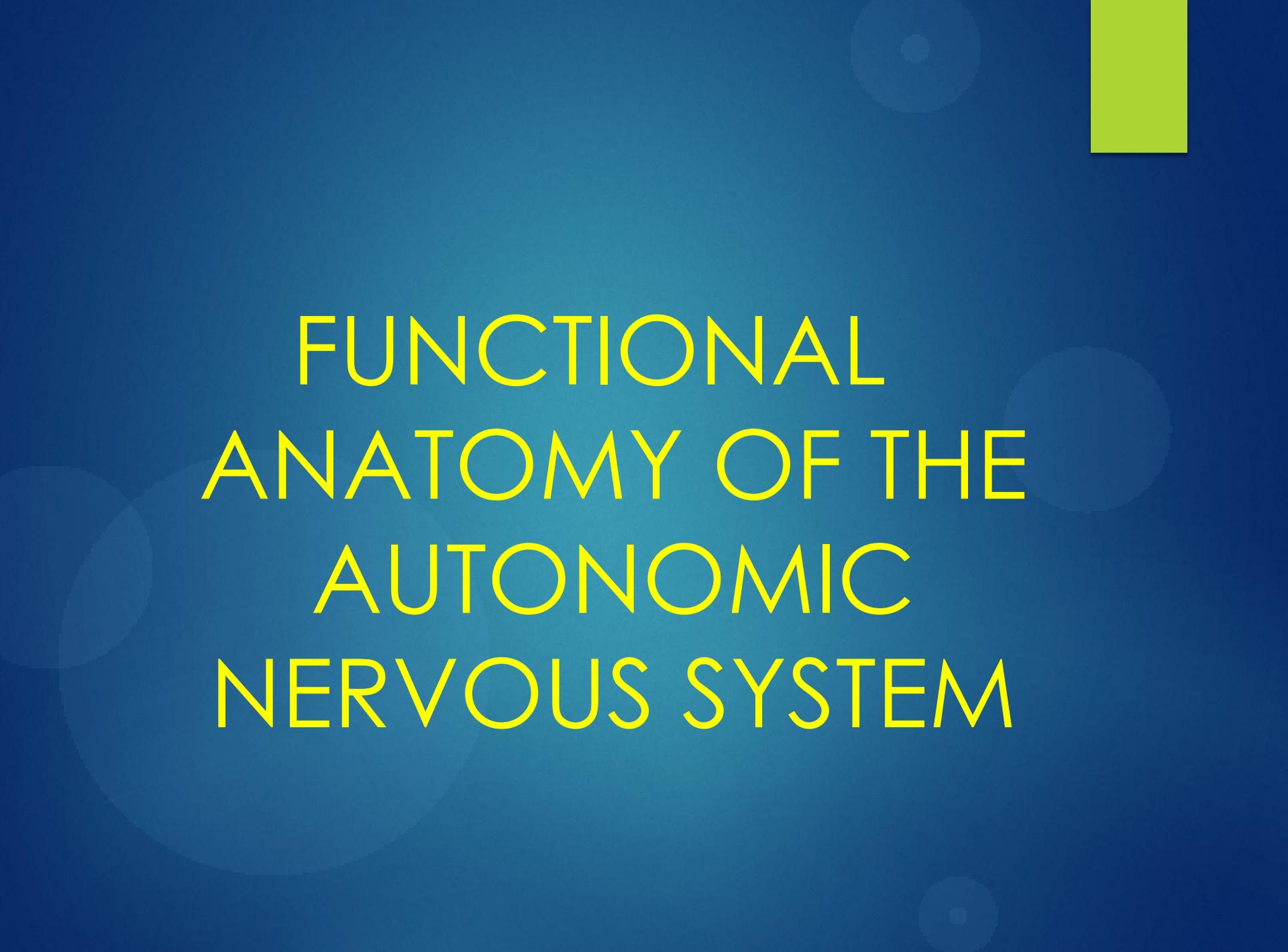


# ▶ Anatomy and physiology of Autonomic Nervous System

▶ At the end of this lectutre the student should be able to:-

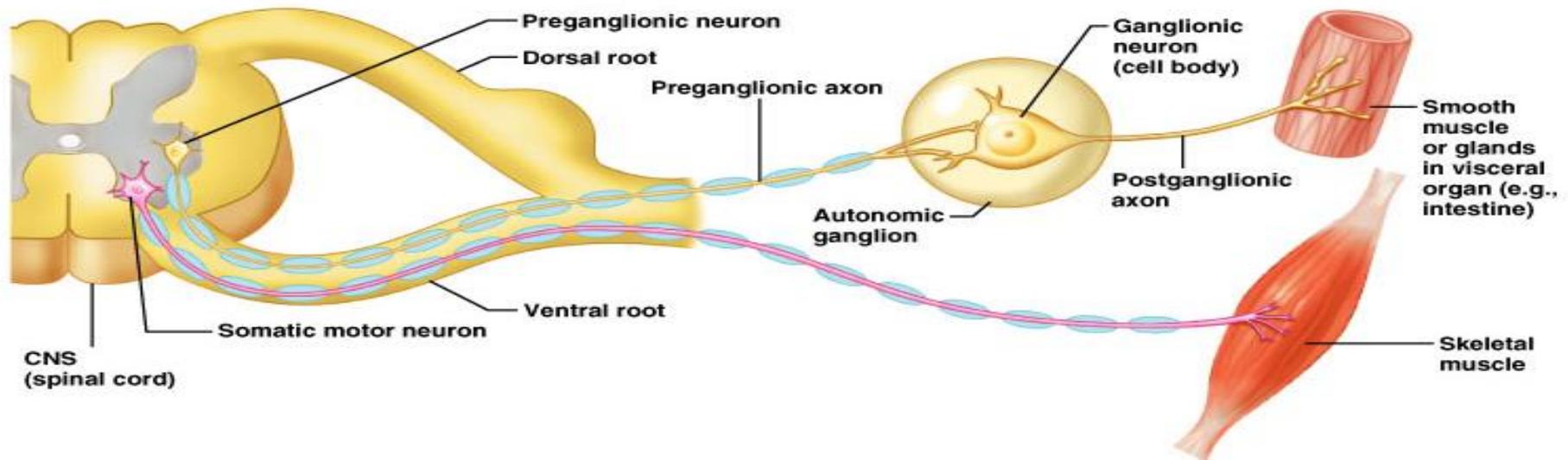
▶ -appreciate the anatomy of sympathetic & parasympathetic nervous system.

▶ -explain physiological functions of Sympathetic & parasympathetic nerves in head & neck, chest, abdomen and pelvis

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# FUNCTIONAL ANATOMY OF THE AUTONOMIC NERVOUS SYSTEM

# Basic anatomical difference between the motor pathways of the voluntary somatic nervous system (to skeletal muscles) and those of the autonomic nervous system



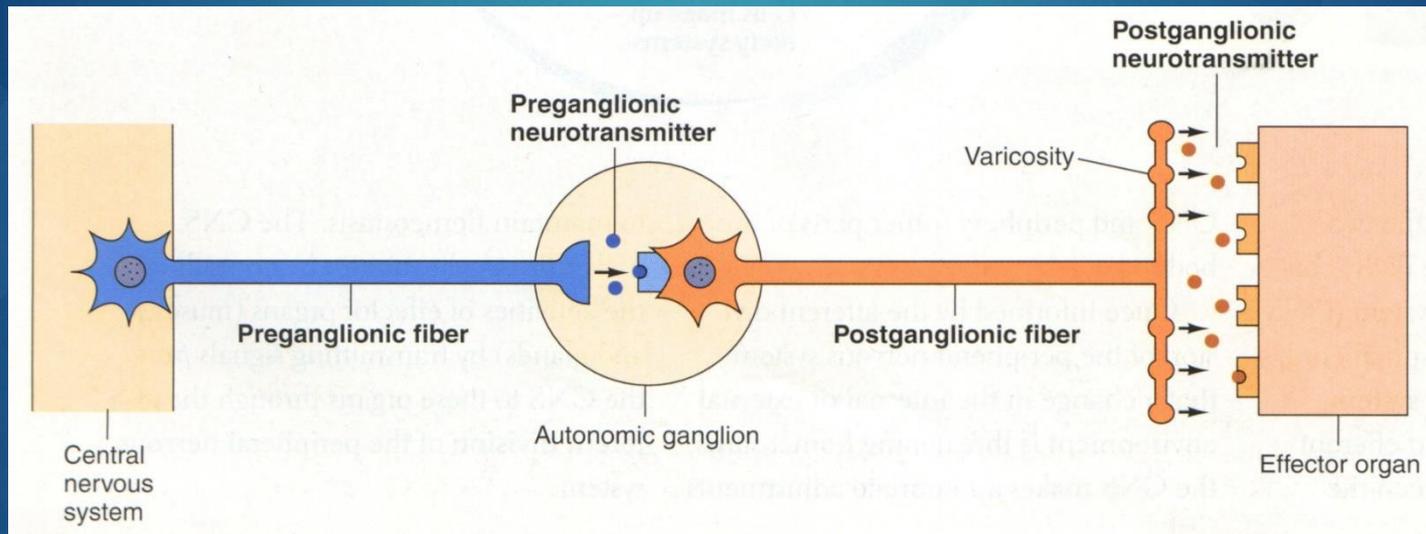
*Basic anatomical difference between the motor pathways of the voluntary somatic nervous system (to skeletal muscles) and those of the autonomic nervous system*

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- ▶ Somatic division:
  - ▶ 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
- ▶ Autonomic system: chains of two motor neurons
  - ▶ 1<sup>st</sup> = preganglionic neuron (in brain or cord)
  - ▶ 2<sup>nd</sup> = ganglionic neuron (cell body in ganglion outside CNS)
  - ▶ Slower because lightly or unmyelinated

- ▶ ANS is the subdivision of the peripheral nervous system that regulates body activities that are generally ***not under conscious control***<sup>11</sup>
- ▶ ***Visceral motor*** innervates ***non-skeletal (non-somatic) muscles***
- ▶ Composed of a special group of neurons serving:
  - ▶ Cardiac muscle (the heart)
  - ▶ Smooth muscle (walls of viscera and blood vessels)
  - ▶ Internal organs
  - ▶ Skin

- ▶ Axon of 1<sup>st</sup> (preganglionic) neuron leaves CNS to synapse with the 2<sup>nd</sup> (ganglionic) neuron
- ▶ Axon of 2<sup>nd</sup> (ganglionic) neuron extends to the organ it serves



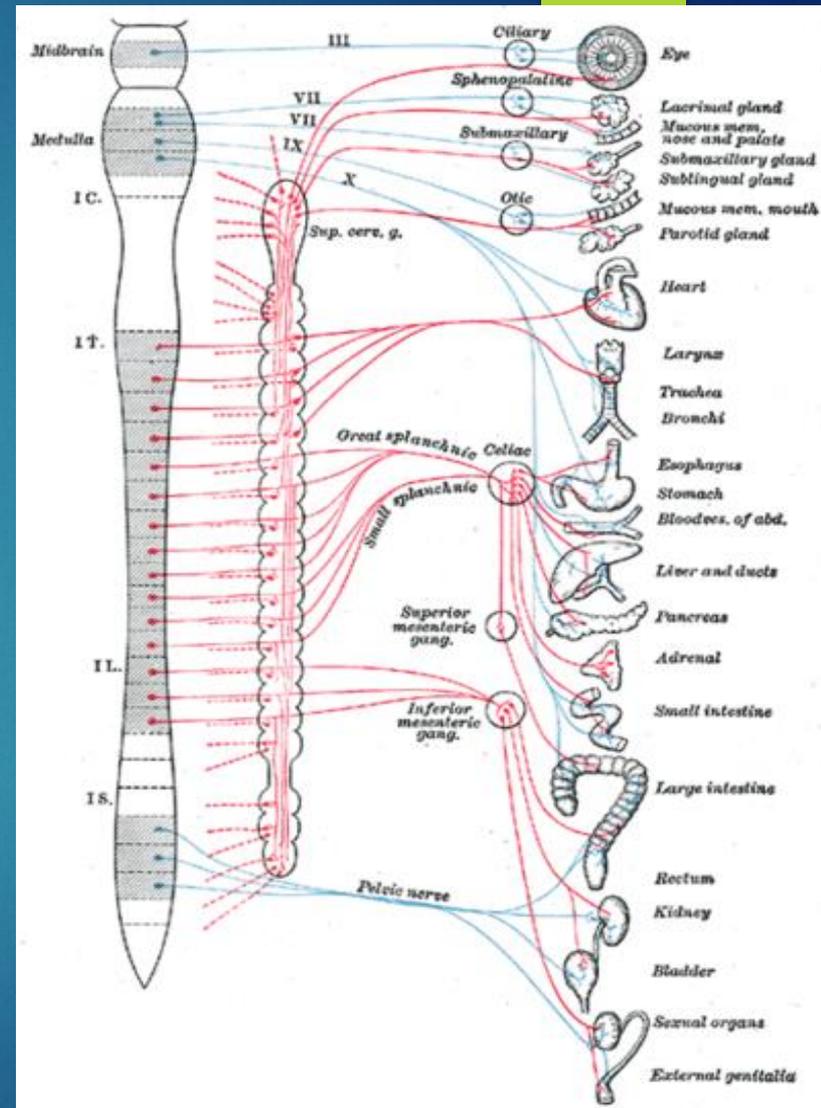
# LOCATIONS OF AUTONOMIC GANGLIA

## Sympathetic Ganglia

### Location

□ Trunk (chain) ganglia near vertebral bodies

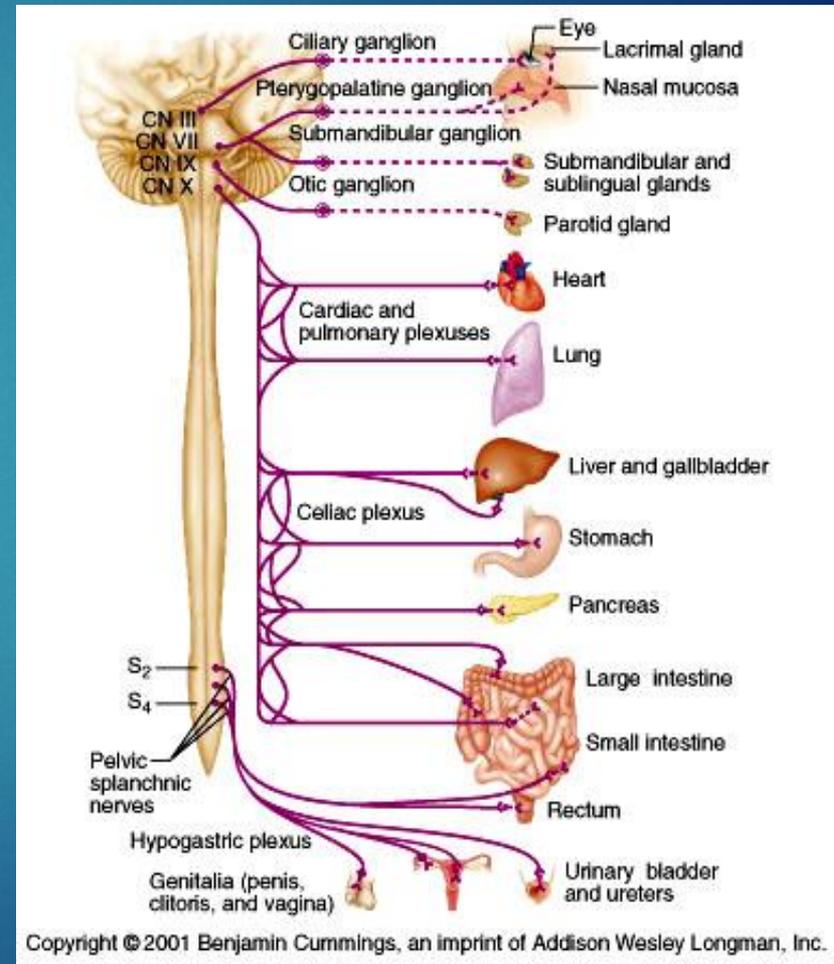
□ Prevertebral ganglia near large blood vessel in gut : celiac ,superior mesenteric & inferior mesenteric



# Parasympathetic Ganglia

## Location :

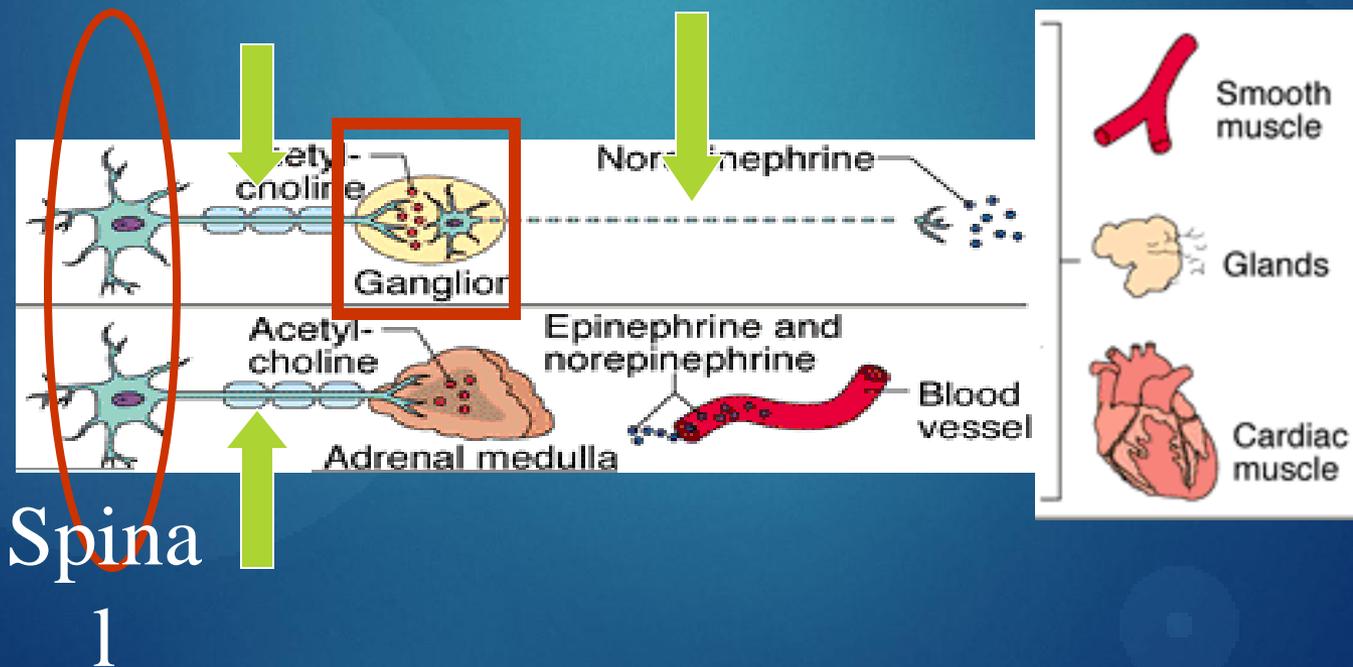
- ▶ Terminal ganglia
- ▶ in the wall of organ



# Sympathetic

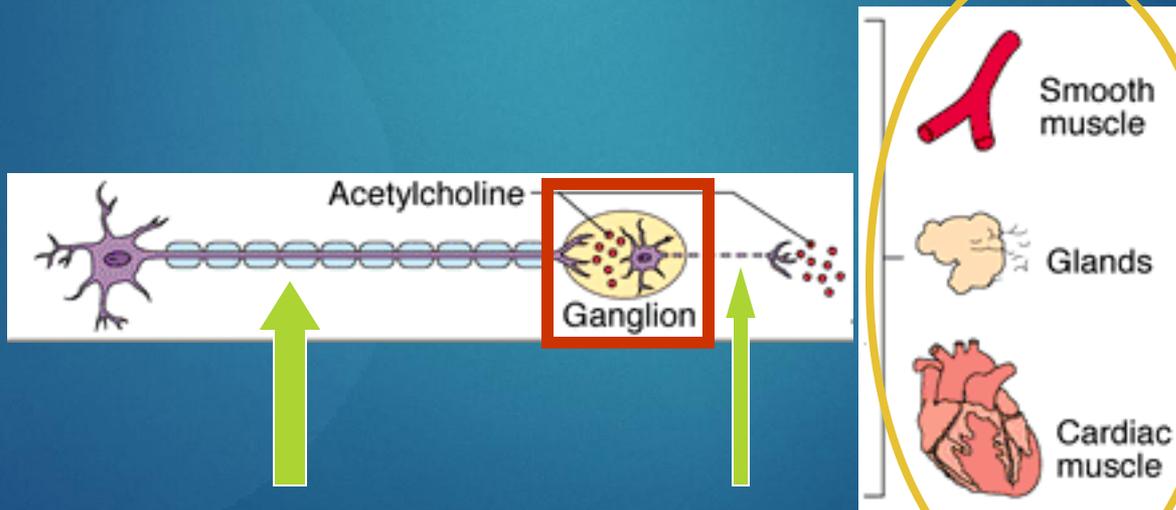
## Innervation of Visceral Targets

- Short, lightly myelinated preganglionic neurons
- Long, unmyelinated postganglionic neurons
- ▶ Ganglia close to spinal cord

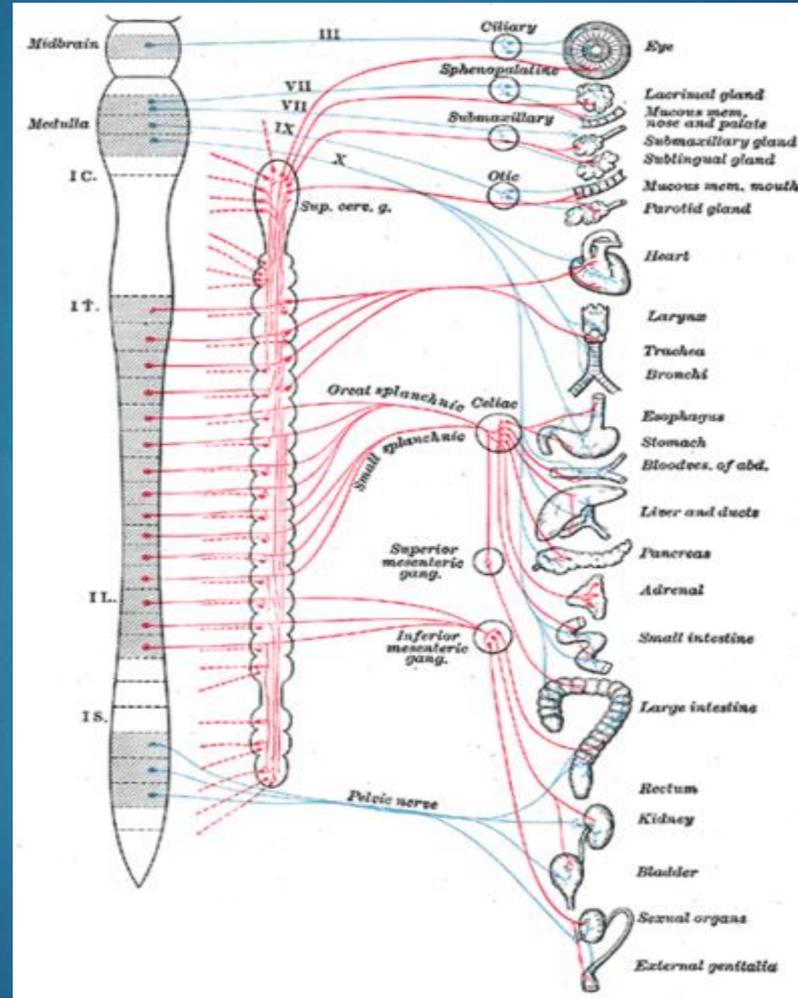


# Parasympathetic Innervation of Visceral Targets

- ▶ Ganglia close to or on target organs
- Preganglionic neurons - long
- Post ganglionic neurons - short



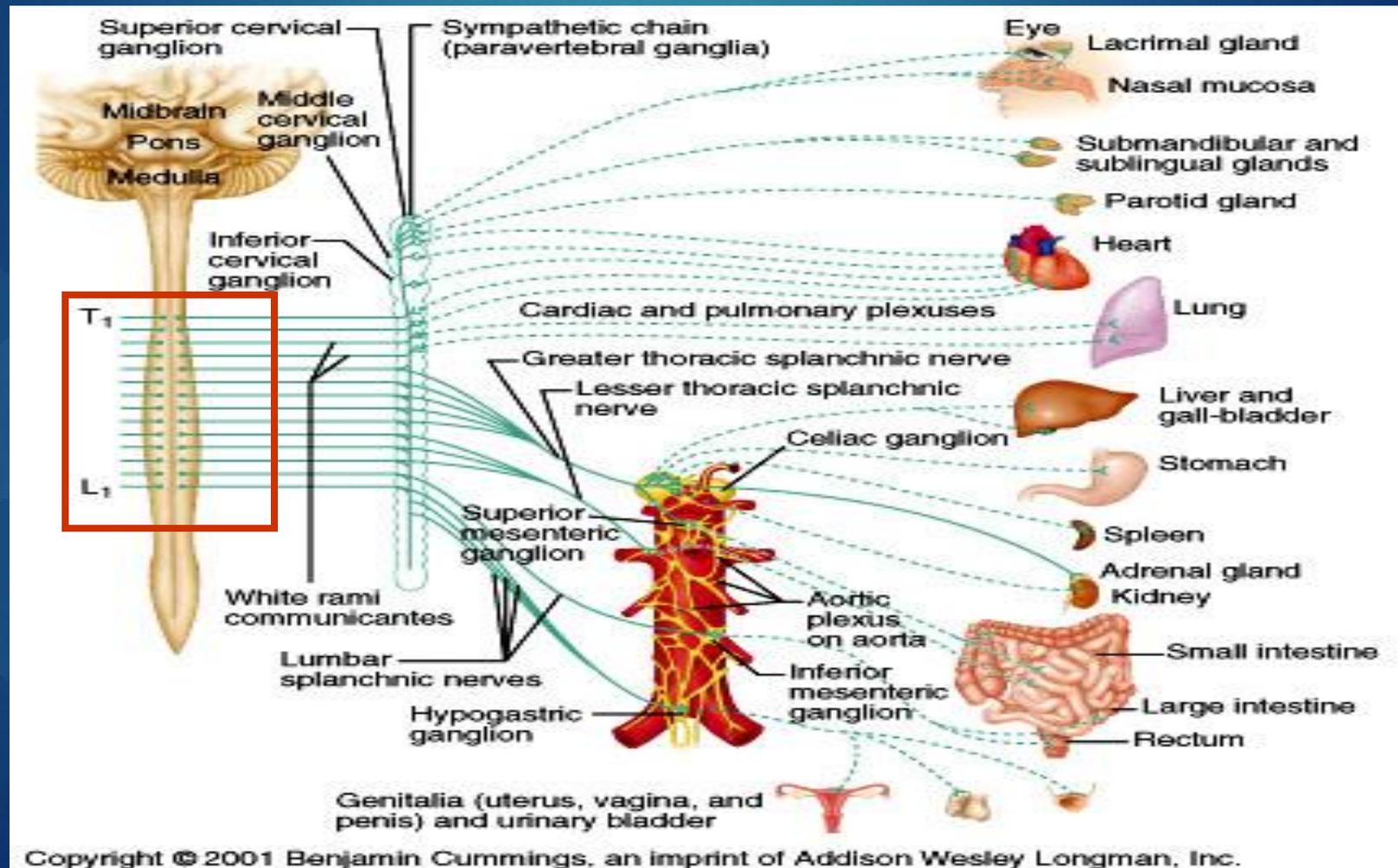
# SYMPATHETIC & PARASYMPATHETIC NERVOUS SYSTEM ORIGIN



**Blue= Para symp; Red symp**

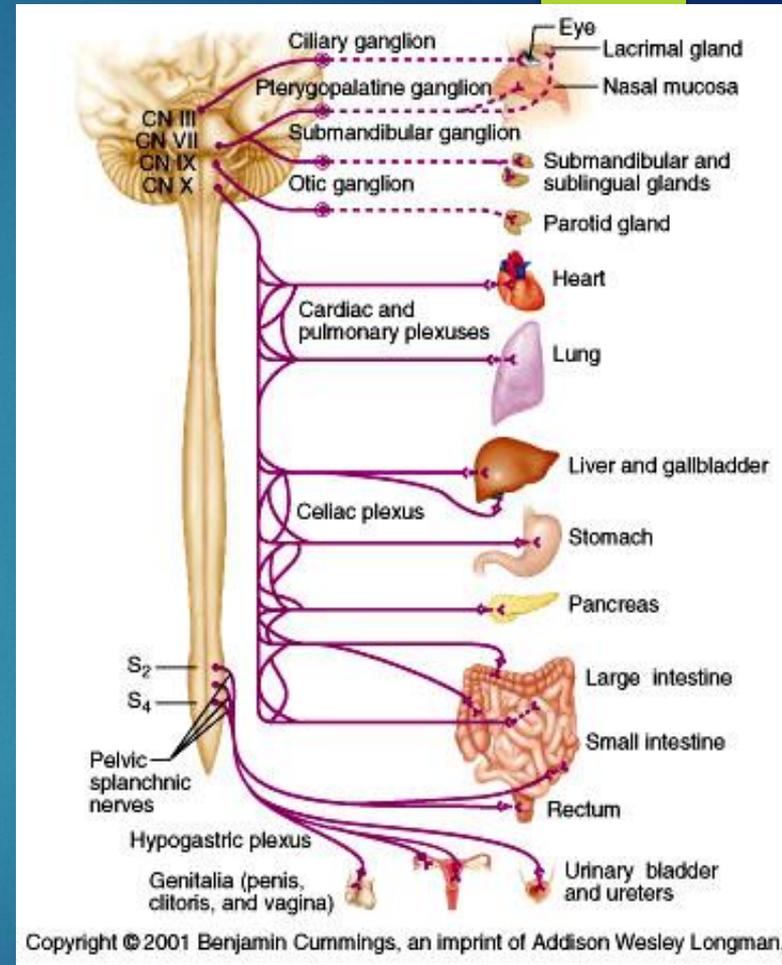
# Sympathetic - Origin

- ▶ Thoracolumbar lateral horns of the spinal segments T1-L2.
- ▶ Nerve fibers originate between T1 & L2



# Parasympathetic - Origin

- Craniosacral Cell bodies of the motor nuclei of the cranial nerves III, VII, IX and X in the brain stem
- Second, third and fourth [S2-S4] sacral segments of the spinal cord
- ▶ Nerve fibers emerge from brain &
- ▶ sacrum cranio-sacral outflow



# 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.

# Autonomic Nervous System

- ▶ 2 divisions:

- ▶ Sympathetic

- ▶ “Fight or flight”

- ▶ “E” division

- ▶ Exercise, excitement, emergency, and embarrassment



- ▶ Parasympathetic

- ▶ “Rest and digest”

- ▶ “D” division

- ▶ Digestion, defecation, and diuresis



# SYMPATHETIC NERVOUS SYSTEM FUNCTIONS

## FEAR, FLIGHT OR FIGHT

- ❑ The sympathetic system enables the body to be prepared for fear, flight or fight
- ❑ Sympathetic responses include an increase in heart rate, blood pressure and cardiac output
- ❑ Diversion of blood flow from the skin and splanchnic vessels to those supplying skeletal muscle
- ❑ Increased pupil size, bronchiolar dilation, contraction of sphincters and metabolic changes such as the mobilisation of fat and glycogen.

# **FUNCTIONS OF SYMPATHETIC NERVOUS SYSTEM**

**Bronchioles dilate, which allows for greater alveolar oxygen exchange.**

**It increases heart rate and the contractility of cardiac cells (myocytes), thereby providing a mechanism for the enhanced blood flow to skeletal muscles.**

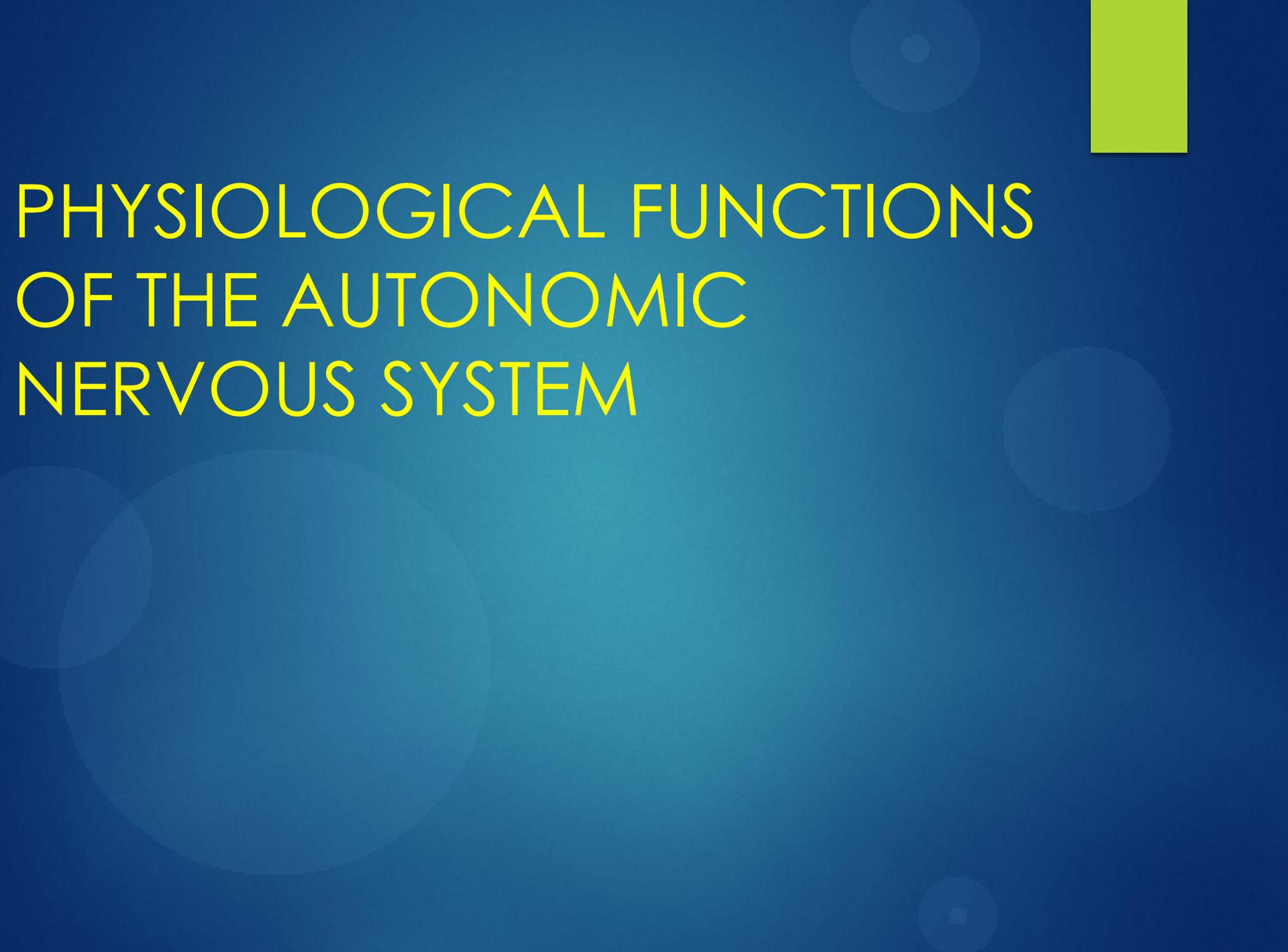
**Sympathetic nerves dilate the pupil and relax the lens, allowing more light to enter the eye.**

# PARASYMPATHETIC NERVOUS SYSTEM FUNCTIONS

- ❑ The parasympathetic nervous system has "rest and digest" activity.
- ❑ In physiological terms, the parasympathetic system is concerned with conservation and restoration of energy, as it causes a reduction in heart rate and blood pressure, and facilitates digestion and absorption of nutrients, and consequently the excretion of waste products
- ❑ The chemical transmitter at both pre and postganglionic synapses in the parasympathetic system is Acetylcholine (Ach).

# THE AUTONOMIC NERVOUS SYSTEM

<b>Subdivision</b>	<b>Nerves Employed</b>	<b>Location of Ganglia</b>	<b>Chemical Messenger</b>	<b>General Function</b>
<b>Sympathetic</b>	<b>Thoracolumbar</b>	<b>Alongside vertebral column</b>	<b>Norepinephrine</b>	<b>Fight or flight</b>
<b>Parasympathetic</b>	<b>Craniosacral</b>	<b>On or near an effector organ</b>	<b>Acetylcholine</b>	<b>Conservation of body energy</b>



# PHYSIOLOGICAL FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM

# The Autonomic Nervous System

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

# The Autonomic Nervous System

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

# MECHANISM OF ACTIONS

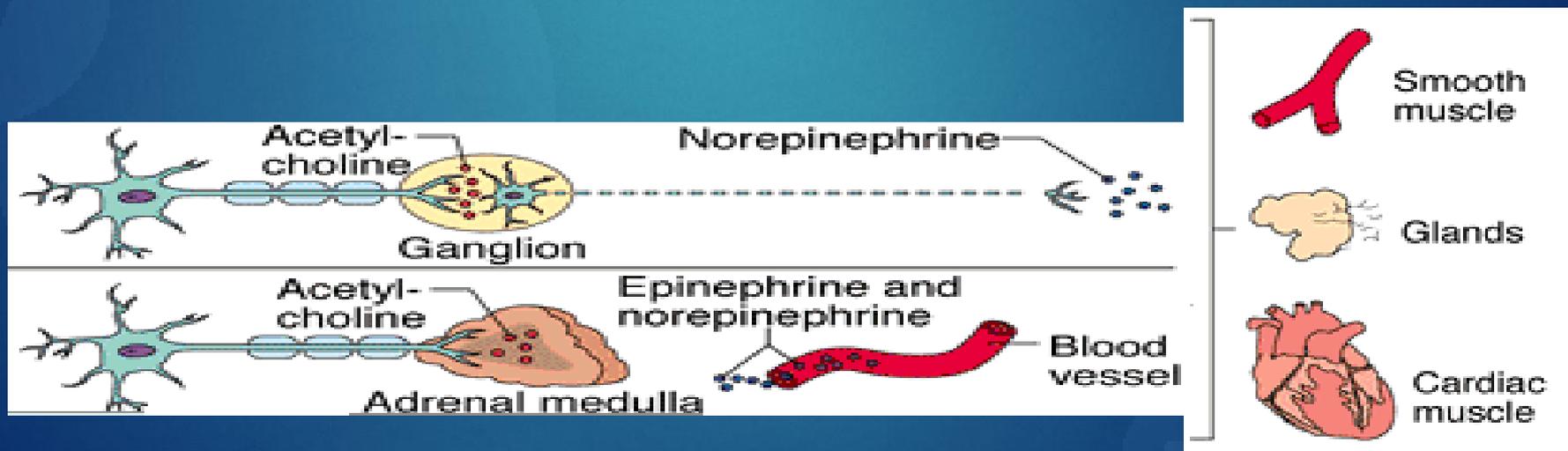
The neurotransmitters  
& receptors of  
Autonomic NS

# OBJECTIVES

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

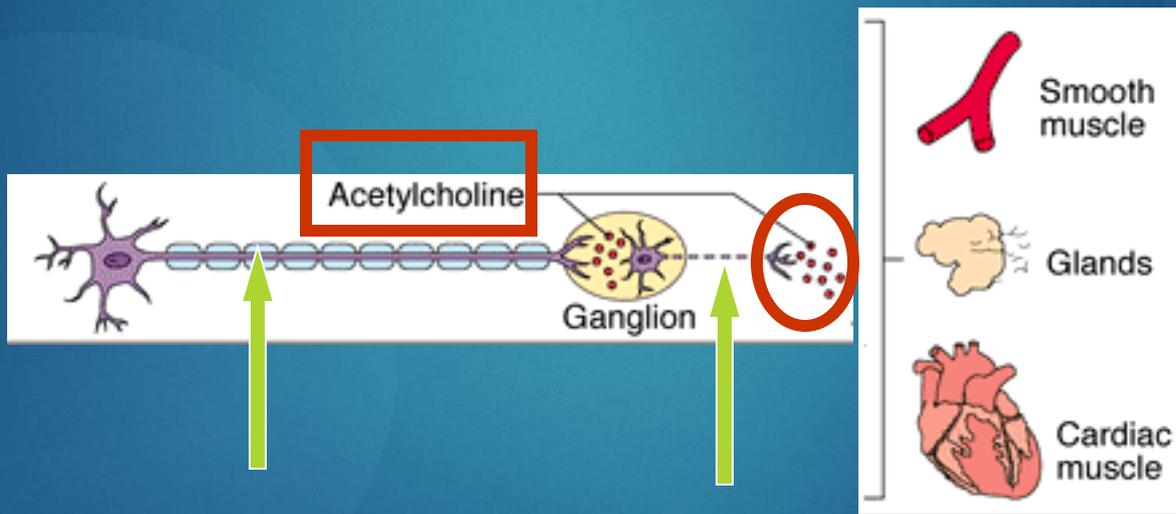
# Sympathetic Neurotransmitters

- ▶ **Cholinergic = ( release acetylcholine )**
- ▶ **Postganglionic neurons:**
  - ▶ **release norepinephrine at target organs**
  - ▶ **ie. Adrenergic**

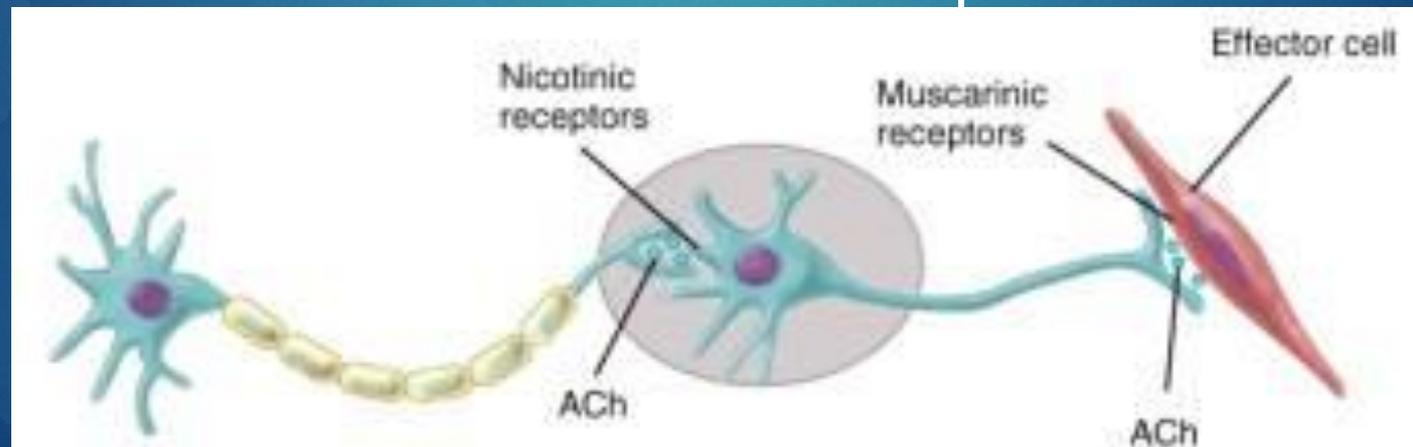
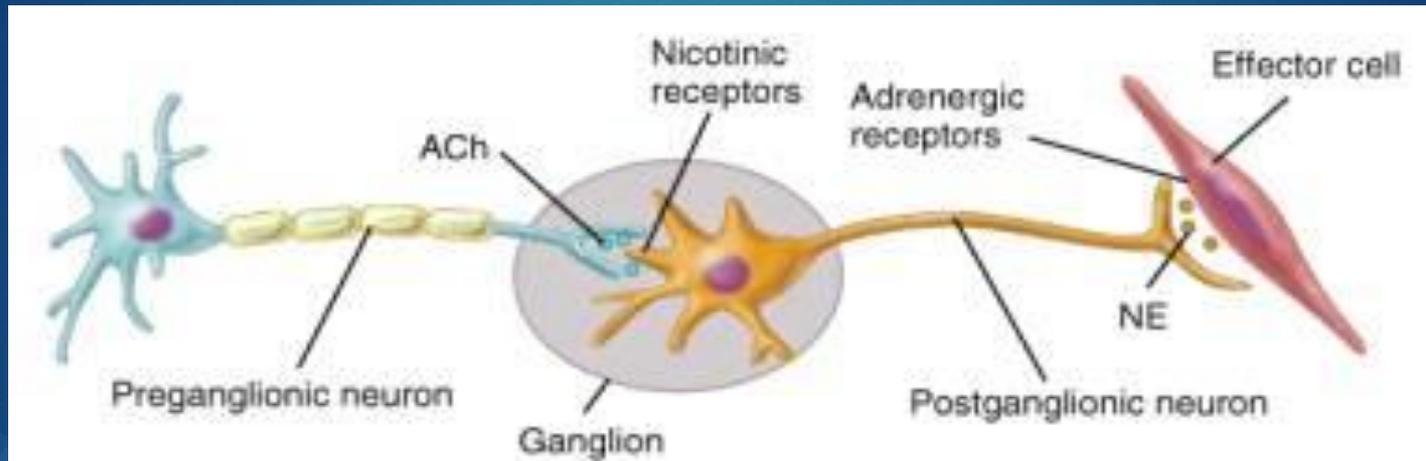


# Parasympathetic Neurotransmitters

- Pre & Postganglionic neurons release acetylcholine = Cholinergic



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



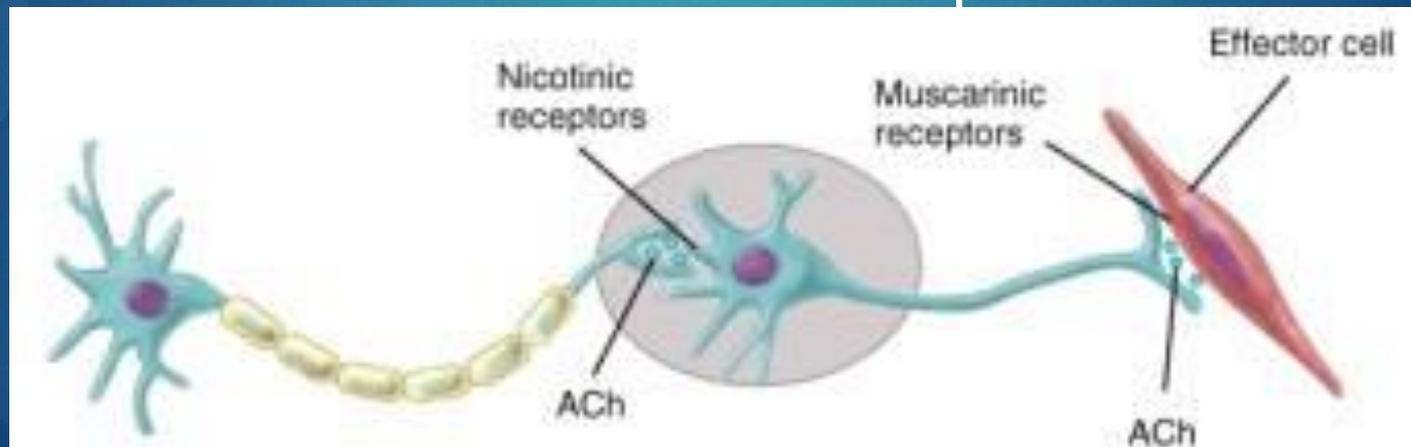
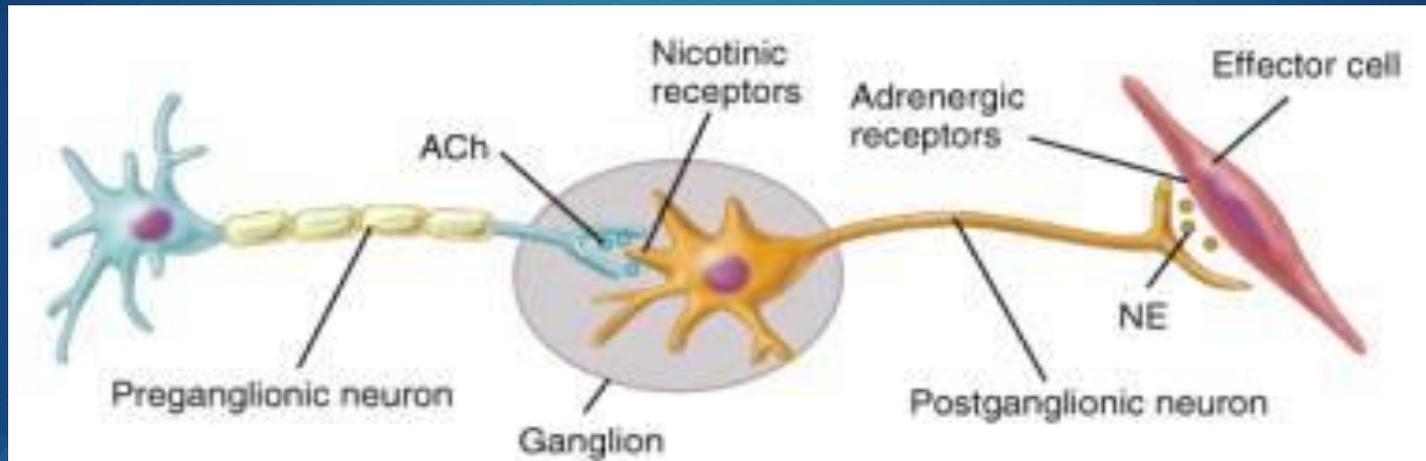
# Chemical or neural transmitter

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

# 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 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.

**ANS Receptors :** Classified as either parasympathetic or sympathetic



## The Sympathetic NS Acts on two types of receptors

:  $\alpha$  and  $\beta$ .

**What do the receptors do?**

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)

# POSTURAL ORTHOSTATIC TACHYCARDIA SYNDROME

raise awareness

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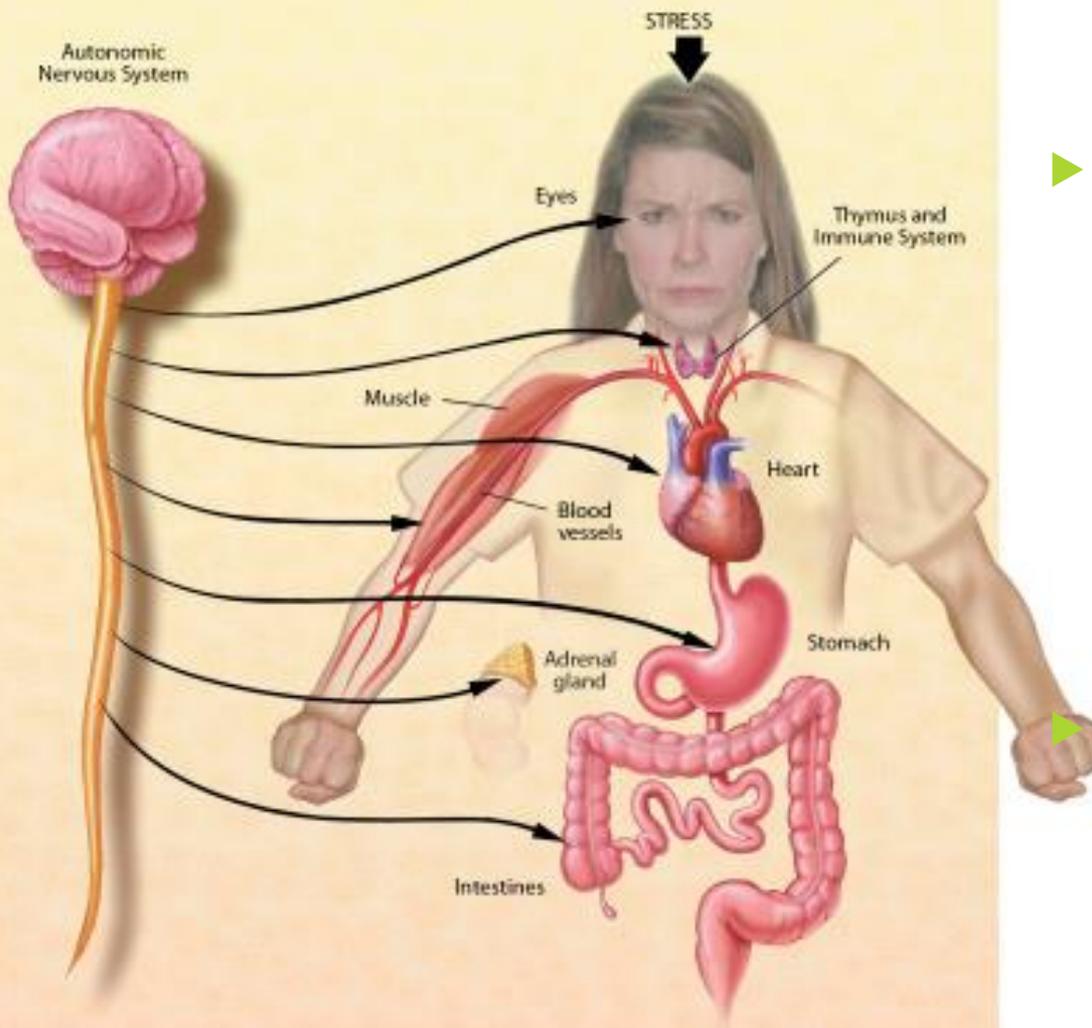
I have Postural Orthostatic  
Tachycardia Syndrome.

My autonomic system is faulty. My blood pressure and heart rate don't adjust well to postural changes. I can't stand for long. I fidget. I can faint or become semiconscious. I may appear drunk because of it. Don't worry, it is not life threatening, but may mean I suddenly need to sit or lie down.



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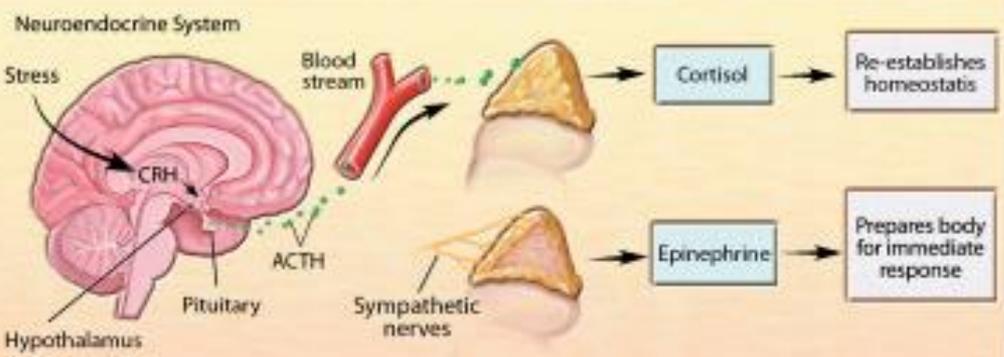
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## THE STRESS REACTION

▶ **When stress occurs, the sympathetic nervous system is triggered. Norepinephrine is released by nerves, and epinephrine is secreted by the adrenal glands. By activating receptors in blood vessels and other structures, these substances ready the heart and working muscles for action.**

▶ **Acetylcholine is released in the parasympathetic nervous system, producing calming effects. The digestive tract is stimulated to digest a meal, the heart rate slows, and the pupils of the eyes become smaller. The neuroendocrine system also maintains the body's normal internal functioning.**



# Chronic stress

- ▶ When glucocorticoids or adrenaline are secreted in response to the prolonged psychological stress commonly encountered by humans, the results are not ideal. Normally, bodily systems gear up under stress and release hormones to improve memory, increase immune function, enhance muscular activity, and restore homeostasis. If you are not fighting or fleeing, but standing frustrated in a supermarket checkout line or sitting in a traffic jam, you are not engaging in muscular exercise.
- ▶ Yet these systems continue to be stimulated, and when they are stimulated chronically, there are different consequences: Memory is impaired, immune function is suppressed, and energy is stored as fat.

# Response to stress

## Psychological

Short Fuse  
Irritability

Depression  
Frustration  
Emotional Irritability  
Insecurity

Mental Illness  
Anxiety

## Behavioral

Drug/Use Abuse  
Alcohol Use/Abuse

Smoking  
Strained Relationships  
Eating Problems  
Suicide Attempts

Violence  
Impulsive/

Irrational Behavior

## Psychosomatic

Ulcers  
High Blood Pressure  
Insomnia  
Indigestion  
Headaches  
Other  
Cardiovascular  
Body Infections  
Irregular Pulse rate

# THANK YOU

