Physiology of Autonomic Nervous System

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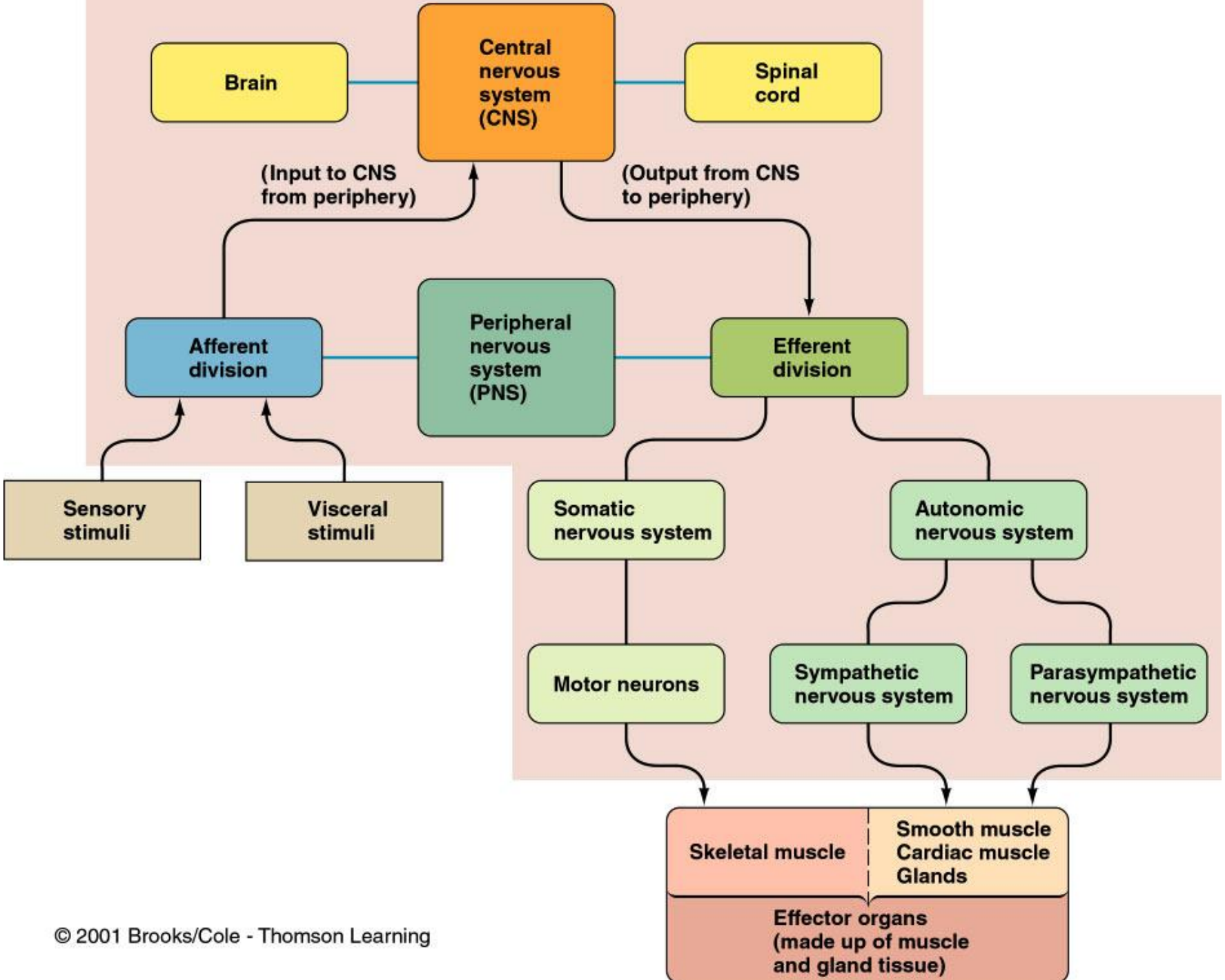
INTRODUCTION

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**



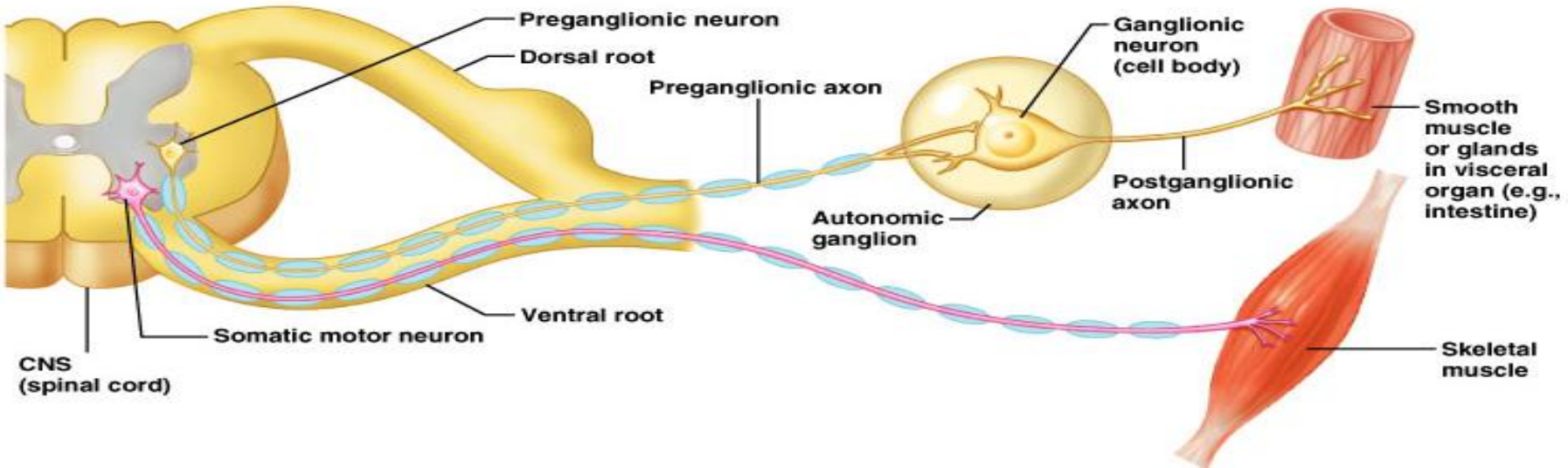
Functional Anatomy & Physiology of Autonomic NS

OBJECTIVES

- **Anatomy and physiology of Autonomic Nervous System**
- At the end of this lecture 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

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

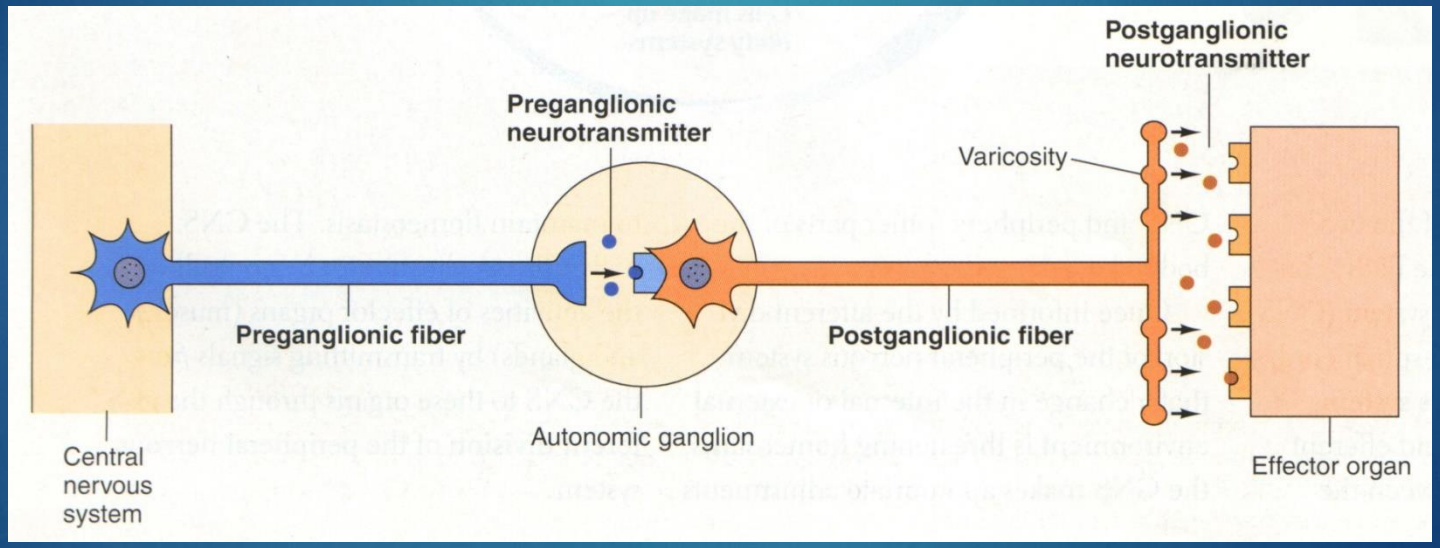


Basic anatomical difference between the motor pathways of the voluntary somatic nervous system (to skeletal muscles) and those of the autonomic nervous system

- 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
  - 1st = preganglionic neuron (in brain or cord)
  - 2nd = gangionic 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***
- ***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 1st (*preganglionic*) neuron leaves CNS to synapse with the 2nd (*ganglionic*) neuron
- Axon of 2nd (*ganglionic*) neuron extends to the organ it serves



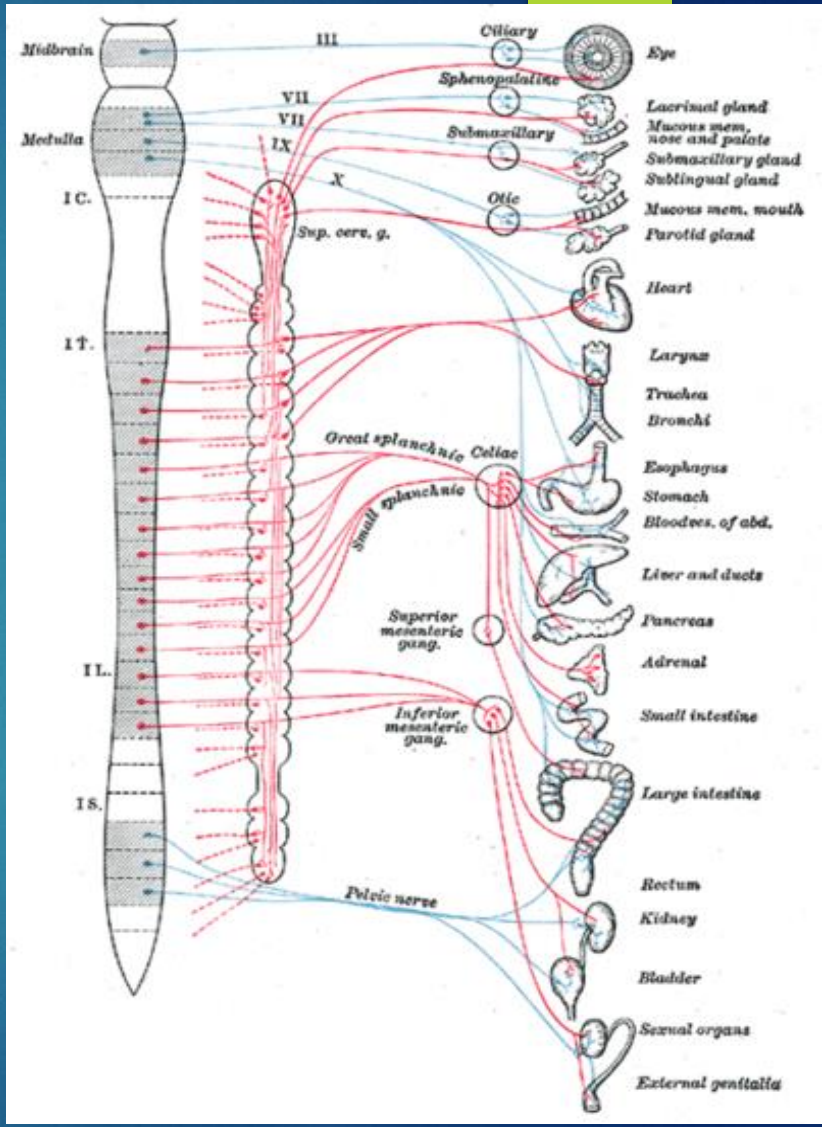
LOCATIONS OF AUTONOMIC GANGLIA

Sympathetic Ganglia

Location

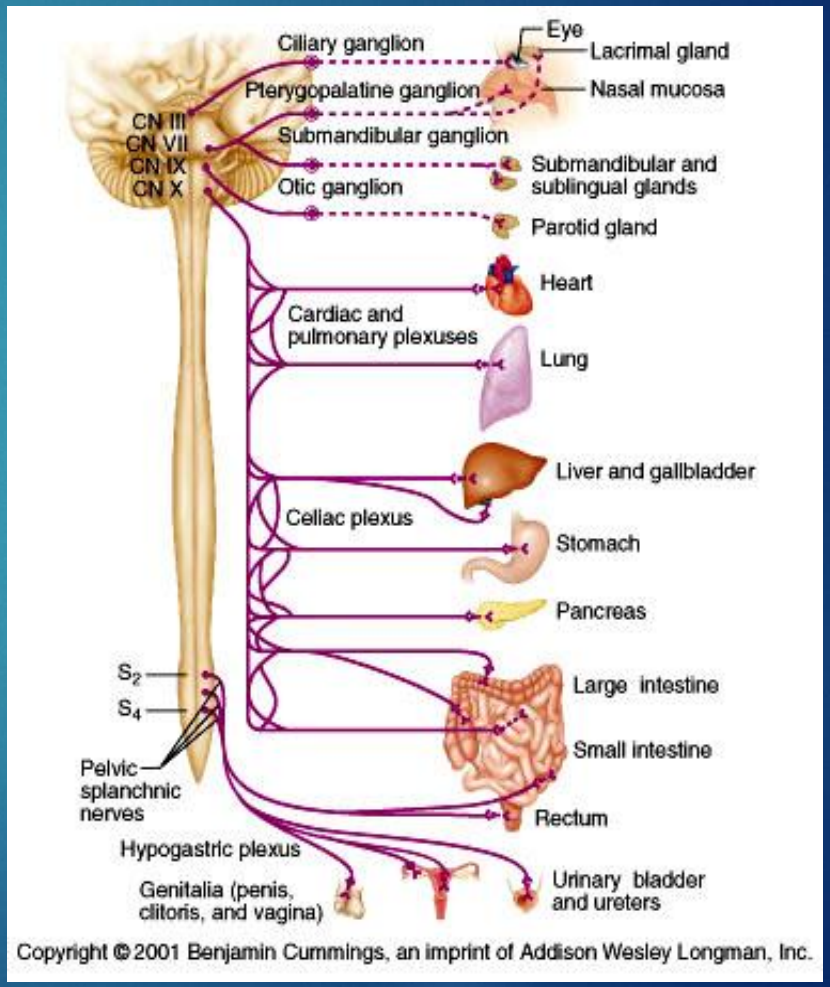
- **Trunk (chain) ganglia near vertebral bodies**
- **Prevertebral ganglia near large blood vessel in gut :celiac ,superior mesenteric &**

inferior mesenteric



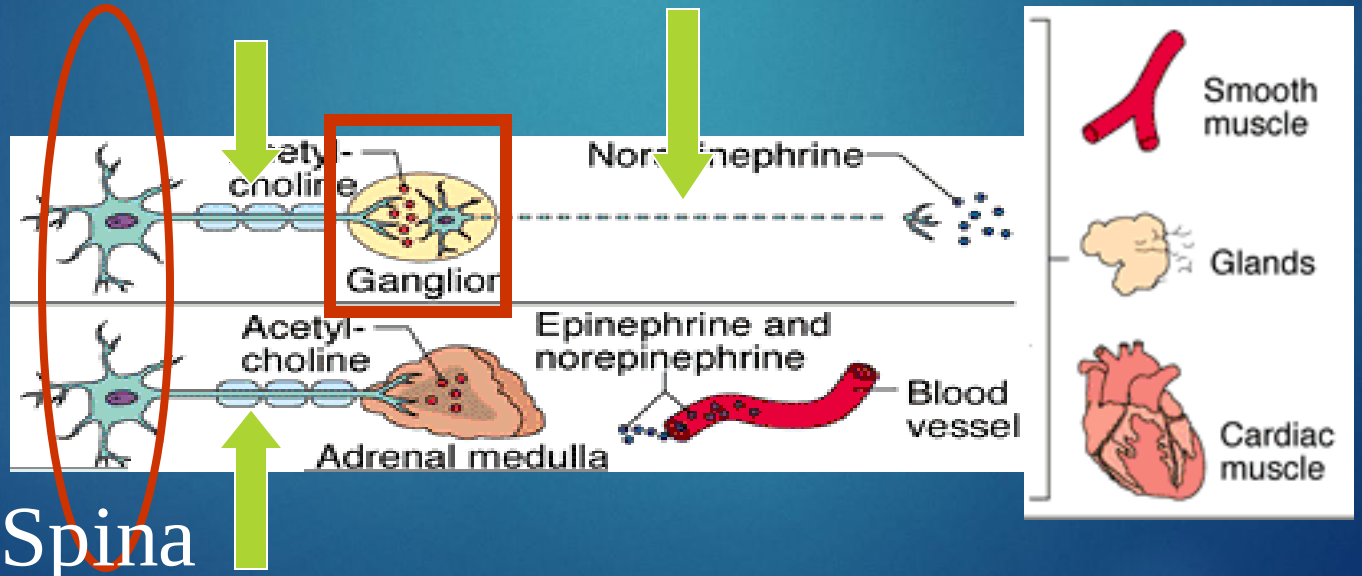
Parasympathetic Ganglia Location :

- Terminal ganglia
- in the wall of organ



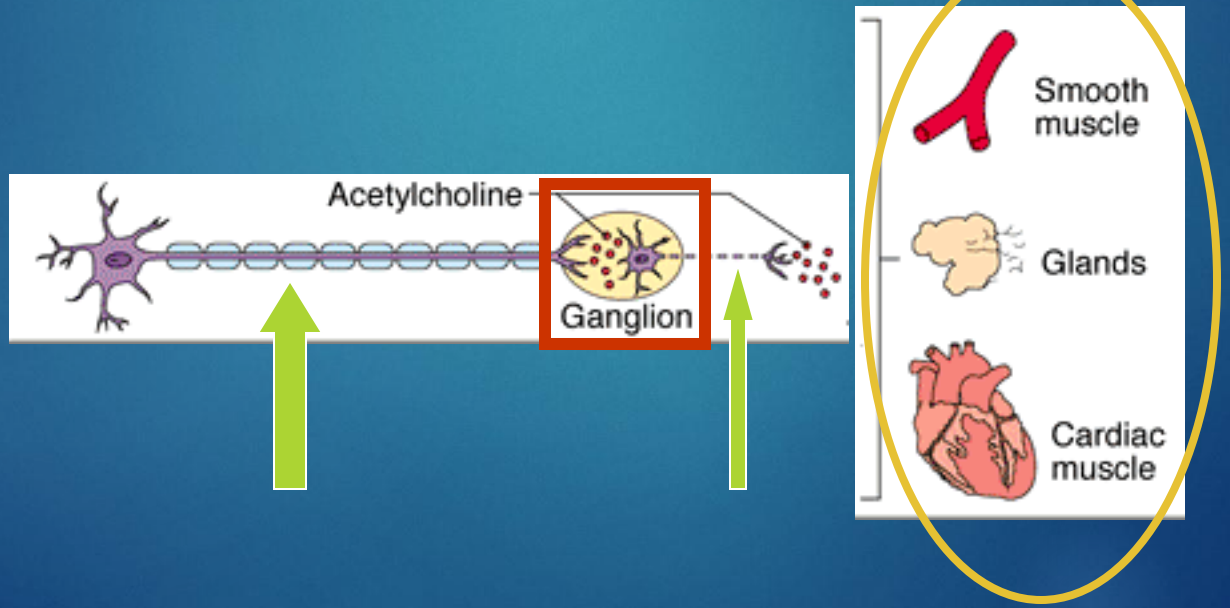
Sympathetic Innervation of Visceral Targets

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

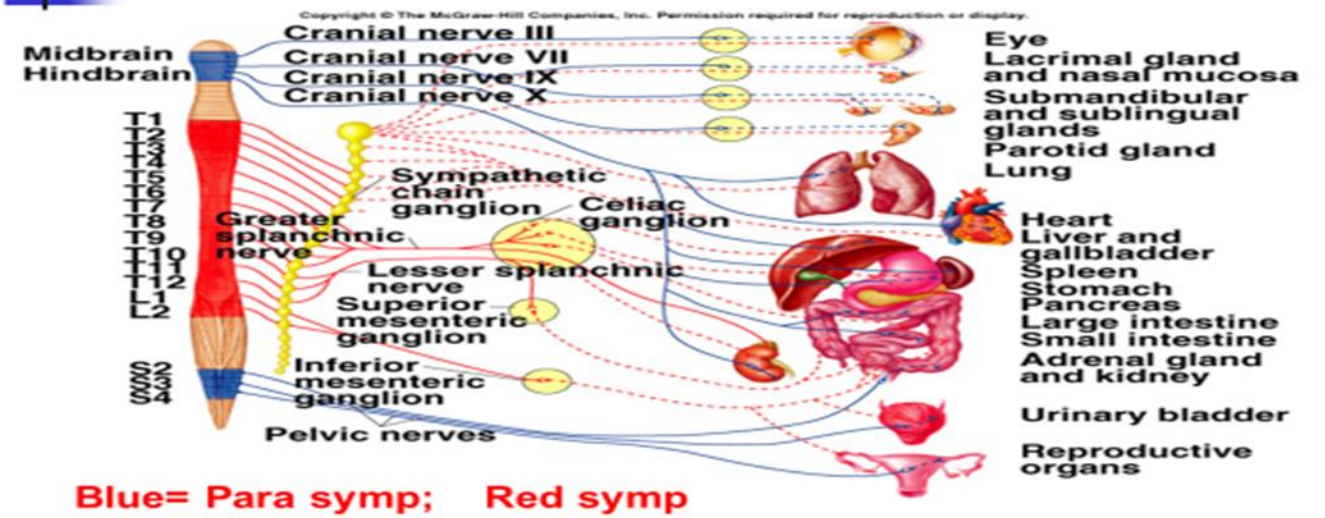


Parasympathetic
Innervation of Visceral Targets

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



SYMPATHETIC & PARASYMPATHETIC NERVOUS SYSTEM ORIGIN



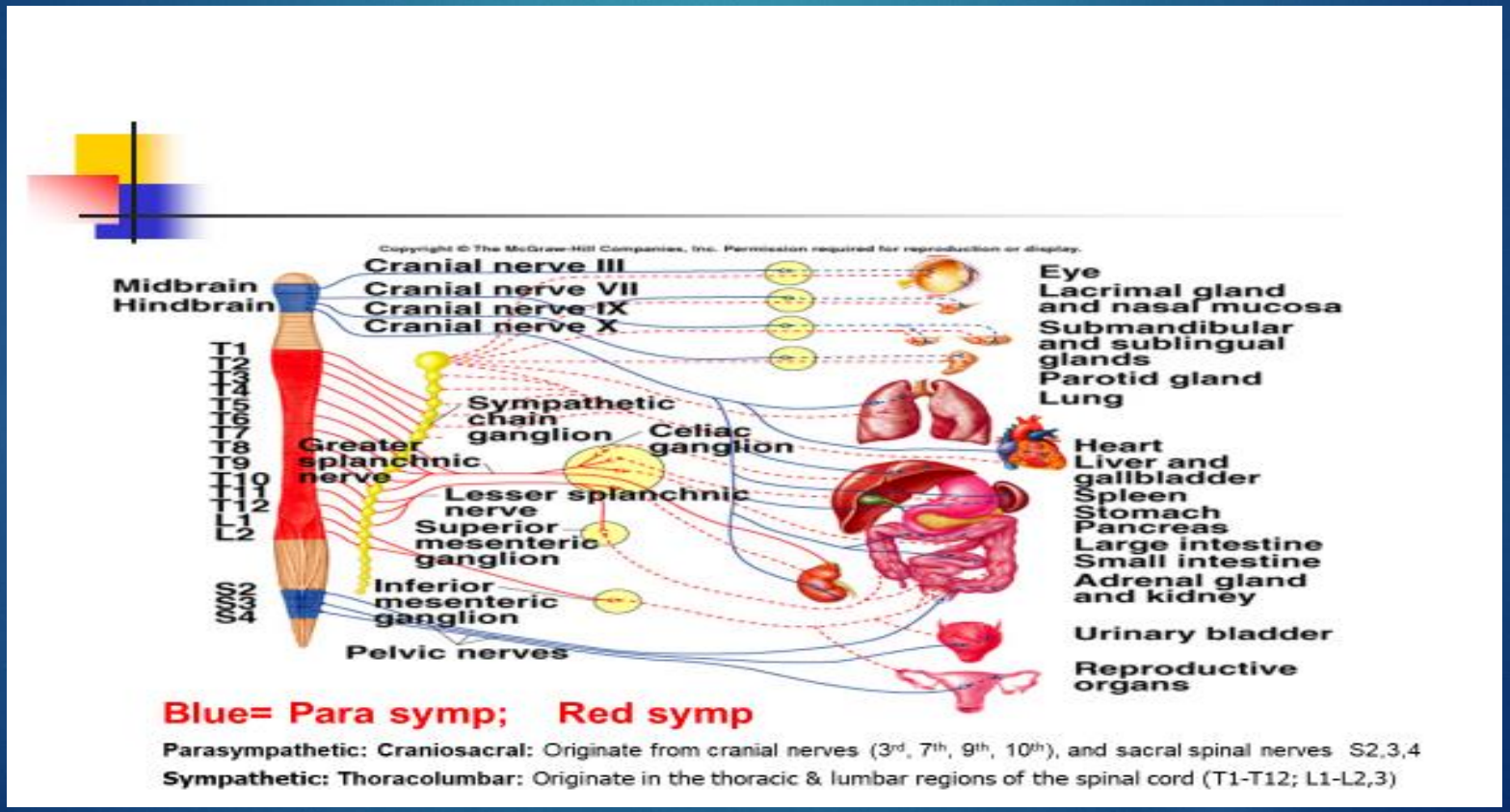
Parasympathetic: Craniosacral: Originate from cranial nerves (3rd, 7th, 9th, 10th), and sacral spinal nerves S2,3,4

Sympathetic: Thoracolumbar: Originate in the thoracic & lumbar regions of the spinal cord (T1-T12; L1-L2,3)

Blue= Para symp; Red symp

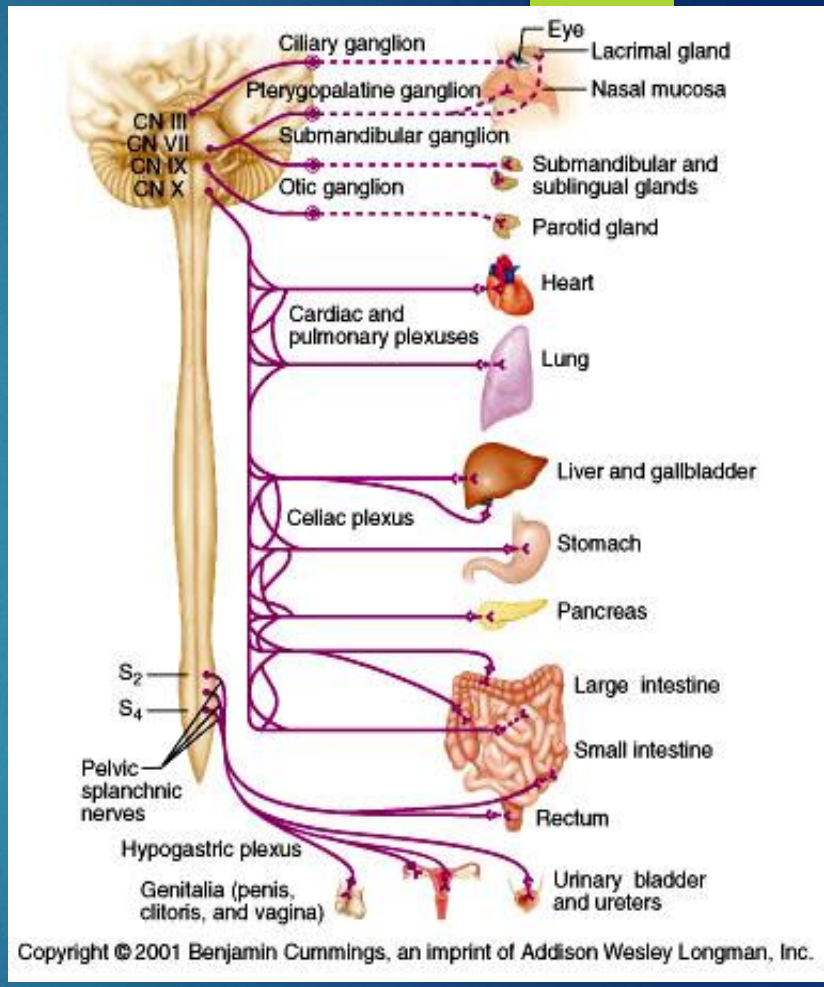
Sympathetic - Origin

- 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

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

PHYSIOLOGICAL FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM

The Autonomic Nervous System

Structure	Sympathetic Stimulation	Parasympathetic Stimulation
Iris (eye muscle)	Pupil dilation	Pupil constriction
Salivary Glands	Saliva production reduced	Saliva production increased
Oral/Nasal 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

The Autonomic Nervous System

Structure	Sympathetic Stimulation	Parasympathetic Stimulation
Stomach	Peristalsis reduced	Gastric juice secreted; motility 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

MECHANISM OF ACTIONS

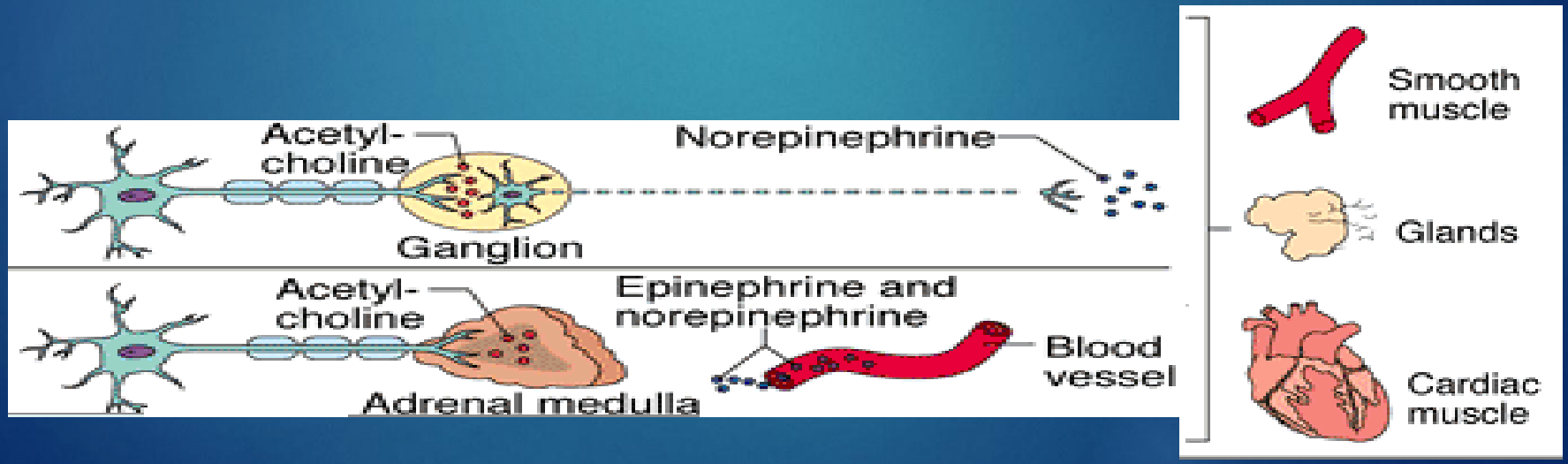
The neurotransmitters & receptors of Autonomic NS

OBJECTIVES

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

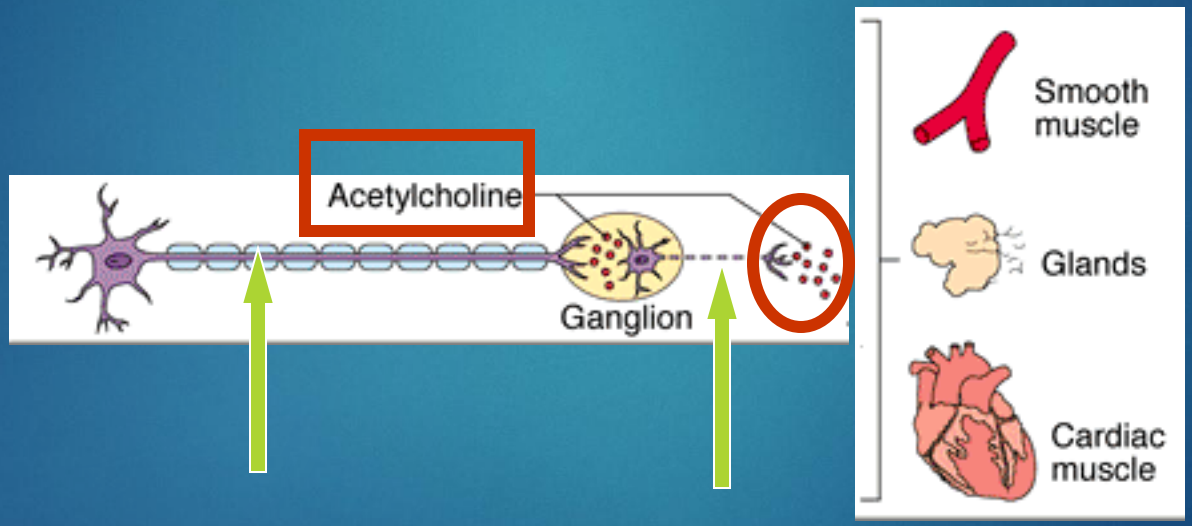
Sympathetic Neurotransmitters

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

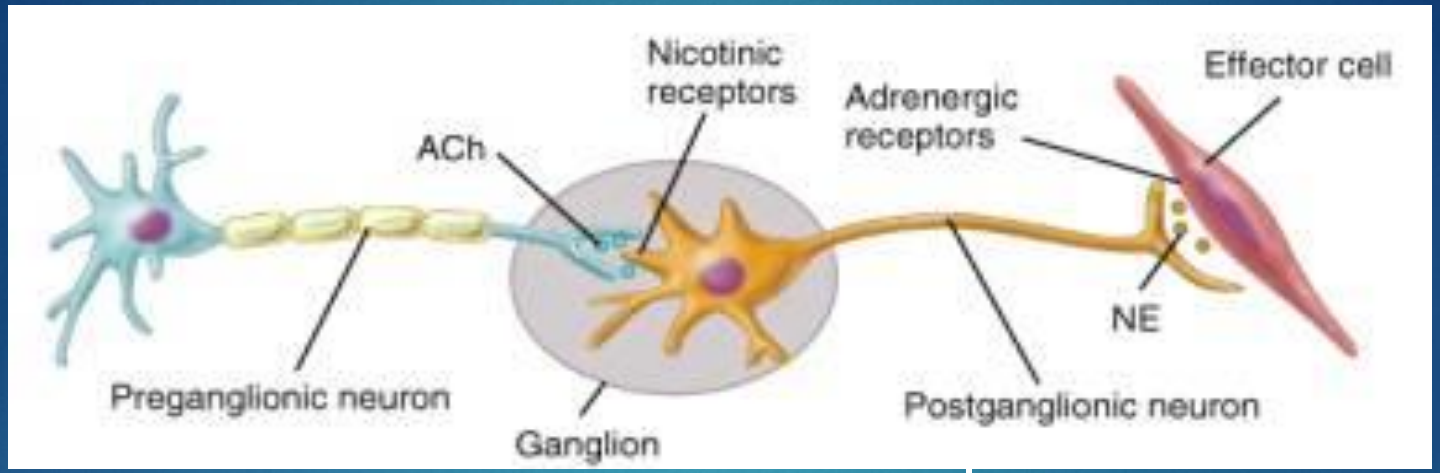


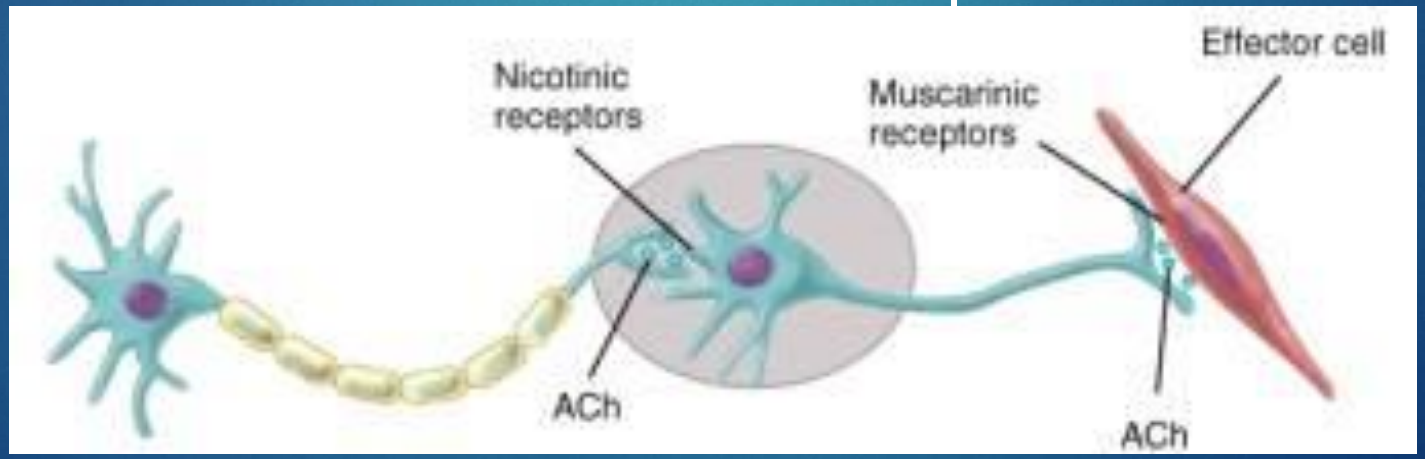
Parasympathetic Neurotransmitters

- Pre & Postganglionic neurons release acetylcholine = Cholinergic



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





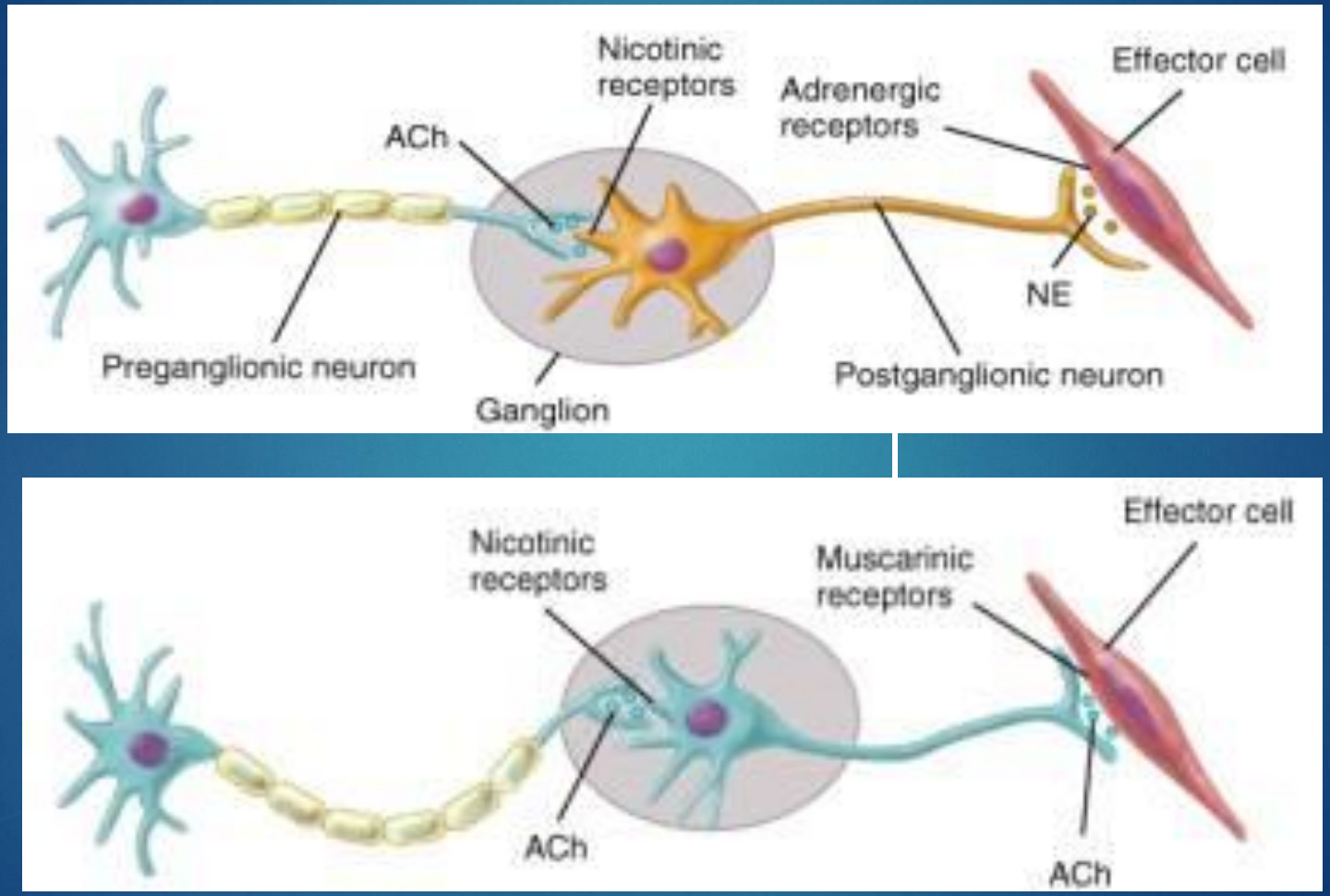
Chemical or neural transmitter

- 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 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.

ANS Receptors : Classified as either parasympathetic or sympathetic



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

What do the receptors do?

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)

THANK YOU