Autonomic Nervous System

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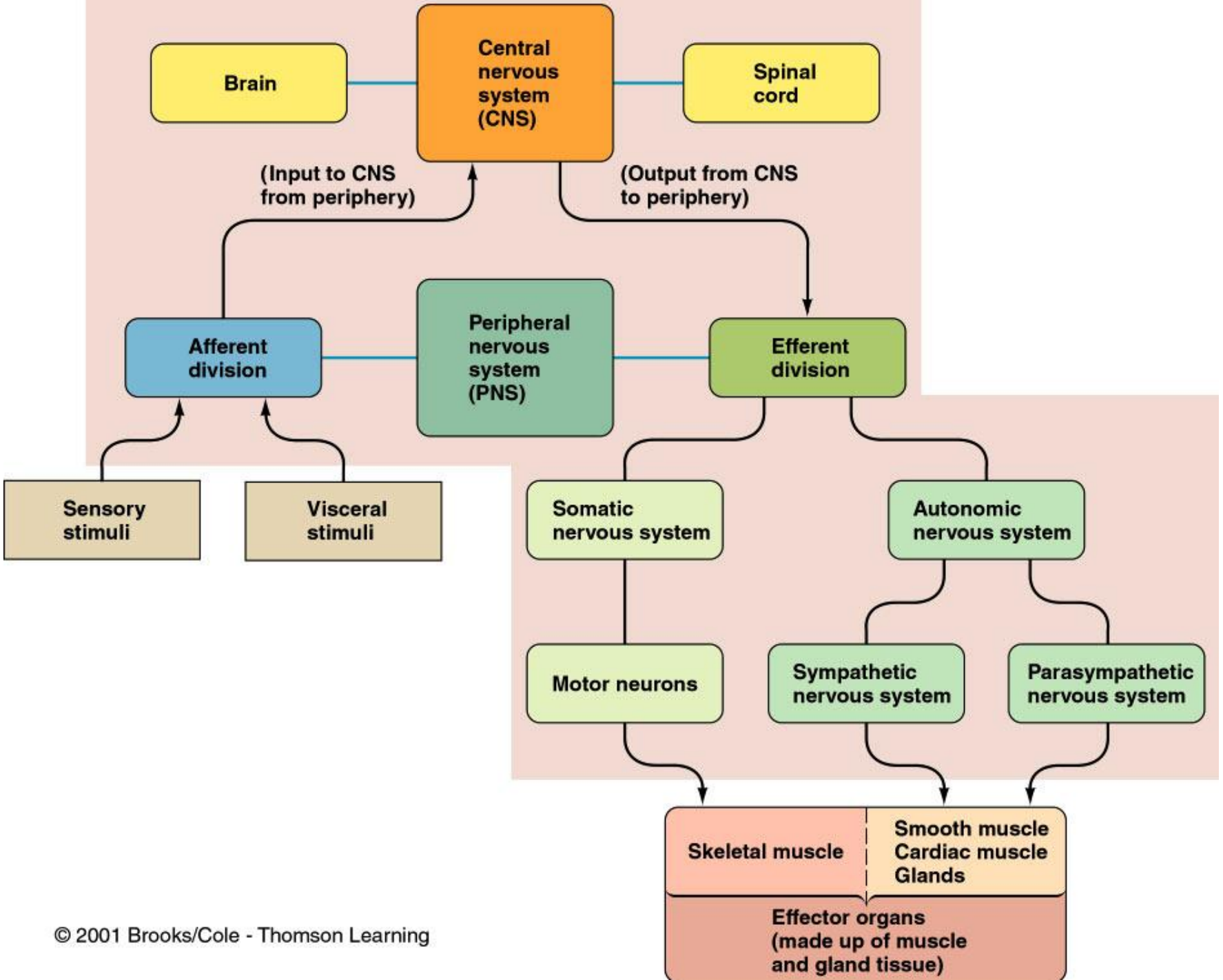
INTRODUCTION

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**



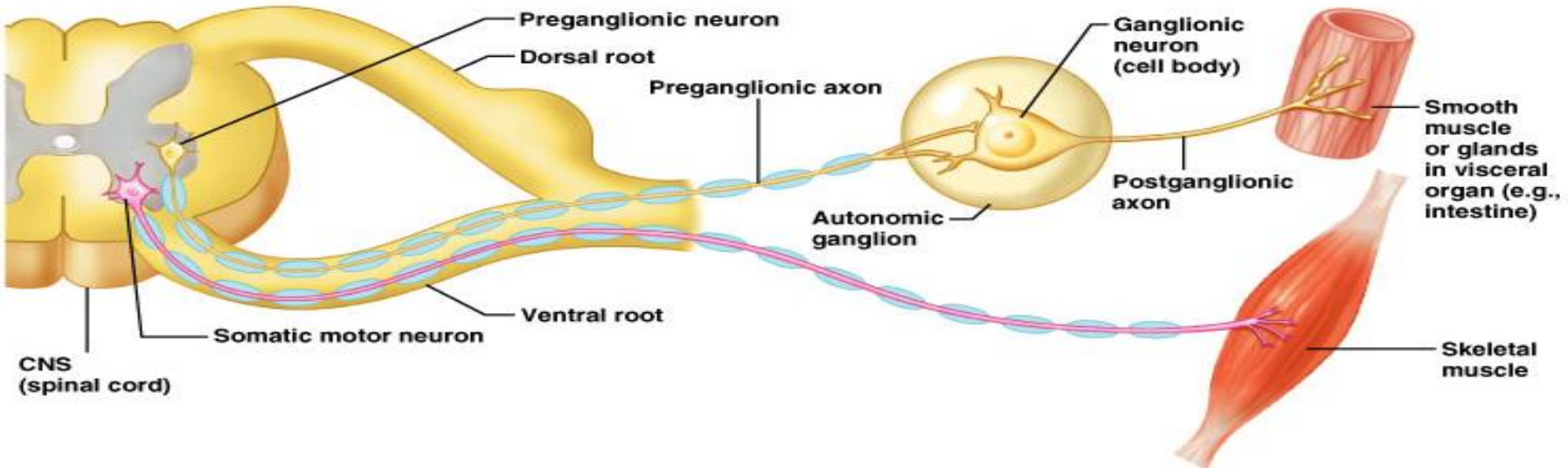
Functional Anatomy & Physiology of Autonomic NS

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

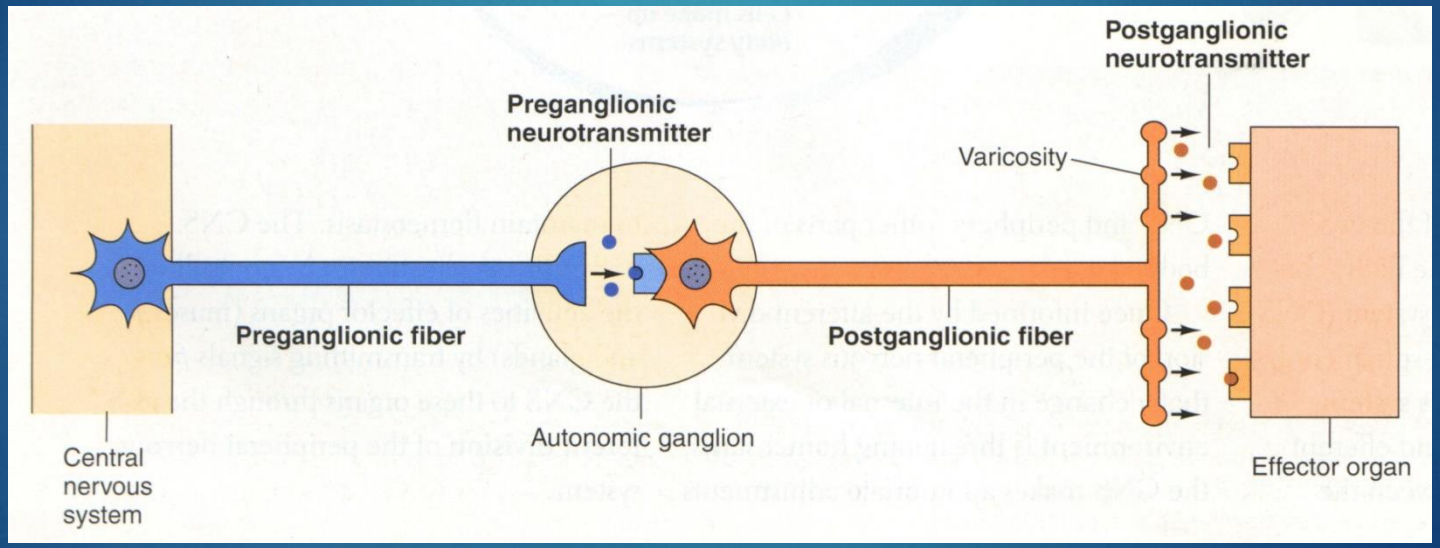


Basic anatomical difference between the motor pathways of the voluntary somatic nervous system (to skeletal muscles) and those of the autonomic nervous system

- 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



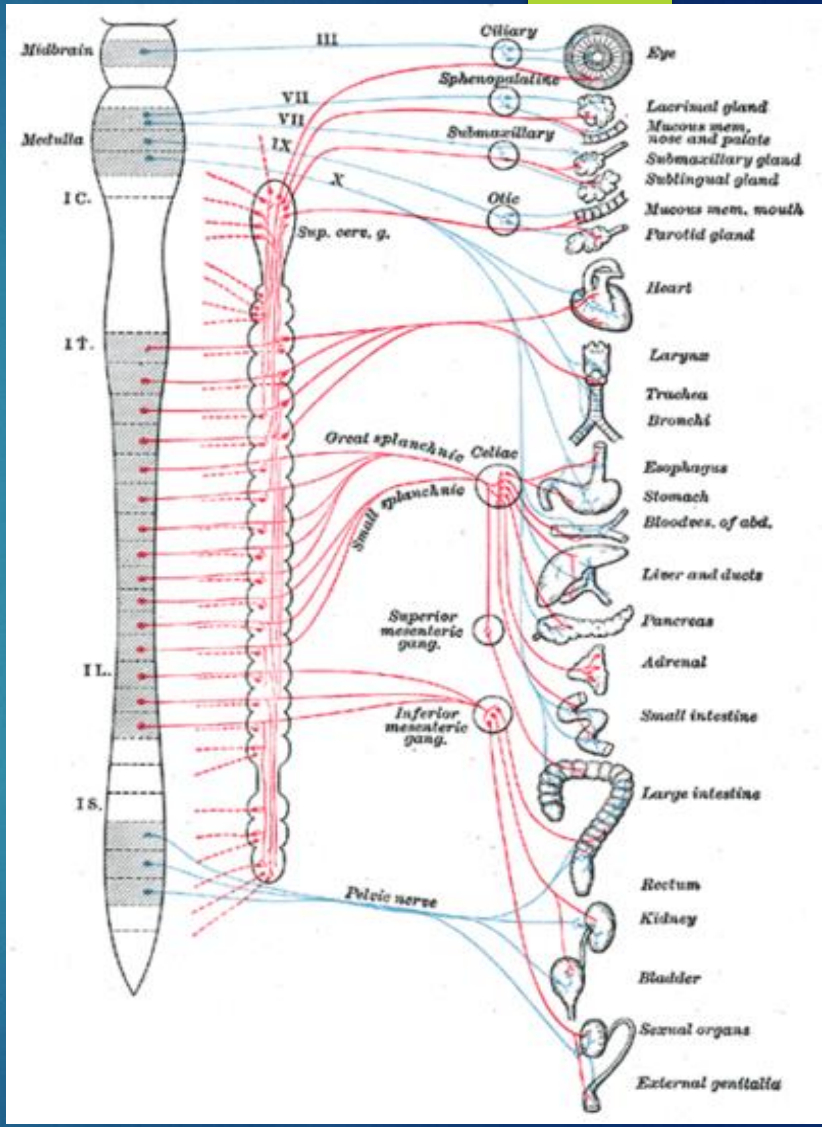
LOCATIONS OF AUTONOMIC GANGLIA

Sympathetic Ganglia

Location

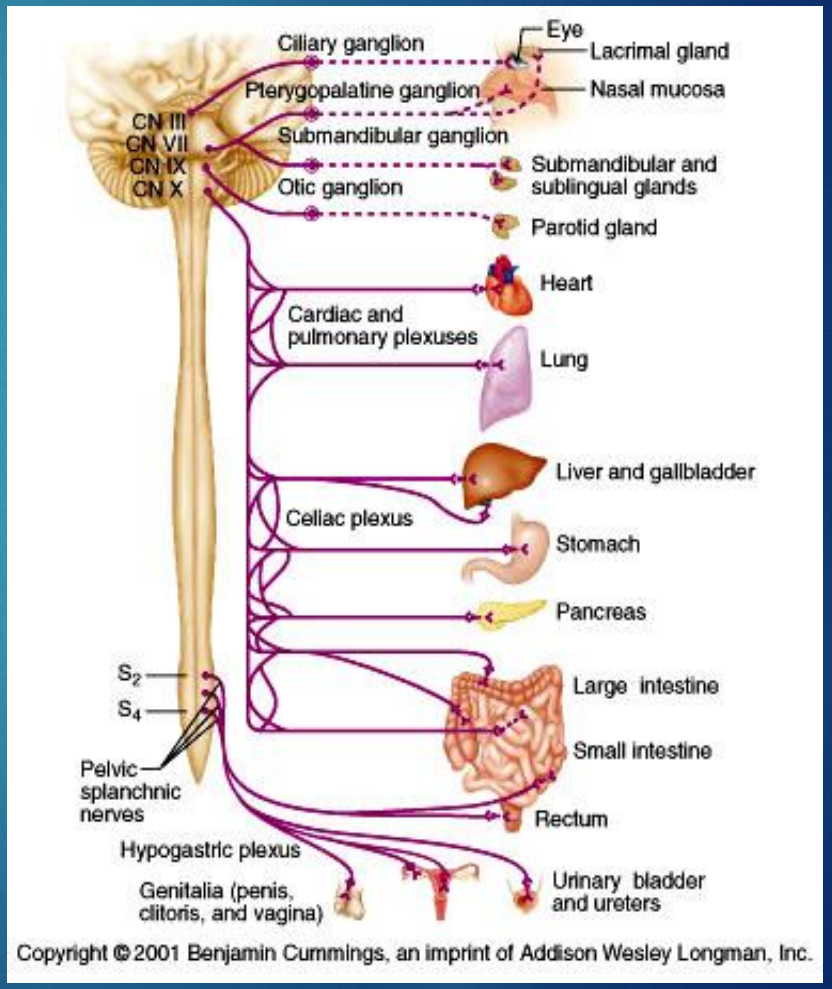
- **Trunk (chain) ganglia near vertebral bodies**
- **Prevertebral ganglia near large blood vessel in gut :celiac ,superior mesenteric &**

inferior mesenteric



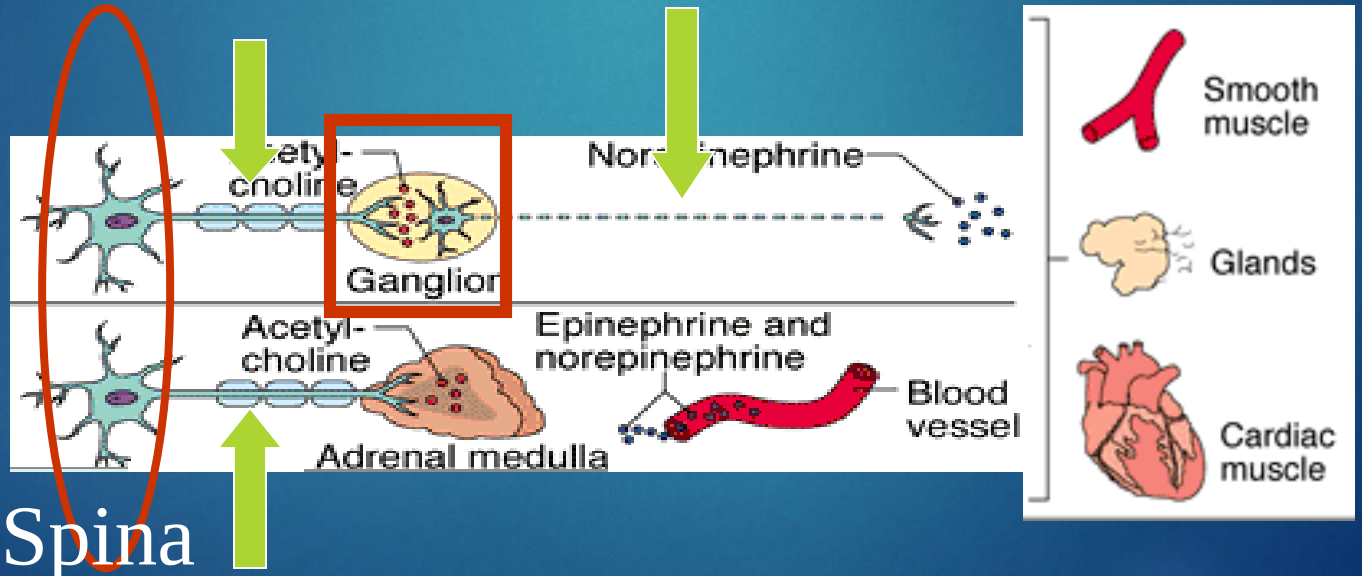
Parasympathetic Ganglia Location :

- Terminal ganglia
- in the wall of organ



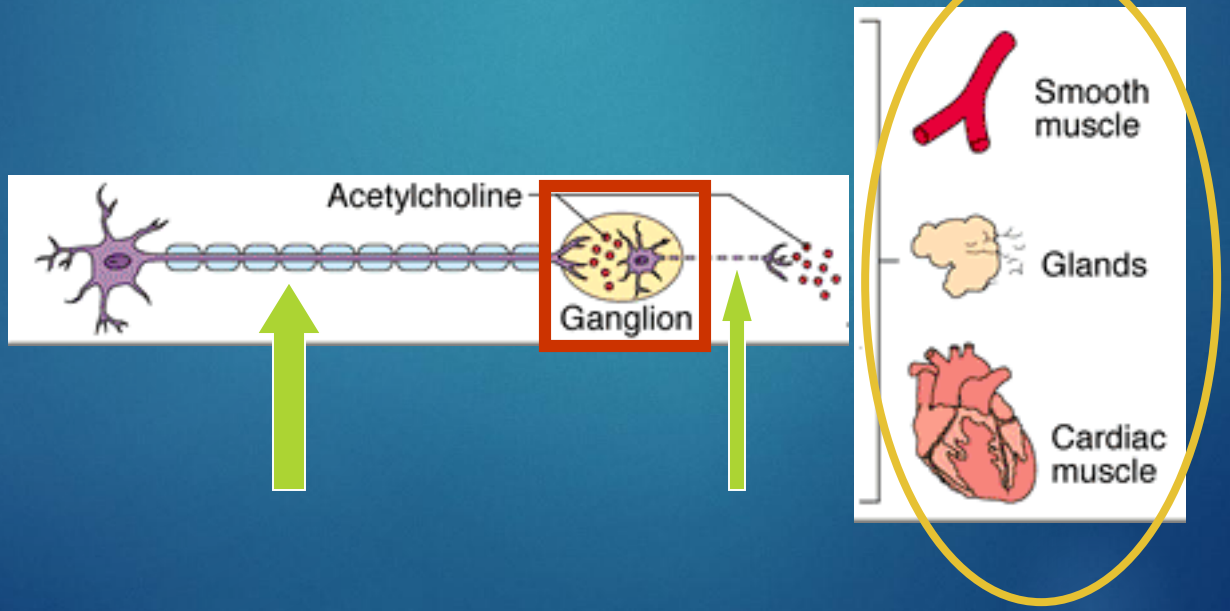
Sympathetic Innervation of Visceral Targets

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

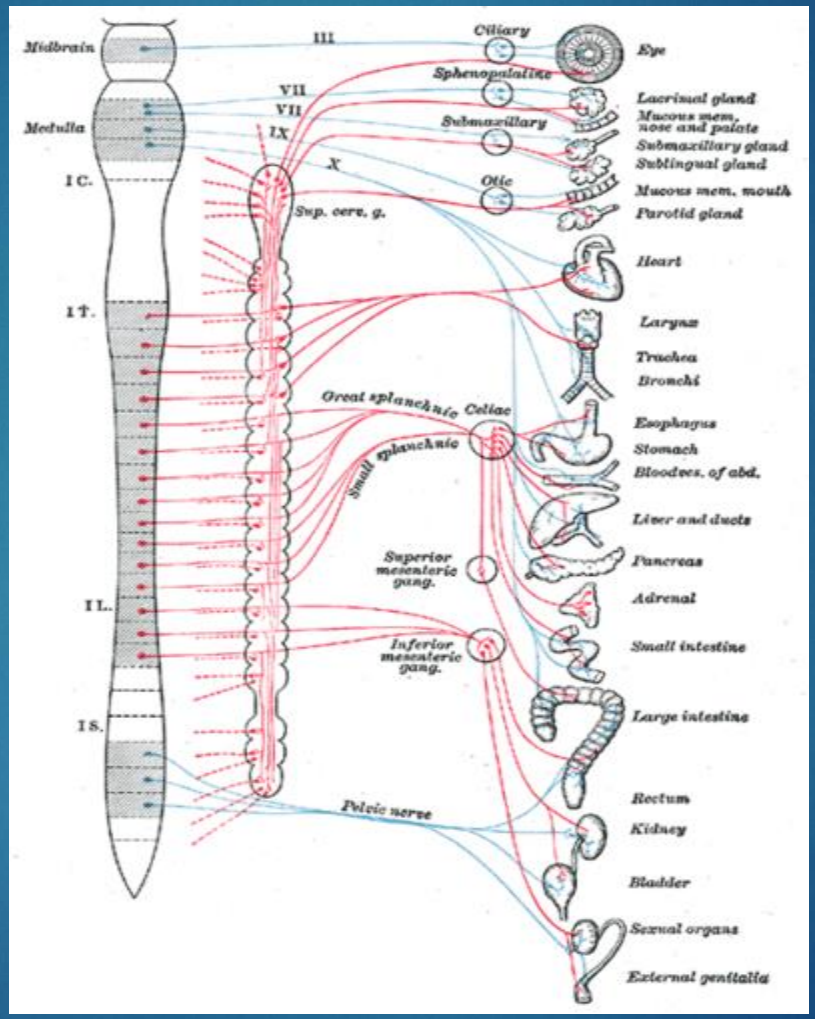


Parasympathetic
Innervation of Visceral Targets

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



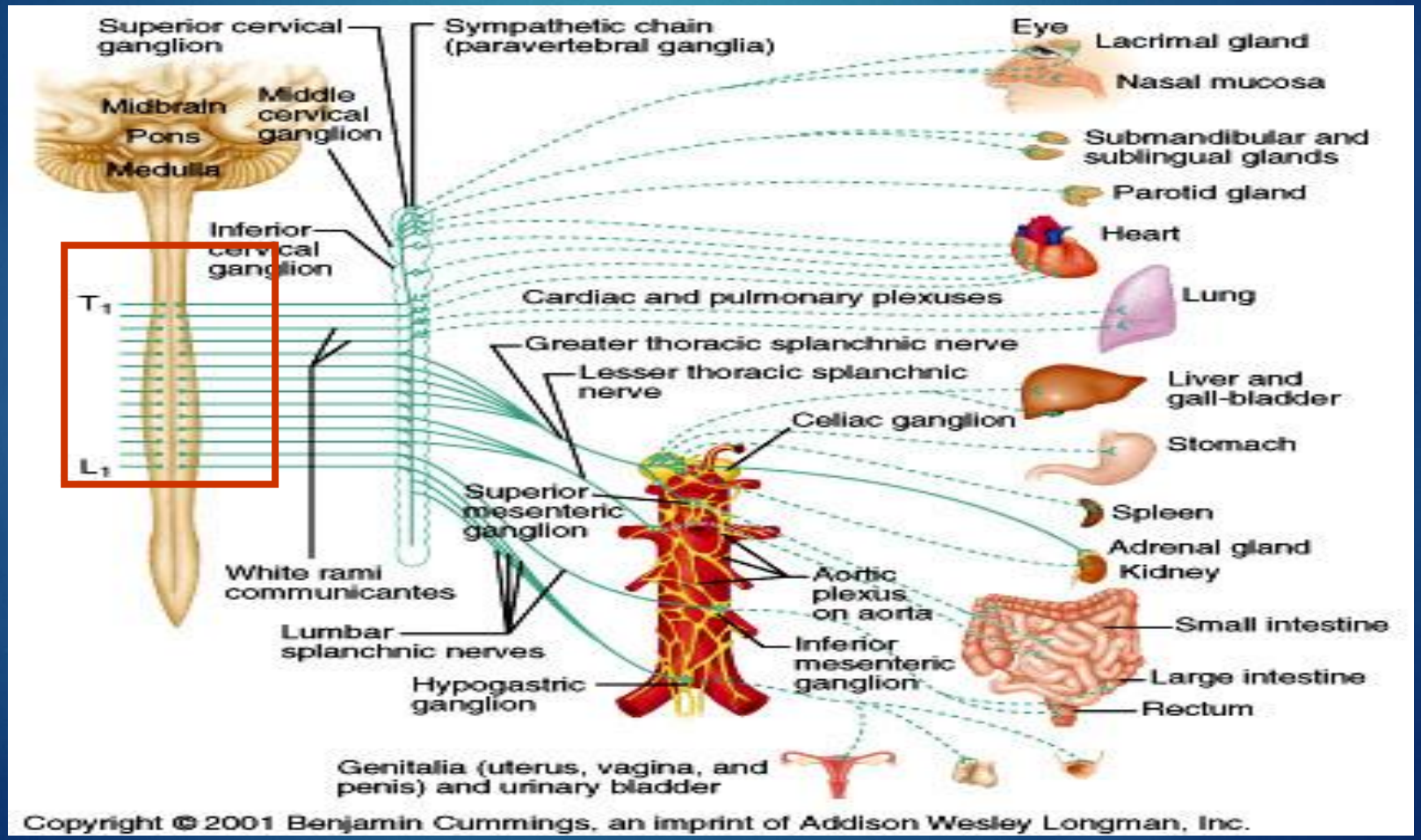
SYMPATHETIC & PARASYMPATHETIC NERVOUS SYSTEM ORIGIN



Blue= Para symp; Red symp

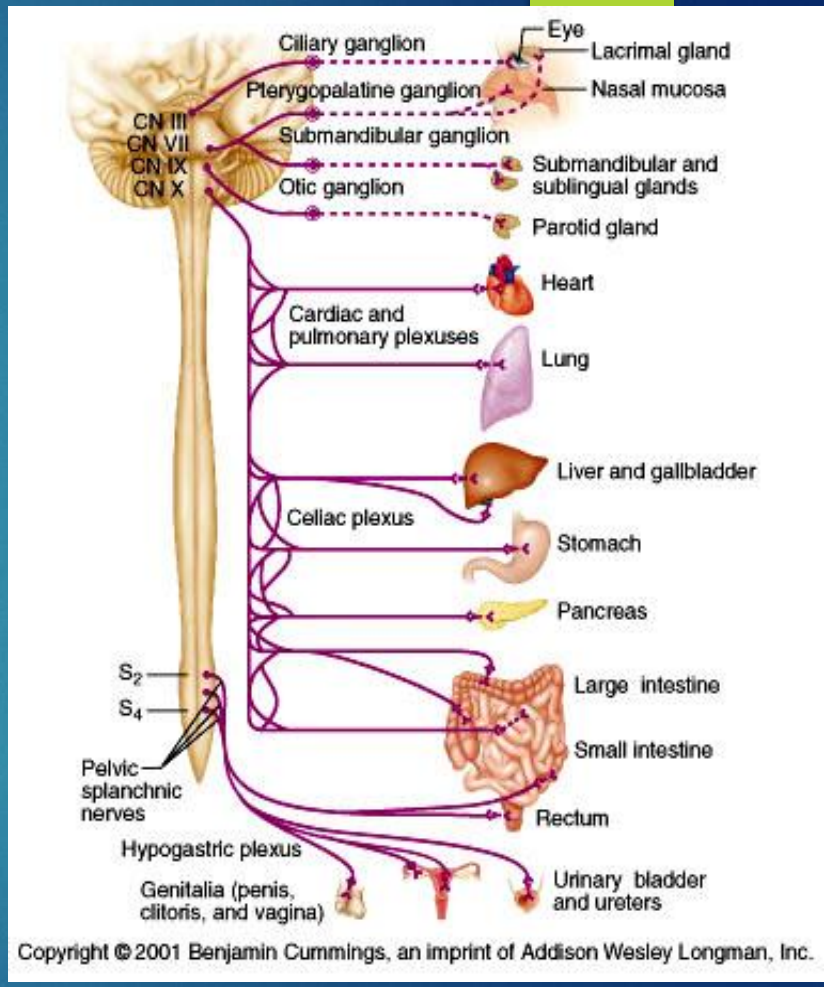
Sympathetic - Origin

- 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

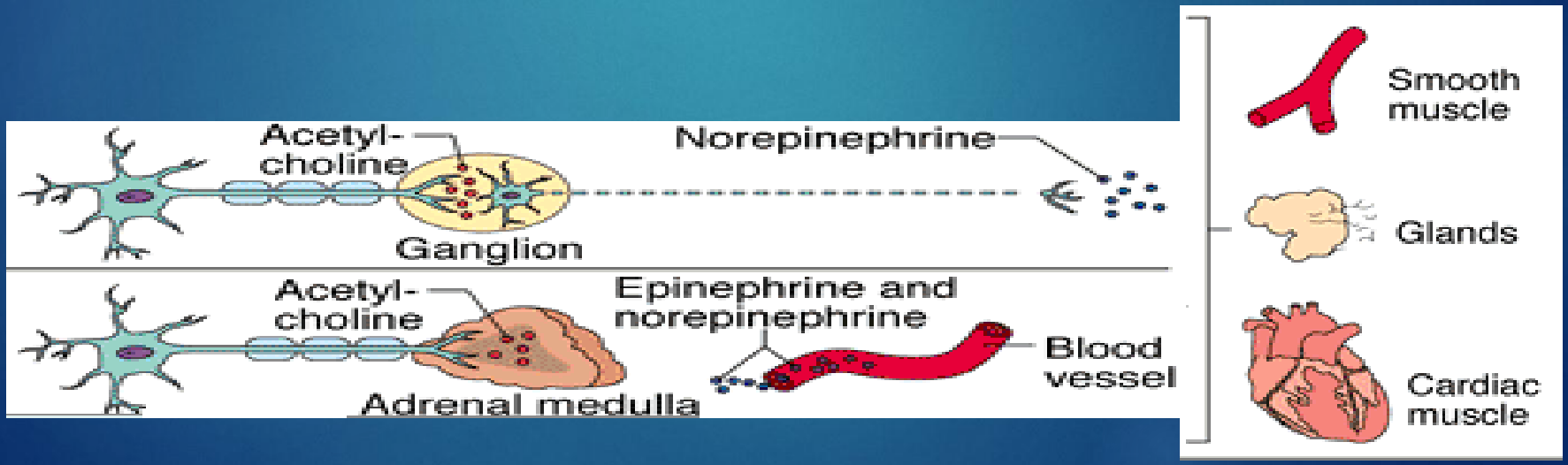
The neurotransmitters & receptors of Autonomic NS

OBJECTIVES

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

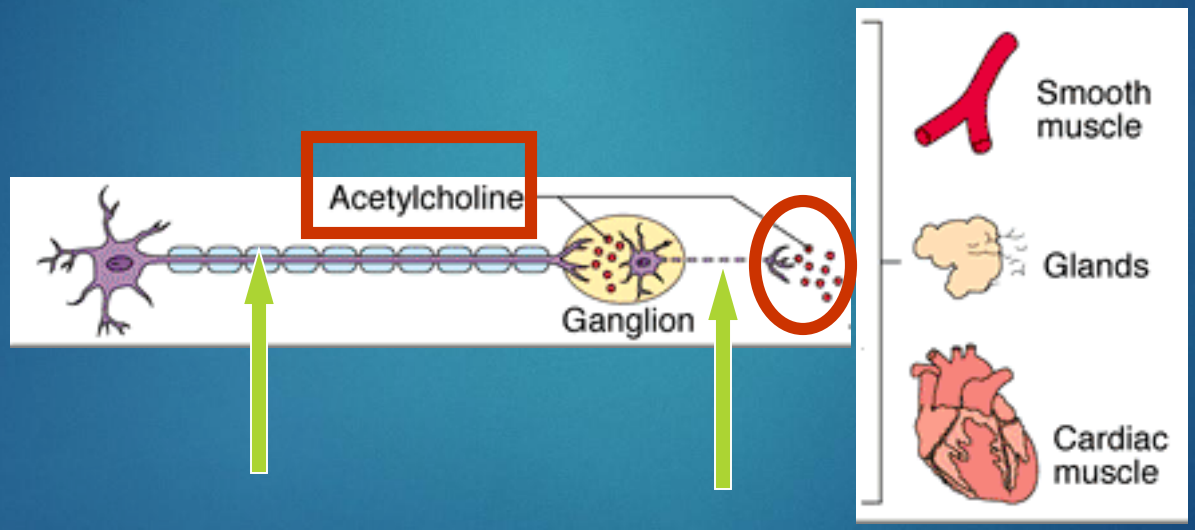
Sympathetic Neurotransmitters

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

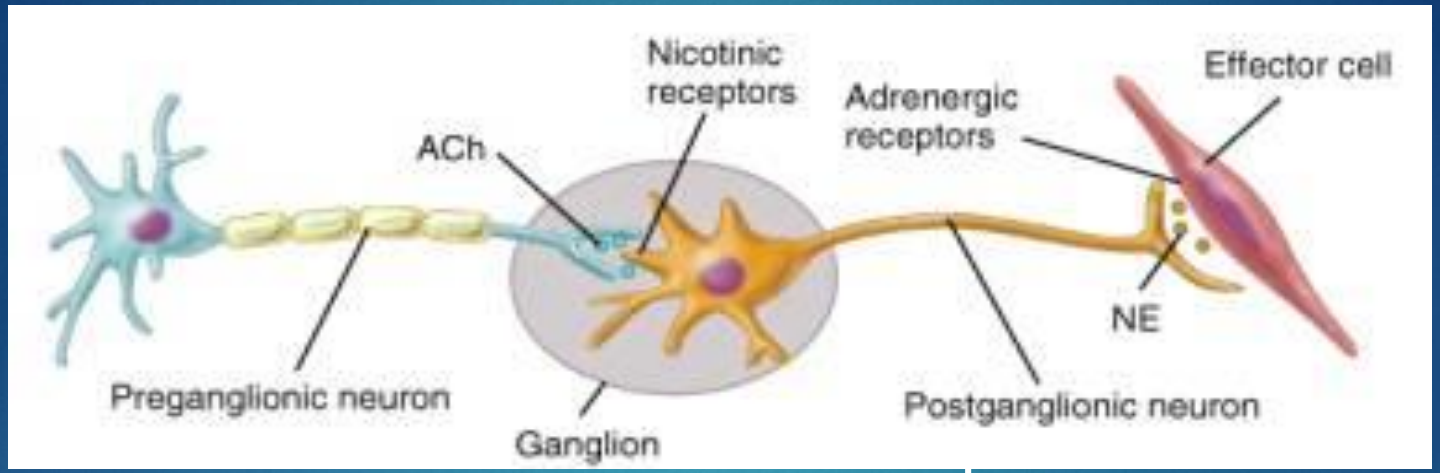


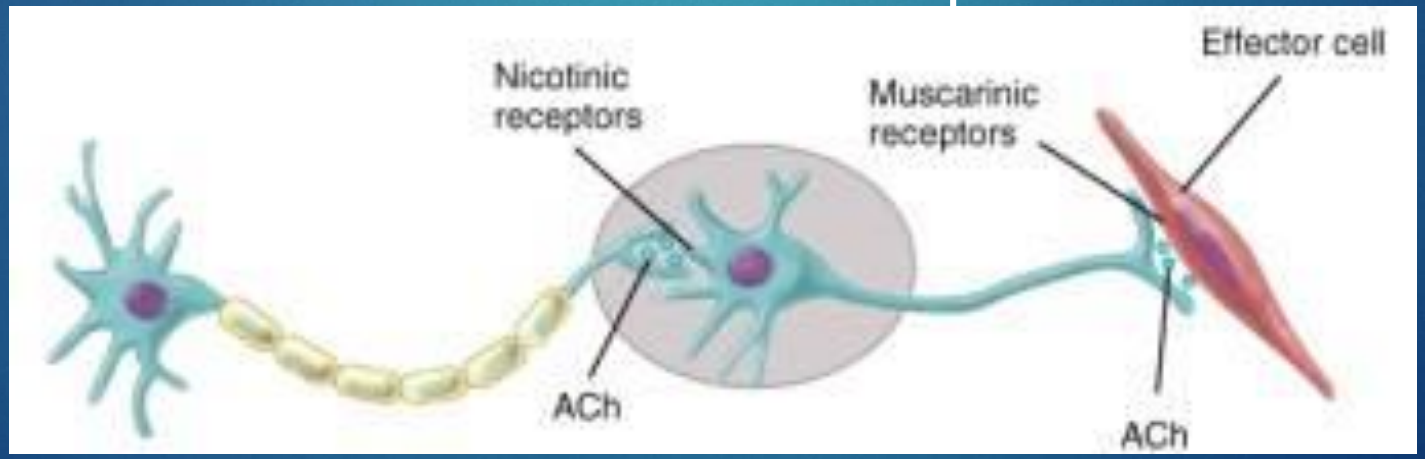
Parasympathetic Neurotransmitters

- Pre & Postganglionic neurons release acetylcholine = Cholinergic



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





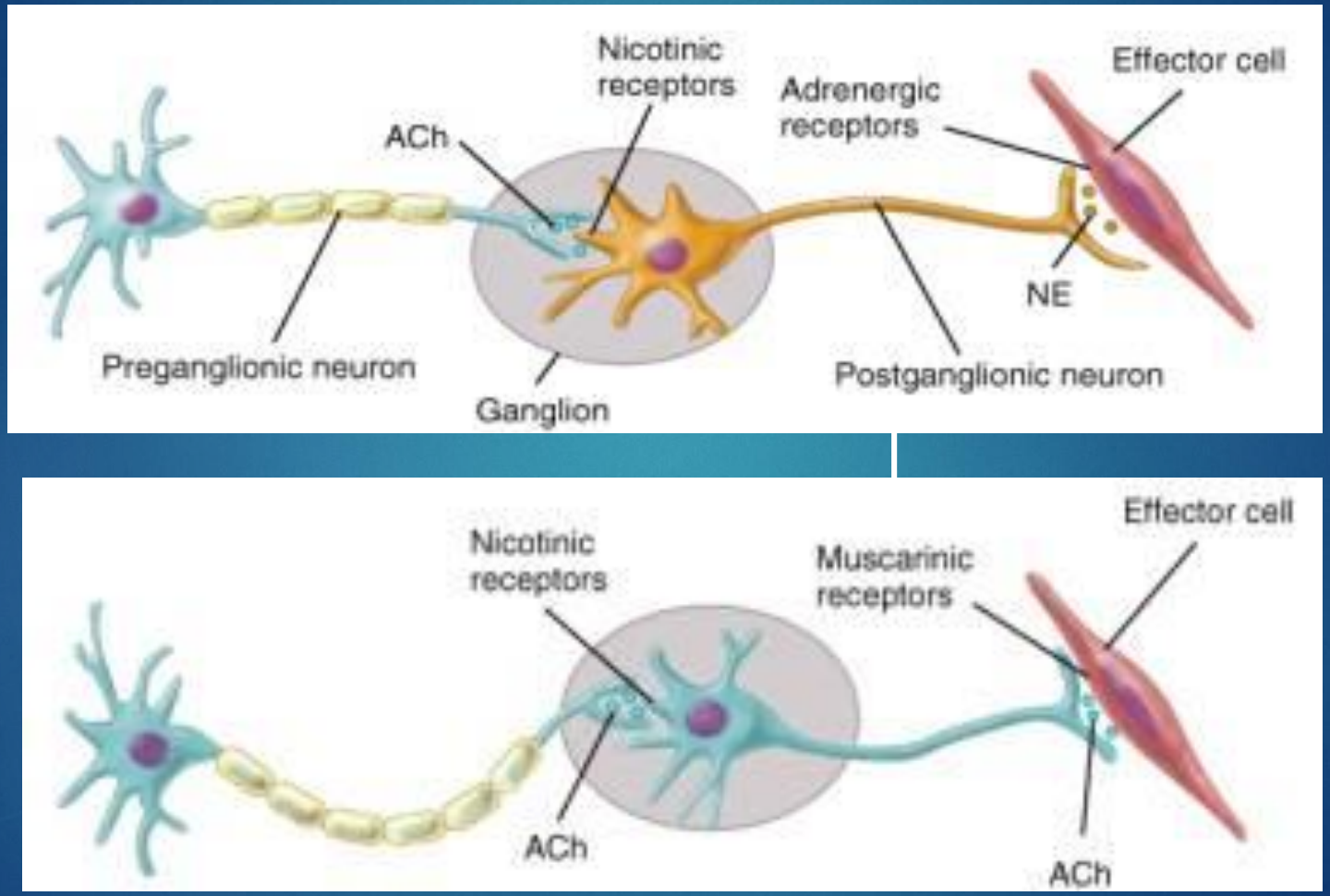
Chemical or neural transmitter

- 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



ANS: Neurotransmitters & Receptors

- alpha - receptors
- Adrenergic receptors :
- beta - receptors
- in General, NE or epinephrine binding to alpha-receptors are stimulatory while their binding to beta- receptors are inhibitory.
- Both receptors have distinct subtypes (alpha 1 , 2 , beta 1, 2).

Alpha-1 & Alpha-2 Receptors

- Alpha-1 receptors:
- reflect the "flight or fight" RX.
- cause constriction of blood vessels (control of B.P.).
- Inhibit motility in the gut by contracting sphincter muscles and relaxing non – sphincter tissue.
- Mobilize energy by breaking down liver glycogen to glucose.
- Alpha-2 receptors:
- found in pre–synaptic membranes and provide feed back control of neurotransmitter secretion (inhibit Ca++ influx, decrease neurotransmitter release).

Beta-1 & Beta-2 Receptors:

- beta-1 receptors:
- well known for their effects in the heart (increase rate and force of contraction).
- induce muscle relaxation in the gut.
- beta-2 receptors:
- Induce bronchodilation.
- Induce smooth muscle relaxation in the gut.
- Induce conversion of glycogen to glucose.
- Stimulate secretion of insulin from pancreas

Cholinergic Receptors:

- Nicotinic receptors:
- Are all excitatory.
- Their response is rapid (milliseconds).
- Muscarinic receptors:
- Either excitatory or inhibitory , depending on the target organ .
- Have distinct subtypes (M1 , M2 , M3).
- Decrease heart activity.
- Increase motility in G.I. tract.
- Depolarization of smooth muscle fibers, hyperpolarization of cardiac muscle fibers.

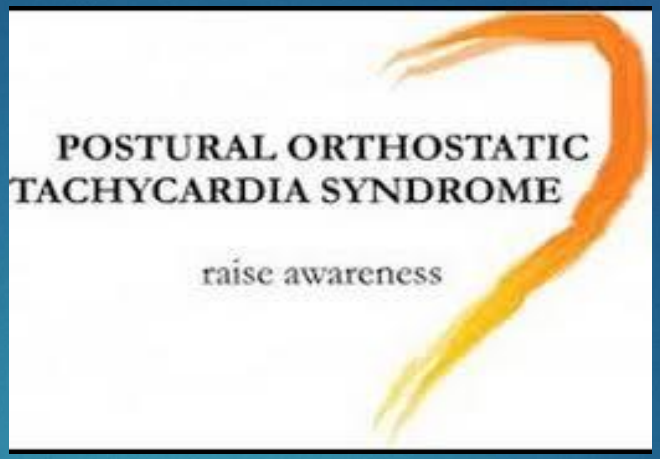
The Sympathetic NS Acts on tow types of receptors : a and β.

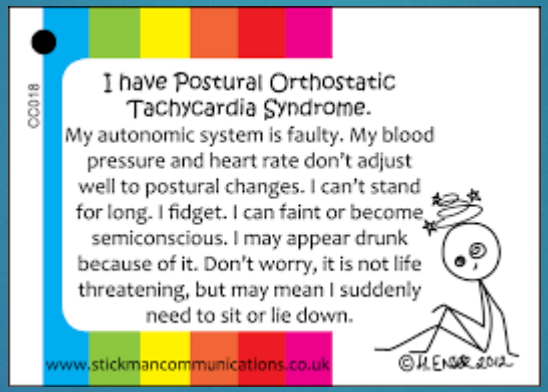
What do the receptors do?

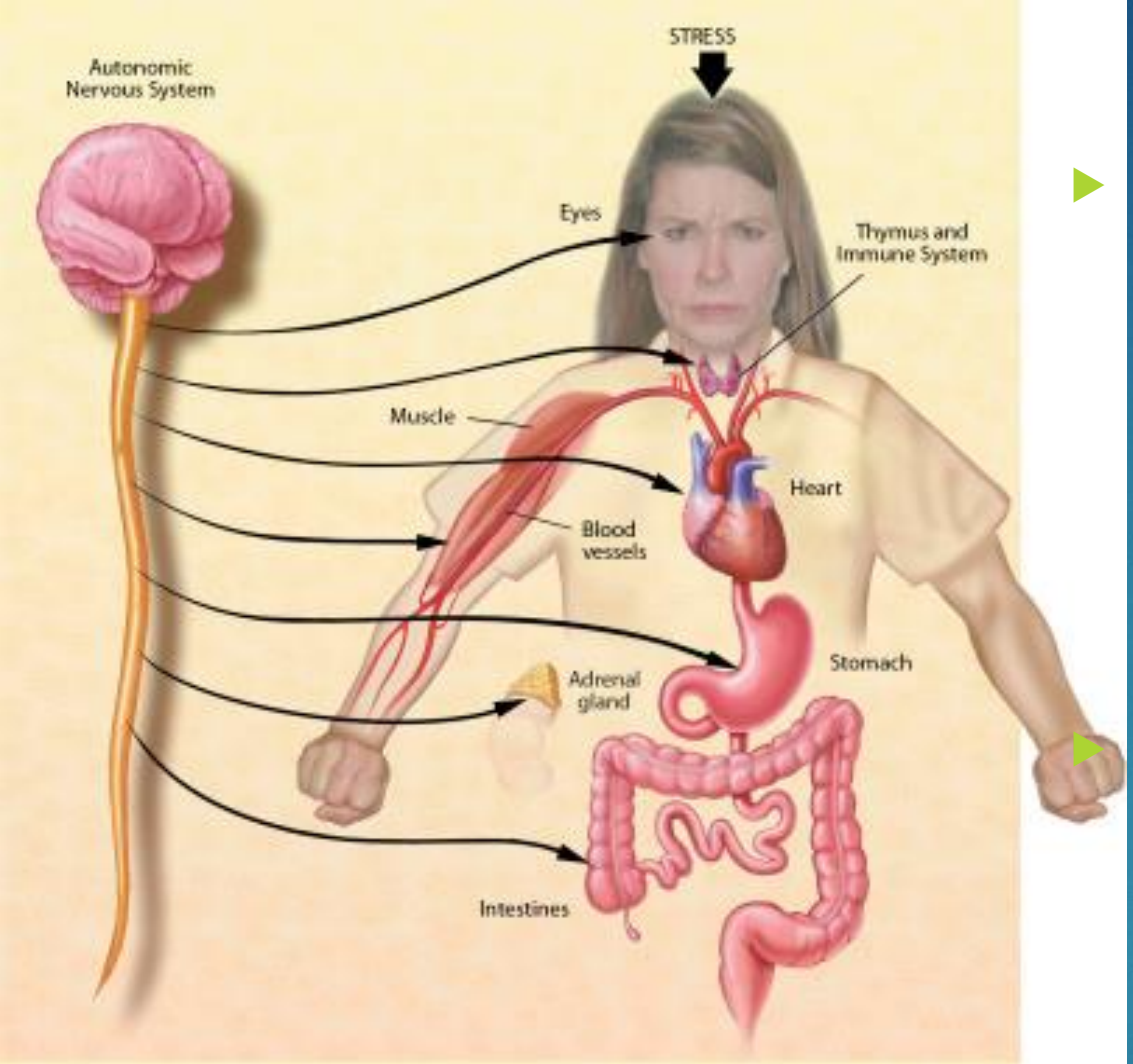
<u>Activation</u> of α receptors leads to smooth muscle <u>contraction</u>

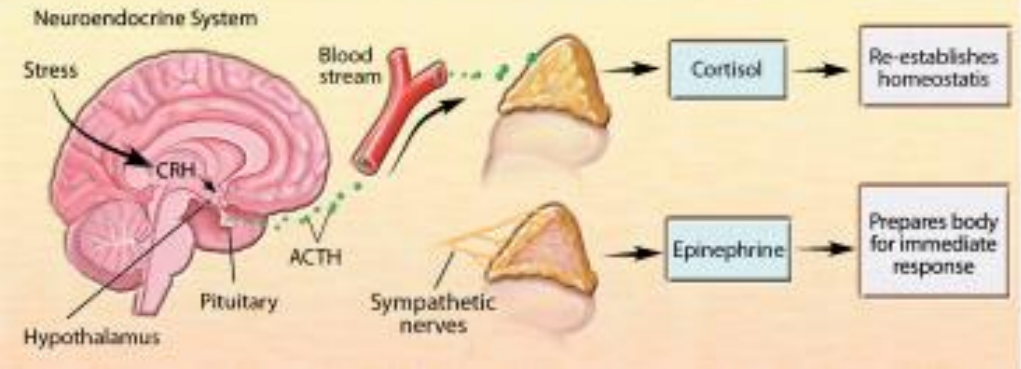
<u>Activation</u> of β_2 receptors leads to smooth muscle <u>relaxation</u>

<u>Activation</u> of β_1 receptors leads to smooth muscle <u>contraction</u> (especially in heart)


POSTURAL ORTHOSTATIC
TACHYCARDIA SYNDROME
raise awareness


CC018
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.
www.stickmancommunications.co.uk





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 traffc 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	Behavioral	Psychosomatic
Short Fuse	Drug/Use Abuse	Ulcers
Irritability	Alcohol Use/Abuse	High Blood Pressure
Depression	Smoking	Insomnia
Frustration	Strained Relationships	Indigestion
Emotional Irritability	Eating Problems	Headaches
Insecurity	Suicide Attempts	Other Cardiovascular
Mental Illness	Violence	Body Infections
Anxiety	Impulsive/ Irrational Behavior	Irregular Pulse rate

THANK YOU