

# **Chapter 60:**

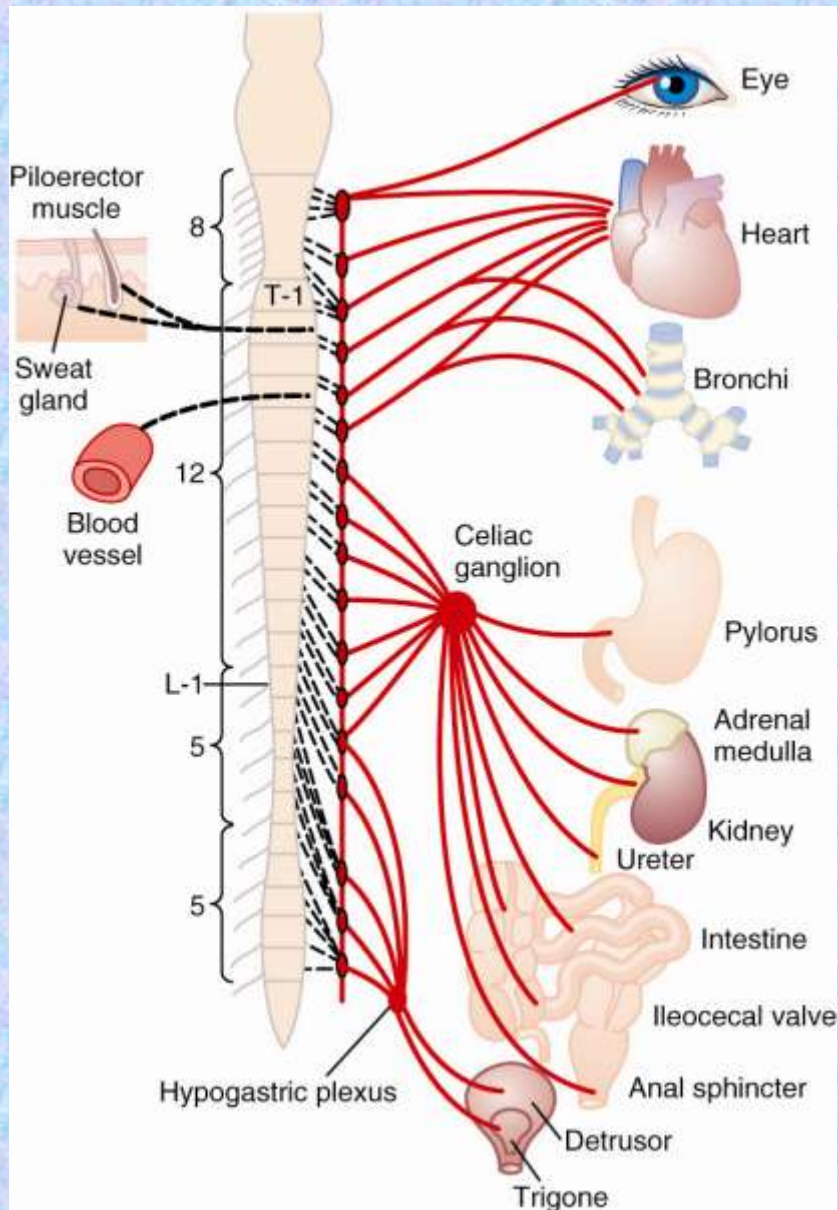
The Autonomic Nervous System;  
The Adrenal Medulla

# Organization of the Autonomic Nervous System

- motor system for visceral organs, blood vessels and secretory glands
- cell body of preganglionic axon located in brain stem or spinal cord
- axon of this visceral motor neuron is thinly myelinated and projects to an autonomic ganglia
- cell body of the postganglionic neuron located within the autonomic ganglia, unmyelinated axon projects to visceral effector cell

# Organization of the Autonomic Nervous System

- Sympathetic ganglia are located close to the spinal cord.
- Parasympathetic ganglia are located close to the effector tissues.
- Sympathetic pathways have short preganglionic fibers and long postganglionic fibers.
- Parasympathetic pathways have long preganglionic and short postganglionic fibers.



# Sympathetic Nervous System

Figure 60-1



# Physiologic Anatomy of the sympathetic Nervous System

visceral motor neuron located in the intermediolateral horn of the spinal cord from T-1 to L-2.

Axons can take 1 of 3 paths

1. enter the sympathetic chain via the white ramus and terminate there
2. enter the sympathetic chain via the white ramus and ascend or descend a few segments before terminating
3. enter via the white ramus and exit via a splanchnic nerve and terminate in a prevertebral ganglia

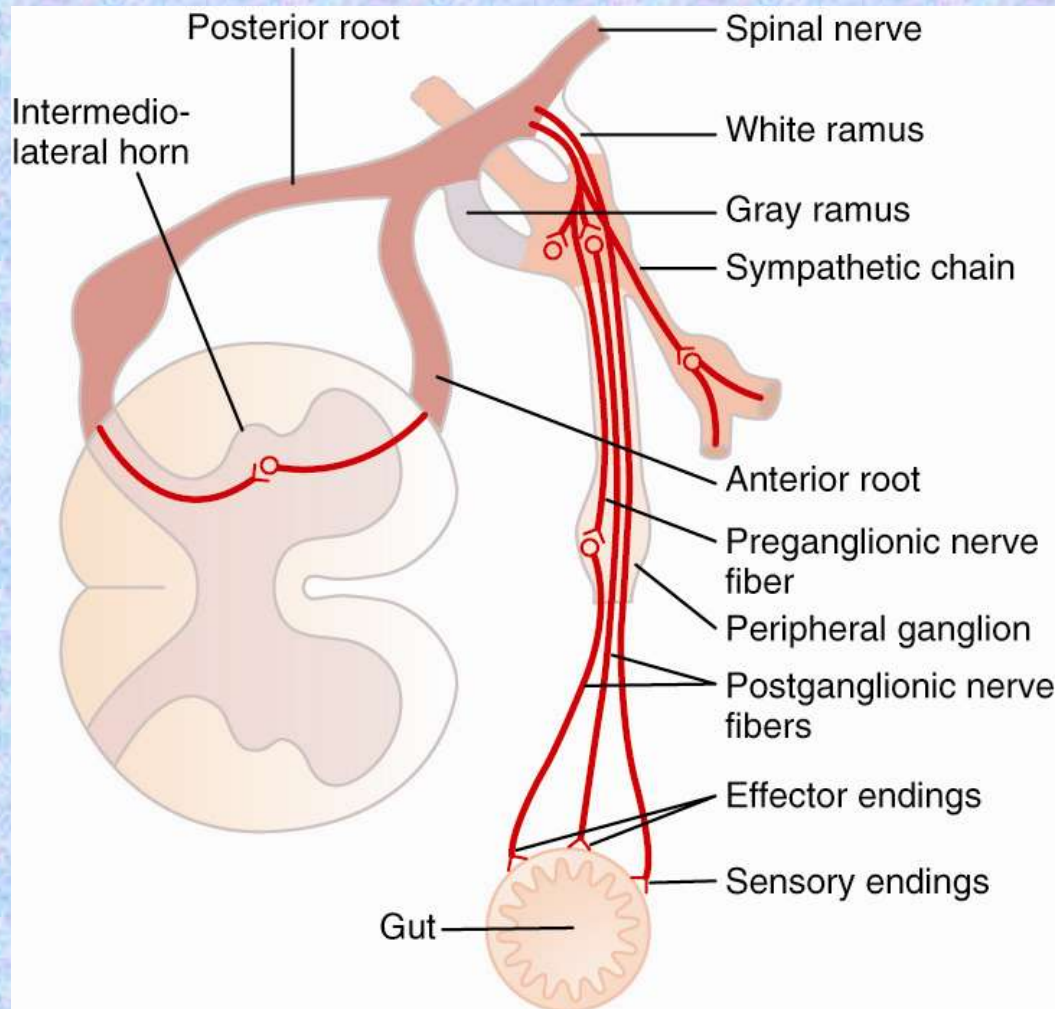
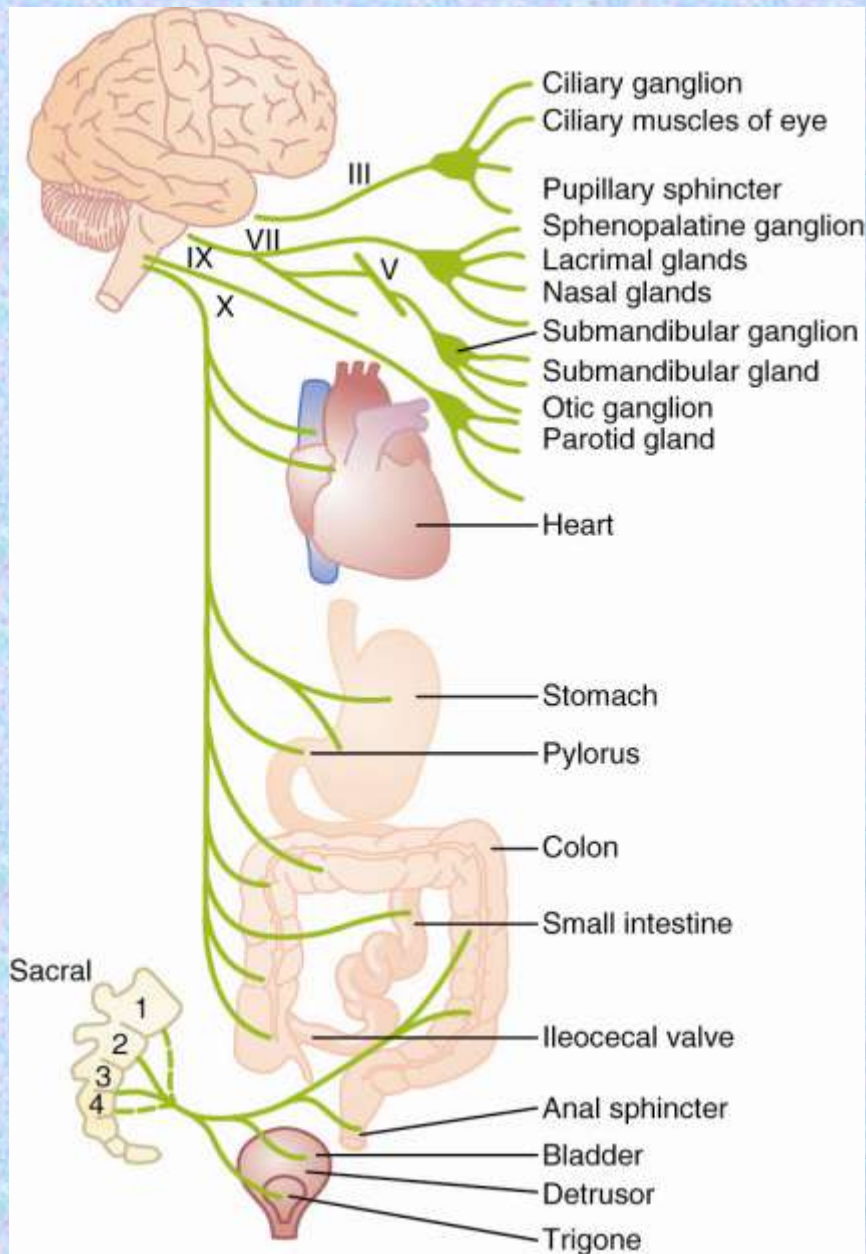


Figure 60-2

# Physiologic Anatomy of the Parasympathetic Nervous System

- Visceral motor neurons are located in discrete brain stem nuclei and in sacral segments 2-4.
- Parasympathetic nerves originate from cranial nerves III, VII, IX, and X and the sacral spinal cord.
  - **oculomotor nerve** - fibers to the pupillary sphincters and ciliary muscle
  - **facial nerve** - fibers to nasal, lacrimal and submandibular gland
  - **glossopharyngeal nerve** - fibers to parotid gland
  - **vagus nerve** - motor inputs to visceral organs
  - **sacral segments** - fibers to descending colon, rectum, bladder and genitalia



## Parasympathetic Nervous System

Figure 60-3



# Characteristics of Sympathetic and Parasympathetic Function

- sympathetic nerves release norepinephrine at their nerve endings
  - these nerves are call *adrenergic nerves*
- parasympathetic nerves release acetylcholine at their nerve endings
  - these nerves are called *cholinergic nerves*
- almost all postganglionic sympathetic nerves release norepinephrine
  - except for sweat glands, piloerector muscles and select blood vessels



# Characteristics of Sympathetic and Parasympathetic Function

- All postganglionic parasympathetic nerves release acetylcholine.
- All preganglionic sympathetic and parasympathetic nerves release acetylcholine.
- Norepinephrine and epinephrine are synthesized from the amino acid tyrosine.
  - tyrosine → DOPA → dopamine → norepi → epi
- Acetylcholine is a combination of acetyl CoA and choline.

# Neurotransmitters

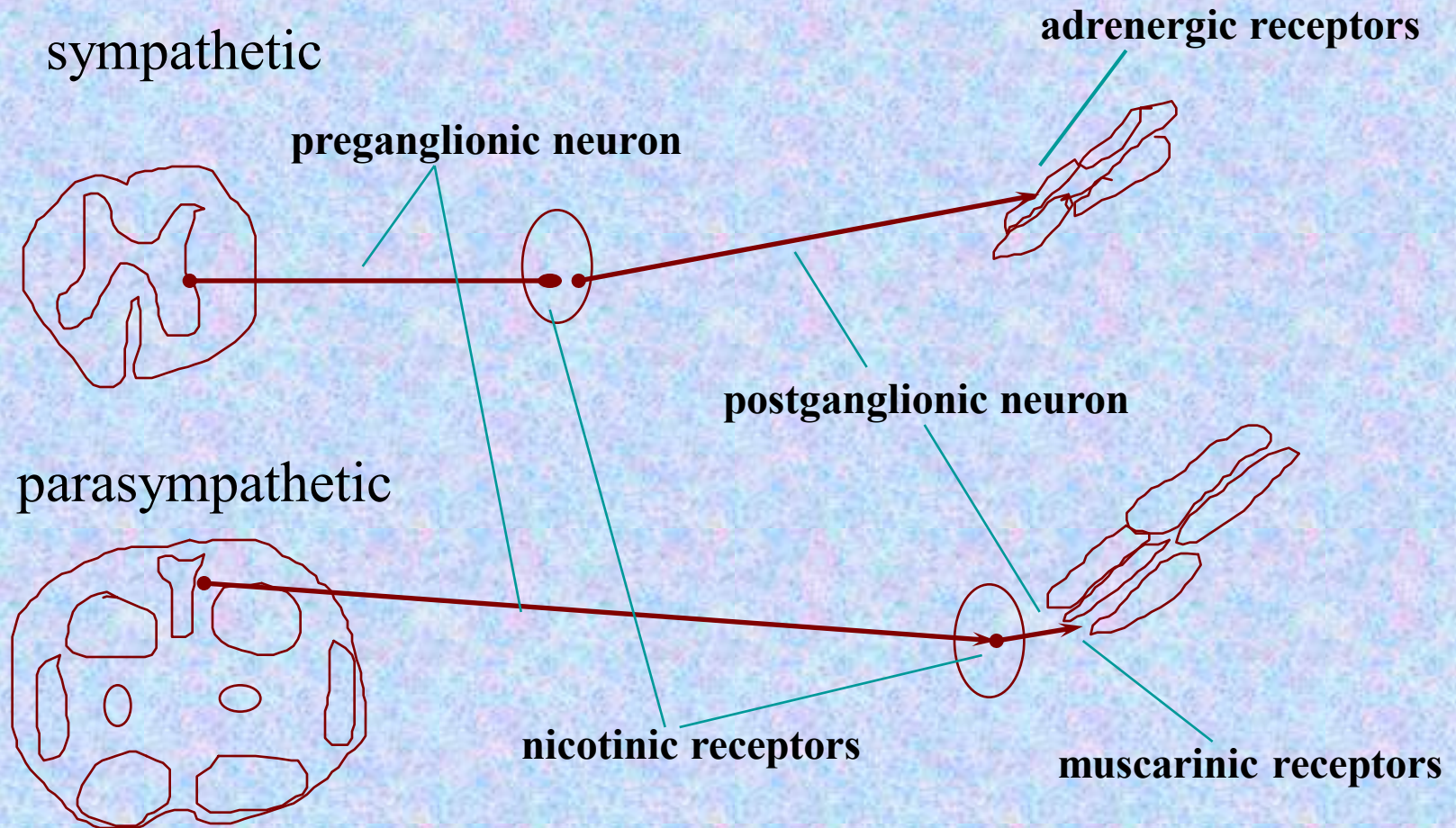
- Sympathetic nerves release *norepinephrine*.
  - Norepinephrine stimulates *alpha* and *beta* adrenergic receptors.
  - Alpha receptors are located on blood vessels where they cause vasoconstriction.
  - Beta receptors are further divided into *beta<sub>1</sub>* and *beta<sub>2</sub>*.
    - activation of *beta<sub>1</sub>* - causes an increase in heart rate and contractility
    - activation of *beta<sub>2</sub>* - causes bronchial dilation, dilation of blood vessels in skeletal muscles, calorigenesis, and glycogenolysis

# Neurotransmitters

- Parasympathetic nerves release *acetylcholine*.
  - Acetylcholine excites two types of receptors *nicotinic* and *muscarinic*.
  - Nicotinic receptors are found in synapses between the pre- and post- ganglionic neurons.
  - Muscarinic receptors are found on all effector cells stimulated by postganglionic parasympathetic fibers.



# Receptors of the Autonomic Nervous System



# Effect of the Autonomic Nervous System on the Organs

- **eye**
  - sympathetic --pupillary dilation
  - parasympathetic--pupillary constriction and accommodation (focusing) of the lens
- **glands of the body**
  - parasympathetic stimulate the nasal, lacrimal, salivary, and G.I. glands
  - sympathetic stimulates the sweat glands

# Effect of the Autonomic Nervous System on the Organs

- **G.I. tract**
  - parasympathetic stimulates overall activity including G.I. smooth muscle
  - sympathetic has very little effect
- **heart**
  - sympathetic increases the rate and contractility
  - parasympathetic decreases heart rate
- **blood vessels**
  - sympathetic causes vasoconstriction
  - parasympathetic causes some vasodilation



# Function of the Adrenal Medulla

- large sympathetic ganglion
- when stimulated releases epinephrine (80%) and norepinephrine (20%) into the blood
- causes prolonged activity of the substances
  - stimulation of cardiovascular function and metabolic rate
- helps the body deal with stress

# Sympathetic and Parasympathetic “Tone”

- the basal rate of activity of each system
  - this background activity allows for an increase or decrease in activity by a single system
    - sympathetic tone normally causes about a 50 % vasoconstriction
      - » increasing or decreasing “tone” can change vessel diameter
    - parasympathetic tone provides background G.I. activity

# Stress Response

- mass sympathetic discharge
  - increase in arterial pressure, heart rate and contractility, blood flow to muscles, blood glucose, metabolic rate, muscle strength, mental activity, blood coagulation
- prepares the body for vigorous activity need to deal with a life-threatening situation
- AKA - the *fight or flight* response



# Pharmacology of the Sympathetic Nervous System

- **adrenergic or sympathomimetic drugs** act like norepi and epi
- these drugs have an effect which is much more prolonged than that of either norepi or epi
  - *phenylephrine* stimulates alpha receptors
  - *isoproterenol* stimulates both  $\beta_1$  and  $\beta_2$  receptors
  - *albuterol* stimulates only  $\beta_2$  receptors
- some drugs act indirectly by increasing the release of norepi from its storage terminals
  - *ephedrine, tyramine, and amphetamine*

# Pharmacology of the Sympathetic Nervous System

- drugs that block the effect of norepi and epi
- synthesis and storage
  - *reserpine*
- release from the nerve terminal
  - *guanethidine*
- alpha blockers
  - *phentolamine* and *phenoxybenzamine*
- beta blockers
  - $\beta_1$  and  $\beta_2$  - *propranolol*,  $\beta_1$  - *metoprolol*
- ganglionic blockers
  - *hexamethonium*

# Pharmacology of the Parasympathetic Nervous System

- **parasympathomimetic drugs**

- *nicotine*

- activates nicotinic receptors

- *pilocarpine* and *methacholine*

- activates muscarinic receptors, cause profuse sweating

- **cholinesterase inhibitors**

- *neostigmine*, *pyridostigmine*, and *ambenonium*

- potentiates the effect of acetylcholine

- **antimuscarinic drugs**

- *atropine* and *scopolamine*

- blocks the effect of acetylcholine on effector cells