

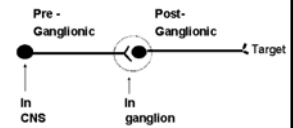
# The Autonomic Nervous System

## Chapter 16

### Introduction

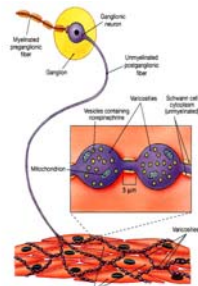
- Makes all routine adjustments in physiological systems.
- Consists of visceral motor (efferent) neurons
- Involves 2 neurons synapsing in an autonomic ganglion
  - **Preganglionic** (neuron #1)
  - **Postganglionic** (neuron #2)

General Structure = 2 neuron path



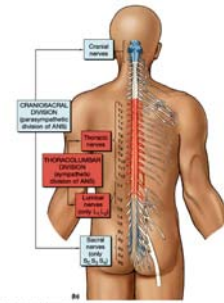
### Nerve Fibers of the ANS

- **Preganglionic (neuron #1)**
  - Always myelinated
  - **Neurotransmitter**
    - **ACh**
- **Postganglionic (neuron #2)**
  - Always nonmyelinated
  - Neurotransmitter
    - **Ach**
    - **Norepinephrine**



### Subdivisions of the ANS

- **Sympathetic division (thoracolumbar)**
  - Cell bodies for neurons #1
    - thoracic and lumbar portions of the spinal cord.
    - T<sub>1</sub> – L<sub>2</sub>
- **Parasympathetic division (craniosacral)**
  - Cell bodies
    - brain stem (cranial nerves)
    - sacral portion of the spinal cord.



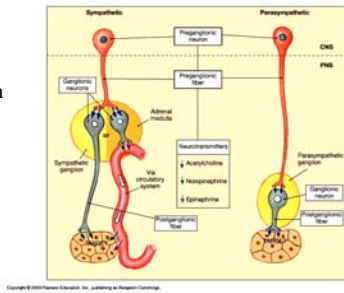
### Functions of the ANS

- **Sympathetic division**
  - Stimulates heart beat & tissue metabolism, increases alertness, prepares the body to deal with emergencies (“**fight or flight**” division)
- **Parasympathetic division**
  - Slows the heart rate, inhibits senses, prepares the body for rest and relaxation; (“**rest and digest**” division).

## The Sympathetic Division

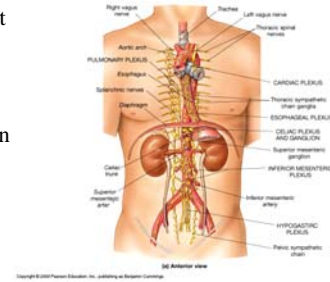
## Organization of the SNS

- Neurons #1
  - Short
  - Usually synapse with neurons #2 (long) in ganglia
- **Ganglia**
  - Sympathetic chain
  - Collateral



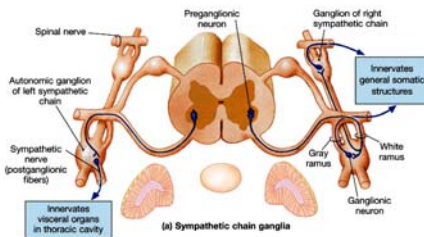
## Sympathetic Chain Ganglia

- A chain of ganglia that run alongside the spinal cord
- Extends on both sides of the vertebral column
- Carries preganglionic fibers and cell bodies of postganglionic neurons



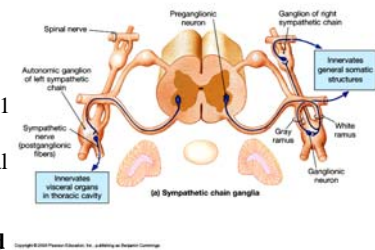
## Anatomy of the Sympathetic Chain

- **Rami communicantes** from spinal nerves connect to the chain
- **Splanchnic nerves** project from the chain



## Routes of Preganglionic Axons

- Cell bodies of neurons #1
  - In **lateral gray horns**
- Axons of neurons #1 enter ventral root
- Axons pass to spinal nerve
- Axons leave spinal nerve via **white and gray branches (rami communicantes)**

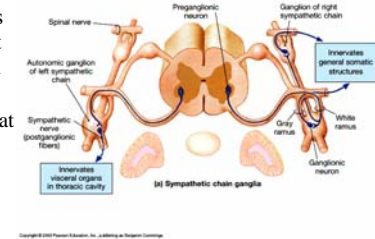


## Routes of Preganglionic Axons

- There are 4 possible routes that sympathetic neurons #1 may follow

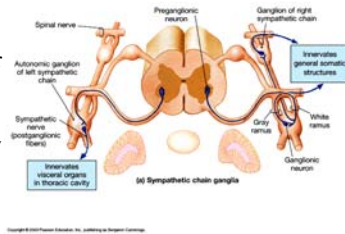
## Routes of Preganglionic Axons – Possibility #1

- Neuron #1 synapses with the ganglion at same level of spinal cord
  - Neuron #2 leaves at that level via the gray ramus communicans, rejoins the same level spinal nerve



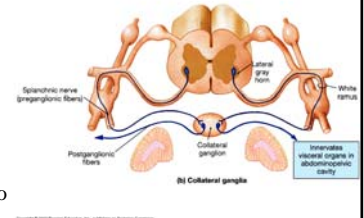
### Routes of Preganglionic Axons - Possibility #2

- Neuron #1 goes up or down the chain and synapses at some other level.
  - Neuron #2 leaves at that level via the gray rami communicans, rejoins the spinal nerve at that level.



### Routes of Preganglionic Axons - Possibility #3

- Neuron #1 does not synapse in the chain but exits by a splanchnic nerve and synapses in a **collateral ganglion**.
  - Neuron #2 travels from that ganglion to its destination.



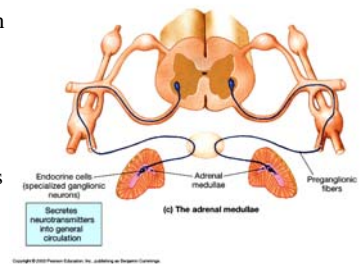
### Collateral Ganglia

- Location – anterior to the aorta in the abdominopelvic cavity
  - **Celiac ganglion**
    - Innervates upper abdominal viscera
  - **Superior mesenteric ganglion**
    - Innervates middle abdominal viscera
  - **Inferior mesenteric ganglion**
    - Innervates lower abdominal & pelvic organs

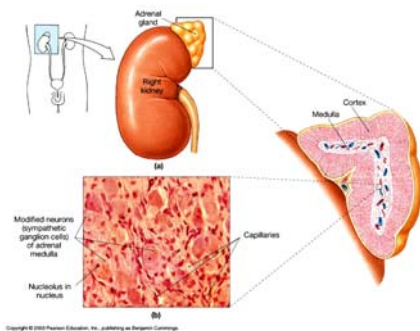


### Routes of Preganglionic Axons – Possibility #4

- Neuron #1 does not synapse in a ganglion
  - Synapses with **adrenal medulla**
  - Only *preganglionic* neurons are in this pathway
- Neuron #1 stimulates the medulla
- The medulla releases norepinephrine and **epinephrine (adrenaline)** to blood

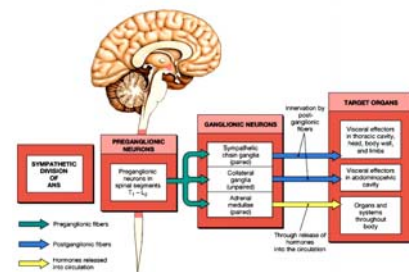


### Adrenal Medulla



### Effects of Sympathetic Stimulation

- Widespread
  - The sympathetic chain allows one preganglionic fiber to synapse with many postganglionic neurons
- Enhanced & prolonged by the adrenal medulla



### Neurotransmitters

- Preganglionic fibers release **acetylcholine (ACh)**
  - **Cholinergic**
- Postganglionic fibers (most) release **norepinephrine (NE)**
  - **Adrenergic**
- Adrenal medulla releases norepinephrine and **epinephrine (adrenaline)**

### Membrane Receptors & Sympathetic Function

- 2 types of receptors in synapses
  - The same neurotransmitter can have different effects
- **Alpha receptors** cause a rise in intracellular calcium
- **Beta receptors** cause changes in the metabolic activity of the target cells

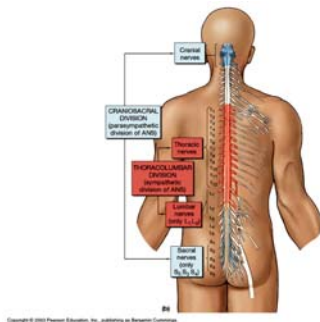
### Summary of Sympathetic Division

- Cell bodies are found in the thoracic and lumbar portions of the spinal cord
- Preganglionic fibers are short, connect to the sympathetic chain, and synapse with long postganglionic fibers
- Preganglionic fibers produce ACh, postganglionic fibers produce NE or Ach
- “Fight or flight” division

### The Parasympathetic Division

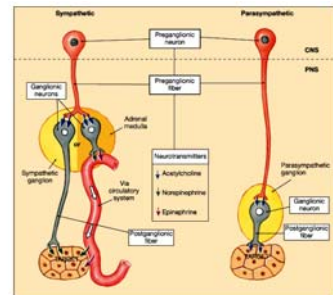
### Organization of the PNS

- Cell bodies are in the brain or in the gray matter of the spinal cord (sacral region)
- Neurons #1 exit the cranial region through cranial nerves 3, 7, 9, & 10
- Neurons #1 exit the spinal cord through the sacral spinal nerves



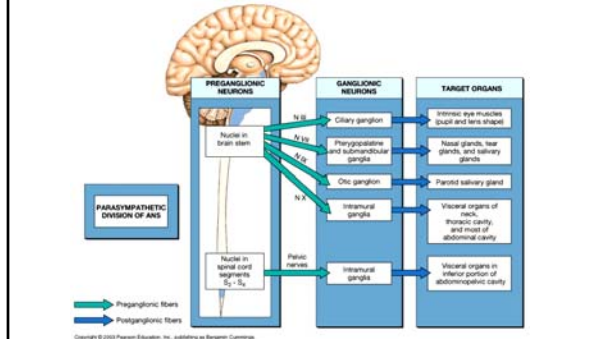
### Organization of the PNS

- Neurons #1 are long and synapse with neurons #2 (short) in ganglia
- **Ganglia** are found on near the visceral effector



## Effects of Parasympathetic Stimulation

- The **cranial nerve fibers** involved are motor - control smooth muscle & glands in the upper body



## General Functions of the PNS

- Prepares the individual for rest and relaxation
- “Rest & digest” division
- Effects on various organs:
  - Decreases heart rate
  - Constricts bronchioles
  - Increases salivation
  - Increases motility of stomach
  - Increases motility of colon
  - Constricts pupils

## Neurotransmitter

- Both preganglionic and postganglionic fibers release acetylcholine
  - Causes localized and short-term effects

## Summary of the Parasympathetic Division

- Cell bodies are found in the brain and in the sacral region of the spinal cord
- Preganglionic fibers are long and synapse with short postganglionic fibers on or near the target viscera
- Both preganglionic and postganglionic fibers produce Ach
- “Rest & digest” division

## Relationship Between the Sympathetic and Parasympathetic Divisions

- Most organs receive **dual innervation**
- Visceral organs are **intrinsically excited**
  - ANS either increase excitation or inhibit the activity
  - Eg. Heart rate

