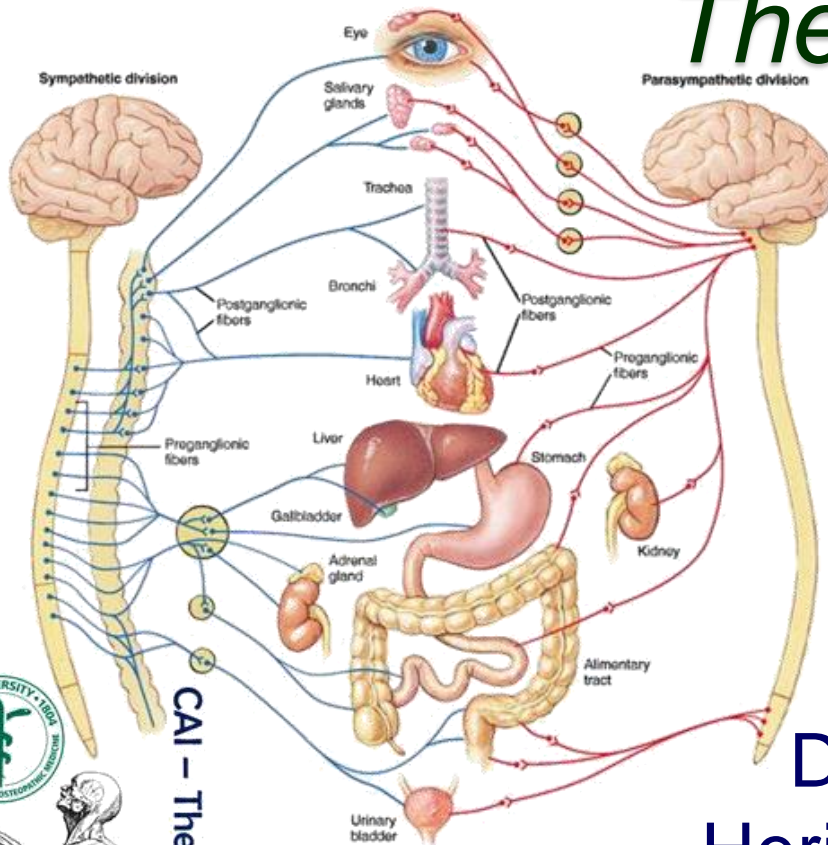


# Peripheral Nervous System 2: The Autonomic System

7 August 2017

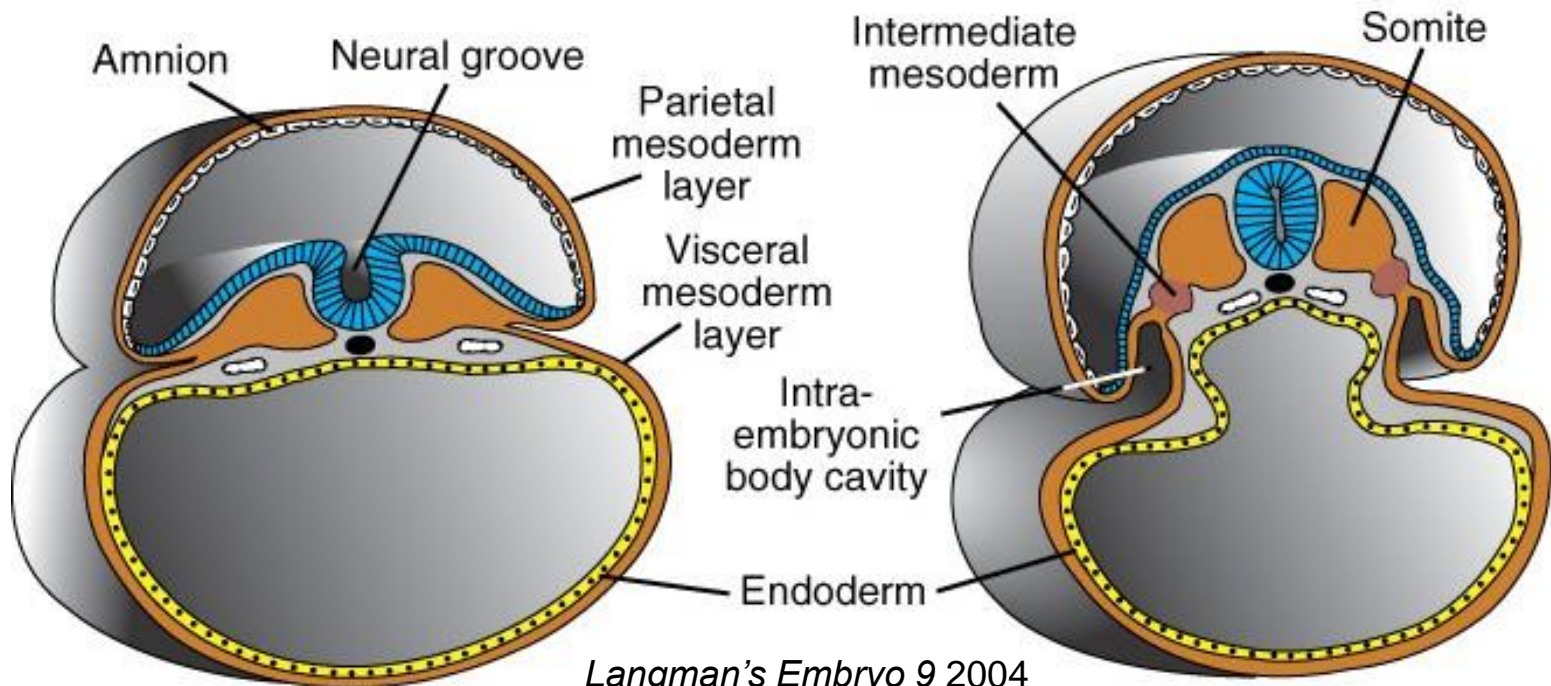
Reading: Moore's ECA5 33–39  
ECA4 36–43

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# Somatic vs. Visceral

attribute	Somatic System	Visceral System
embryological origin of tissue	“body wall:” somatic (parietal) mesoderm (dermatome, myotome)	“organs:” splanchnic (visceral) mesoderm, endoderm
examples of adult tissues	dermis of skin, skeletal muscles, connective tissues	glands, cardiac muscle, smooth muscle
perception	conscious, voluntary	unconscious, involuntary



# Sensory/Motor + Somatic/Visceral

	<b>Somatic</b>	<b>Visceral</b>
<b>Sensory (Afferent)</b>	<i>somatic sensory</i> [General Somatic Afferent (GSA)]	<i>visceral sensory</i> [General Visceral Afferent (GVA)]
<b>Motor (Efferent)</b>	<i>somatic motor</i> [General Somatic Efferent (GSE)]	<i>visceral motor</i> [General Visceral Efferent (GVE)]



***Somatic  
Nervous  
System***

(July 24)



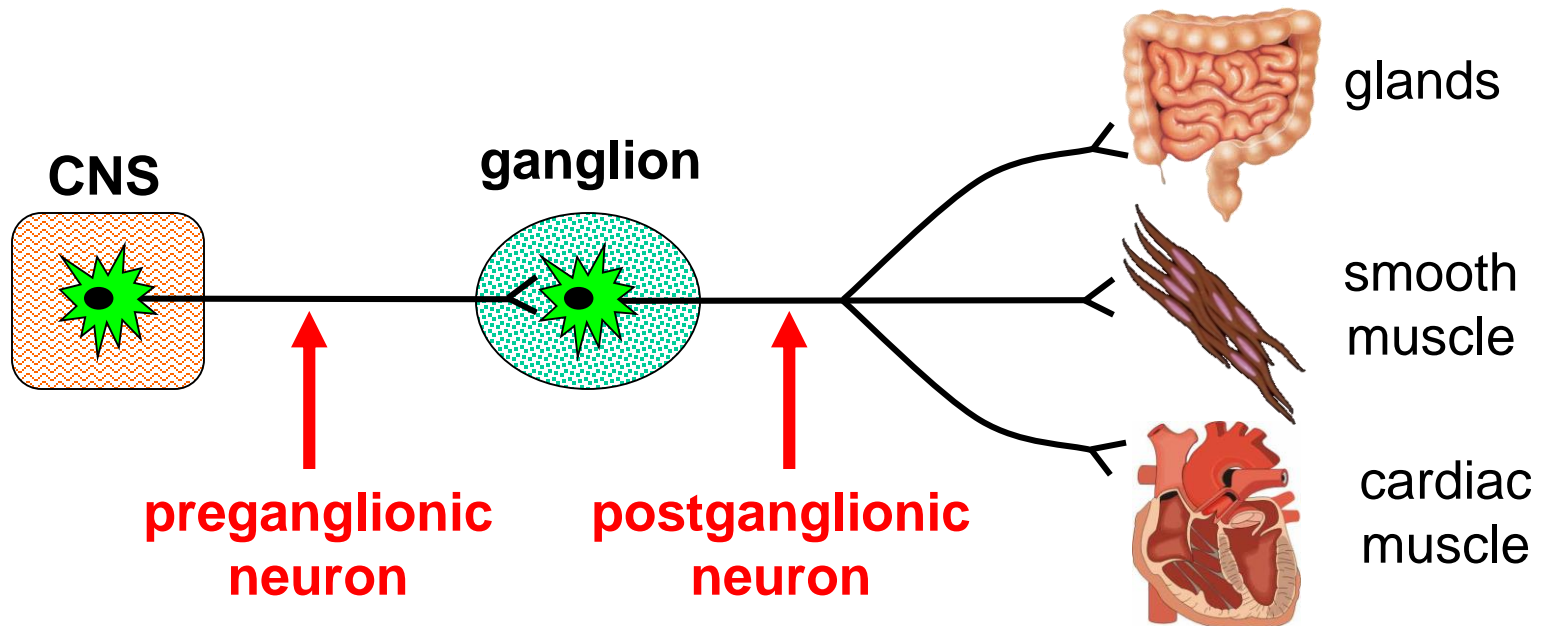
***Autonomic  
Nervous  
System***

(today)

# Overview of the Autonomic Nervous System

## Similarities between Sympathetic & Parasympathetic

- Both are efferent (motor) systems: “visceromotor”
- Both involve regulation of the “internal” environment generally outside of our conscious control: “autonomous”
- Both involve 2 neurons that synapse in a peripheral ganglion
- Innervate glands, smooth muscle, cardiac muscle



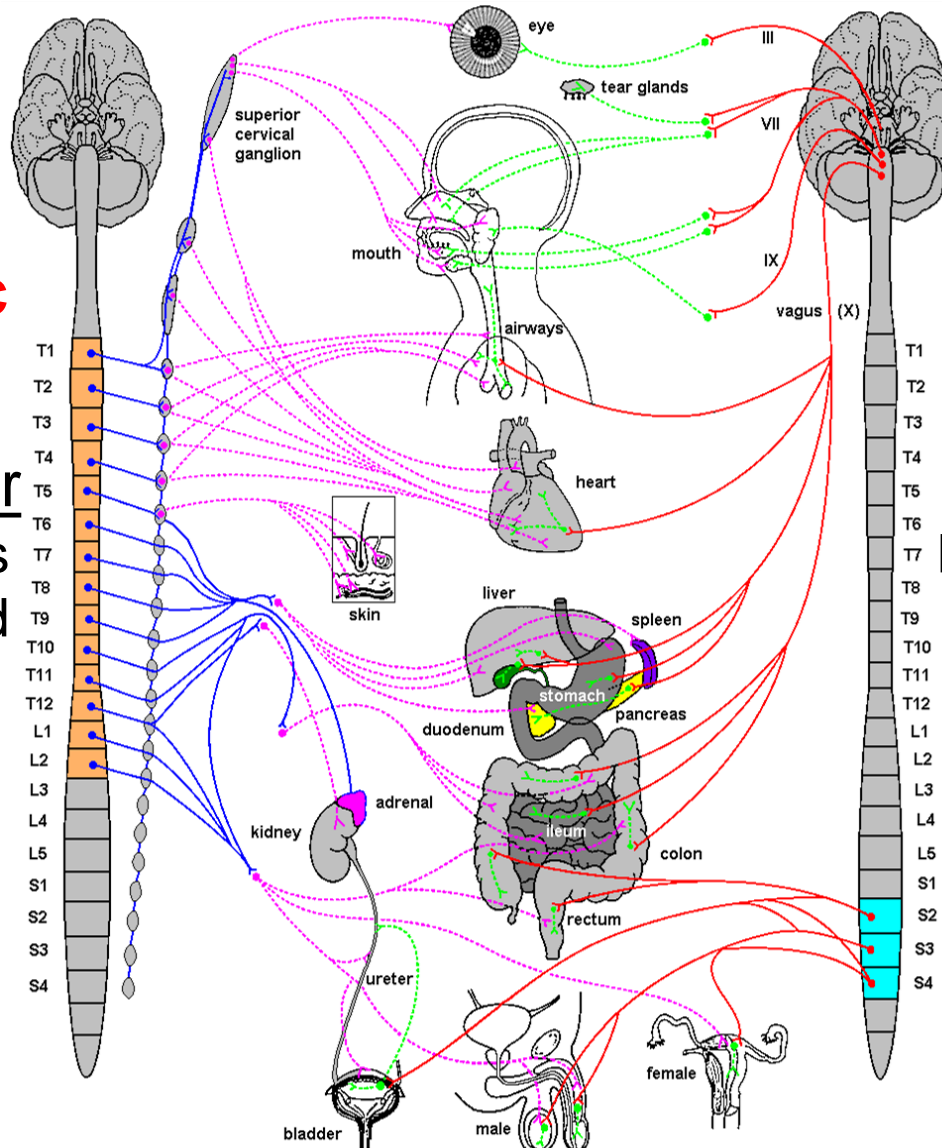
# Overview of the Autonomic Nervous System

## Differences between Sympathetic & Parasympathetic

### Location of Preganglionic Cell Bodies

**Sympathetic**

**Parasympathetic**



Thoracolumbar  
T1 – L2/L3 levels  
of the spinal cord

Craniosacral  
Brain: CN III, VII, IX, X  
Spinal cord: S2 – S4

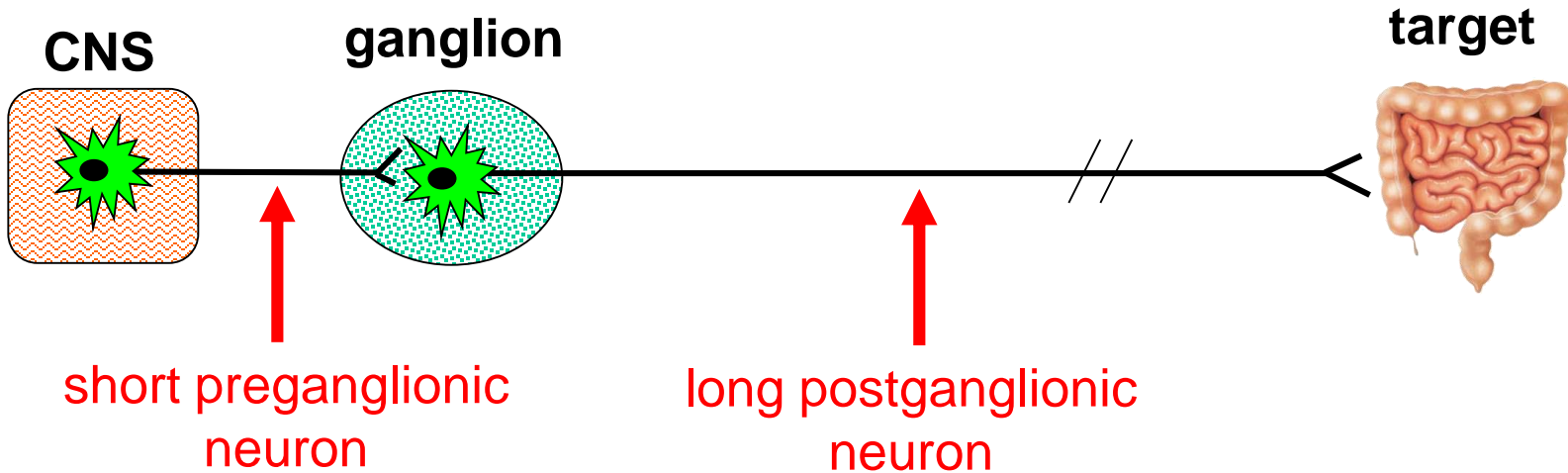


# Overview of the Autonomic Nervous System

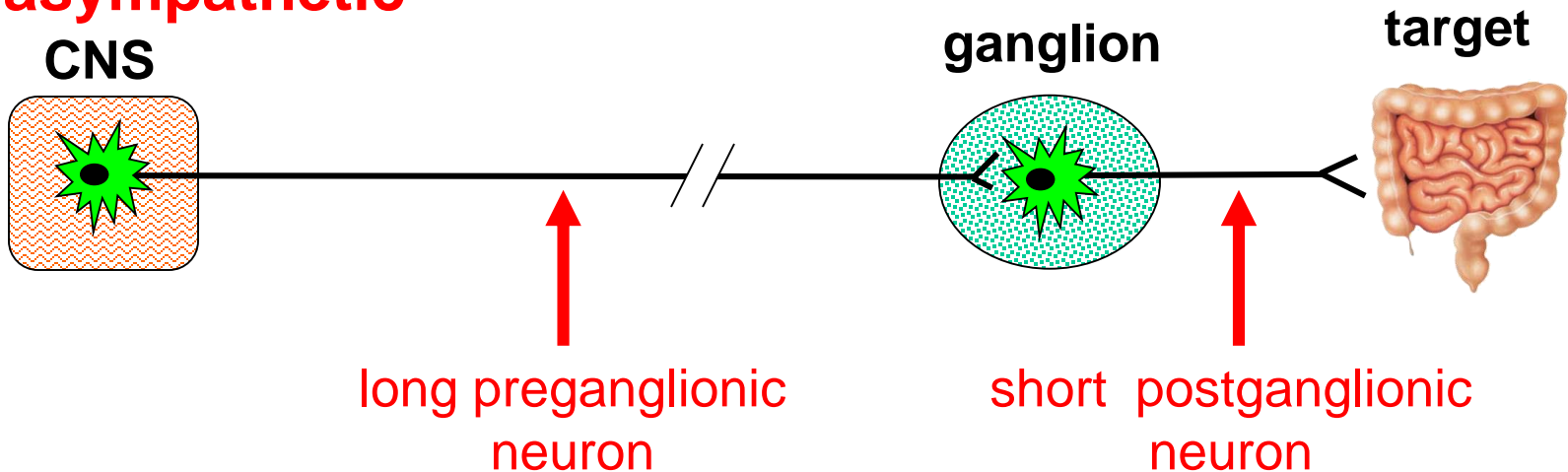
## Differences between Sympathetic & Parasympathetic

### Relative Lengths of Neurons

#### Sympathetic



#### Parasympathetic

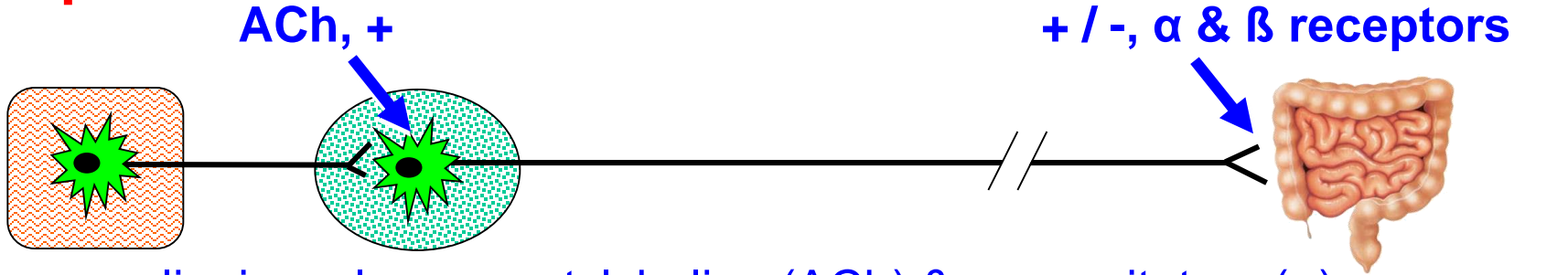


# Overview of the Autonomic Nervous System

## Differences between Sympathetic & Parasympathetic

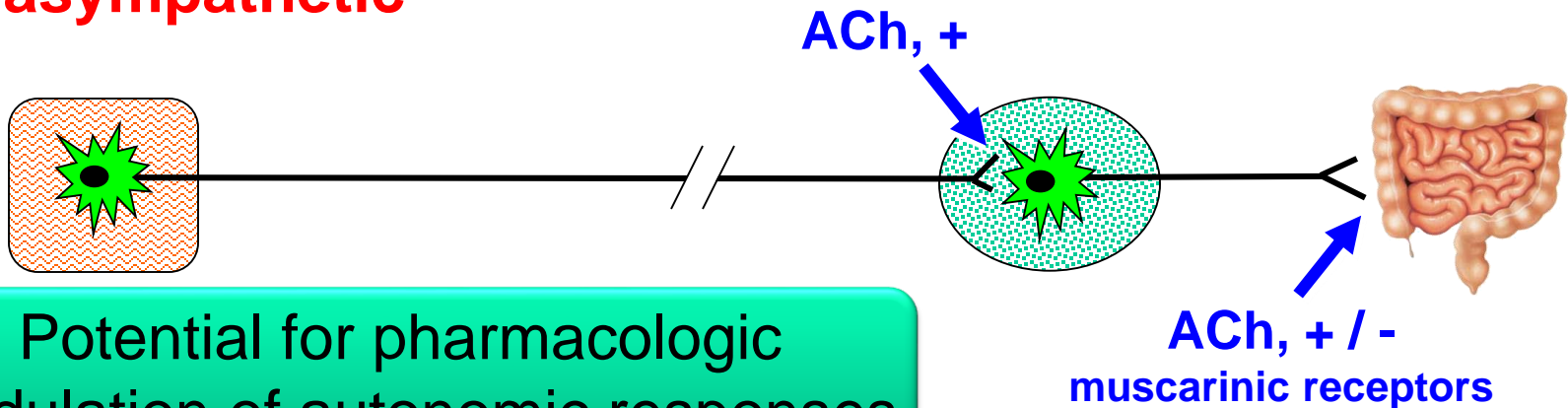
### Neurotransmitters

#### Sympathetic



- All preganglionics release acetylcholine (ACh) & are excitatory (+)
- Symp. postgangl. — norepinephrine (NE) & are excitatory (+) or inhibitory (-)
- Parasymp. postgangl. — ACh & are excitatory (+) or inhibitory (-)
- Excitation or inhibition is a receptor-dependent & receptor-mediated response

#### Parasympathetic



Potential for pharmacologic modulation of autonomic responses

# Overview of the Autonomic Nervous System

## Differences between Sympathetic & Parasympathetic

### Target Tissues

#### **Sympathetic**

- Organs of head, neck, trunk, & external genitalia
- Adrenal medulla
- Sweat glands in skin
- Arrector muscles of hair
- *ALL* vascular smooth muscle

#### **Parasympathetic**

- Organs of head, neck, trunk, & external genitalia

- » Sympathetic system is distributed to essentially all tissues (because of vascular smooth muscle)
- » Parasympathetic system never reaches limbs or body wall (except for external genitalia)



# Overview of ANS

## Functional Differences

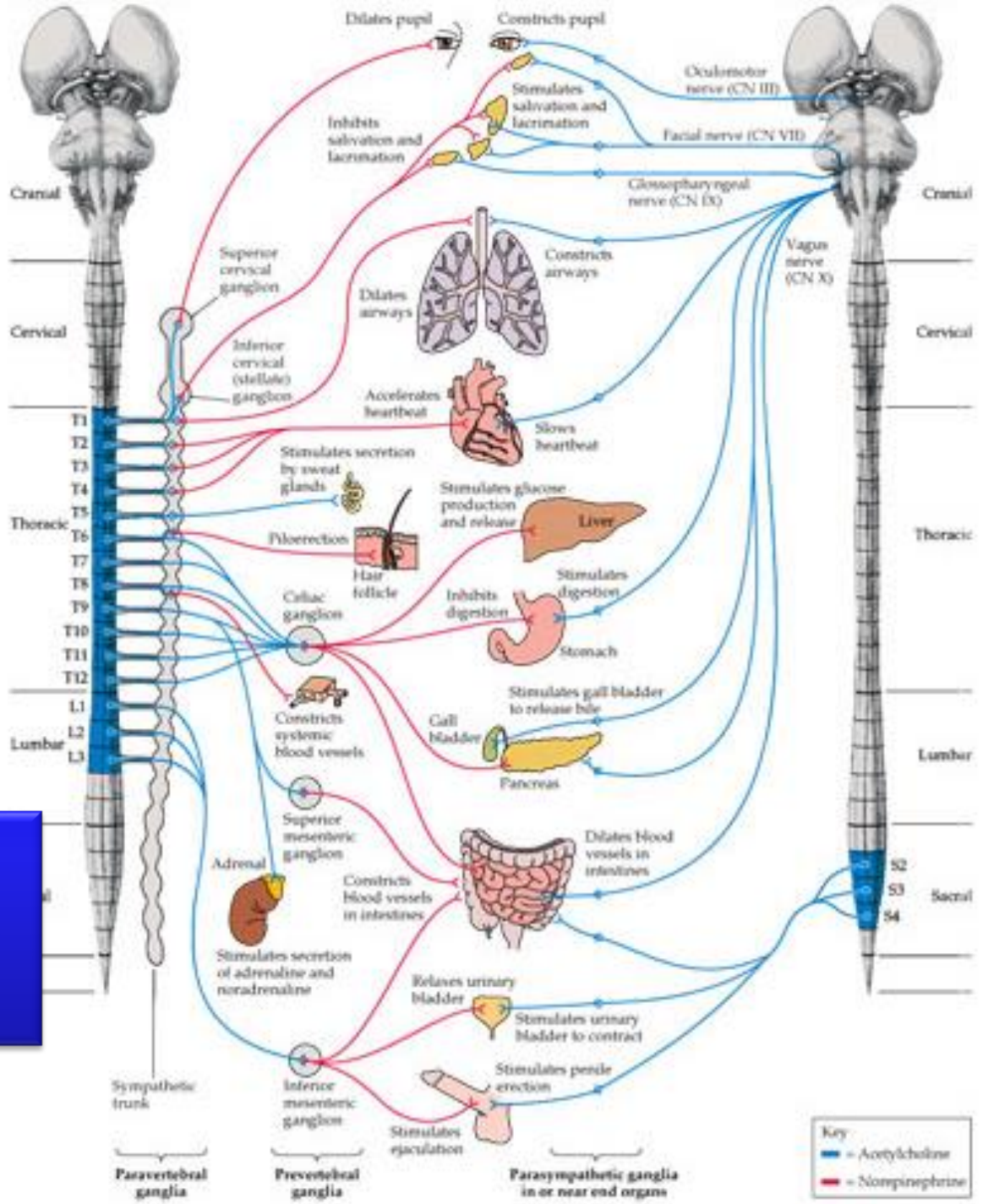
### Sympathetic

- “Fight or flight”
- Catabolic (expend energy)

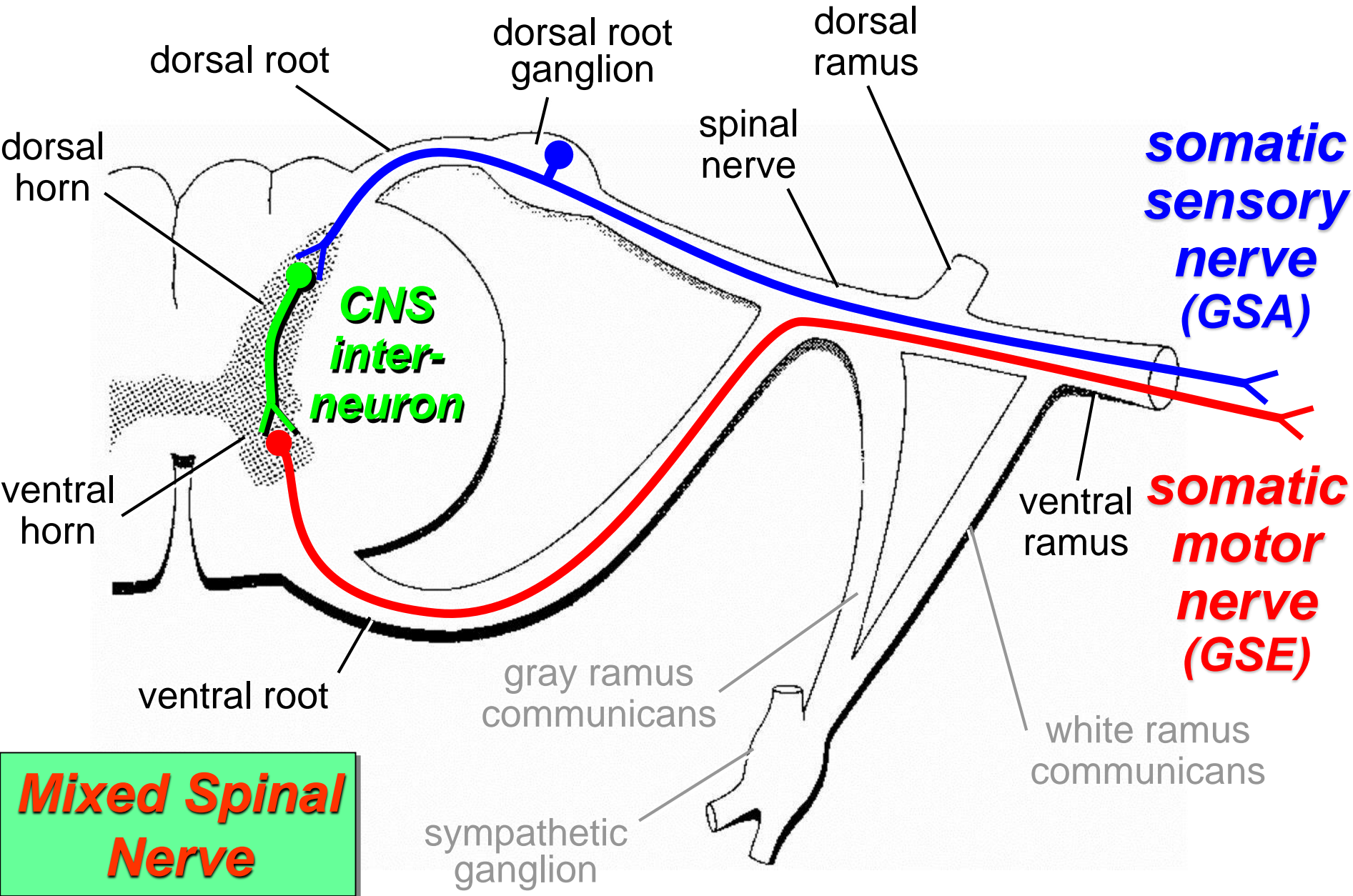
### Parasympathetic

- “Feed & breed”, “rest & digest”
- Homeostasis

» Dual innervation of many organs — having a brake and an accelerator provides more control

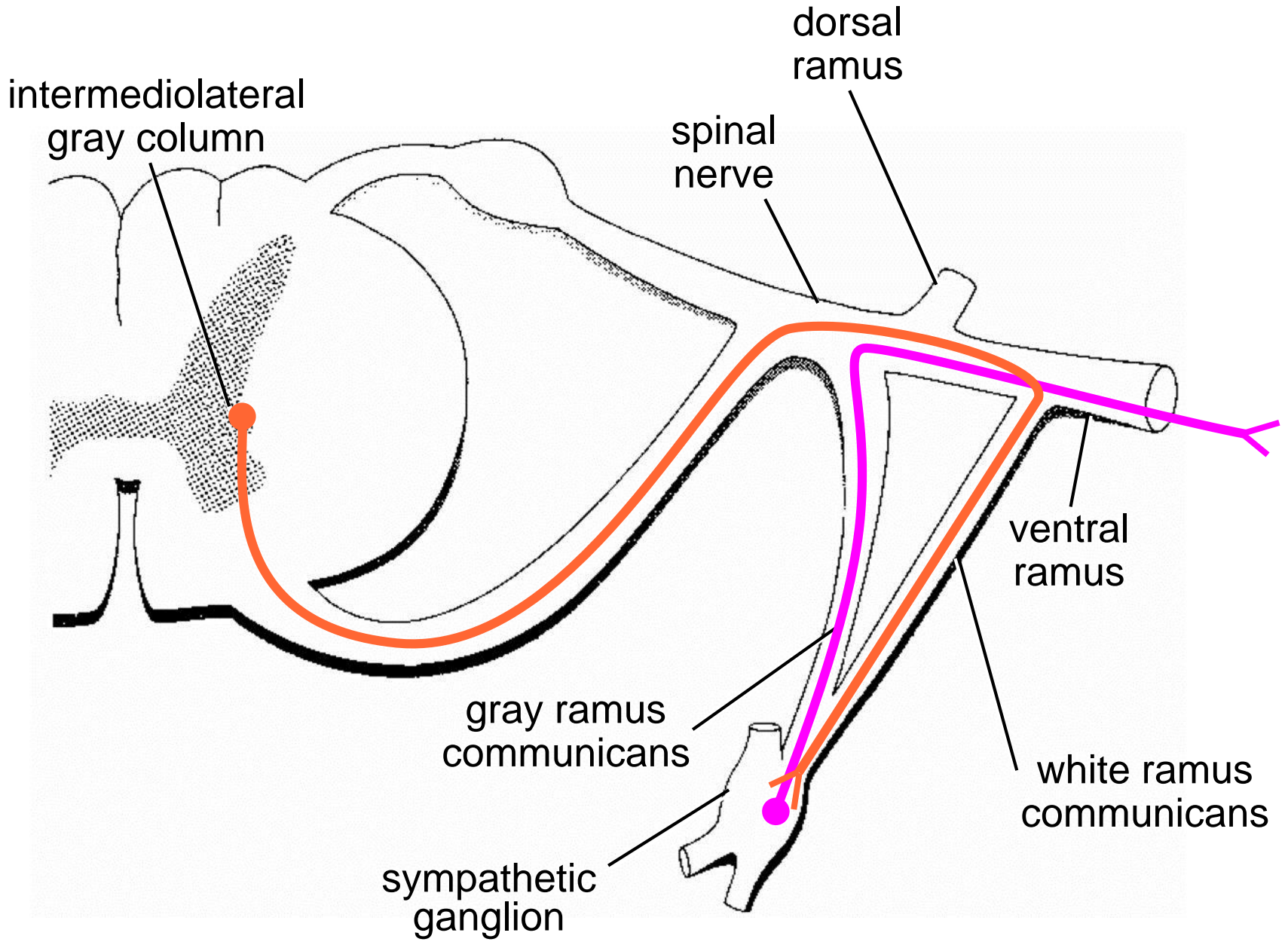


# Structure of spinal nerves: Somatic pathways



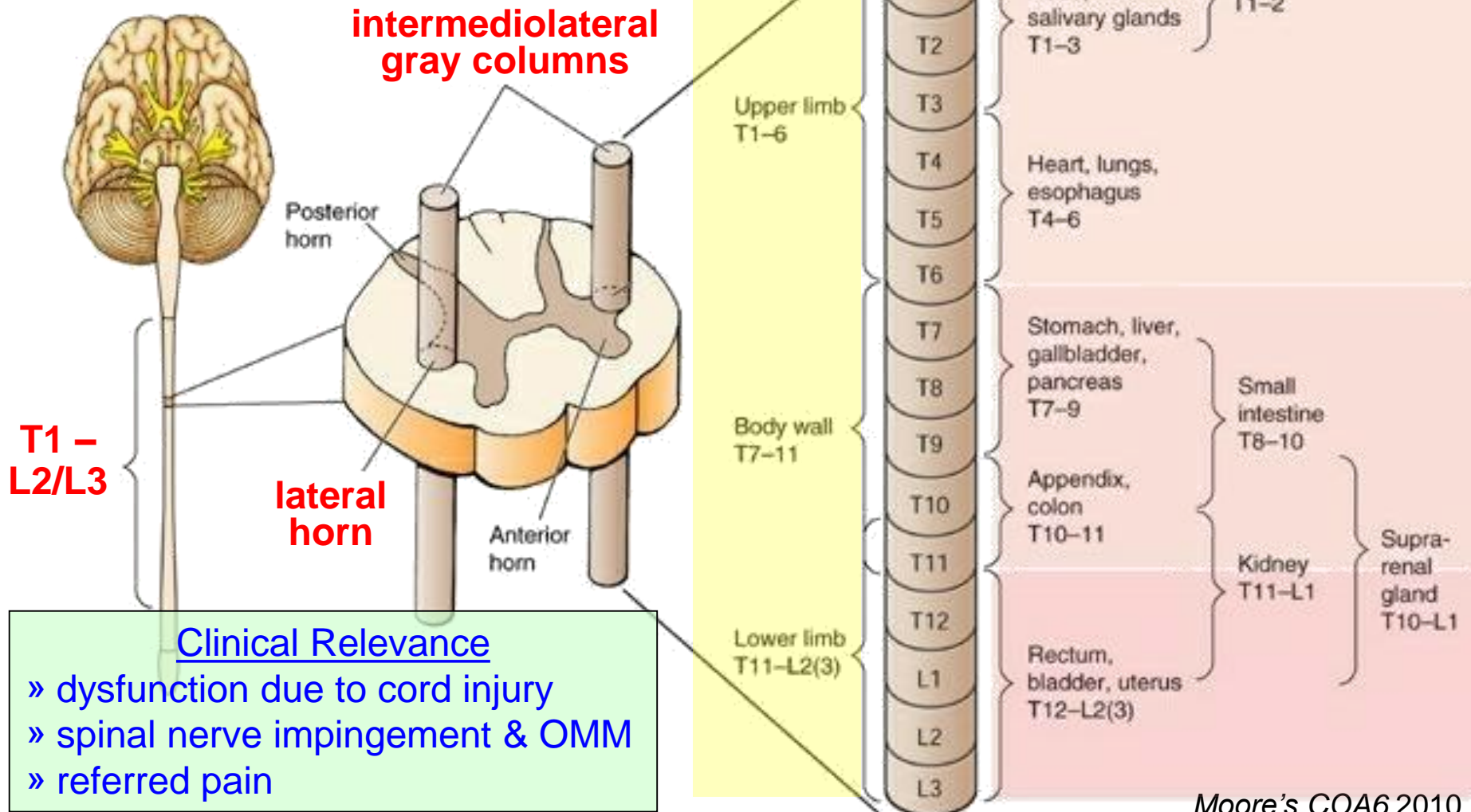


# Structure of spinal nerves: Sympathetic pathways



# Sympathetic System: Preganglionic Cell Bodies

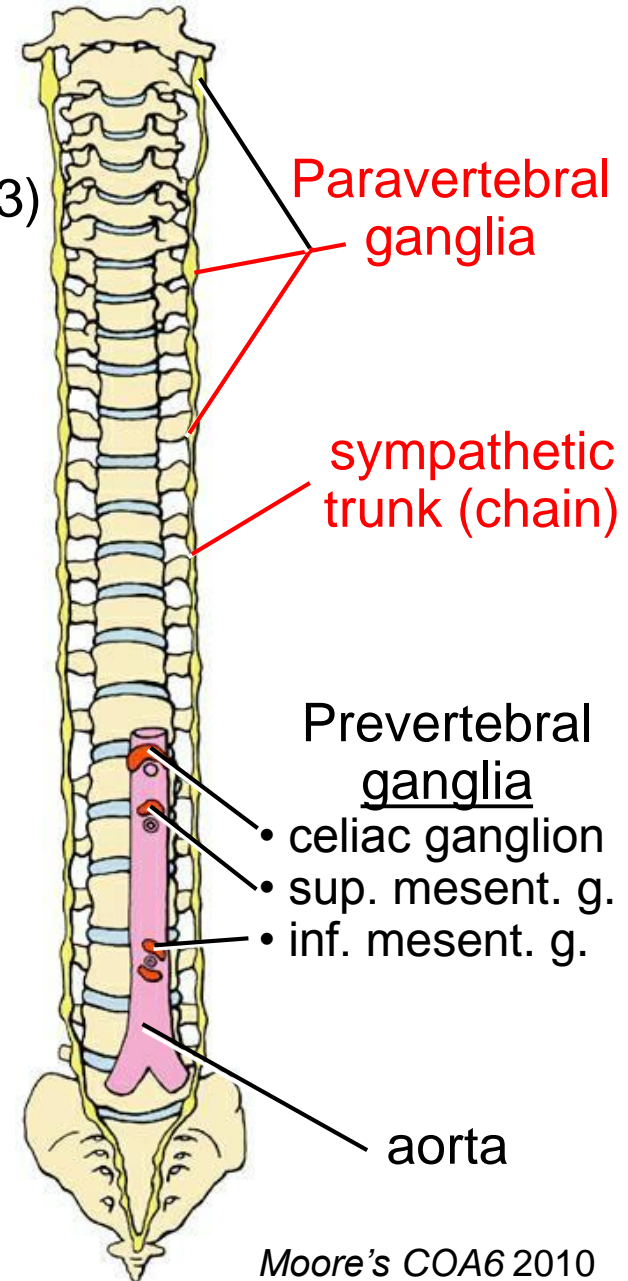
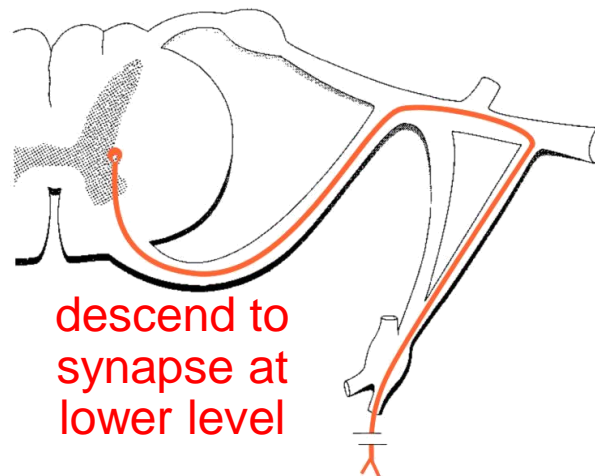
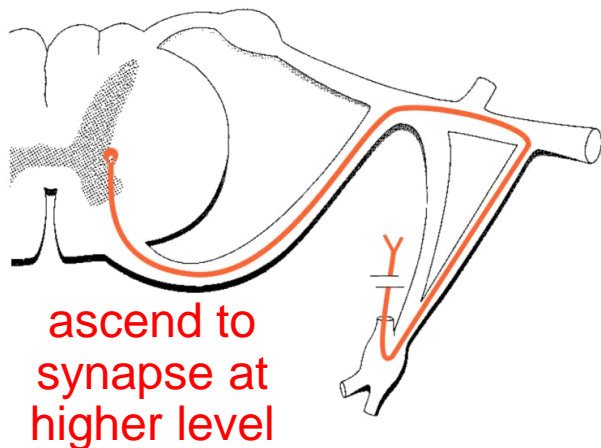
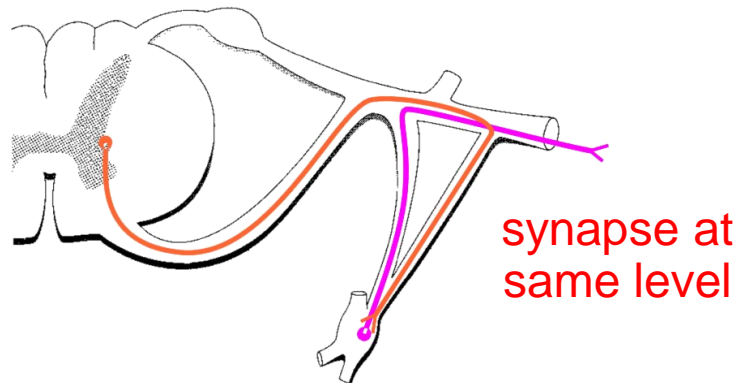
- Preganglionic cell bodies in intermediolateral gray
- T1 – L2/L3
- Somatotopic organization



# Sympathetic System: Postganglionic Cell Bodies

## 1. Paravertebral ganglia

- Located along sides of vertebrae
- United by preganglionics into Sympathetic Trunk
- Preganglionic neurons are thoracolumbar (T1–L2/L3) but postganglionic neurons are cervical to coccyx
- Some preganglionics ascend or descend in trunk

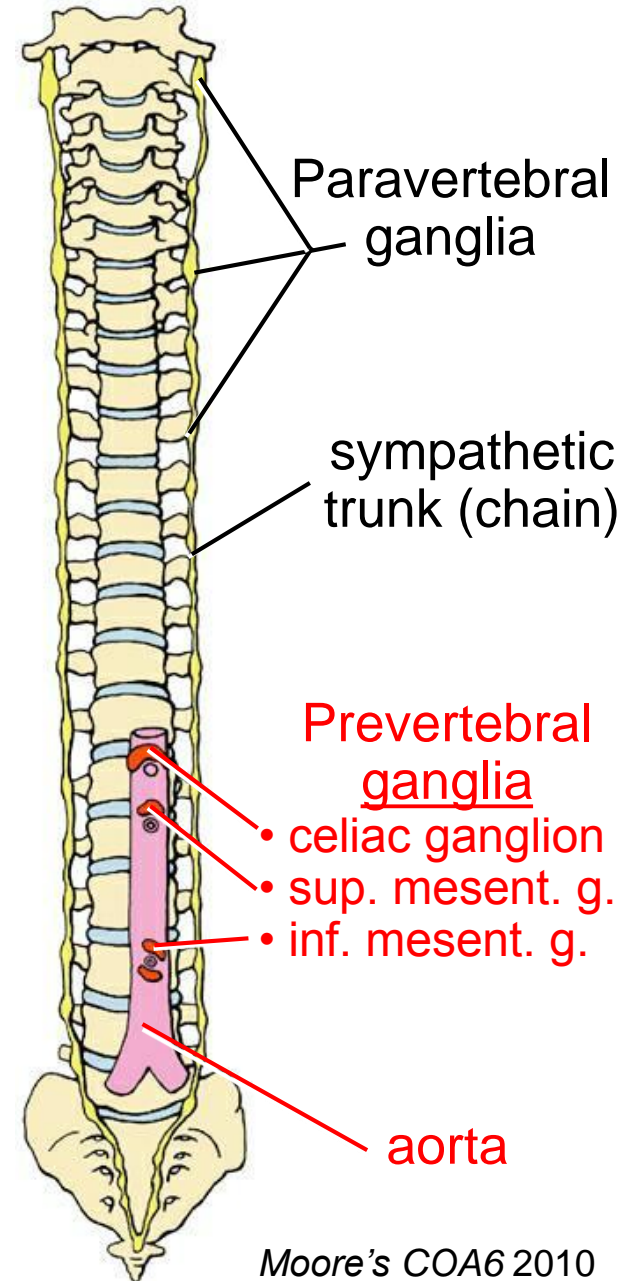
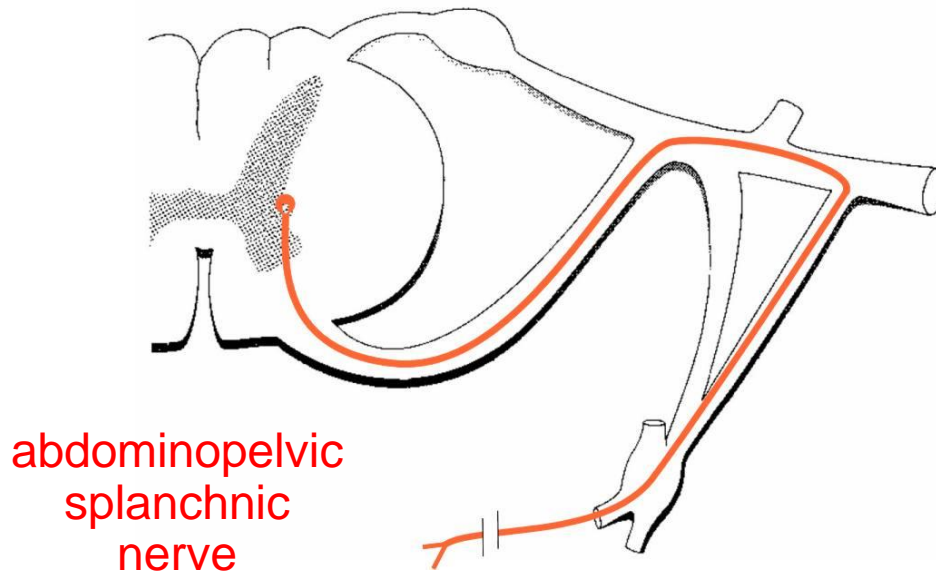




# Sympathetic System: Postganglionic Cell Bodies

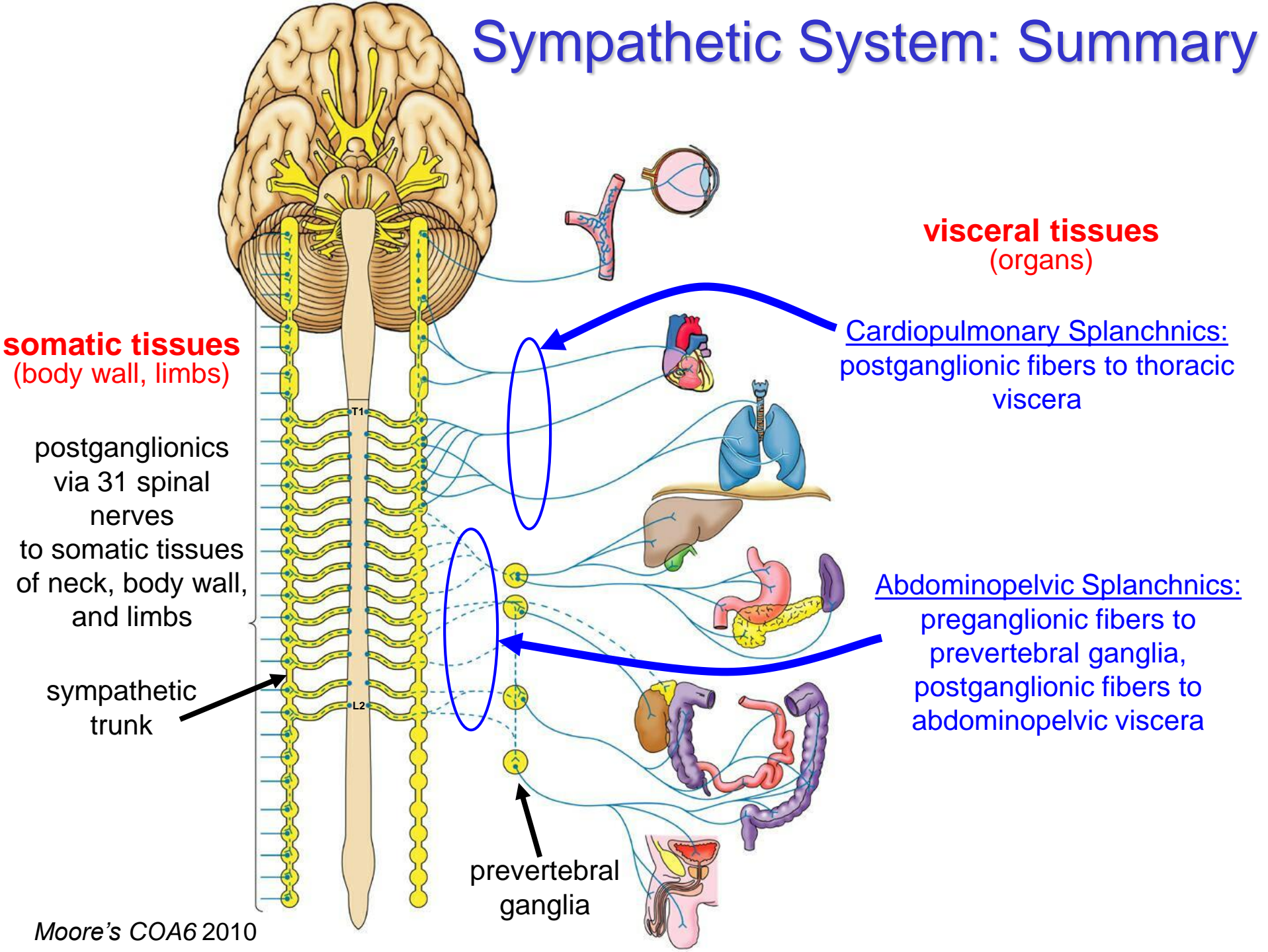
## 2. Prevertebral (preaortic) ganglia

- Located anterior to abdominal aorta, in plexuses surrounding its major branches
- Preganglionics reach prevertebral ganglia via abdominopelvic splanchnic nerves





# Sympathetic System: Summary



# Parasympathetic Pathways

## Cranial outflow

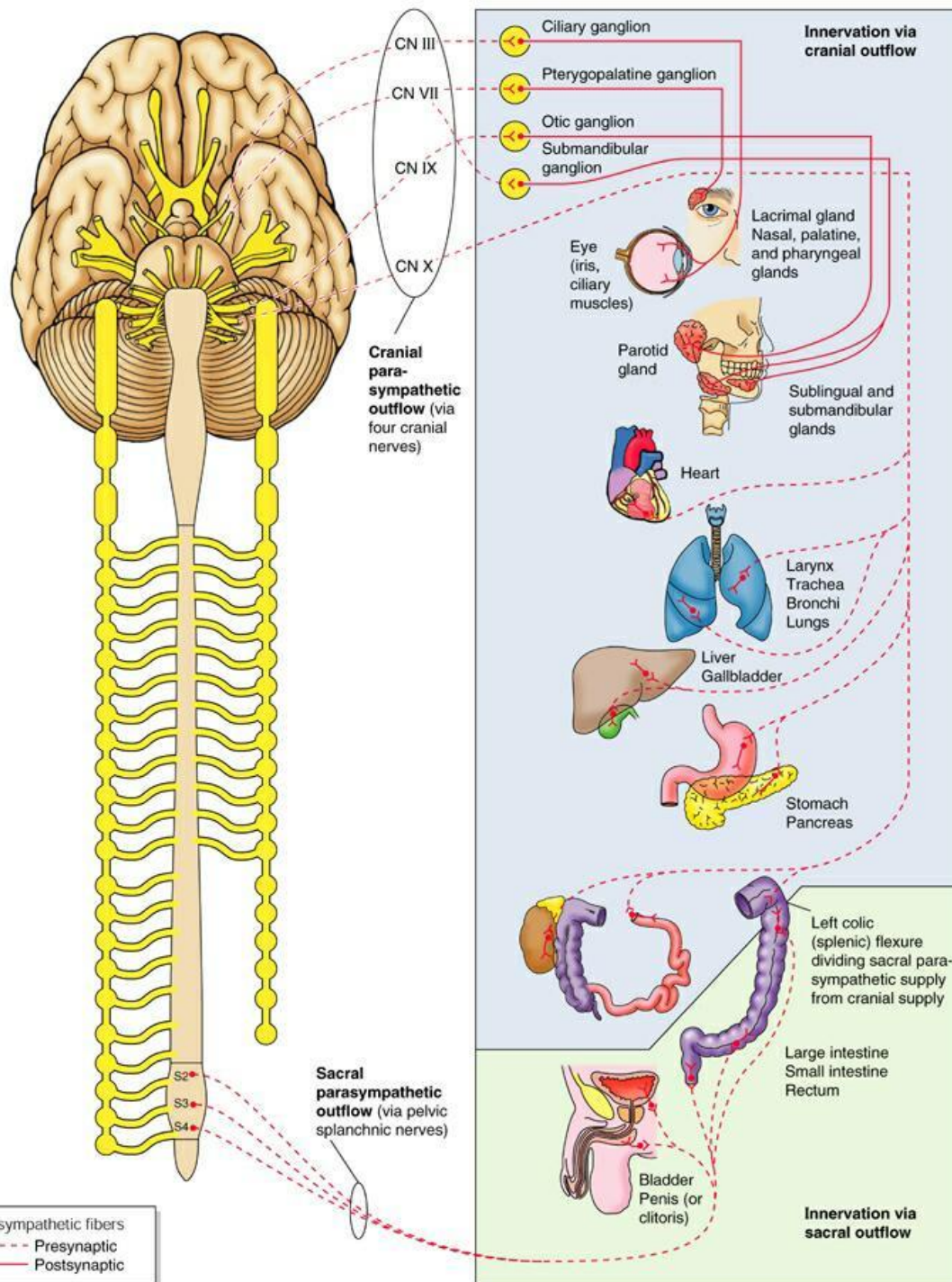
- CN III, VII, IX, X
- Four ganglia in head
- Vagus nerve (CN X) is major preganglionic parasymp. supply to thorax & abdomen
- Synapse in ganglia within wall of the target organs (e.g., enteric plexus of GI tract)

## Sacral outflow

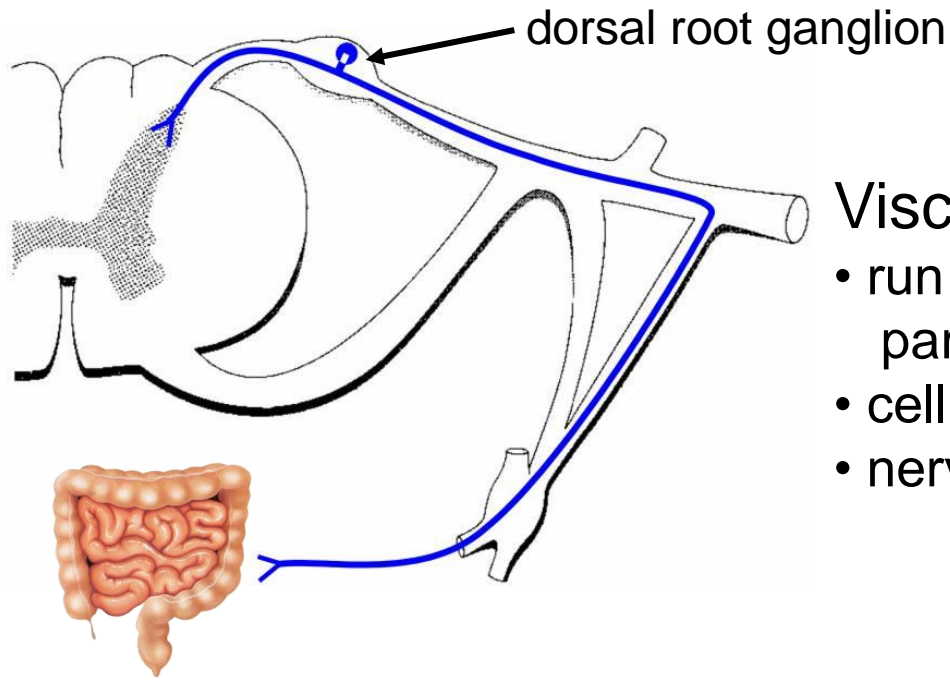
- S2–S4 via pelvic splanchnics
- Hindgut, pelvic viscera, and external genitalia

## Clinical Relevance

- » Surgery for colorectal cancer puts pelvic splanchnics at risk
- » Damage causes bladder & sexual dysfunction



# Visceral Afferents and Referred Pain



## Visceral sensory nerves [GVA]

- run with sympathetic & parasympathetic nerves
- cell bodies in dorsal root ganglion
- nerve ending in viscera

## Somatic sensation:

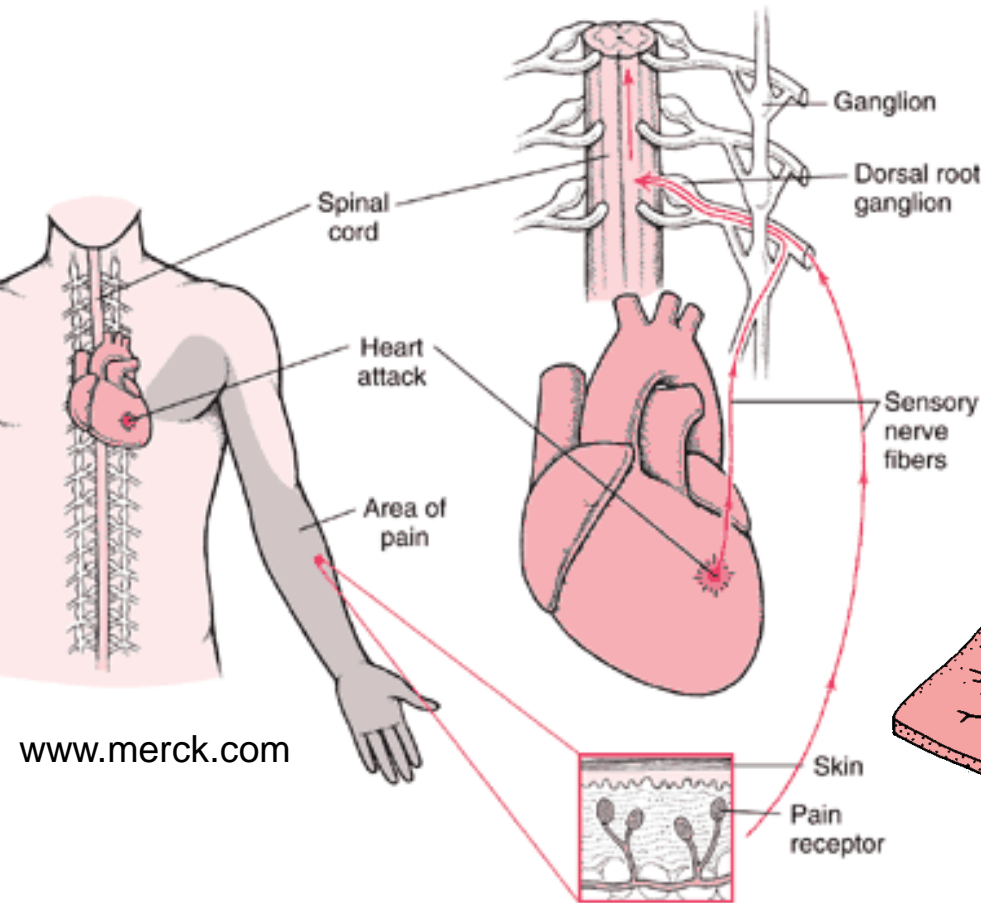
- conscious, sharp, well-localized
- touch, pain, temperature, pressure, proprioception

## Visceral sensation:

- often unconscious; if conscious: dull, poorly-localized
- distension, blood gas, blood pressure, cramping, irritants

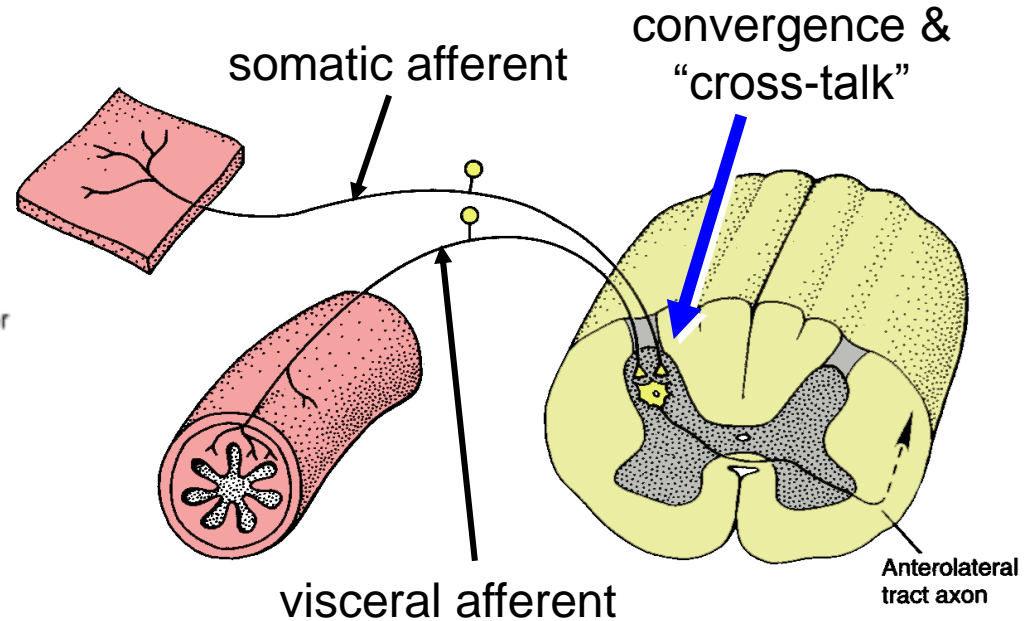


# Visceral Afferents and Referred Pain



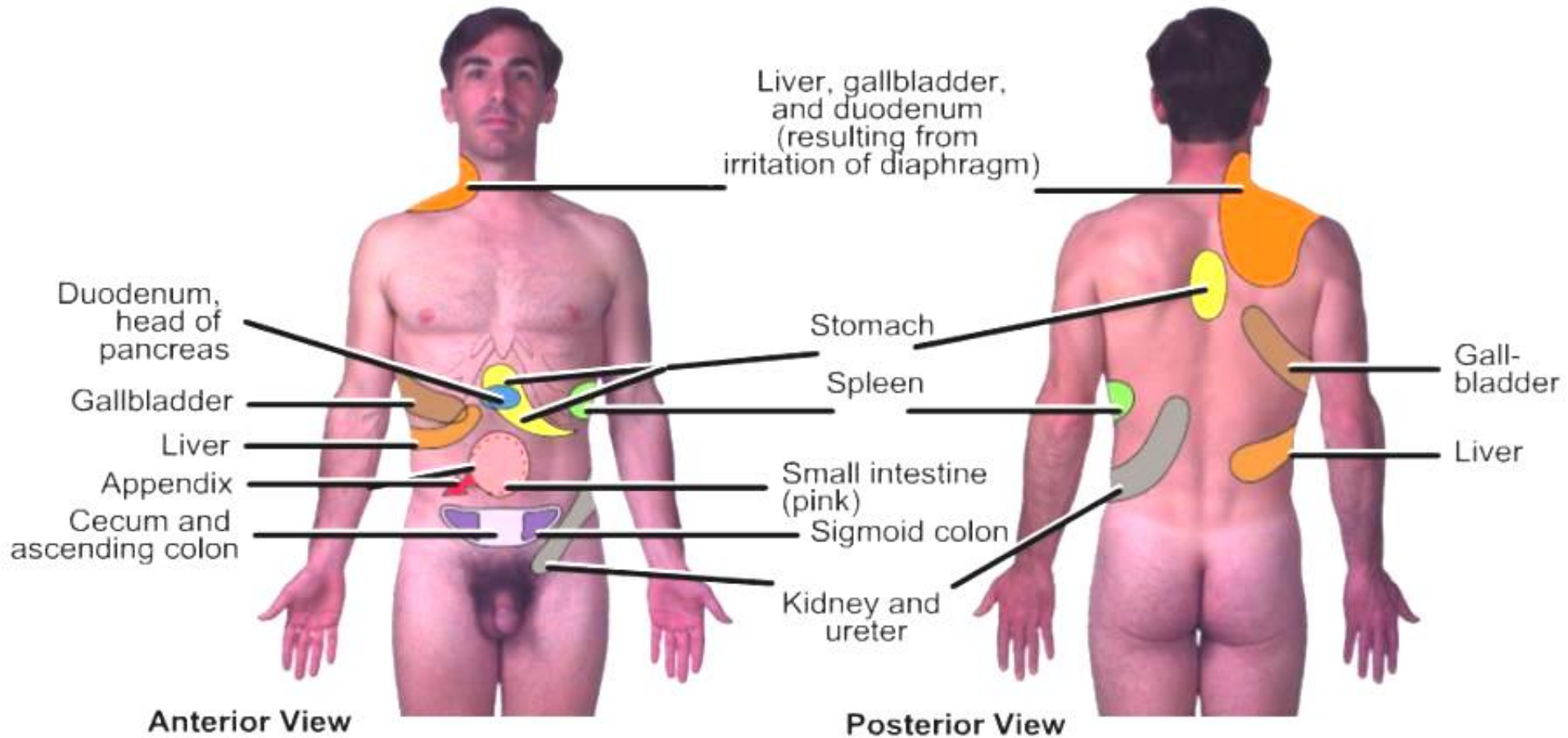
## Referred Pain:

- Pain originating in a visceral structure perceived as being from an area of skin innervated by the same segmental level as the visceral afferent
- Results from convergence of somatic & visceral afferents on the same segmental level of the spinal cord
- “Cross-talk” in the dorsal horn



# Visceral Afferents and Referred Pain

## Maps of Referred Pain



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