AUTONOMIC NERVOUS SYSTEM

- **The autonomic nervous system is the part of the nervous system that supplies the internal organs, including the blood vessels, stomach, intestine, liver, kidneys, bladder, genitals, lungs, pupils, heart, and sweat gland, salivary gland, and digestive glands.**
- **ANS -: glands – secretomotor**
- **Almost all glands supply- parasym.**
- **Exception- sweat gland (s)**

- **Area for ANS in CH- hypothalamus and prefrontal cortex.**
- **In brainstem- cranial nerve nuclei**
- **In spinal cord- intermediolateral grey column**

The autonomic nervous system has two main divisions:

1. Sympathetic

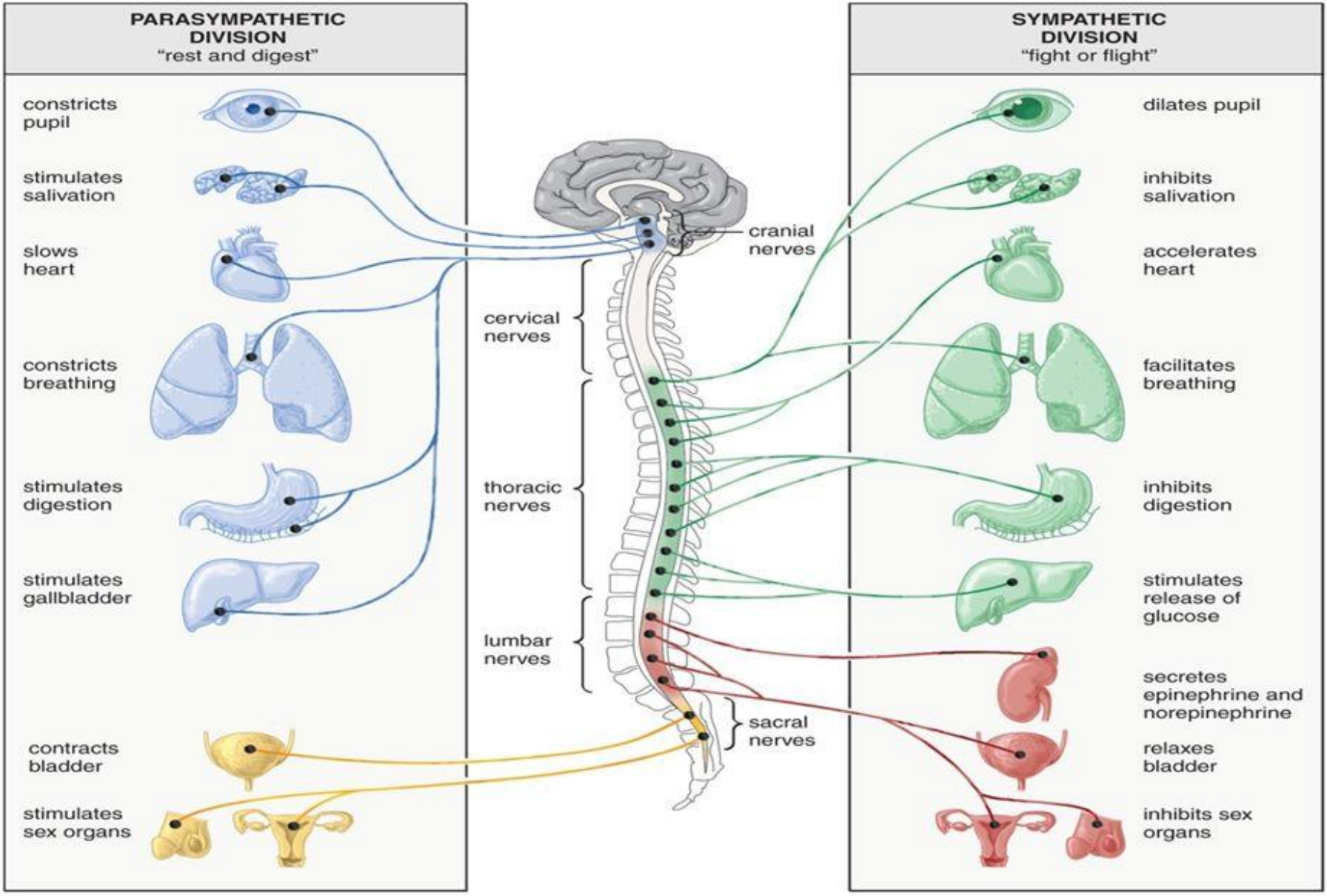
2. Parasympathetic

Most organs have dual innervation. In general, nerve impulses from one division of the ANS stimulate the organ to increase its activity (excitation), and impulses from the other division decrease the organ's activity (inhibition).

- **The sympathetic division is often called the fight-or-flight division. Sympathetic activities result in increased alertness and metabolic activities in order to prepare the body for an emergency situation.**

- **The parasympathetic division is often referred to as the rest and-digest division because its activities conserve and restore body energy during times of rest or digesting a meal. The parasympathetic division conserves energy and refill nutrient stores.**

The Autonomic Nervous System (Ch 13)



- **The autonomic nervous system contains two types of neurons**

1. Preganglionic neurons- Its cell body is in the brain or spinal cord, and its axon exits the CNS as part of a cranial or spinal nerve.

These preganglionic neurons form synapses with postganglionic neurons at autonomic ganglia that decorate either side of the spinal cord.

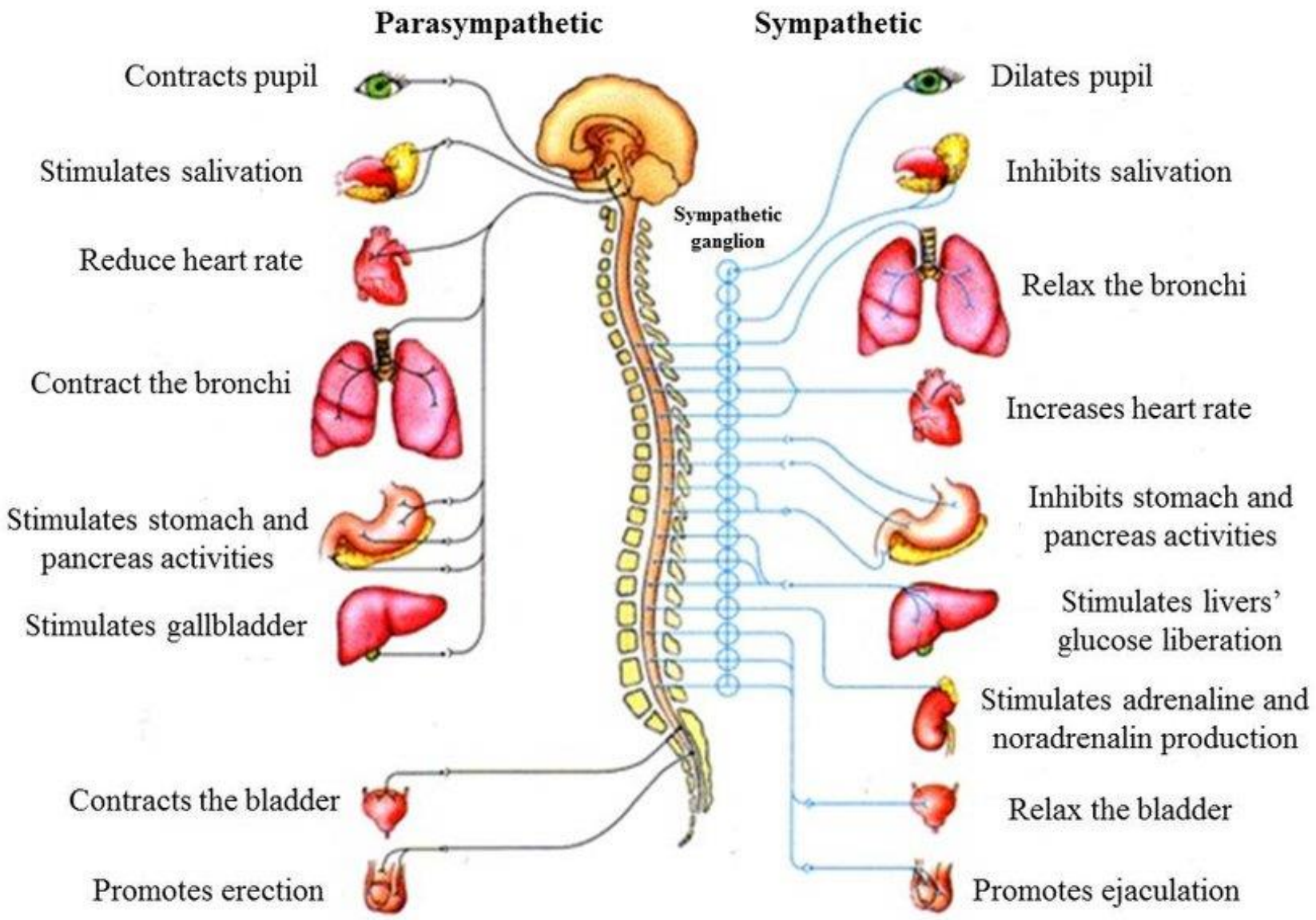
C

In the sympathetic division, the preganglionic neurons have their cell bodies in the lateral horns of the gray matter in the 12 thoracic segments and the first 2 or 3 lumbar segments of the spinal cord. For this reason, the sympathetic division is also called the thoracolumbar division and the axons of the sympathetic preganglionic neurons are known as the thoracolumbar outflow.

Cell bodies of preganglionic neurons of the parasympathetic division are located in the nuclei of four cranial nerves in the brain stem (III, VII, IX, and X) and in the lateral gray matter of the 2^{nd} to 4^{th} sacral segments of the spinal cord. Hence, the parasympathetic division is also known as the craniosacral division and the axons of the parasympathetic preganglionic neurons are referred to as the craniosacral outflow.

2. **Postganglionic neurons- lies entirely outside the CNS. Its cell body and dendrites are located in an autonomic ganglion, where it forms synapses with one or more preganglionic axons. The axon of a postganglionic neuron is terminates in a visceral effectors.**

Thus, preganglionic neurons convey nerve impulses from the CNS to autonomic ganglia, and postganglionic neurons relay the impulses from autonomic ganglia to visceral effectors.


Parasympathetic
Sympathetic
Contracts pupil
Stimulates salivation
Reduce heart rate
Contract the bronchi
Stimulates stomach and pancreas activities
Stimulates gallbladder
Contracts the bladder
Promotes erection
Sympathetic ganglion
Dilates pupil
Inhibits salivation
Relax the bronchi
Increases heart rate
Inhibits stomach and pancreas activities
Stimulates livers' glucose liberation
Stimulates adrenaline and noradrenalin production
Relax the bladder
Promotes ejaculation

- **Autonomic Ganglia- There are two major groups of autonomic ganglia: (1) sympathetic ganglia, (2) parasympathetic ganglia**

SYMPATHETIC GANGLIA-

There are two major types of sympathetic ganglia: sympathetic trunk ganglia and prevertebral ganglia.

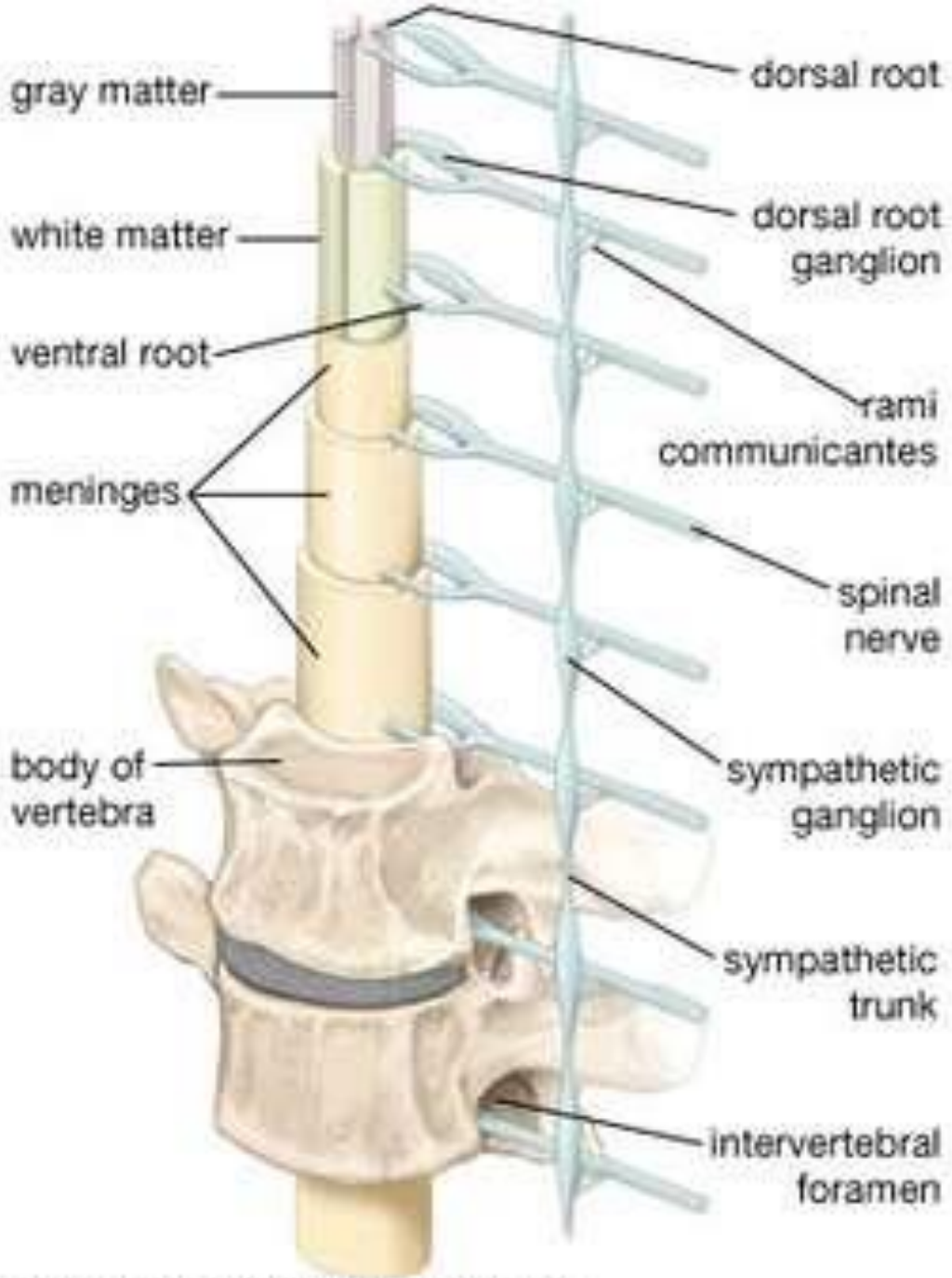
- **Sympathetic trunk ganglia (also called vertebral chain ganglia or paravertebral ganglia)- lie in a vertical row on either side of the vertebral column. These ganglia extend from the base of the skull to the coccyx. Postganglionic axons from sympathetic trunk ganglia primarily innervate organs above the diaphragm.**

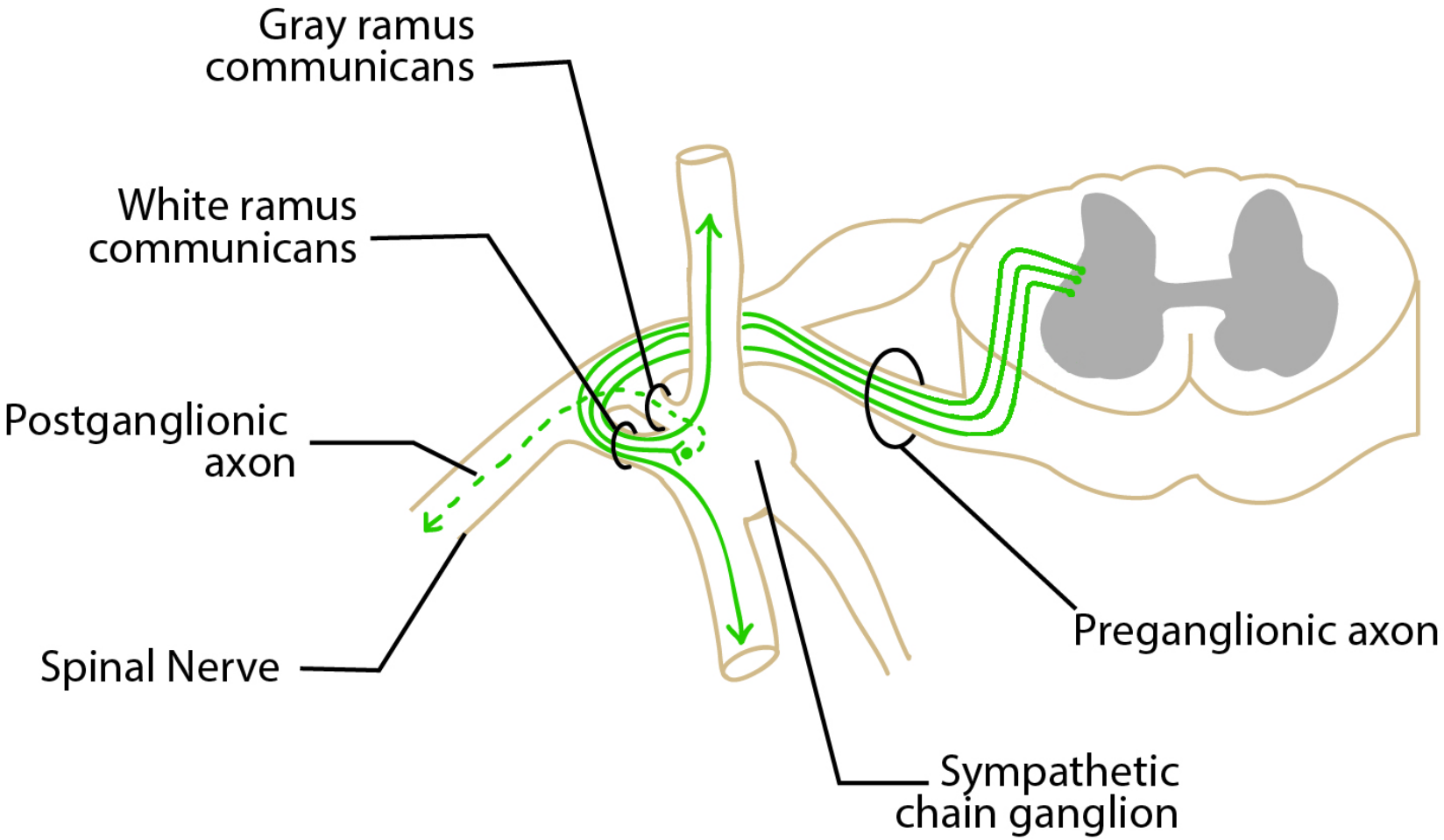
- **No. of Sympathetic trunk ganglia in cervical region-3 (superior, middle, and inferior cervical ganglia)**
- **In thorax-11**
- **In lumbar region-4**
- **In sacral region-4**

Note- inferior cervical + 1st thoracic ganglion= stellate ganglion

- **The remaining sympathetic trunk ganglia do not have individual names. Because the sympathetic trunk ganglia are near the spinal cord, most sympathetic preganglionic axons are short and most sympathetic postganglionic axons are long.**
- **sympathetic trunk ganglia fuse= sympathetic trunk- most easily seen part of ANS**
- **Sympathetic trunk are connected to the spinal nerves by- rami communicantes**
- **rami communicantes- 2 type (grey and white)**

- **White rami- carry fibers from spinal nerve to sympathetic trunk**
- **Grey rami- opposite function**




Gray ramus communicans
White ramus communicans
Postganglionic axon
Spinal Nerve
Preganglionic axon
Sympathetic chain ganglion

- **Prevertebral (collateral) ganglia- lies anterior to the vertebral column and close to the large abdominal arteries. In general, postganglionic axons from prevertebral ganglia innervate organs below the diaphragm. There are five major prevertebral ganglia**

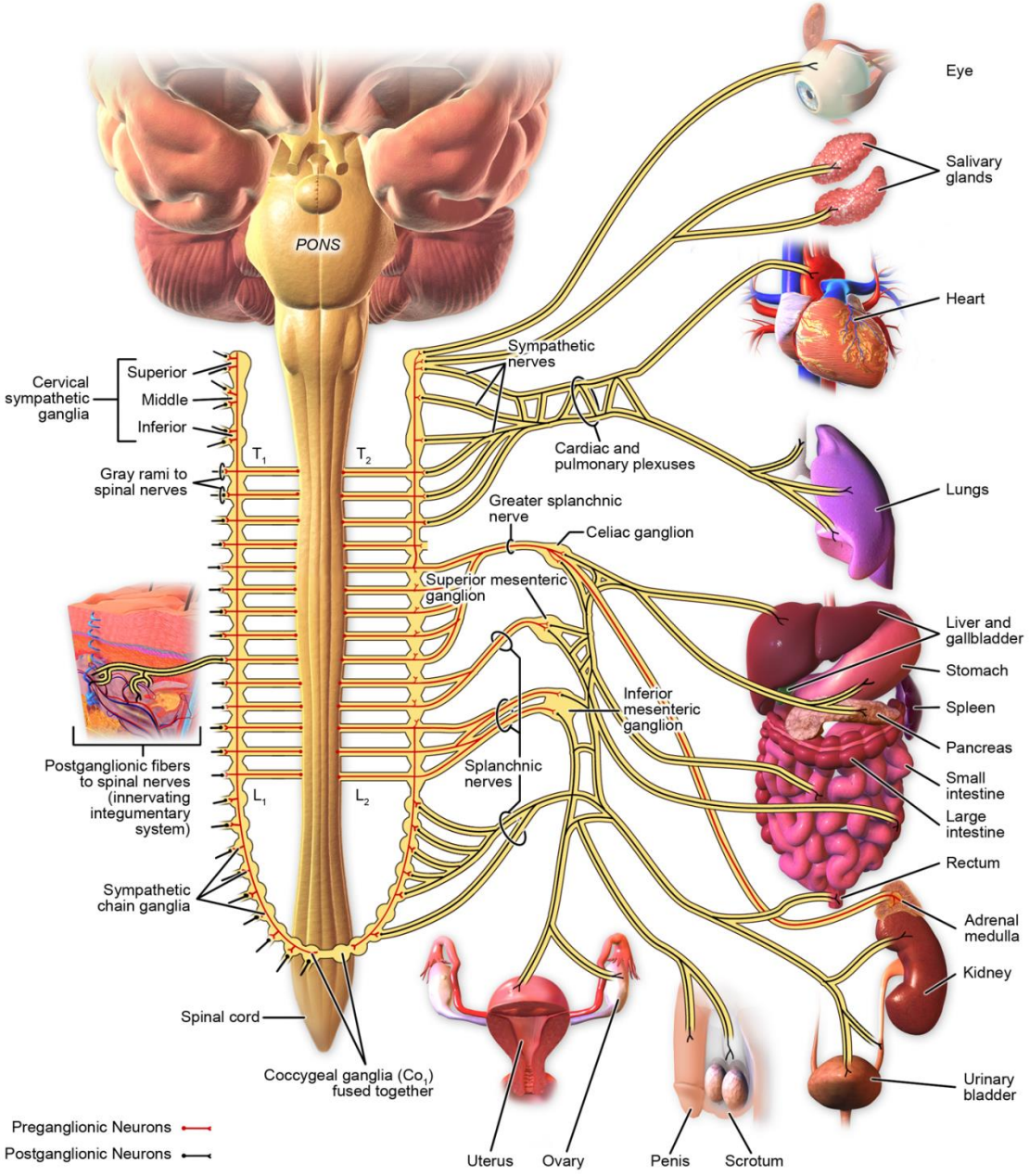
(1) The celiac ganglion is on either side of the celiac trunk.

(2) **The superior mesenteric ganglion is near to superior mesenteric artery.**

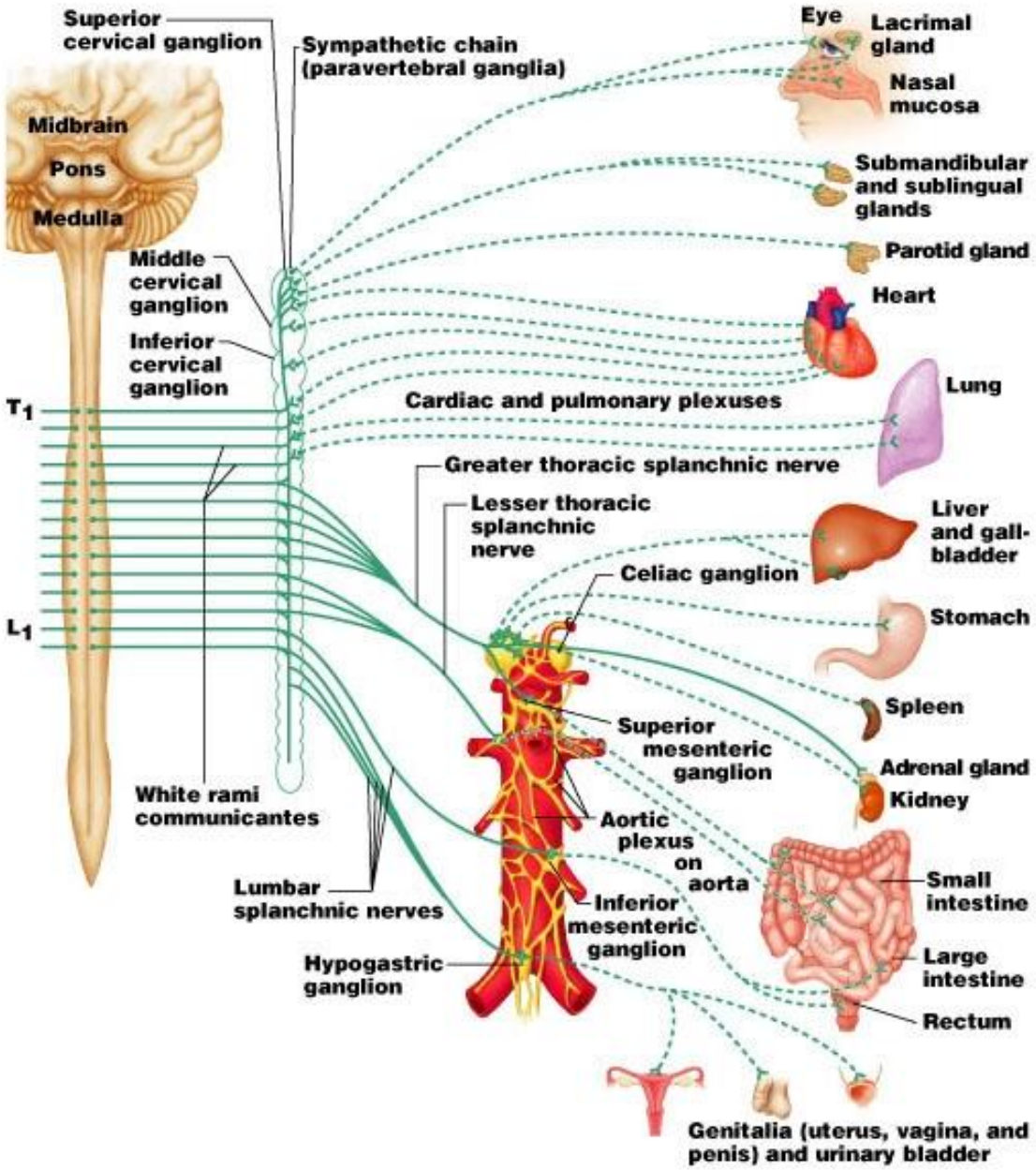
(3) The inferior mesenteric ganglion is near to inferior mesenteric artery

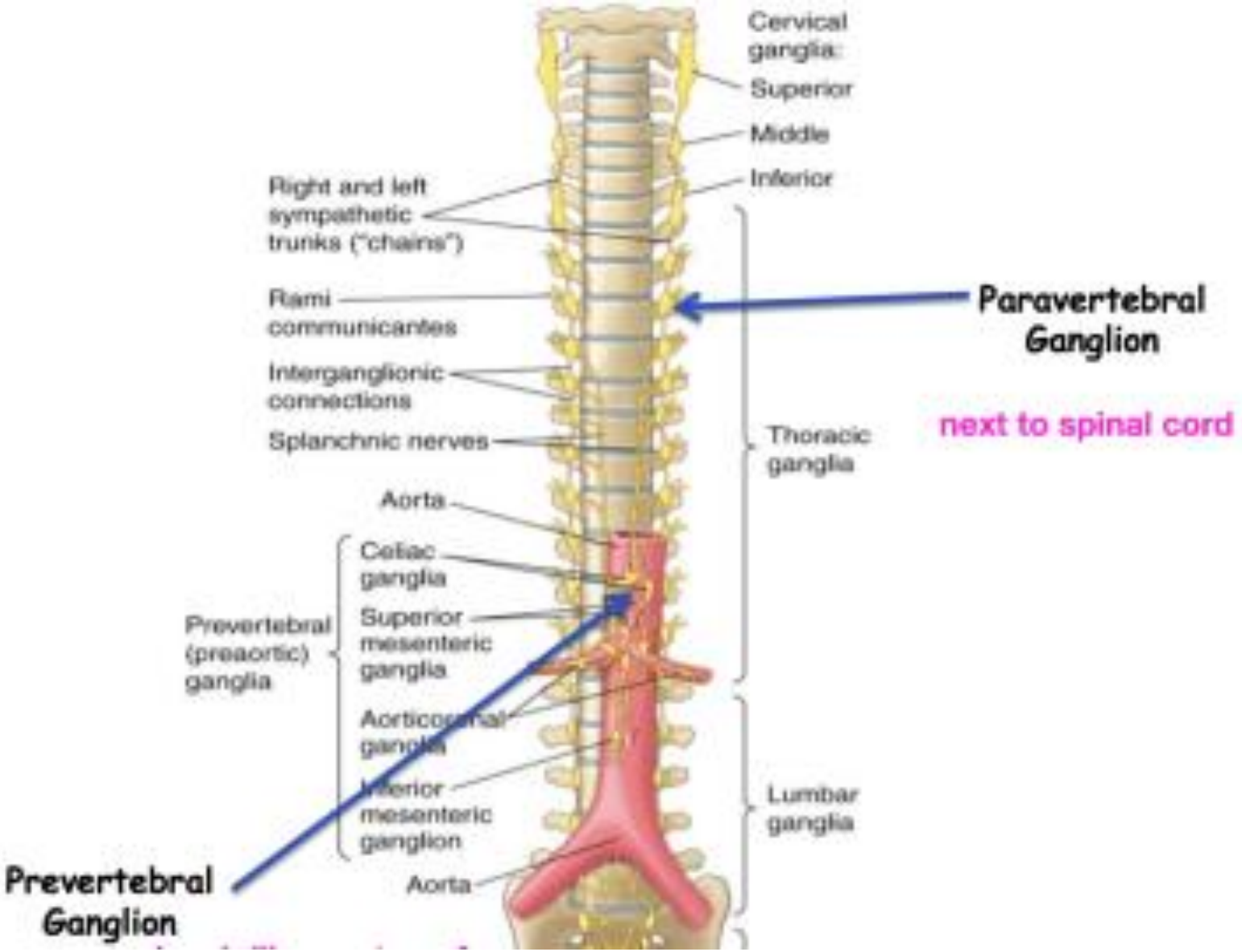
(4) The aorticorenal ganglion

(5) The renal ganglion are near the renal artery of each kidney.



Sympathetic Innervation



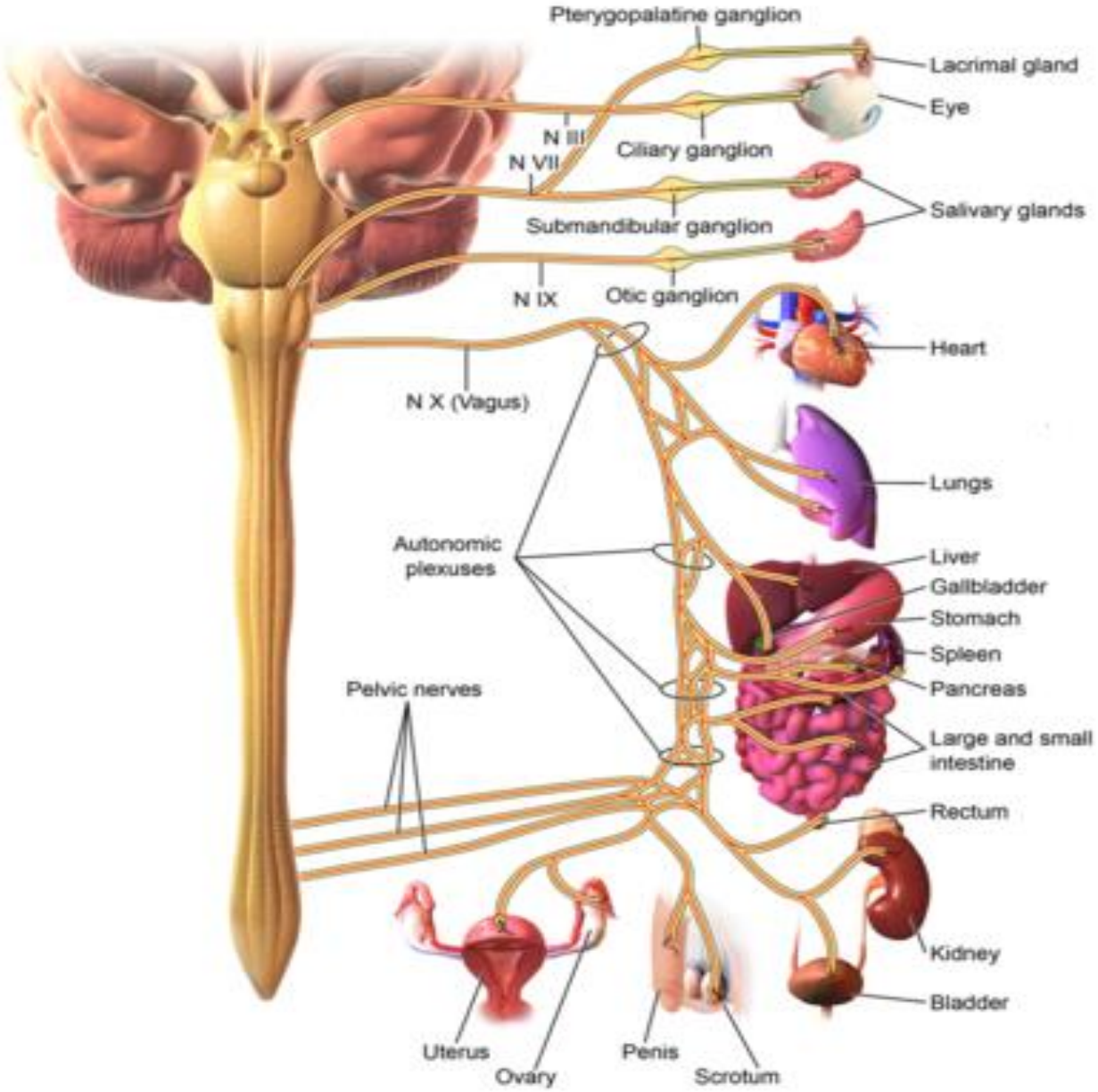

Cervical ganglia:
Superior
Middle
Inferior
Right and left sympathetic trunks ("chains")
Rami communicantes
Interganglionic connections
Splanchnic nerves
Aorta
Celiac ganglia
Superior mesenteric ganglia
Prevertebral (preaortic) ganglia
Aorticorenal ganglia
Inferior mesenteric ganglion
Aorta
Thoracic ganglia
Lumbar ganglia
Paravertebral Ganglion
next to spinal cord
Prevertebral Ganglion

PARASYMPATHETIC GANGLIA-

Preganglionic axons of the parasympathetic division synapse with postganglionic neurons in terminal (intramural) ganglia. Most of these ganglia are located close to or actually within the wall of a visceral organ.

Terminal ganglia in the head have specific names eg. ciliary ganglion, pterygopalatine ganglion, submandibular ganglion, and otic ganglion.

- **Parasympathetic preganglionic axons are long, in contrast to parasympathetic postganglionic axons, which are short.**



Parasympathetic Innervation

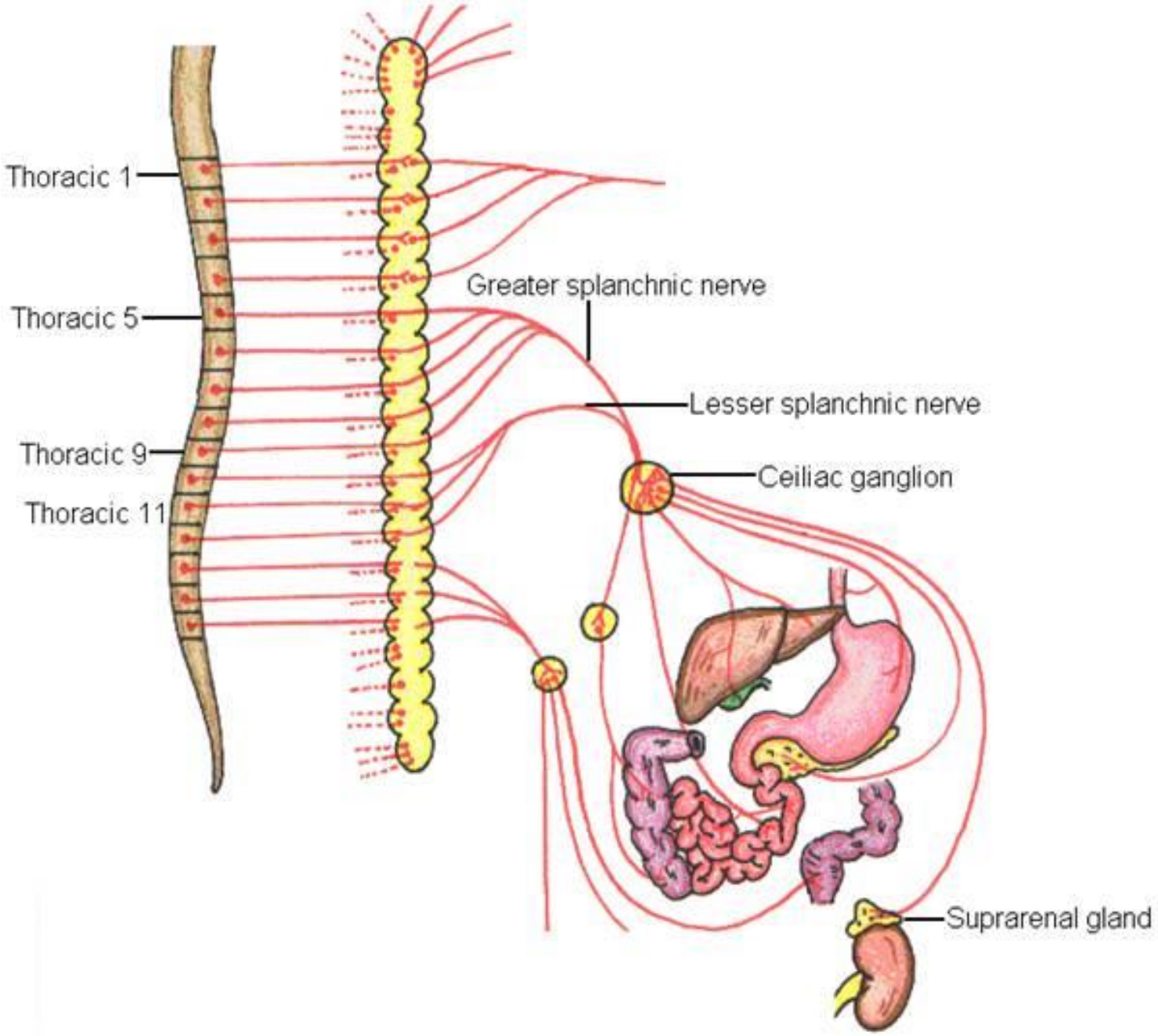
SPLANCHNIC NERVES

- **Some sympathetic preganglionic axons pass through the sympathetic trunk without terminating in it and extend to outlying prevertebral ganglia.**

- **Splanchnic nerves to abdominopelvic organs- Most sympathetic preganglionic axons that enter splanchnic nerves are destined to synapse with sympathetic postganglionic neurons in the prevertebral ganglia that supply the organs of the abdominopelvic cavity.**
- **Preganglionic axons from T5–T9 or T10 form the greater splanchnic nerve. It pierces the diaphragm, and enters the celiac ganglion of the celiac plexus. From there, postganglionic neurons follow and innervate blood vessels to the stomach, spleen, liver, kidneys, and small intestine.**

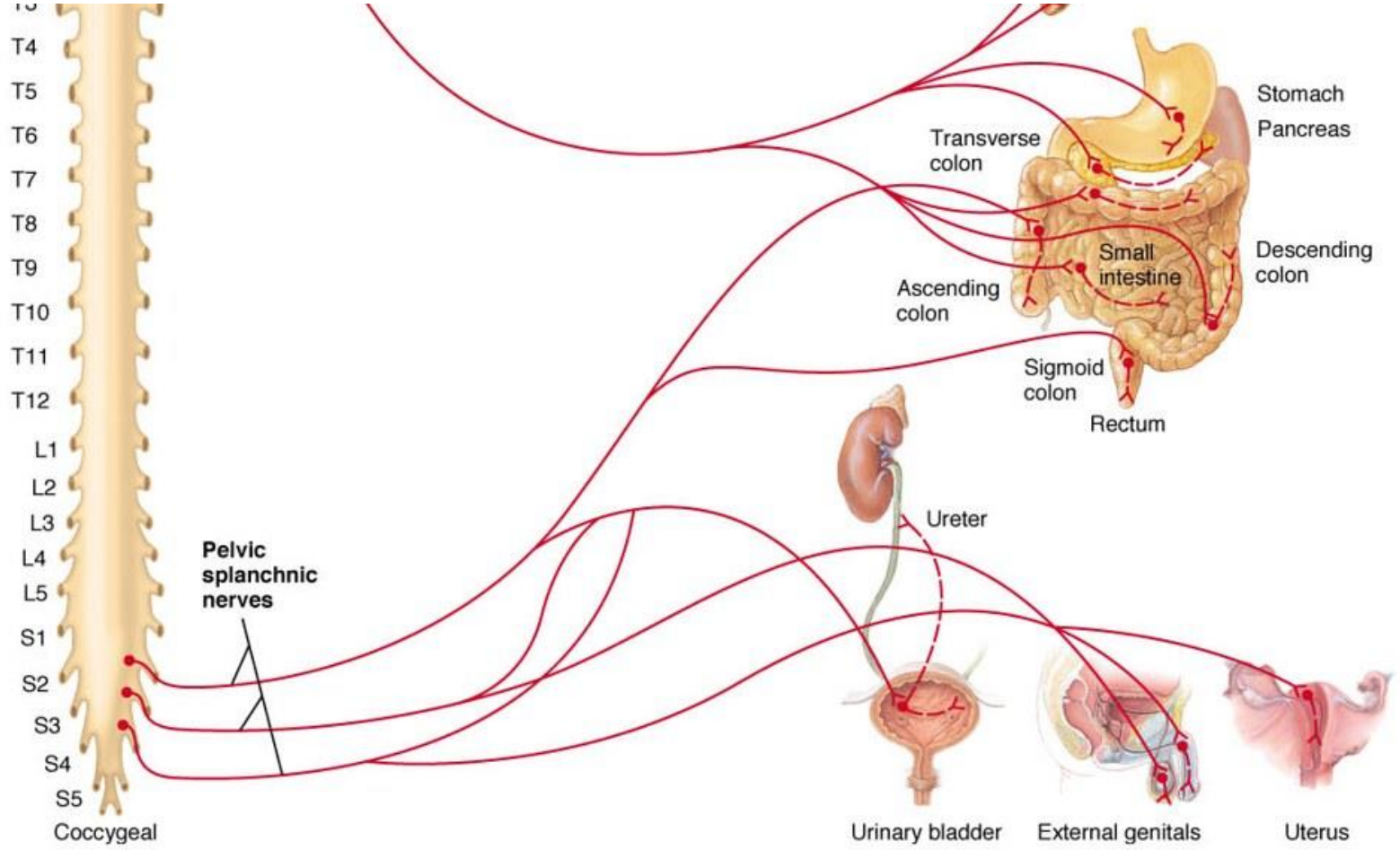
- **Preganglionic axons from T10–T11 form the lesser splanchnic nerve. It pierces the diaphragm and passes through the celiac plexus to enter the aorticorenal ganglion and superior mesenteric ganglion of the superior mesenteric plexus. Postganglionic neurons from the superior mesenteric ganglion follow and innervate blood vessels of the small intestine and proximal colon.**

- **The least (lowest) splanchnic nerve, which is not always present, is formed by preganglionic axons from T12 or a branch of the lesser splanchnic nerve. It pierces the diaphragm and enters the renal plexus near the kidney. Postganglionic neurons from the renal plexus supply kidney arterioles and the ureters.**


Thoracic 1
Thoracic 5
Thoracic 9
Thoracic 11
Greater splanchnic nerve
Lesser splanchnic nerve
Ceiliac ganglion
Suprarenal gland

- **Preganglionic axons that form the lumbar splanchnic nerve from L1–L4 enter the inferior mesenteric plexus and terminate in the inferior mesenteric ganglion, where they synapse with postganglionic neurons.**
- **Axons of postganglionic neurons extend through the inferior mesenteric plexus to supply the distal colon and rectum; they also extend through the hypogastric plexus to supply blood vessels of the distal colon, rectum, urinary bladder, and genital organs.**

- **Pelvic splanchnic nerves or nervi erigentes are splanchnic nerves that arise from sacral spinal nerves S2, S3, S4 to provide parasympathetic innervation to the hindgut.**
- **They contribute to the innervation of the pelvic and genital organs.**


T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
Coccygeal
Pelvic splanchnic nerves
Stomach
Pancreas
Transverse colon
Small intestine
Descending colon
Ascending colon
Sigmoid colon
Rectum
Ureter
Urinary bladder
External genitals
Uterus