Vegetative nervous system

1. General characteristic of the VNS

2. Peculiarities of the vegetative reflex arch

3. Sympathetic nervous system

4. Parasympathetic nervous system

5. Types of reflexes, reffered pain

6. Development of the vegetative nervous system

NERVOUS SYSTEM

(MORPHOLOGYCAL CLASSIFICATION)

CENTRAL

Brain
+
Spinal cord

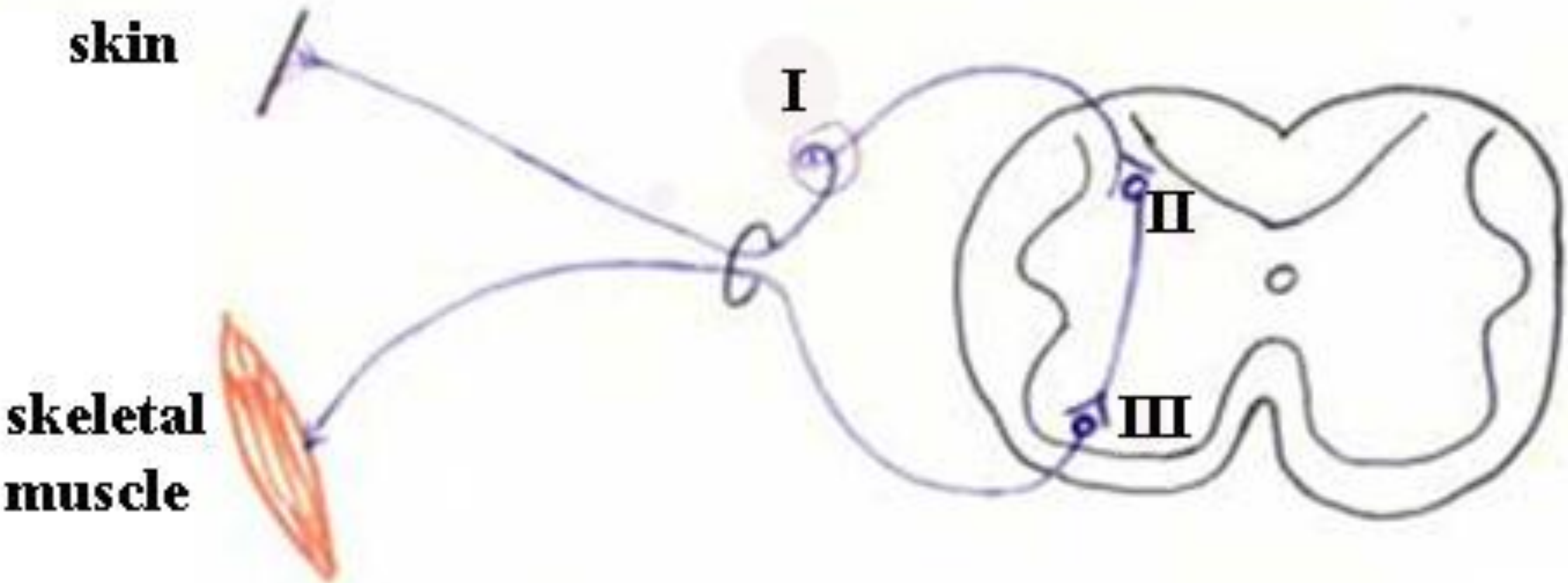
PERIPHERAL

12 pairs of cranial nerves
+
31 pairs of spinal nerve

NERVOUS SYSTEM
(MORPHOFUNCTIONAL CLASSIFICATION)

	VEGETATIVE (AUTONOMIC)	SOMATIC (ANIMAL)
	Functional differences	
Region of supply:	smooth muscles, glands	striated muscles
Action :	slow	fast
Duration:	permanent	during the action of excitant
Functions:	metabolism, growth, homeostasis	motion
	Structural differences	
	*has not segmental structure *ascending part does not form visible nerves *vegetative nerves form plexuses around blood vessels	*has segmental structure *ascending & descending fibers form visible nerves

Somatic reflex arch

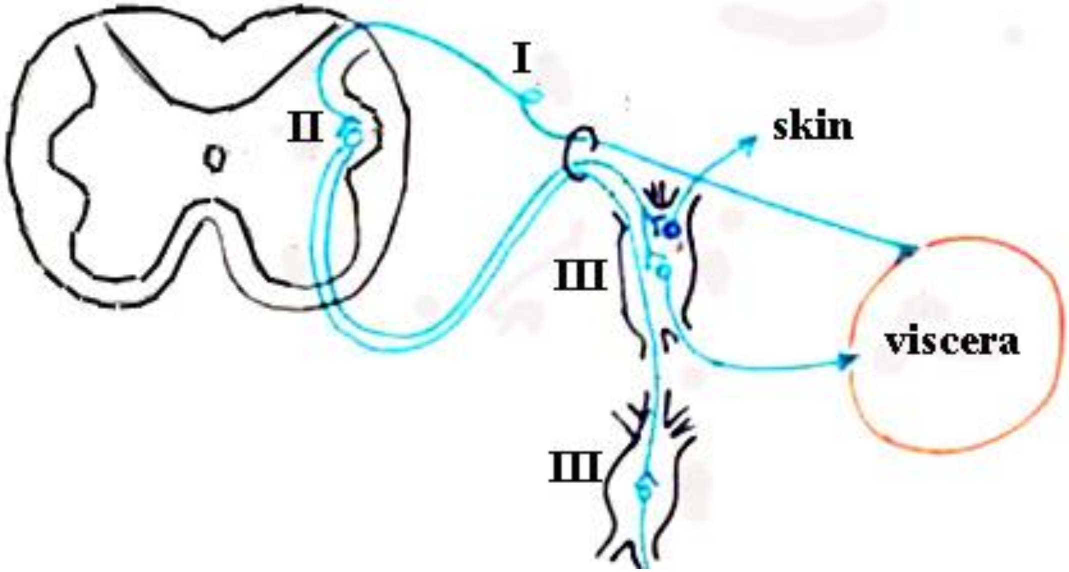


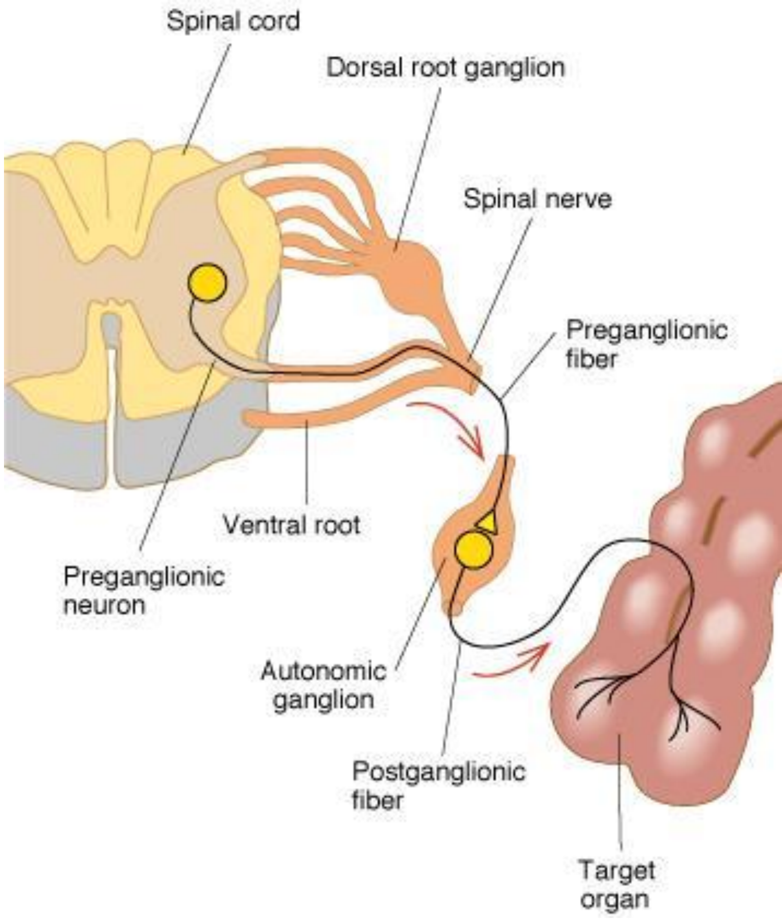
<u>I neuron:</u> ***in the spinal ganglion**

<u>II neuron:</u> ***posterior horn of the spinal cord**

<u>III neuron:</u> ***anterior horn**
*** the II neuron finishes in the spinal cord**
*** descending part is unineuronal**

Vegetative reflex arch



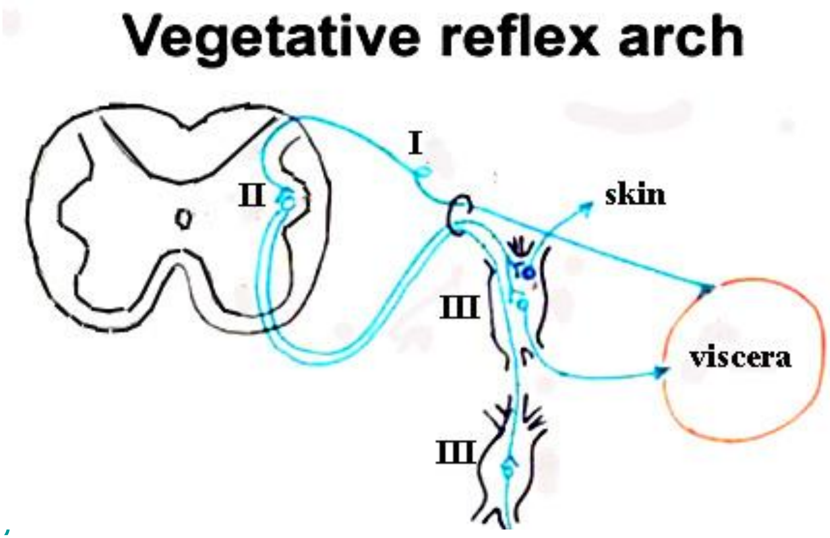


I neuron: ***in the spinal ganglion**

II neuron: *** lateral horn of the spinal cord**

III neuron: ***outside of the of the spinal cord, in the vegetative ganglion**
*** the II neuron doesn't finish in the spinal cord**
*** descending part is bineuronal**
*** postganglionary fibers form the visceral and somatic parts**
*** preganglionary fibers form white communicating branch**
*** postganglionary fibers form gray communicating branch**

- There are 2 neurons of efferent way. The second neuron is located in ganglion
- Preganglionic fibers are myelin – associated.
- Postganglionic fibers are without myelin.



Differential features:

- **Mediator**

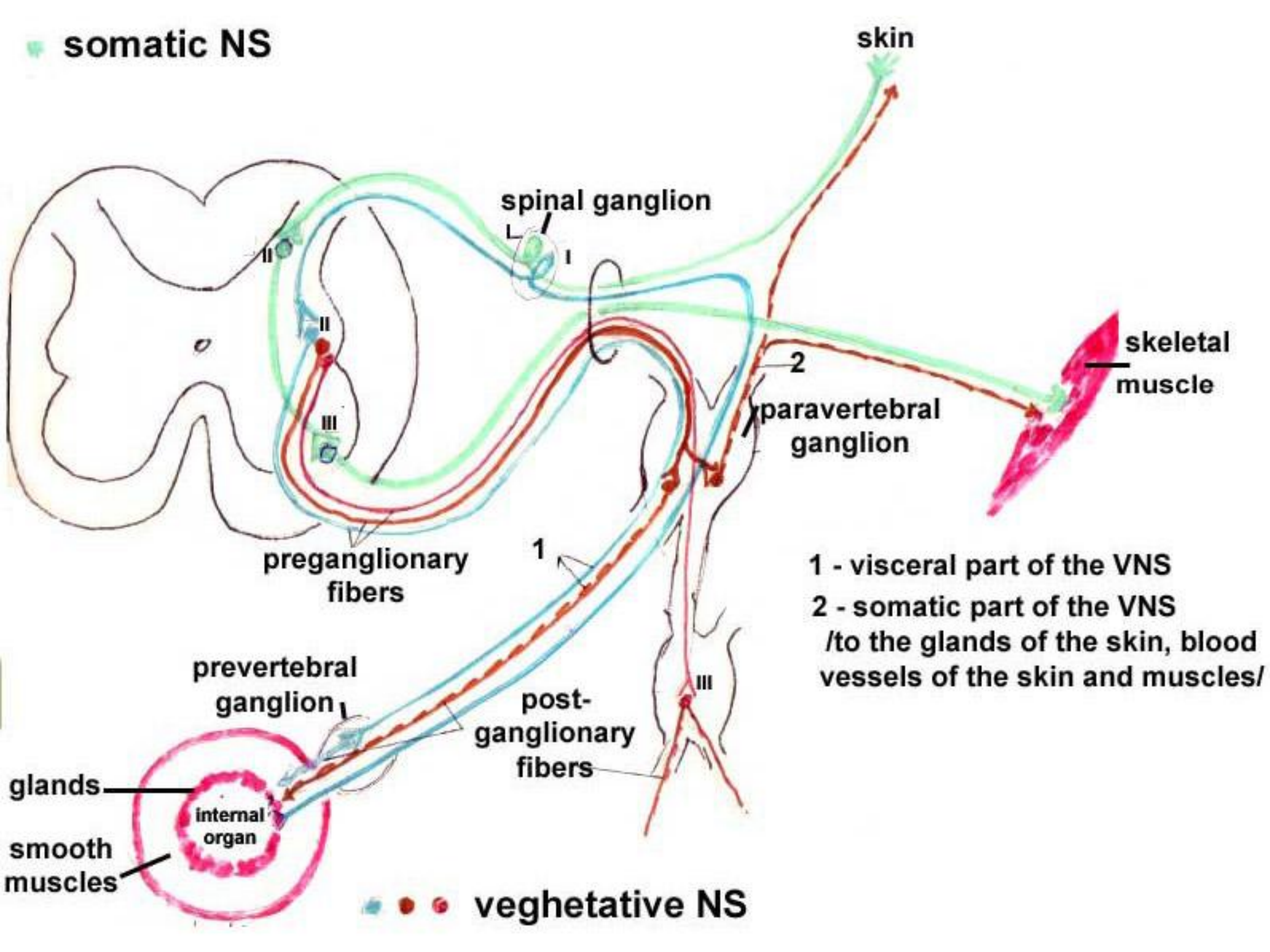
Sympathetic nervous system – adrenalin, noradrenalin

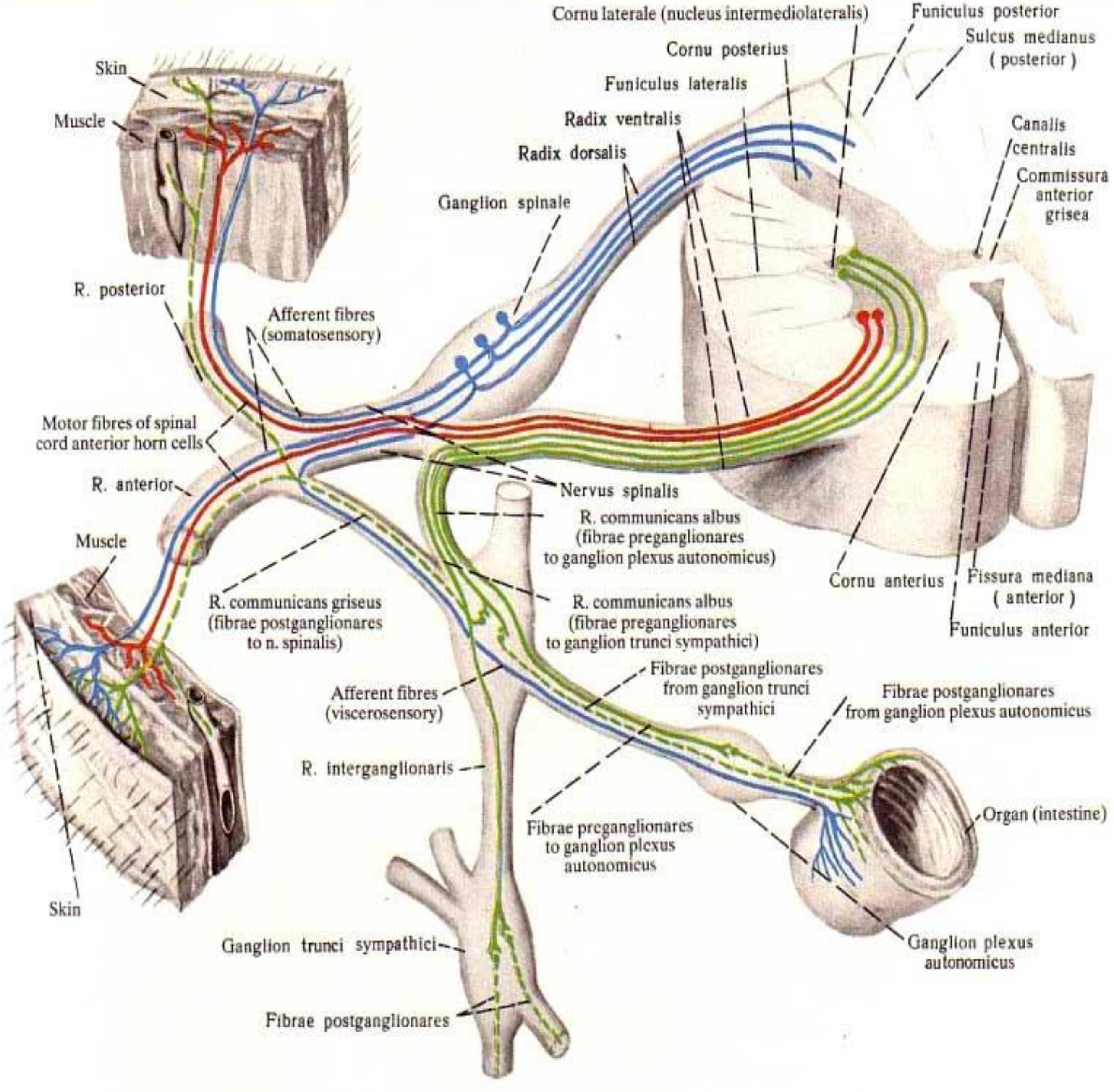
Parasympathetic nervous system – acetylcholine

- **The length of fibers**

Sympathetic nervous system – short pre- and long postganglionic fibers

Parasympathetic nervous system – long pre – and short postganglionic fibers


somatic NS
skin
spinal ganglion
I
II
II
III
skeletal
muscle
2
paravertebral
ganglion
preganglionary
fibers
1
1 - visceral part of the VNS
2 - somatic part of the VNS
/to the glands of the skin, blood
vessels of the skin and muscles/
prevertebral
ganglion
post-
ganglionary
fibers
III
glands
internal
organ
smooth
muscles
veghetative NS



Course of spinal nerve fibres and their communications with sympathetic trunk (diagram).

White Rami

Connecting the spinal nerves to each sympathetic trunk are rami communicantes.

Carry preganglionic sympathetic axons from the C8–L2 spinal nerves to the sympathetic trunk.

Associated only with the C8–L2 spinal nerves.

Preganglionic axons are myelinated.

The white ramus has a whitish appearance

Gray Rami

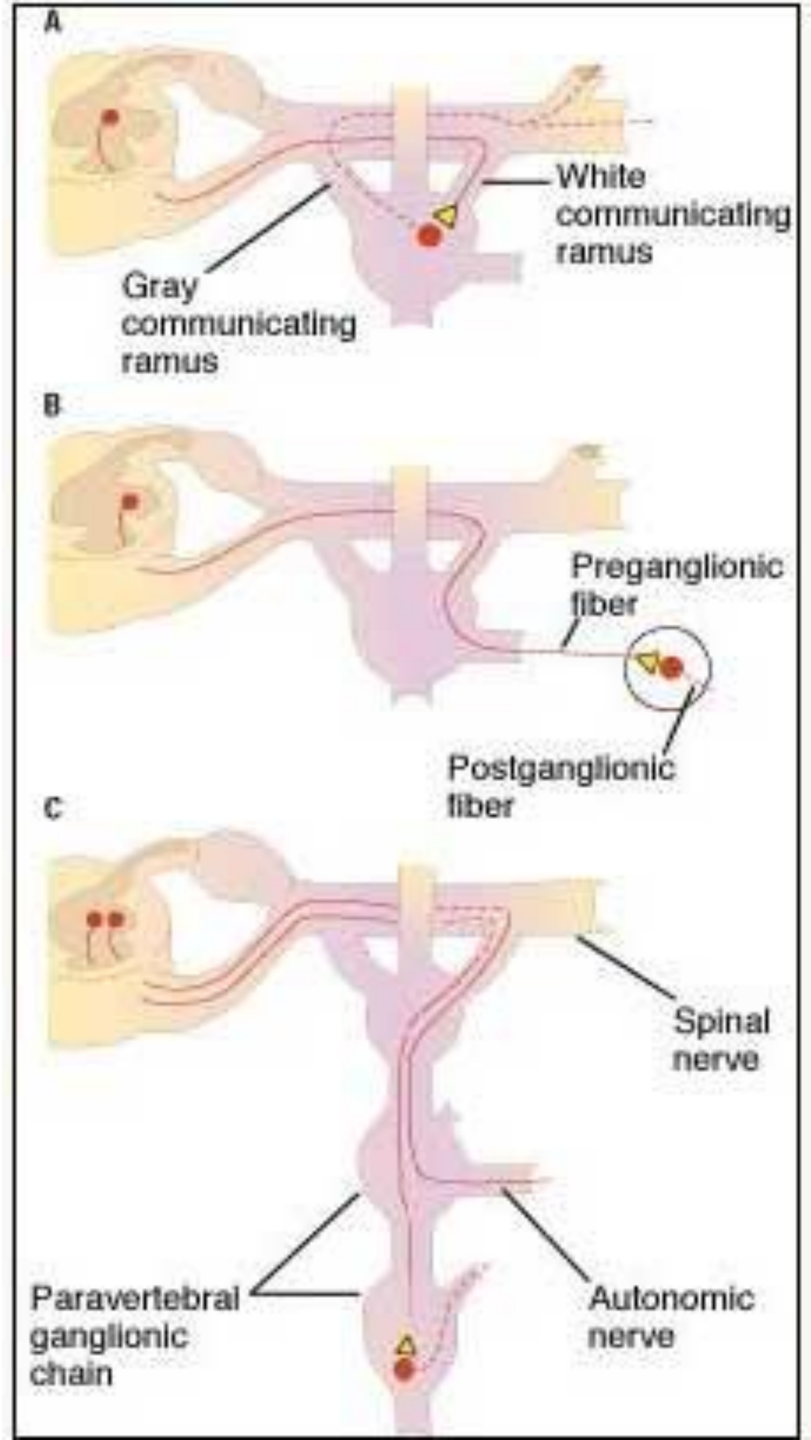
Carry postganglionic sympathetic axons
from the sympathetic trunk to the spinal nerve.

Axons are unmyelinated.
gray rami have a grayish appearance

Similar to "exit ramps" on a highway.

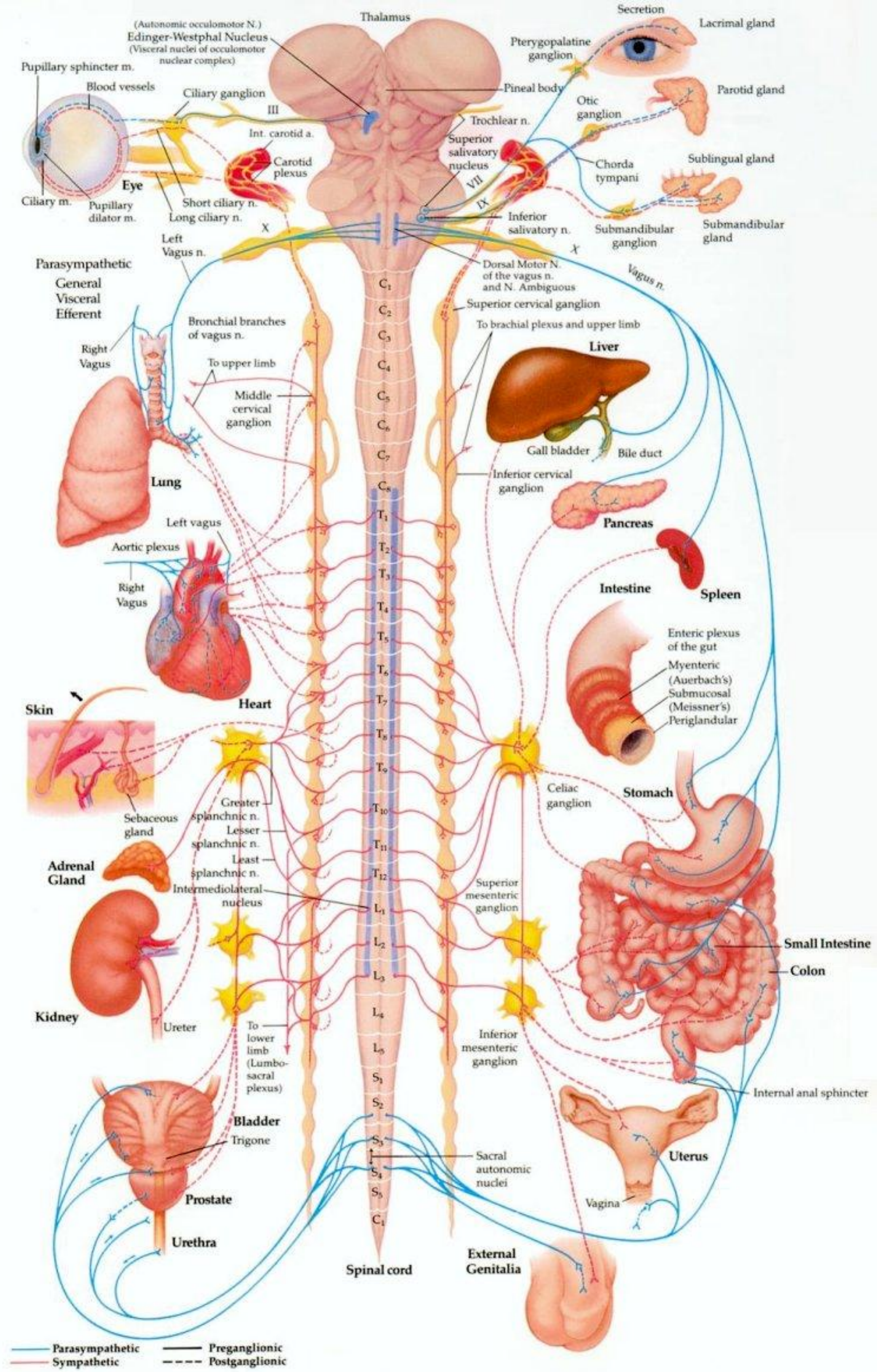
Connect to all spinal nerves.

Sympathetic information that starts in the thoracolumbar region can be dispersed to all parts of the body.

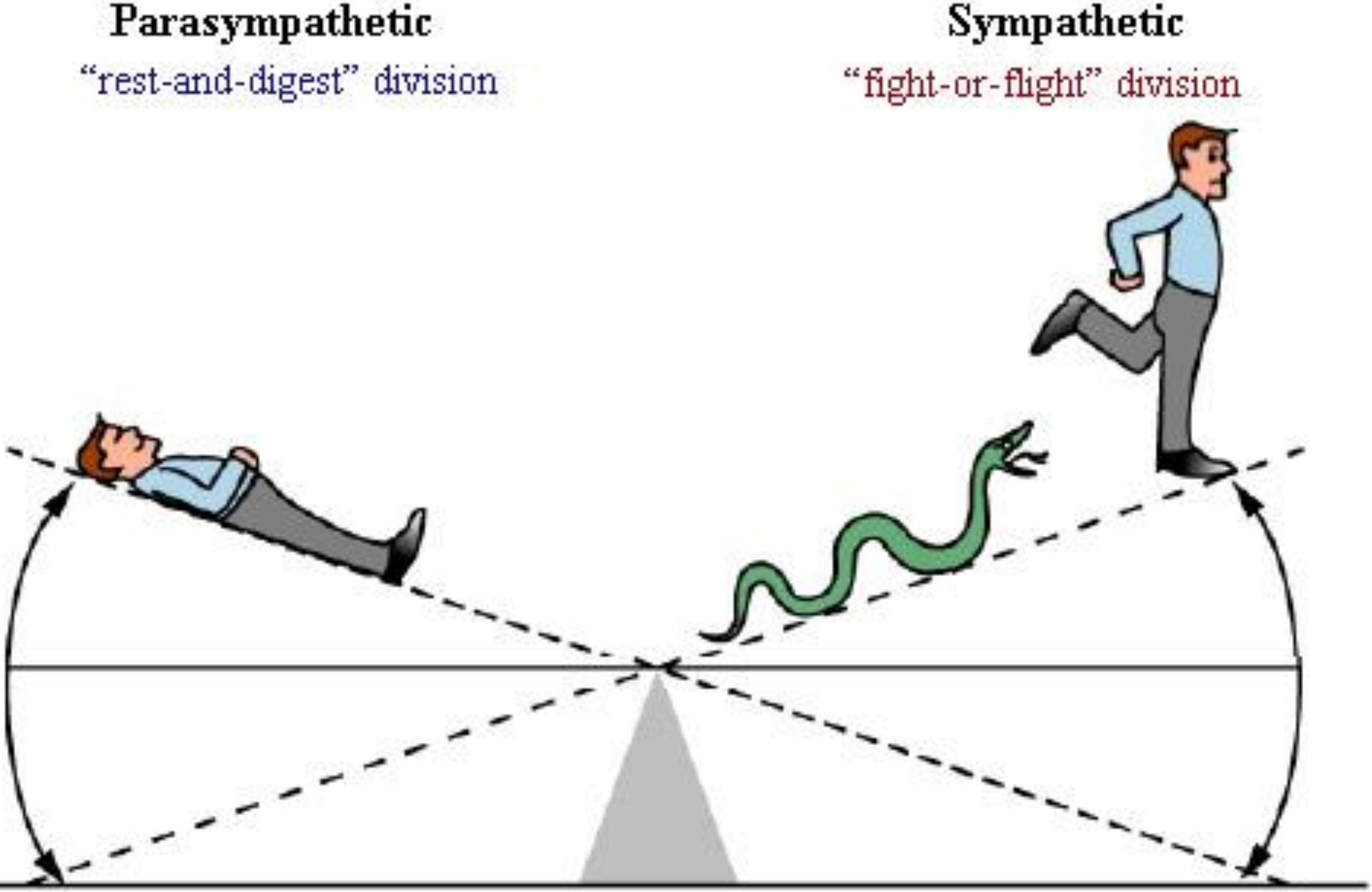


Divisions of the ANS

- Two divisions
  - Parasympathetic division
  - Sympathetic division
- Divisions are similar:
  - both use a preganglionic neuron (cell body in the CNS)
  - Both use a postganglionic neuron (cell body in the ganglion)
    - innervates muscles or glands.
  - Both are involuntary
  - Both are concerned with the body's internal environment (homeostasis)
- Divisions perform dramatically different functions.



DIVISIONS OF THE VNS



Functions: Regulates body temperature. Coordinates CV, respiratory, excretory & reproductive activities.

COMPONENTS OF AUTONOMIC NERVOUS SYSTEM

Parasympathetic (craniosacral) division

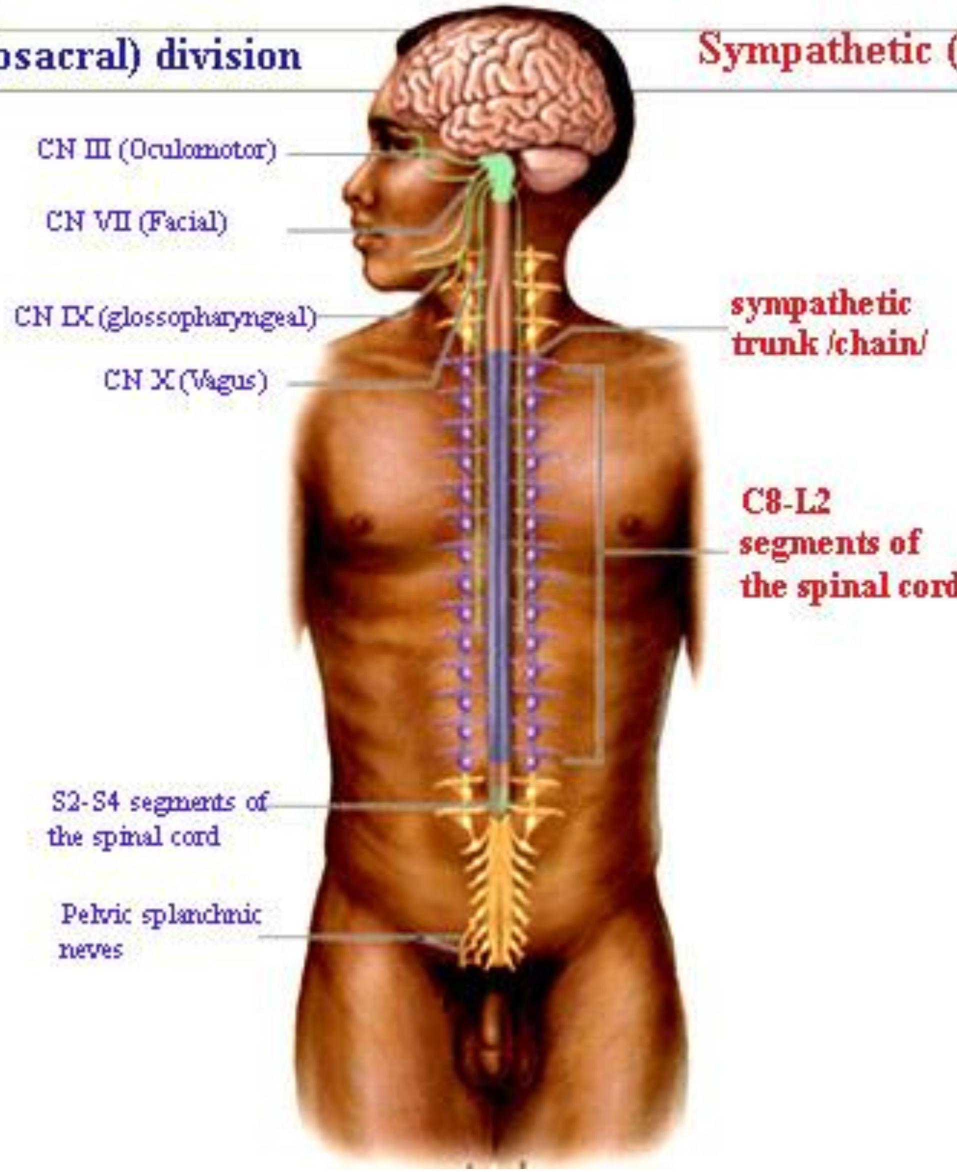
Origin: **preganglionic neurons located in brainstemnuclei & lateral horns of S2-S4 segments of the spinal cord.**

Functions:
rest & digest response, brings body to homeostasis.

Sympathetic (thoracolumbar) division

Origin: **preganglionic neurons located in lateral horns of C8-L2 of the spinal cord.**

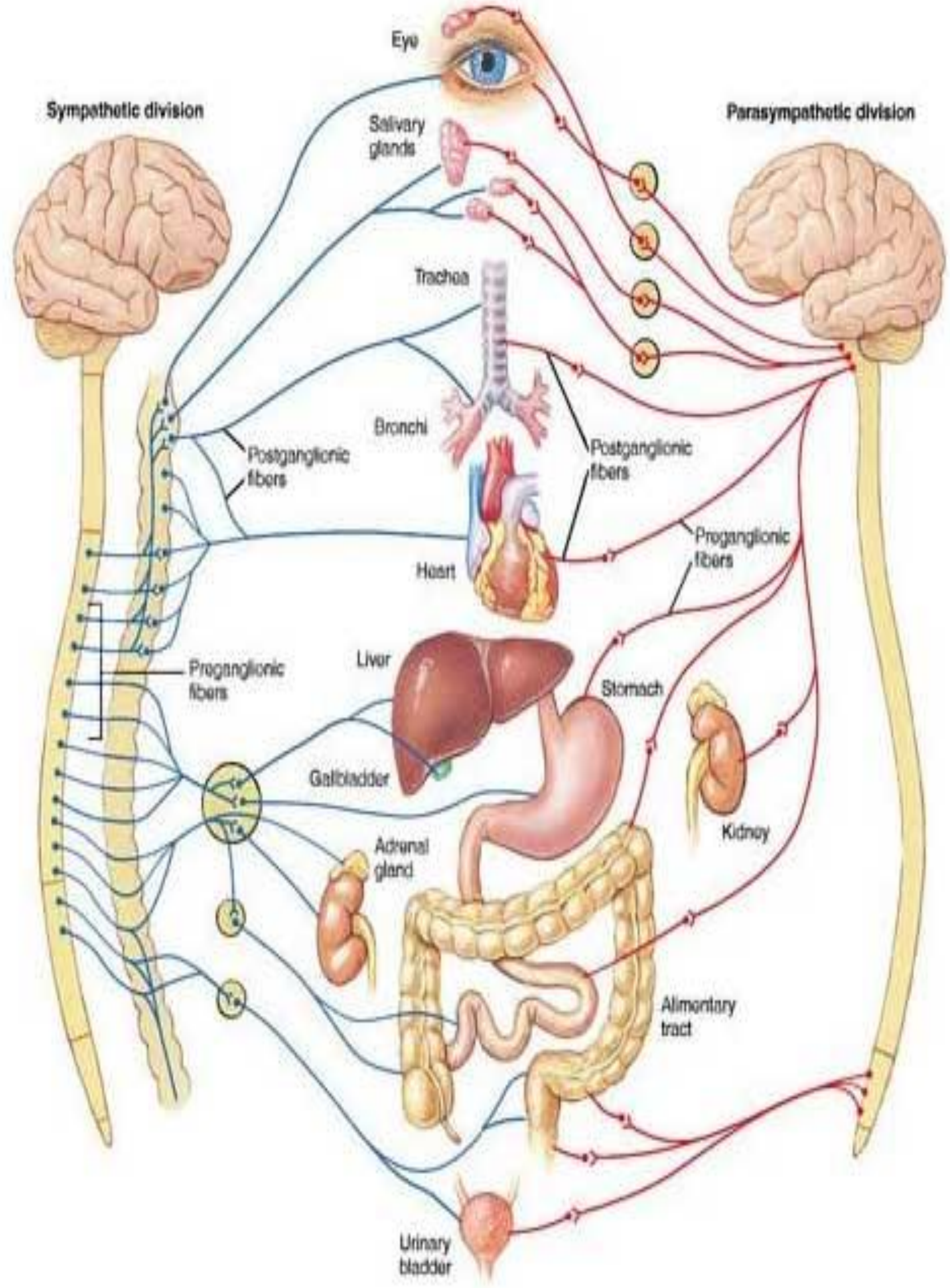
Functions:
emergency stimulation, fight or flight response, involves with homeostasis.

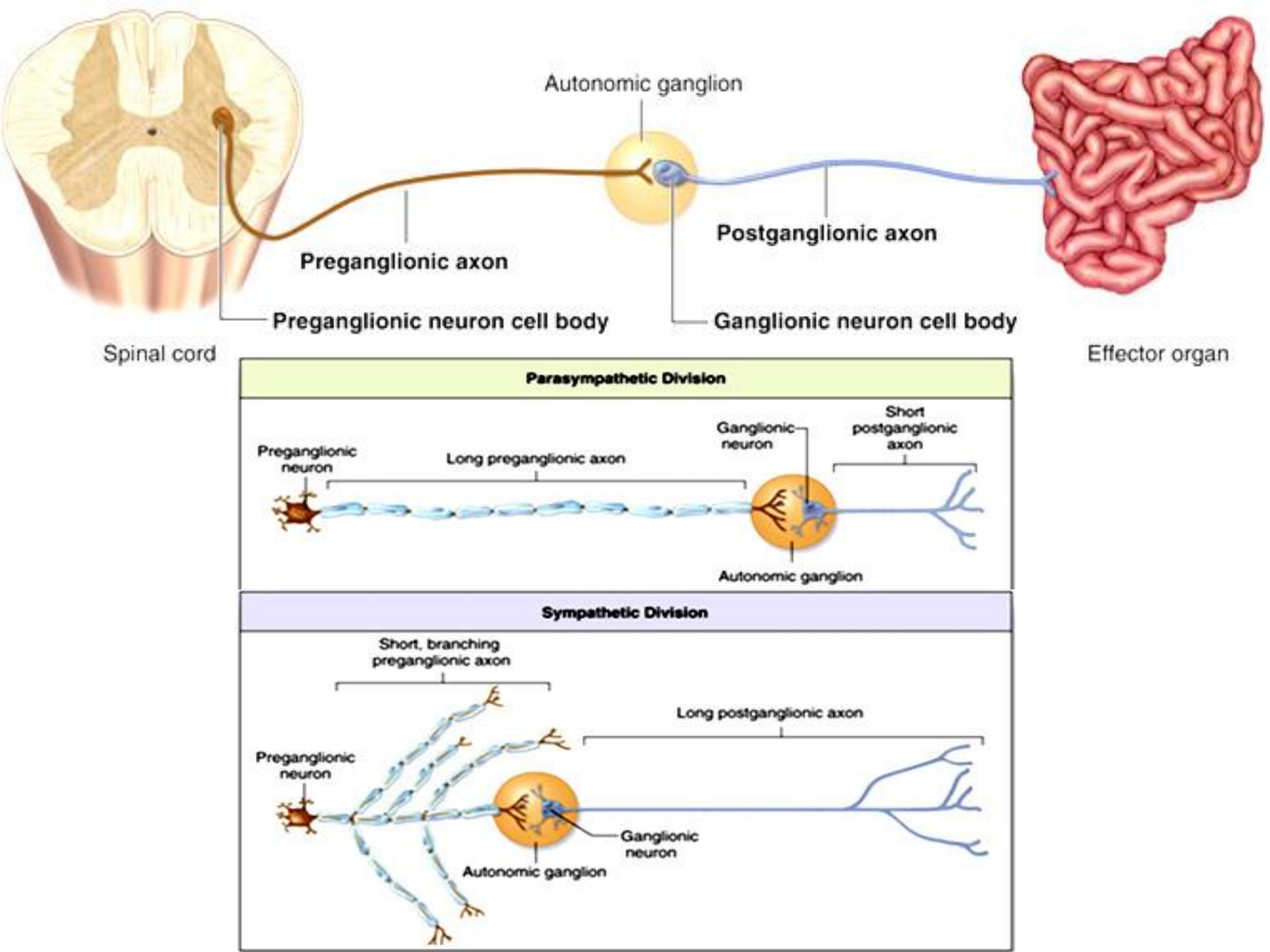


Structural differences of the sympathetic and parasympathetic nervous systems

SNS
- **central**
  - C8-12
- **peripheral**
  - fibers
    - preganglionic
    - postganglionic
  - ganglia
    - paravertebral
    - prevertebral

PSNS
- **central**
  - Brain stem S2-S4
- **peripheral**
  - fibers
    - preganglionic
    - postganglionic
  - ganglia
    - terminal
    - intramural

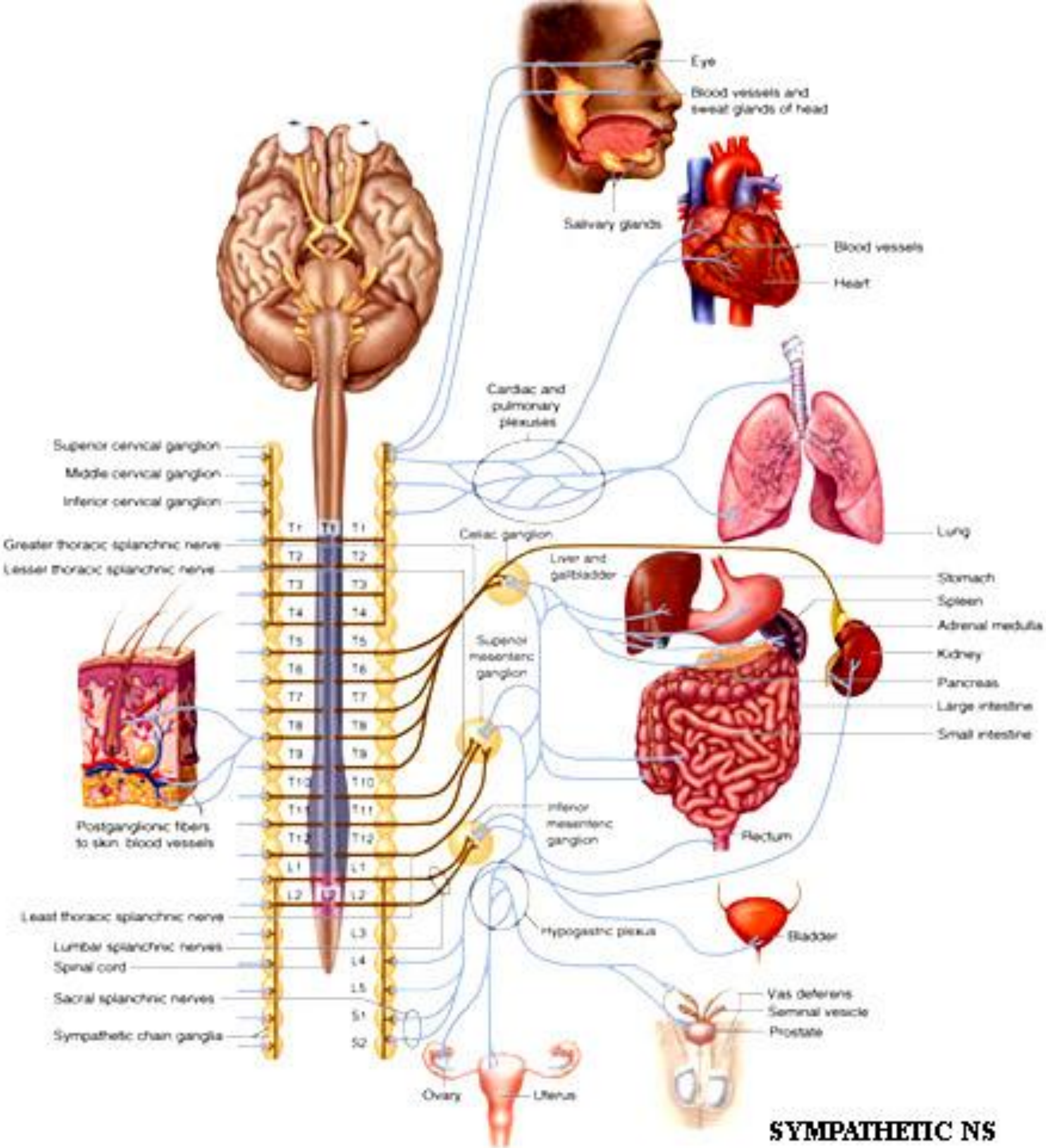




Autonomic ganglion
Preganglionic axon
Postganglionic axon
Preganglionic neuron cell body
Ganglionic neuron cell body
Spinal cord
Effector organ
Parasympathetic Division
Preganglionic neuron
Long preganglionic axon
Ganglionic neuron
Short postganglionic axon
Autonomic ganglion
Sympathetic Division
Short, branching preganglionic axon
Long postganglionic axon
Preganglionic neuron
Ganglionic neuron
Autonomic ganglion

The Sympathetic Division

- Also termed the thoracolumbar division
- Primarily concerned with preparing the body for emergencies.
  - referred to as the "fight-or-flight" division
- Increased sympathetic activity results in:
  - increased alertness
  - Increased metabolic activity



Sympathetic division

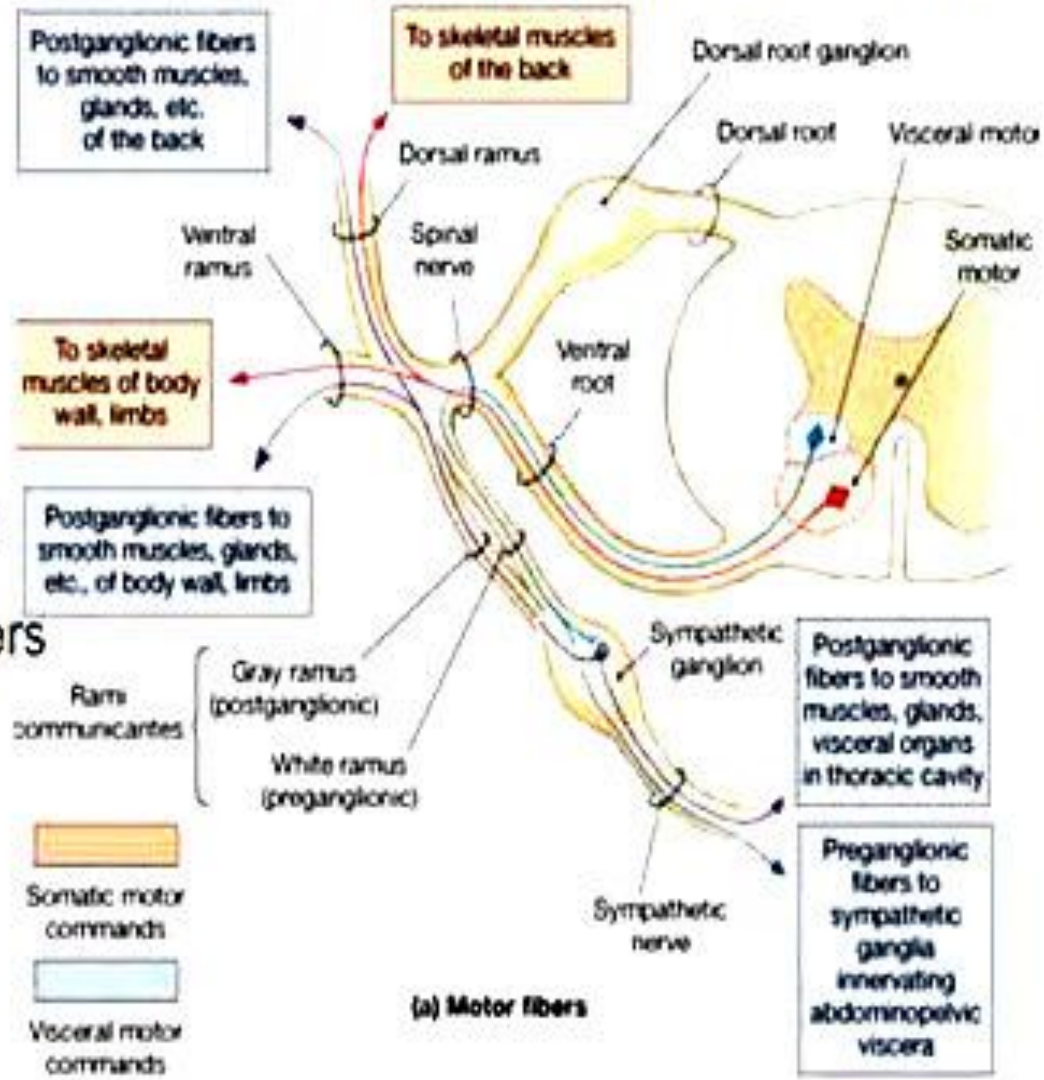
Preganglionic neurons

- located within the lateral horn of the C8-L2 spinal segments
- their axons enter ventral roots of the C8-L2 spinal nerves
- axons synapse in sympathetic ganglia /para- or prevertebral/
- all preganglionic fibers are stimulatory
- fibers are divergent
- 1 preganglionic fiber can synapse with 1 of ganglionic neurons

Vegetative component of the spinal nerves

SYMPATHETIC CHAIN

- 3 cervical, 11-12 thoracic, 2-5 lumbar, 4-5 sacral & 1 coccygeal sympathetic ganglia

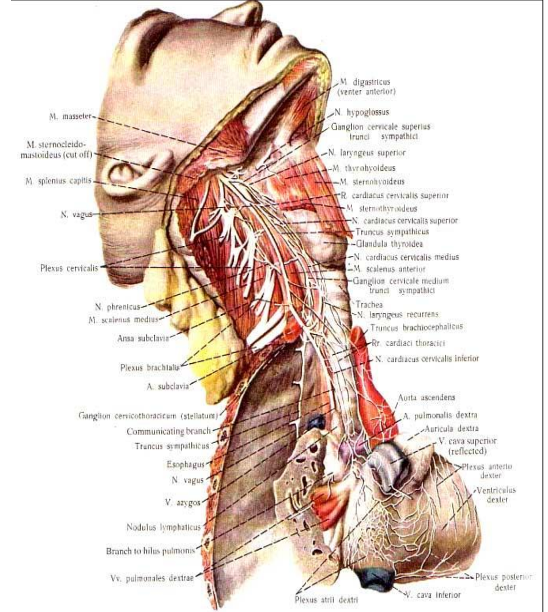


- common spinal nerve branches to white ramus communicans
  - myelinated, preganglionic fibers
- common spinal nerve receives gray rami communicans from ganglia
  - unmyelinated, postganglionic fibers

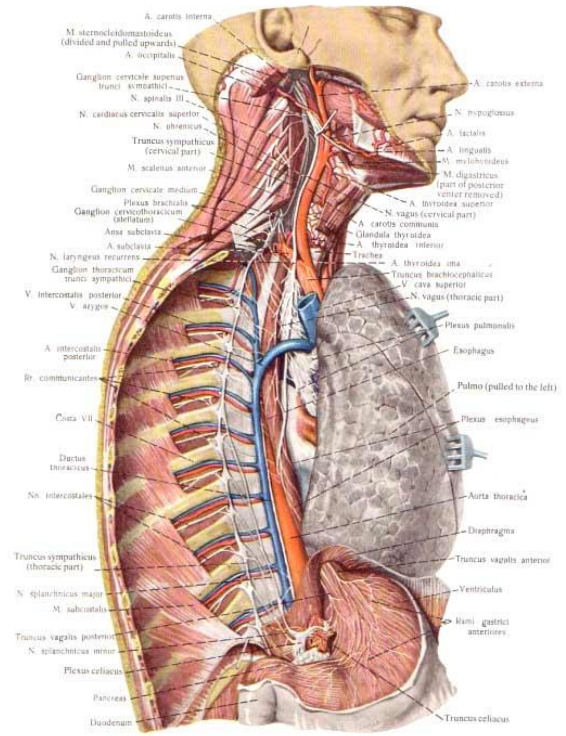
NOTE:
- preganglionic fibers only from **C8-L2**
- every spinal nerve receives postganglionic fiber

Left and Right Sympathetic Trunks

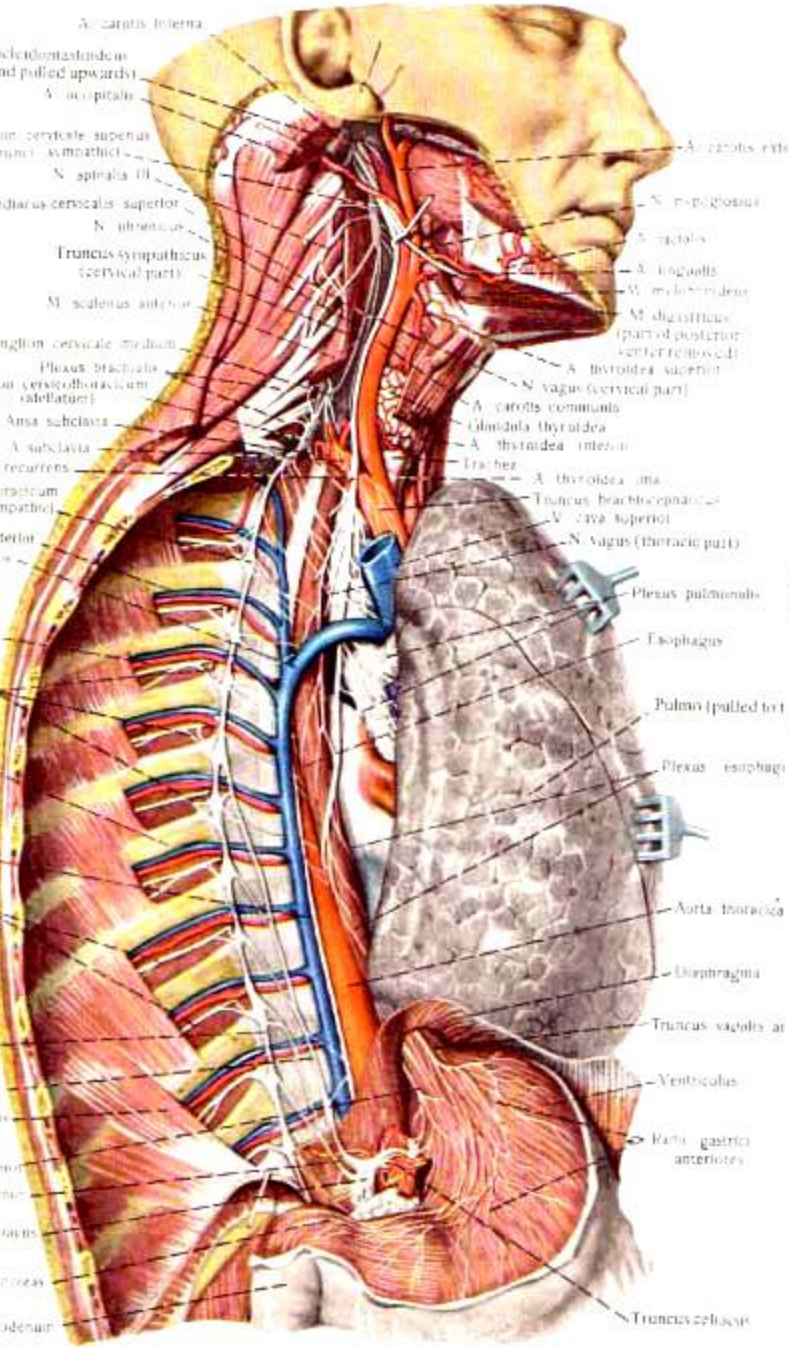
- Immediately anterior to the paired spinal nerves are the left and right sympathetic trunks.
- Each is located immediately lateral to the vertebral column.
- A sympathetic trunk is like a pearl necklace:
  - the "string" of the "necklace" is composed of bundles of axons
  - the "pearls" are the sympathetic trunk (or paravertebral) ganglia
    - house sympathetic ganglionic neuron cell bodies
- One sympathetic trunk ganglion is approximately associated with each spinal nerve.
- Cervical portions
  - three sympathetic trunk ganglia
    - superior, middle, and inferior cervical ganglia
    - opposed to the eight cervical spinal nerves.



Cervical ganglia, nerves of the heart



Nerves and plexuses of thoracic organs; right aspect ($\frac{1}{4}$).



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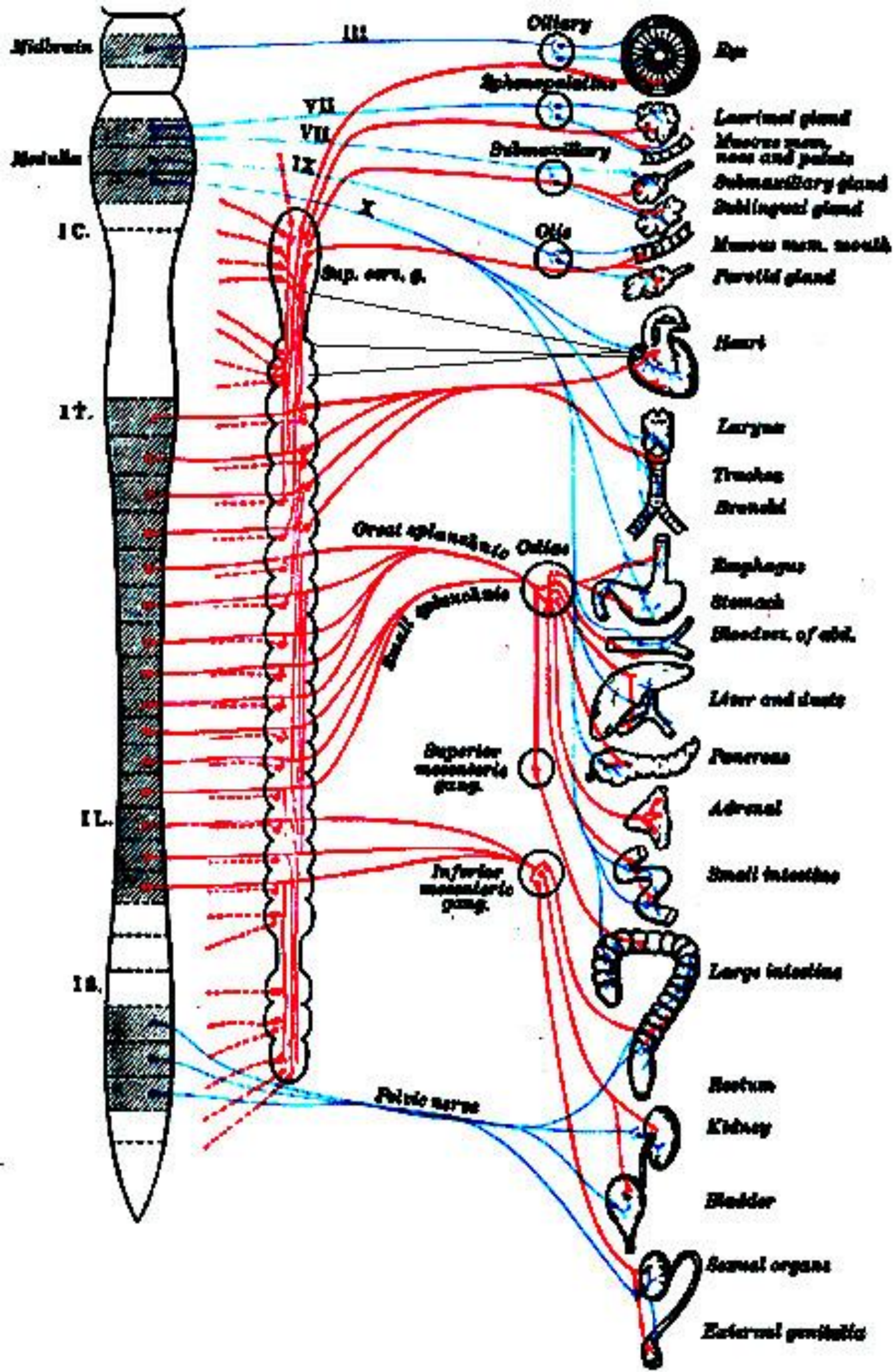


BRANCHES OF THE SYMPATHETIC CHAIN

- C1 g.
  - carotid nerves (ext., int)
  - jugular nerve
  - the larynx and pharynx
  - superior cervical nerve of the heart
- C2 g.
  - middle cervical nerve of the heart
  - subclavian branches
- C3 g.
  - branches to the vagus and phrenicus nerves
  - inferior cervical nerve of the heart
- C3 +Th1= g. stelatum
  - rr. bronchiales - plexus pulmonaris
  - rr.esophagei
- Th1-Th4-5
  - plexus aorticus thoracicus
  - nervi cardiaci thoracici
- Th5-9 — n. splanchnicus major
- Th10-12 — n.splanchnicus minor
- L1-5 — plexus aorticus abdominalis
- S1-Co
  - rectalis
  - vesicalis
  - plexus cavernosus penis
  - ductus deferentis
  - prostaticus
  - uterovaginalis

Lower thoracic and lumbar ganglia:

- Visceral and autonomic disorders of the organs of abdominal cavity.

Solar(celiac) plexus:

- Dull pain in the abdomen
- Increased aorta pulsation
- Instable AP
- Instable stool
- Poli – oligouria
- Glucosuria

TYPES OF PREVERTEBRAL GANGLIA

Differ from the sympathetic trunk ganglia.

Are single structures, rather than paired.

Are anterior to the vertebral column, on the

anterior surface of the aorta.

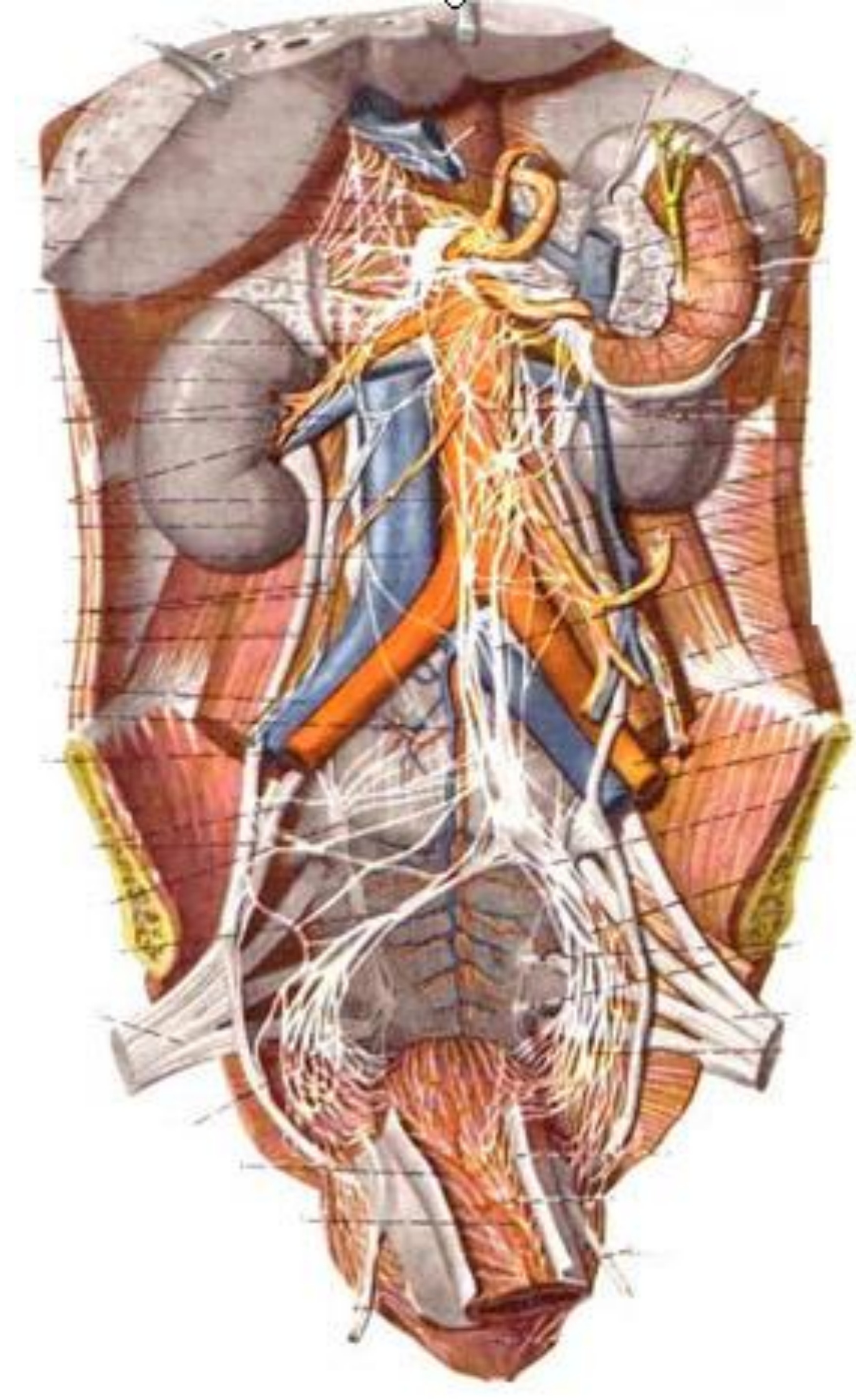
Located only in the abdominopelvic cavity.

Prevertebral ganglia include:

the celiac ganglion

superior mesenteric ganglion

interior mesenteric ganglion.



SPLANCHNIC NERVES

- Composed of preganglionic sympathetic axons.
- Run anteriorly from the sympathetic trunk to most of the viscera.
- Should not be confused with the pelvic splanchnic nerves associated with the parasympathetic division.
- Larger splanchnic nerves have specific names:

    greater thoracic splanchnic nerves

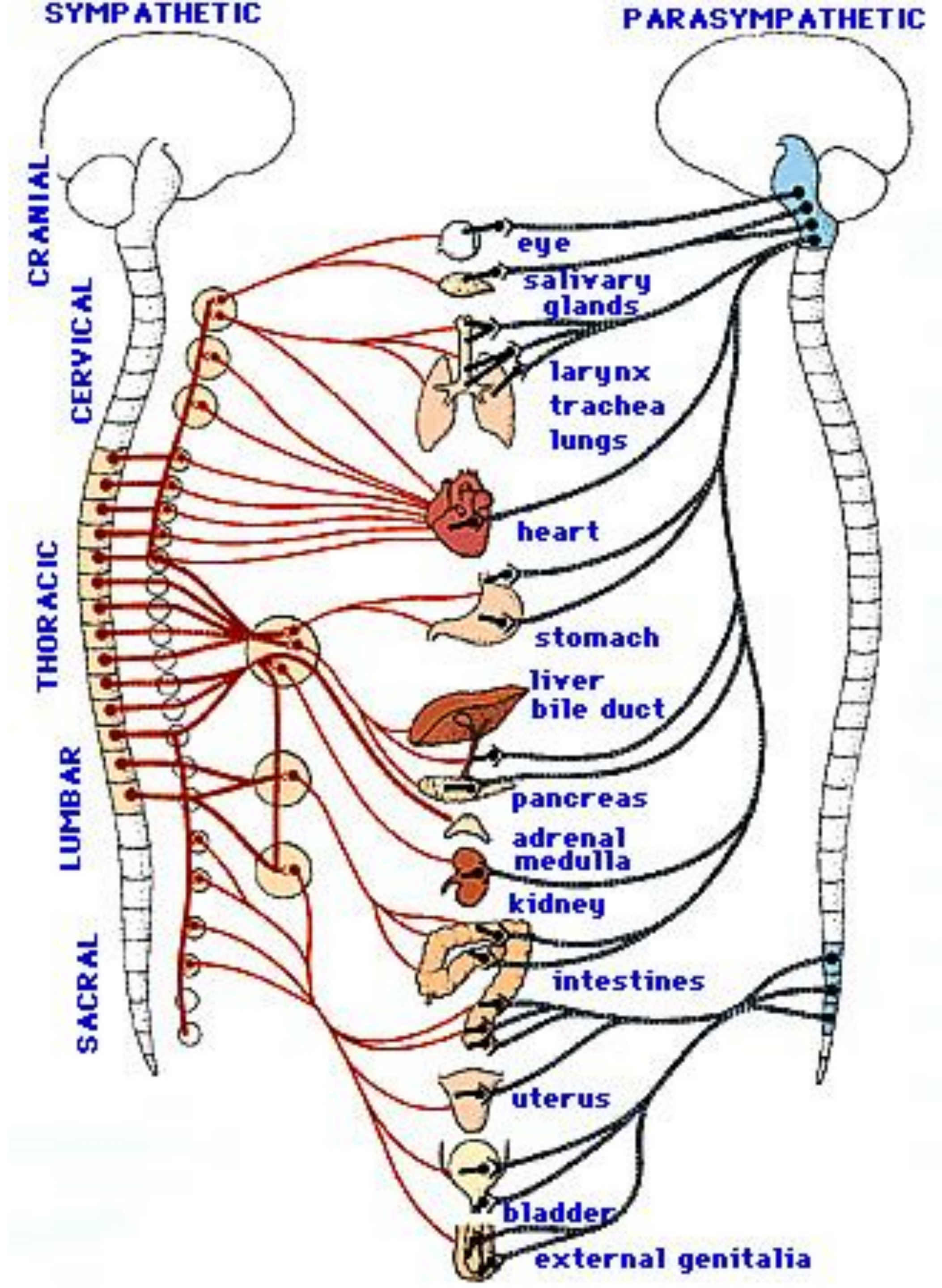
    lesser thoracic splanchnic nerves

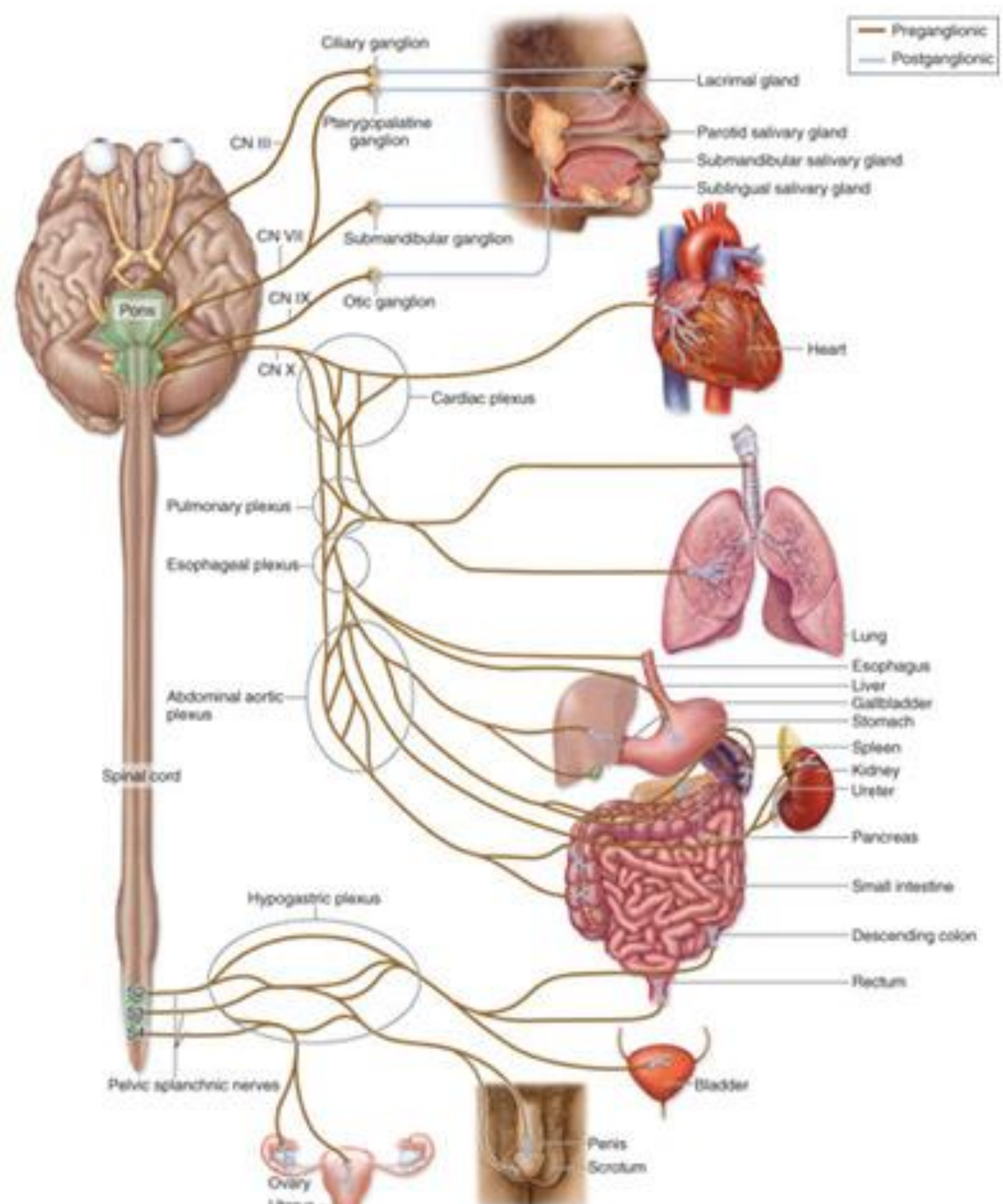
    least thoracic splanchnic nerves

    lumbar splanchnic nerves

    sacral splanchnic nerves

- Terminate in prevertebral (or collateral) ganglia called “prevertebral” because they are immediately anterior to the vertebral column.
- Prevertebral ganglia typically cluster around the major abdominal arteries and are named for these arteries.





PARASYMPATHETIC NS

Parasympathetic division

is also termed the *craniosacral division* because its preganglionic neurons are:

> **housed within nuclei in the brainstem, within the lateral gray regions of the S2–S4 spinal cord segments.**

Postganglionic neurons in the parasympathetic division are found in *terminal ganglia:* are located close to the target organ & *intramural ganglia:* located within the wall of the target organ.

Vegetative component of the cranial nerves

Nerves associated with the parasympathetic division:

the oculomotor (CN III)

facial (CN VII)

glossopharyngeal (CN IX)

vagus (CN X)

First three **of these nerves convey parasympathetic innervation to the head.**

Vagus nerve **is the source of parasympathetic stimulation for:**

organs of the neck,

thoracic organs,

most abdominal organs.

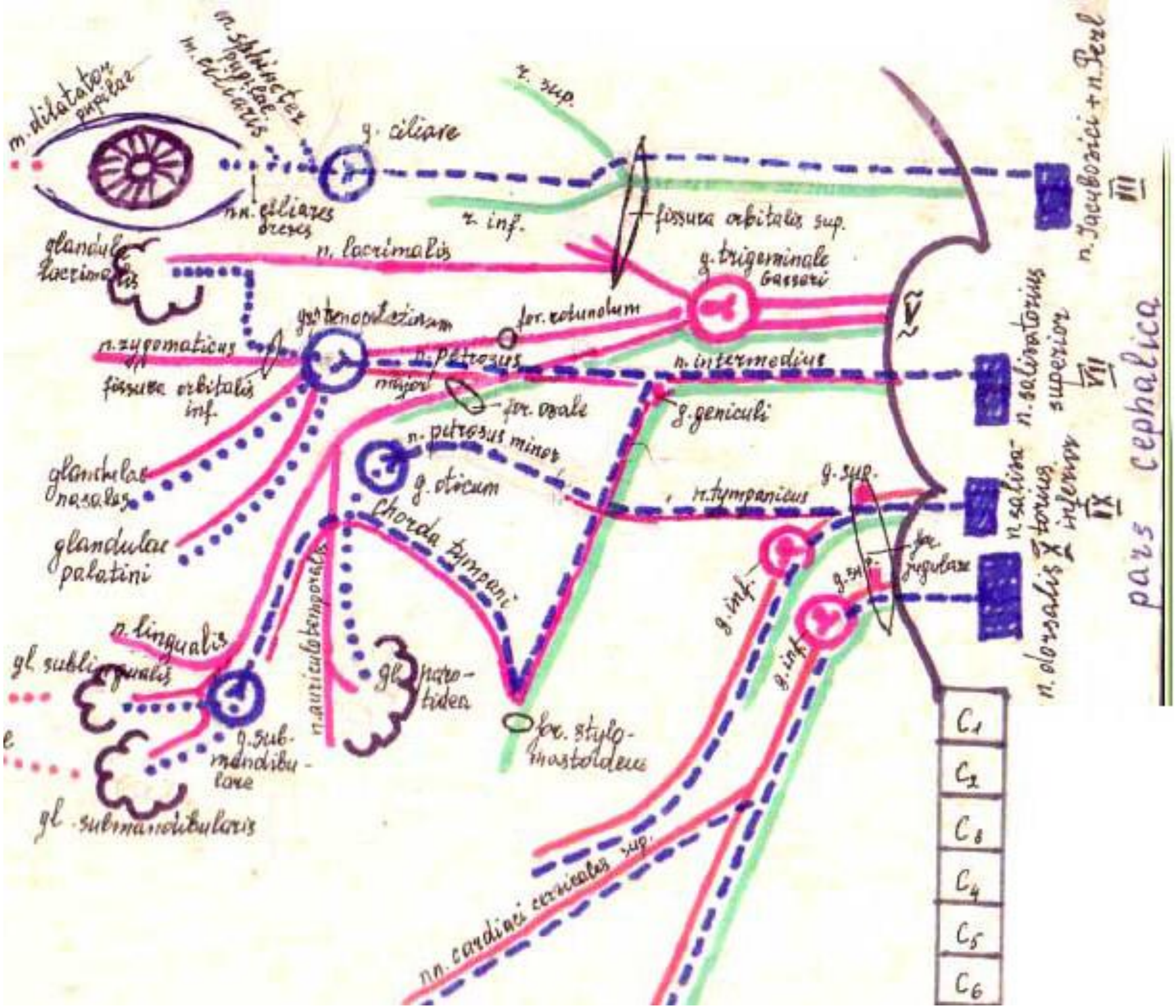
Parasympathetic nervous system

Cerebral part

nuclei	nerve	Neuron-effector	Region of the supply
n.Iacubovich n.Perl	III */oculomotorius/*	g.ciliare /in the orbit/	m.constrictor pupilae m.ciliaris
n.salivatorius superior	VII */facial/*	g.sphenopalatinum /fossa pterygopalatina/ g.submandibulare /fossa glandlae submandibularis/	gl. lacrimalis +glandulae mucosae /nose+mouth/ gl.submandibularis gl.sublingualis
n.salivatorius inferior	IX */glossopharyngeus/*	g.oticum /foramen ovale/	gl.parotidea
n.dorsalis	X */vagus/*	gg. terminales gg. intramurales	Internal organs of the neck, thorax, abdominal cavity /to the level of the descendens colon/

Sacral part:

* supplies the descendens colon, sigmoid colon, organs of the pelvis



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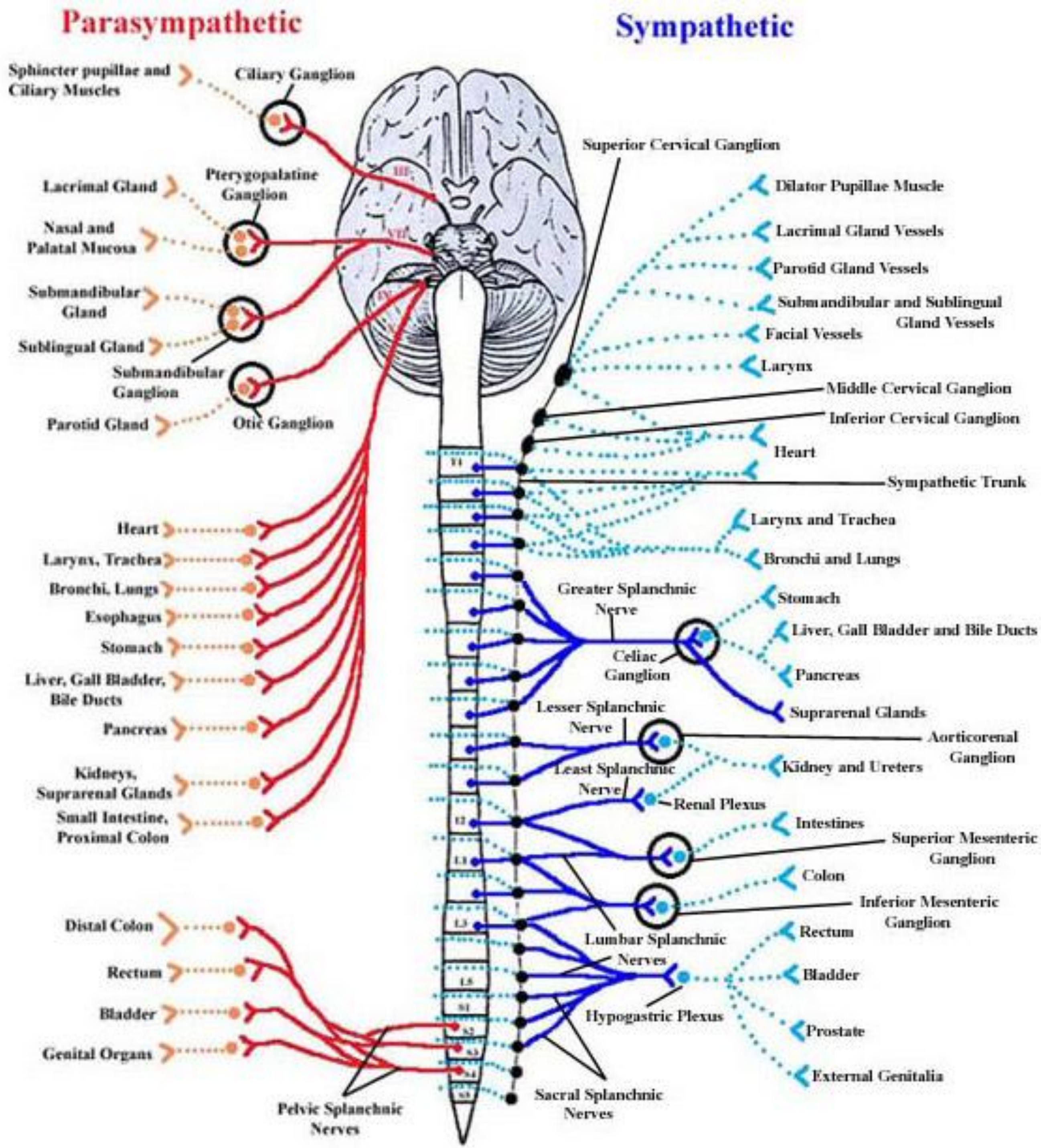


Parasympathetic
Sympathetic
Sphincter pupillae and Ciliary Muscles
Ciliary Ganglion
Lacrimal Gland
Pterygopalatine Ganglion
Nasal and Palatal Mucosa
Submandibular Gland
Sublingual Gland
Submandibular Ganglion
Parotid Gland
Otic Ganglion
Heart
Larynx, Trachea
Bronchi, Lungs
Esophagus
Stomach
Liver, Gall Bladder, Bile Ducts
Pancreas
Kidneys, Suprarenal Glands
Small Intestine, Proximal Colon
Distal Colon
Rectum
Bladder
Genital Organs
Pelvic Splanchnic Nerves
Superior Cervical Ganglion
Dilator Pupillae Muscle
Lacrimal Gland Vessels
Parotid Gland Vessels
Submandibular and Sublingual Gland Vessels
Facial Vessels
Larynx
Middle Cervical Ganglion
Inferior Cervical Ganglion
Heart
Sympathetic Trunk
Larynx and Trachea
Bronchi and Lungs
Greater Splanchnic Nerve
Stomach
Liver, Gall Bladder and Bile Ducts
Celiac Ganglion
Pancreas
Suprarenal Glands
Lesser Splanchnic Nerve
Aorticorenal Ganglion
Kidney and Ureters
Least Splanchnic Nerve
Renal Plexus
Intestines
Superior Mesenteric Ganglion
Colon
Inferior Mesenteric Ganglion
Rectum
Lumbar Splanchnic Nerves
Bladder
Hypogastric Plexus
Prostate
External Genitalia
Sacral Splanchnic Nerves

Dual Innervation of the organs by the ANS

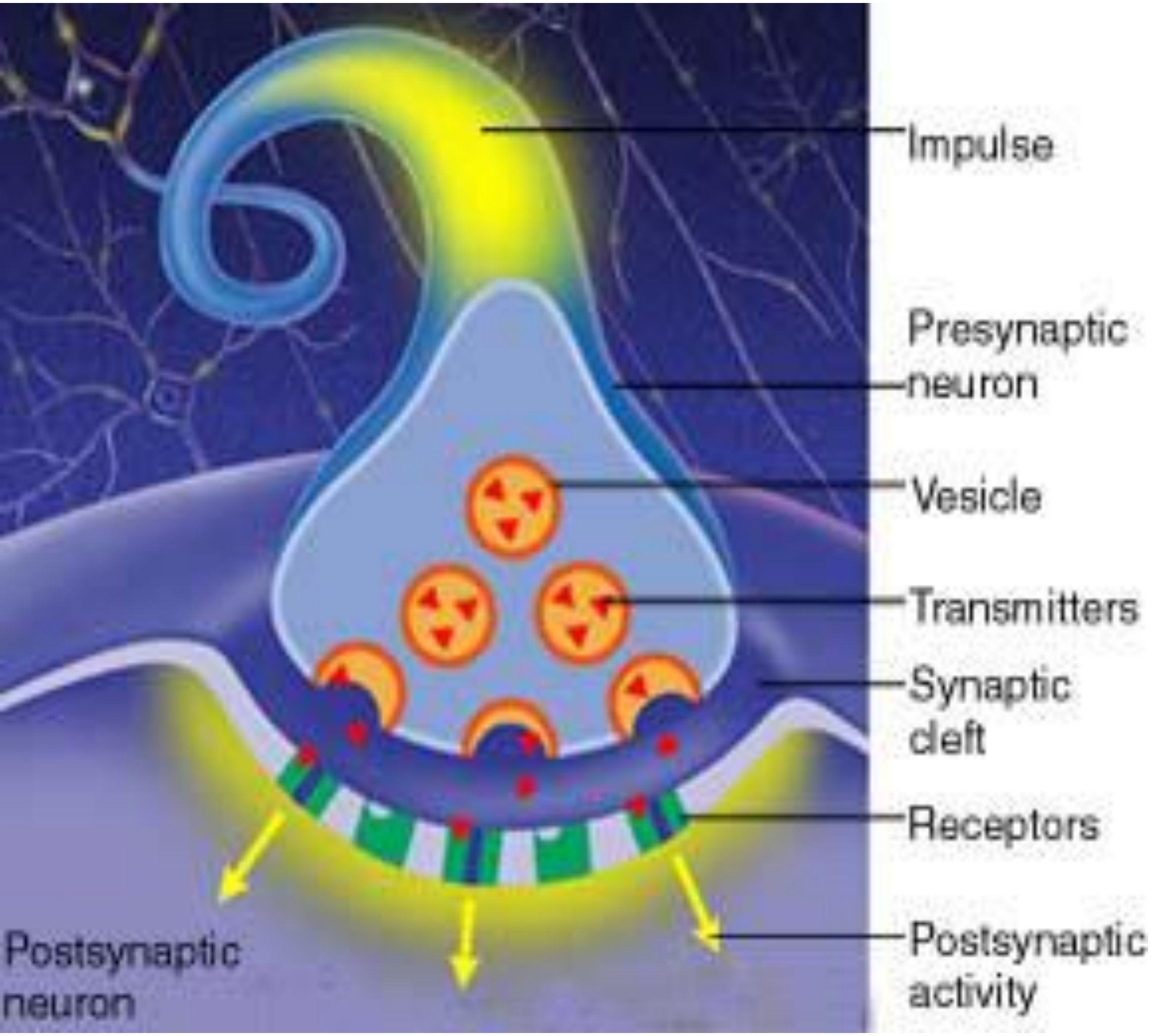
Innervate organs through specific axon bundles called autonomic plexuses.

Communication by chemical messengers, called *neurotransmitters*, specific in each division of the autonomic nervous system

Usually all organs are innervated by both divisions of the autonomic nervous system.

Maintains homeostasis through autonomic reflexes that occur in the innervated organs.

Neurotransmitters and Receptors



Two neurotransmitters are used in the ANS: **acetylcholine (ACh)**

norepinephrine (NE)

Neurotransmitters are released by the presynaptic cell.

Bind to specific receptors in the postsynaptic cell membrane.

Binding has either an excitatory or an inhibitory effect on the effector,

depending on the specific receptor.

Both the preganglionic and postganglionic axons in the parasympathetic division release acetylcholine and thus are called *cholinergic*.

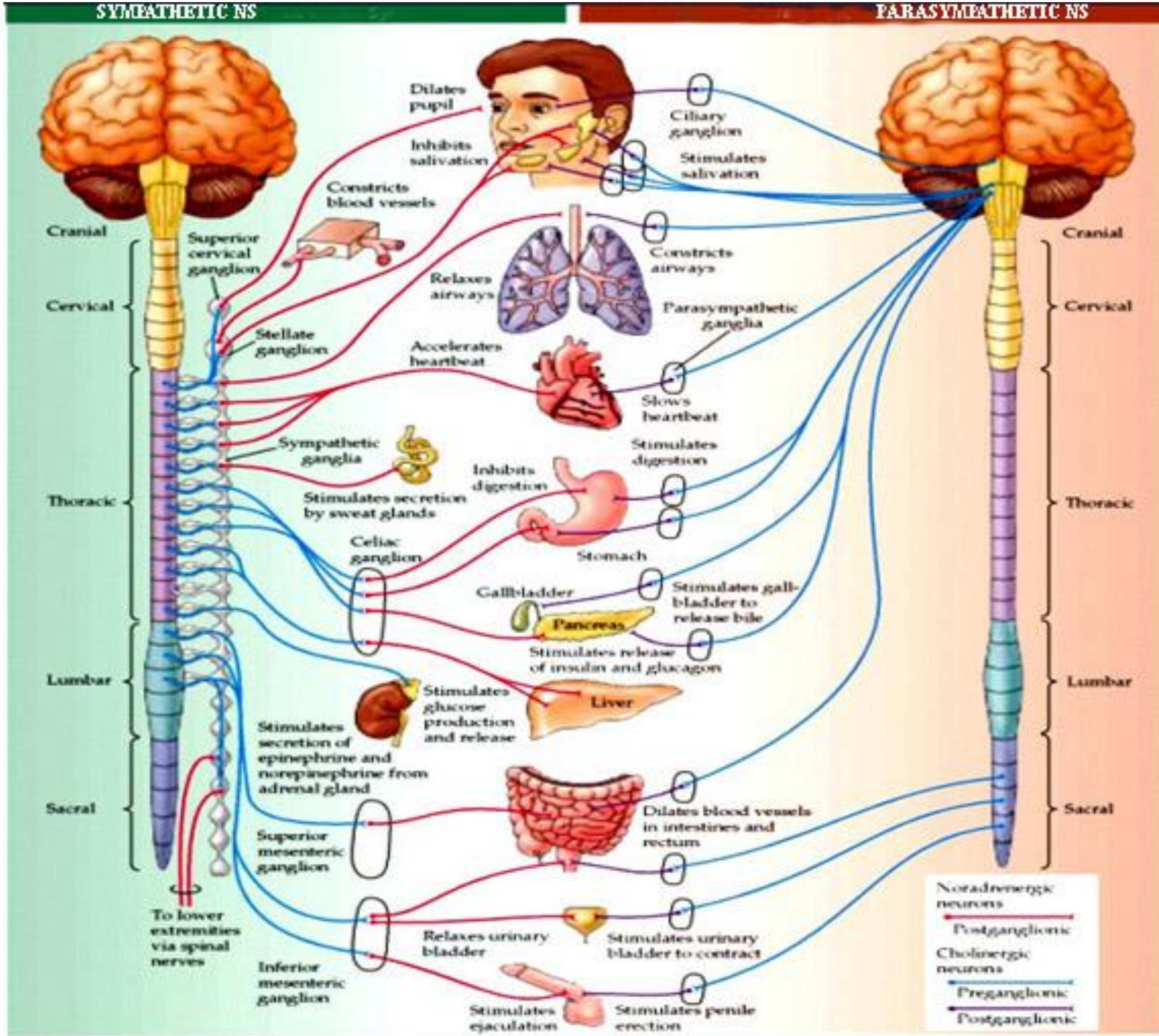
The preganglionic axon and a few postganglionic axons in the sympathetic division are also *cholinergic*.

Most of the postganglionic axons of the

sympathetic division release

norepinephrine and are called *adrenergic.*

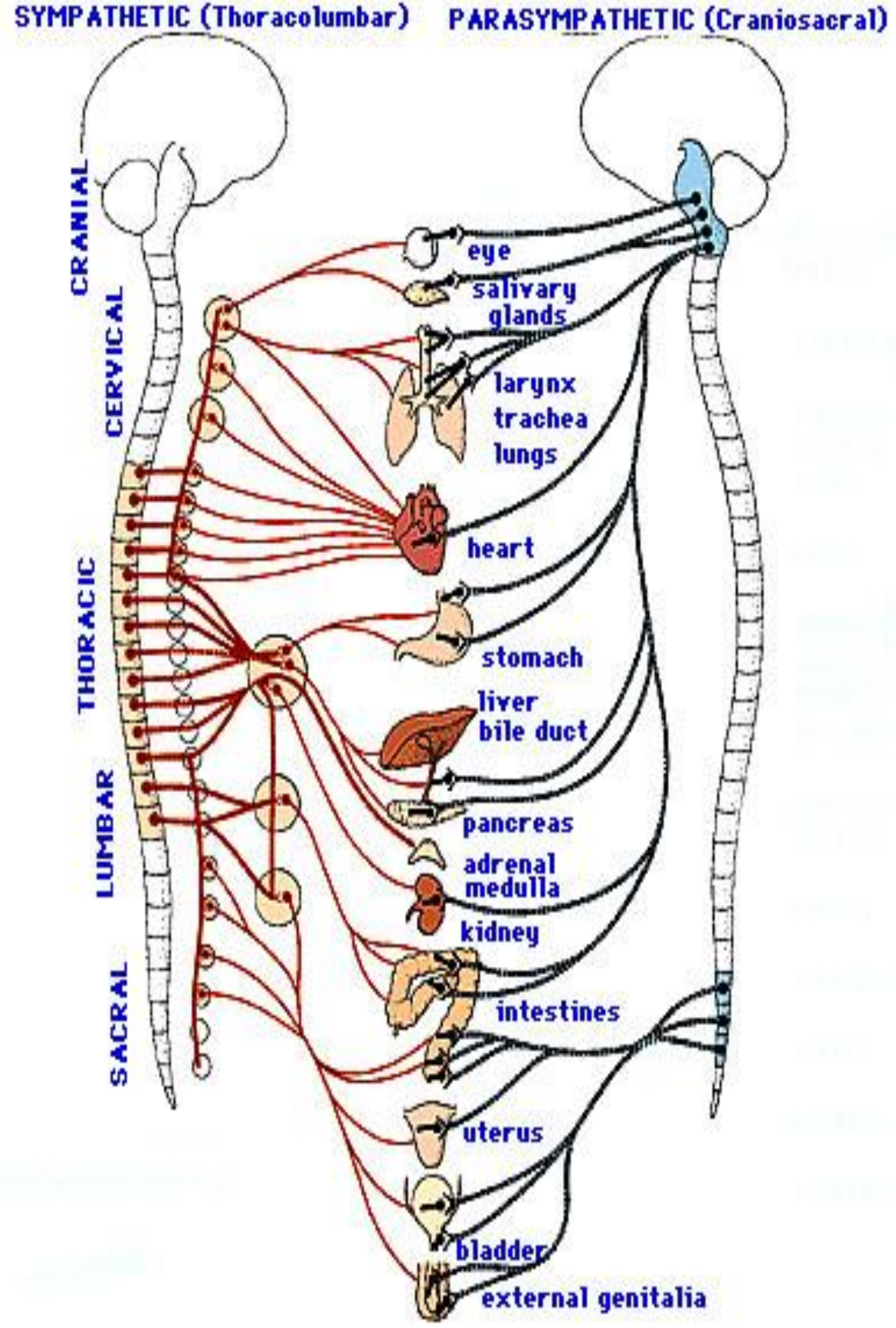
adrenergic neurons



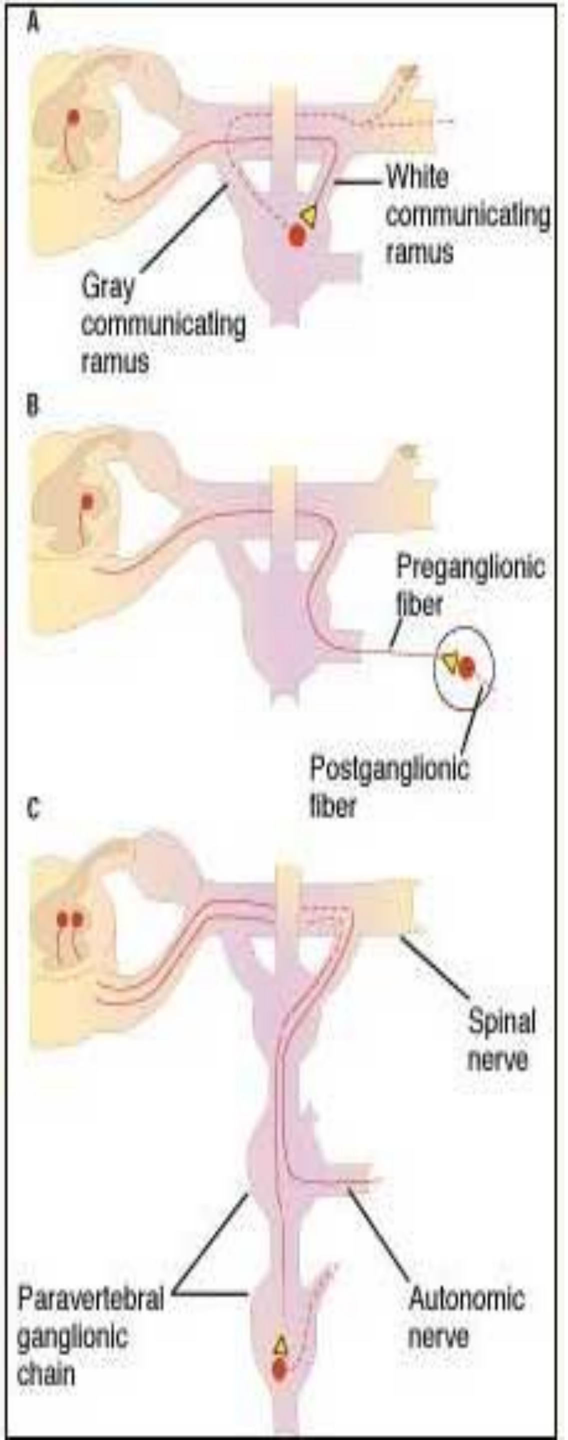
cholinergic neurons

Sympathetic Nervous System

- Also called thoracolumbar system (T1-L2)
- Preganglionic cell bodies in lateral horn
- Preganglionic fibers leave spinal cord with ventral roots
- Leave spinal nerve via white rami communicans
- Postganglionic cell bodies in ganglia
  - Sympathetic chain (paravertebral)
  - Collateral (prevertebral)



- Sympathetic fibers may:
  - Synapse at that level, re-enter spinal nerve via gray ramus communicans
  - Go up the chain before (or after) synapse
  - Go down the chain before (or after) synapse
  - Go through without synapse in chain (as splanchnic nerves)
- Splanchnic nerves
- Postganglionic fibers go to effector organs
- Preganglionic fibers are relatively short; postganglionic relatively long



Sympathetic nervous system

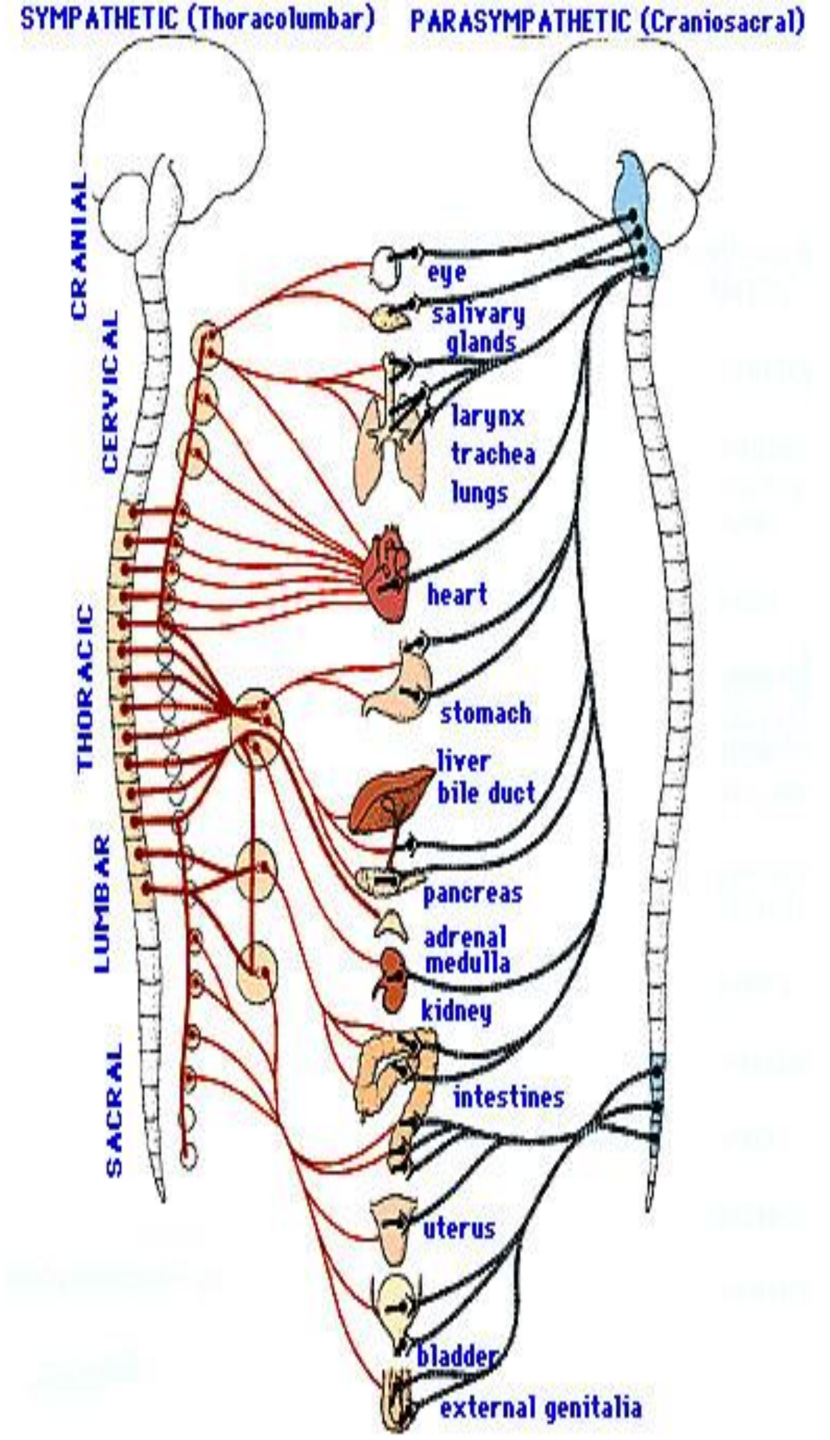
- Consists of the cells of lateral horn of spinal cord from C8 to L2
- The axons within the anterior roots leave the spinal cord
- Some of them are finished in sympathetic trunk (it consists of 20 – 23 ganglia) – 3 cervical, 10 – 12 thoracic, 3 – 4 lumbar, 4 pelvic.
- The rest fibers are going to the prevertebral ganglia or plexuses

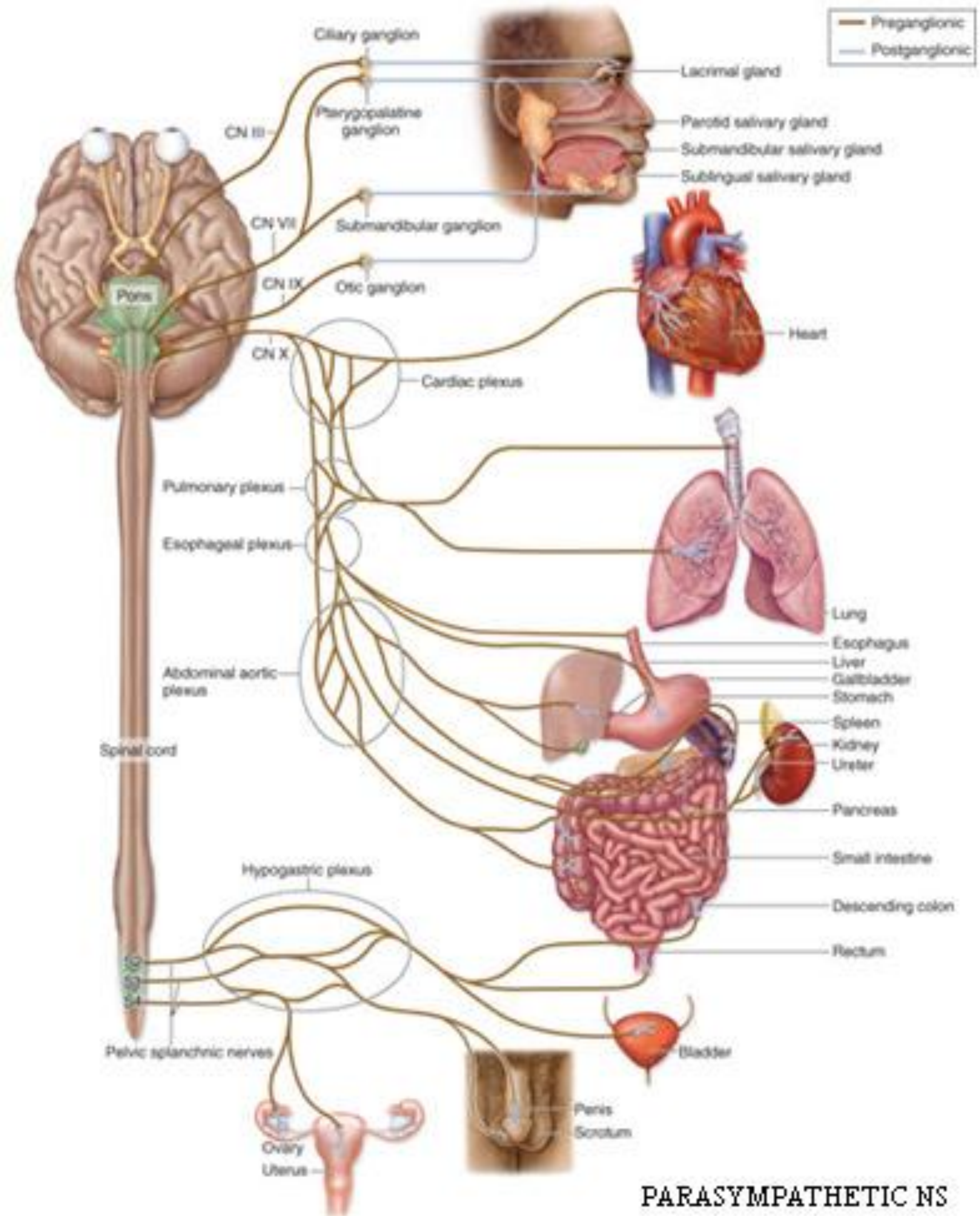
Parasympathetic nervous system

- Mesencephalic level (nuclei of Perlea and Yakubovich), the fibers are going within the III CN and provide innervating of m. Sphincter pupillae, m. Ciliaris

- Bulbar (n.salivatorius superor et inferior, n. dorsalis nervi Vagi) within VII, IX, X CN's innervate parotid, sublingual, submandibular glands and internal organs (except the pelvic organs)

- Sacral part – the cells of lateral horn S2 – S4 – innervating of pelvic organs





PARASYMPATHETIC NS

Two sources of parasympathetic preganglionic fibers

1) the brain stem via cranial nerves III, VII, IX, X
2) sacral part of spinal cord visa spinal nerves S2 through S4

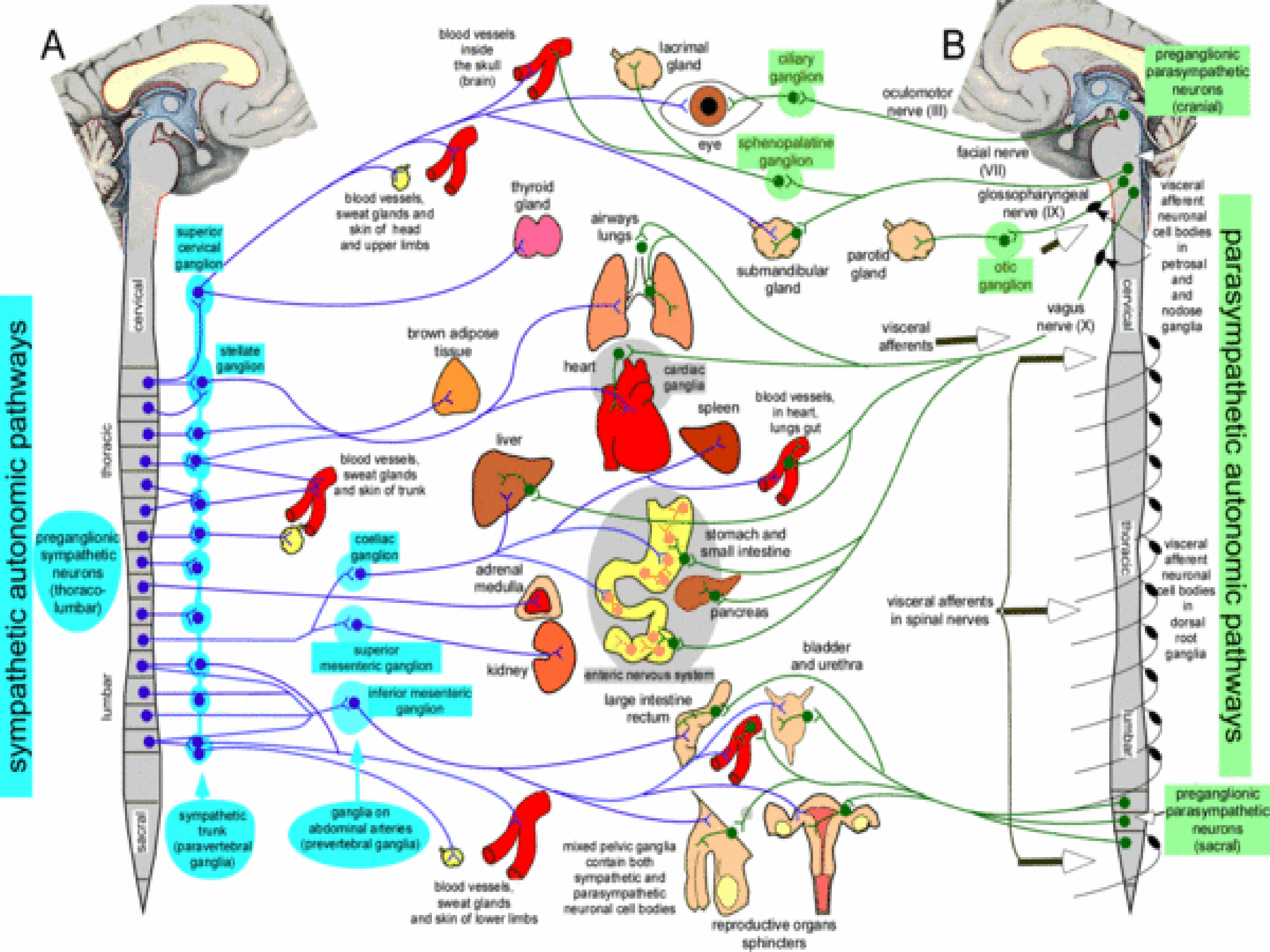
parasympathetic ganglia lie in body close to organ or body part innervated, thus preganglionic parasympathetic fibers tend to be long.

Preganglionic fibers remain in cranial or sacral nerve in which they exited CNS until they reach target.

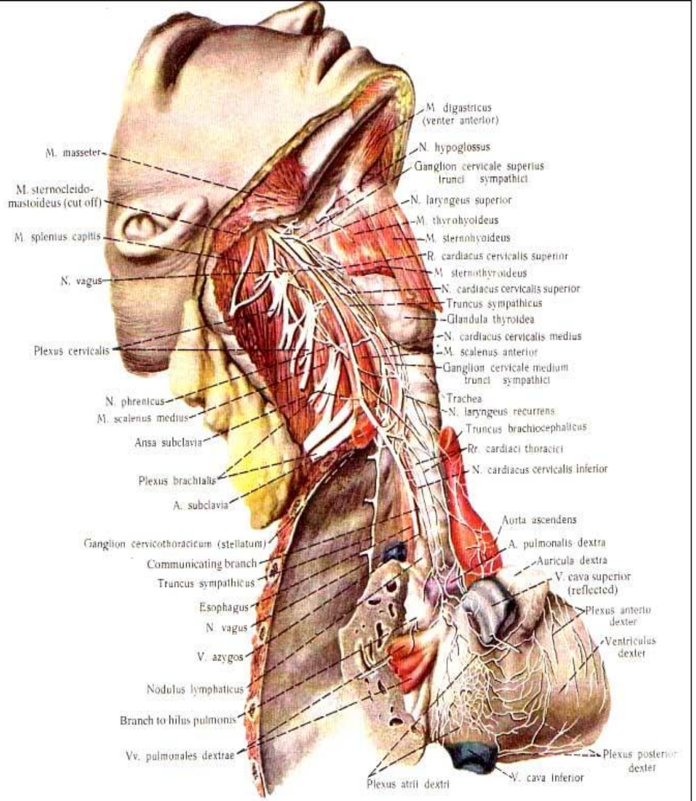
All organs of body except liver receive parasympathetic input, but skin and blood vessels generally not innervated.

Function:

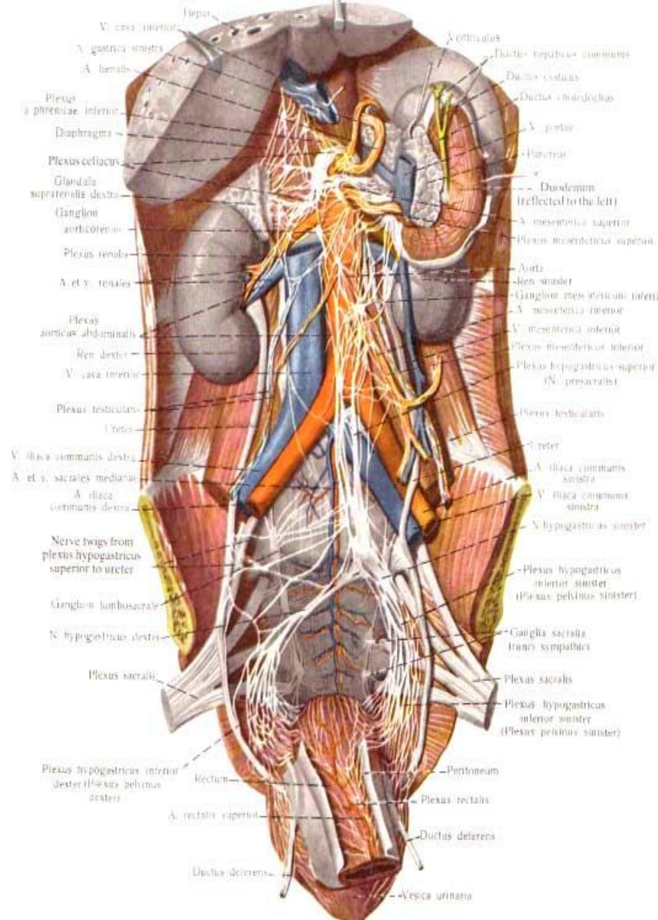
When stimulated, heart rate decreases, blood pressure falls, blood is directed away from skeletal muscles to viscera
Generally relaxes body, although increases activity in digestive system and a few other organs



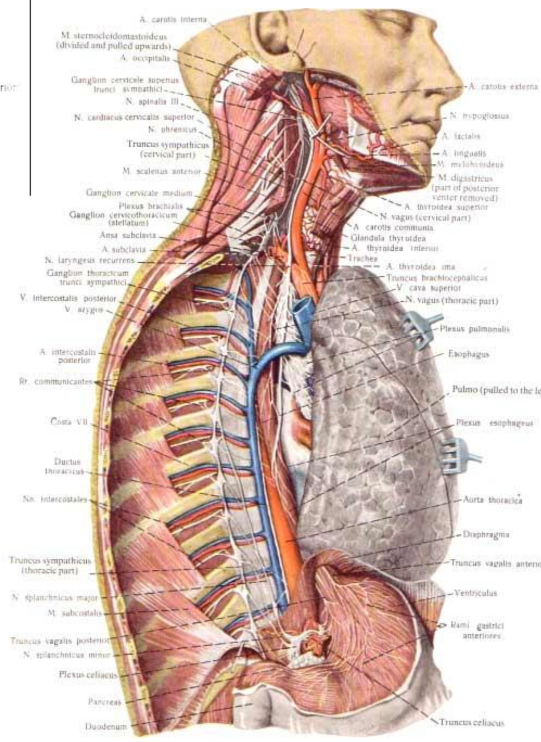
A
B
sympathetic autonomic pathways
parasympathetic autonomic pathways
blood vessels inside the skull (brain)
lacrimal gland
ciliary ganglion
oculomotor nerve (III)
preganglionic parasympathetic neurons (cranial)
eye
sphenopalatine ganglion
facial nerve (VII)
blood vessels, sweat glands and skin of head and upper limbs
thyroid gland
glossopharyngeal nerve (IX)
visceral afferent neuronal cell bodies in petrosal and and nodose ganglia
airways lungs
submandibular gland
parotid gland
otic ganglion
superior cervical ganglion
cervical
vagus nerve (X)
visceral afferents
brown adipose tissue
stellate ganglion
heart
cardiac ganglia
spleen
blood vessels, in heart, lungs gut
thoracic
liver
blood vessels, sweat glands and skin of trunk
stomach and small intestine
preganglionic sympathetic neurons (thoraco-lumbar)
coeliac ganglion
adrenal medulla
visceral afferent neuronal cell bodies in dorsal root ganglia
pancreas
visceral afferents in spinal nerves
superior mesenteric ganglion
kidney
enteric nervous system
bladder and urethra
lumbar
inferior mesenteric ganglion
large intestine rectum
preganglionic parasympathetic neurons (sacral)
sacral
sympathetic trunk (paravertebral ganglia)
ganglia on abdominal arteries (prevertebral ganglia)
mixed pelvic ganglia contain both sympathetic and parasympathetic neuronal cell bodies
blood vessels, sweat glands and skin of lower limbs
reproductive organs sphincters



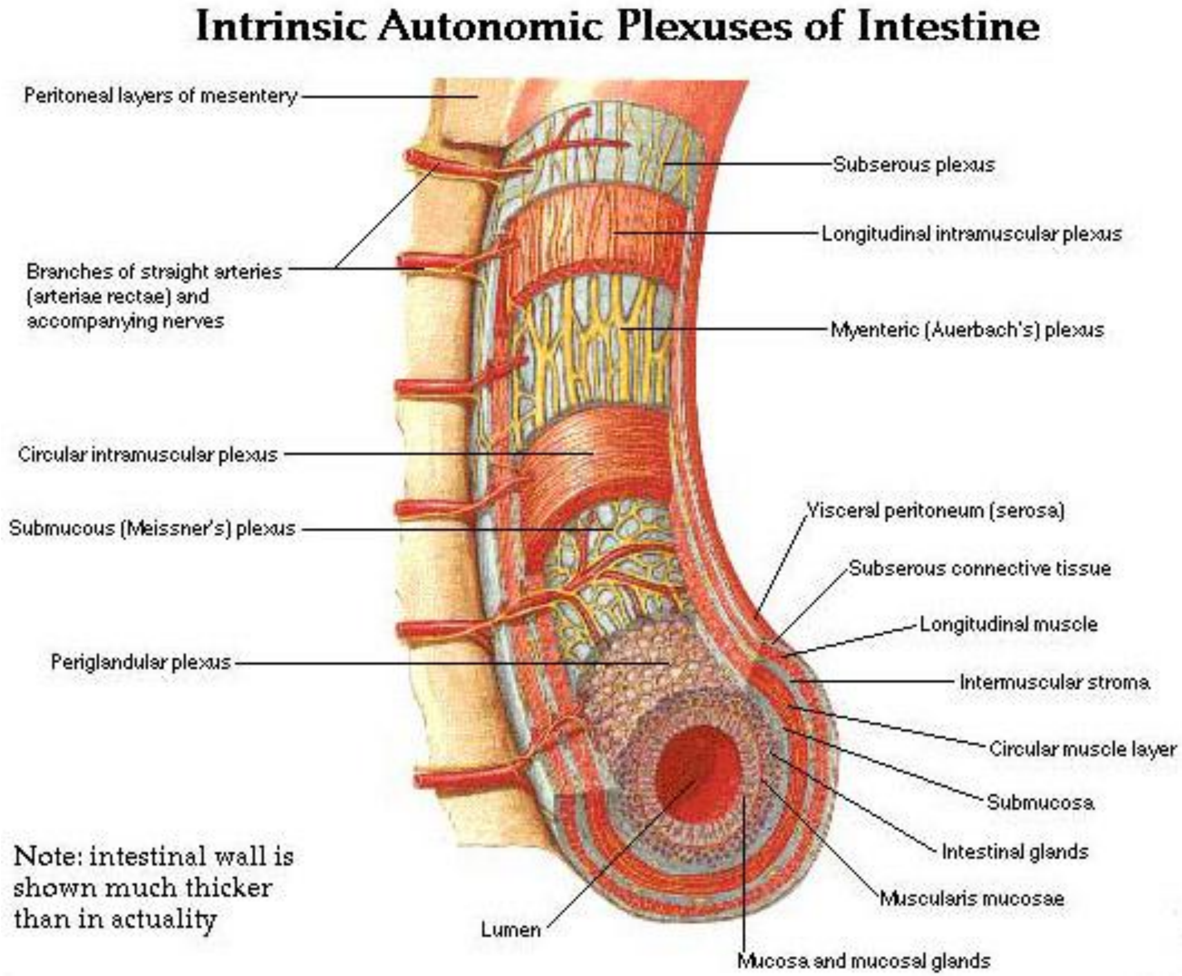
Cervical ganglia, nerves of the heart



Nerves and plexuses of abdominal and pelvic cavities



Nerves and plexuses of thoracic organs; right aspect ($\frac{1}{4}$).



Enteric nervous system

Two arrays of ganglia and nerves distributed along the gut

Myenteric plexus

Ganglia and nerves located between the longitudinal and circular muscles of the intestines

Submucosal plexus

Ganglia and nerves within the submucosa (layer of fibrous connective tissue that attaches a mucus membrane to its subadjacent parts)

Enteric ganglia receive input from both sympathetic and parasympathetic systems

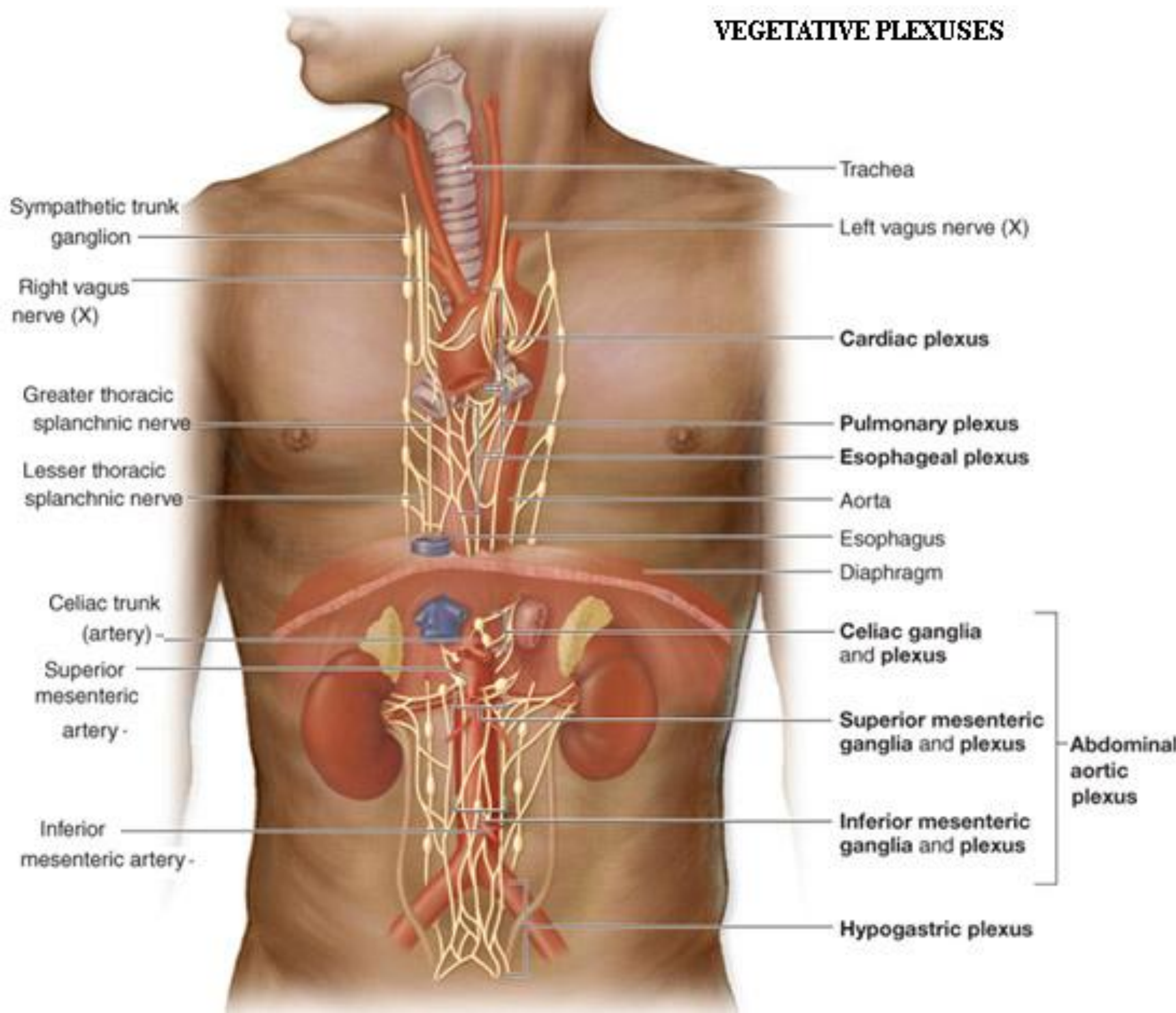
Ganglia contain many local neurons that allow enteric system to function semiautonomously

VEGETATIVE PLEXUSES

Collections of sympathetic postganglionic axons **and** *parasympathetic preganglionic axons*, **as well as some visceral sensory axons.**

Close to one another, but they do not interact or synapse with one another.

Provide a complex innervation pattern to their target organs.



Cardiac plexus

increased sympathetic activity increases heart rate and blood pressure, while

increased parasympathetic activity decreases heart rate

Pulmonary Plexus

parasympathetic pathway causes bronchoconstriction and increased secretion from mucous glands of the bronchial tree

sympathetic innervation causes bronchodilation

Esophageal Plexus

parasympathetic axons control the swallowing reflex

Abdominal aortic plexus

consists of the celiac plexus, superior mesenteric plexus, and inferior mesenteric plexus

Hypogastric plexuses

Autonomic plexuses of abdomen

<u>The celiac plexus:</u> - It lies around the celiac trunk

*it has 5 sympathetic nodules /2 coeliac, 2 aortorenal, 1 superior mesenteric ganglion/

***Formation**:*

a) sympathetic postganglionary fibers

b)parasympathetic preganglionary fibers from nn.vagi /<u>mainly the right</u>/

Branches:

around the celiac trunk and its branches /gastric, splenic, hepatic/

---- the superior mesenteric artery, the renal and gonadal arteries

4)to the suprarenal gland

<u>the intermesenteric plexus</u> **– it** lies between the superior and inferior mesenteric arteries

***Formation**:*

a) sympathetic fibers - from the celiac plexus as well as the first and second lumbar splanchnic nerves /of both sides/

b) parasympathetic fibers – from the pelvic splanchnic nerves of both sides

Branches:

around the inferior mesenteric artery, gonadal artery, iliac arteries

branches to ***<u>the superior hypogastric plexus -</u>*** lies just below aortic bifurcation /in front of L5**/**

divides below into R and L divisions which join the R and L inferior hypogastric plexuses

***Formation**:*

a) sympathetic fibers – from the aortic plexus, the third and fourt lumbar splanchnic nerves of both sides

b) parasympathetic fibers from the pelvic splanchnic nerves of both sides /S2,3,4/

Branches:

a) It divides inferiorly to the R and L hypogastric nerves which descend into the pelvis to form the R and L inferior hypogastric plexuses

b) it also gives branches to the ureteric, gonadal and common iliac plexuses

<u>Inferior hypogastric plexuses</u>

* lying in the extraperitoneal tissue of the pelvis on each side of the rectum and base of the urinary bladder /or cervix of the uterus/

***Formation**:*

a) sympathetic fibers – from the superior hypogastric plexus

the upper 2 sacral sympathetic ganglia

parasympathetic fibers - from the pelvic splanchnic nerves of both sides /S2,3,4/

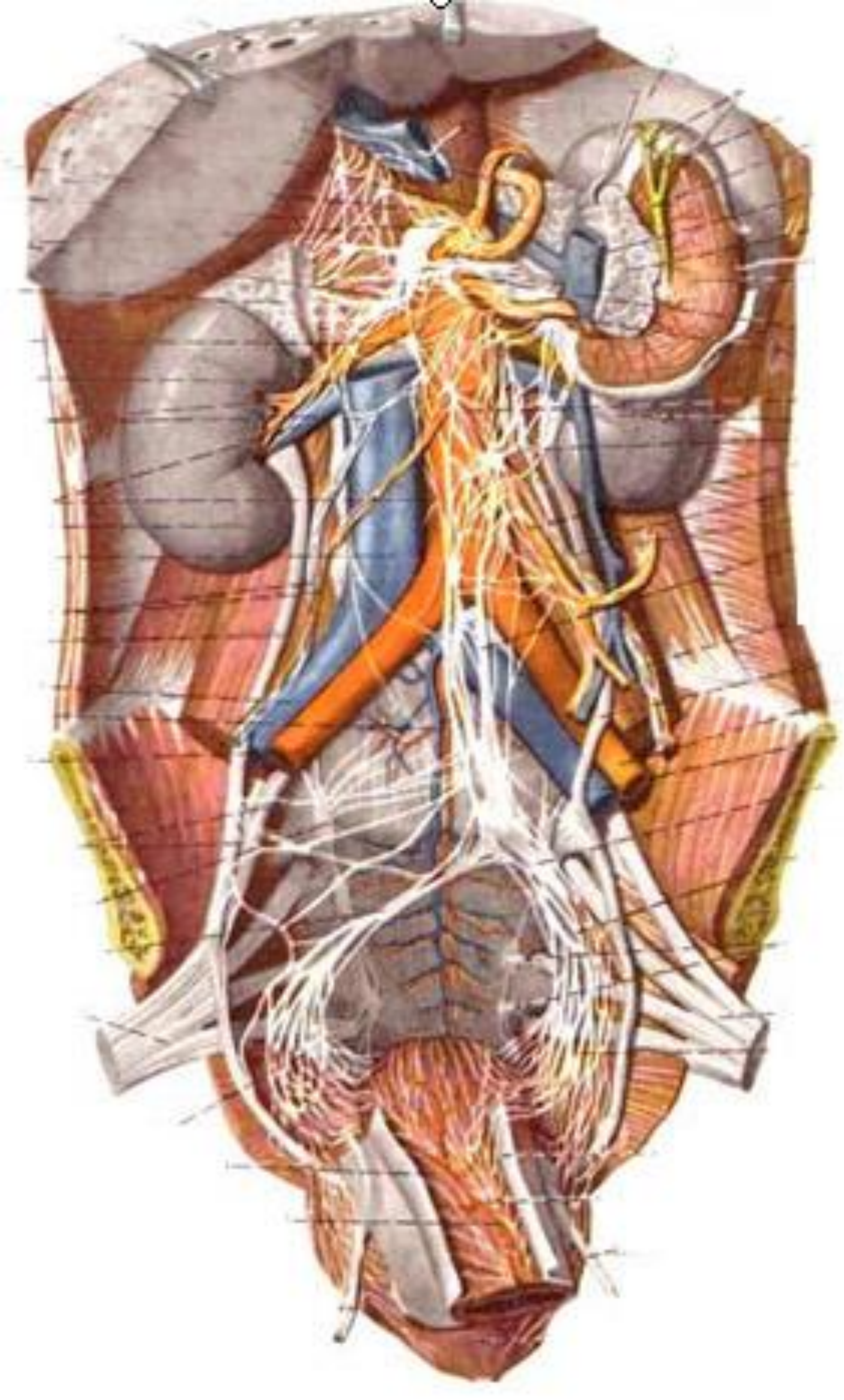
Branches:

middle rectal plexus to the rectum

vesical plexus: to the urinary bladder, seminal vesicles and vas deferens

prostatic: to the prostate and penis

uterovaginal : to the uterus and vagina



Vegetative plexuses:

of the neck and head

common carotid internal carotid
external carotid

of the thorax

cardiac
bronchial – pulmonary
oesophageal
aortic

of the abdomen

coeliac - lienal
- gastric
- hepatic
- pancreatic
upper mesenteric
lower mesenteric
Intermesenteric
renalis – uretericus

of the pelvis

upper hypogastric
2 lower hypogastric
- rectal
- prostatic
- urovaginal

Summary of reflex types

There are a number of ways of classifying reflexes.

One is in terms of the systems that receive the stimulus and give the response.

There are *somato-somatic reflexes*, like the knee jerk that follows tapping the patellar tendon;

***Somato-visceral reflexes*, such as the vasoconstriction that results from cooling the skin;**

***Viscero-visceral reflexes*, for example the decrease in heart rate that follows distention of the carotid sinus;**

and *viscero-somatic reflexes*, like the abdominal cramping that accompanies rupture of the appendix.

***Regulation of the VNS depends on *the highest vegetative centers*:**

* thalamus

* hypothalamus

* cerebellum

* basal nuclei of the brain

* reticular formation

* cortex of the brain

* grey matter surounding the aqueduct of the midbraih

CNS Control of Autonomic Function

Autonomic function is influenced by the cerebrum, hypothalamus, brainstem, and spinal cord.

Sensory processing in the thalamus and emotional states controlled in the limbic system directly affect the hypothalamus.

the integration and command center for autonomic functions

contains nuclei that control visceral functions in both divisions of the ANS

communicates with other CNS regions, including the cerebral cortex, thalamus, brainstem, cerebellum, and spinal cord

The hypothalamus is the central brain structure involved in emotions and drives that act through the ANS.

The brainstem nuclei in the mesencephalon, pons, and medulla oblongata mediate visceral reflexes.

Reflex centers control accommodation of the lens, blood pressure changes, blood vessel diameter changes, digestive activities, heart rate changes, and pupil size.

The centers for cardiac, digestive, and vasomotor functions are housed within the brainstem.

Some responses (defecation and urination), are processed and controlled at the level of the spinal cord without the involvement of the brain.

Higher centers in the brain may consciously inhibit these reflex activities.

Dual Innervation

Many visceral effectors are innervated by postganglionic axons from both ANS divisions.

Actions of the divisions usually oppose each other.

exert antagonistic effects on the same organ

Opposing effects are also achieved by increasing or decreasing activity in one division.

The relevance of the ANS

The autonomic nervous system is so important in regulation of a vast number of body processes that one could say " it's relevant in almost every disease state"! However, autonomic dysfunction plays a particularly prominent role in certain diseases, including:

diabetes mellitus
other conditions where there is autonomic neuropathy
heart failure
tetanus
Guillain-Barré syndrome
porphyria
organophosphate poisoning
ischaemic heart disease and arrhythmias

What does the ANS control?
Resisting the temptation to say 'everything', we note the important functions of the ANS:

Control of heart rate;
Control of exocrine glands;
Influence on certain endocrine glands;
Altered tone in almost all smooth muscle, wherever it's found;
Effects on metabolism.

The Roles of Reflexes

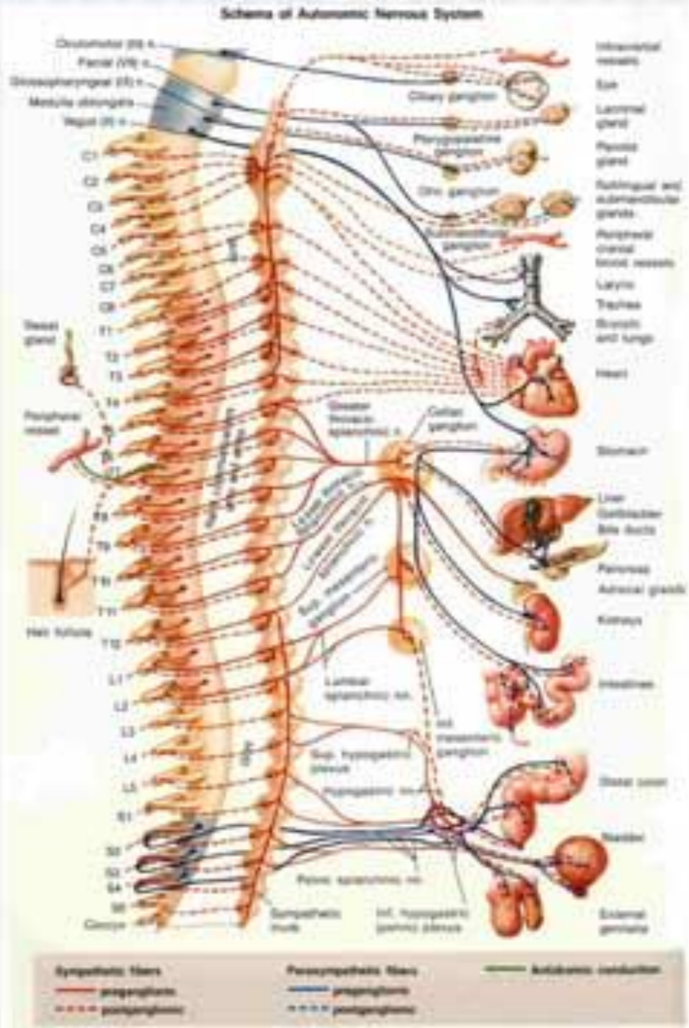
- Communication, Integration, Homeostasis
  - Senses
  - Proprioception
  - Positive & Negative Feedback

Viscero-Visceral Reflexes

- Found in all of the body's systems and may be local (influencing the structure which generated the impulses) or systemic (influencing other structures in response to a given stimuli)

Somato-Visceral & Viscero-Somatic Reflexes

- Somato-Visceral influences via the nervous (central, peripheral, and autonomic) systems
- Viscero-Somatic influences via the nervous (central, peripheral, and autonomic) systems



Psycho-Somato-Visceral Reflexes

- The mind influences the body and vice versa via complex interconnections and interactions

Psycho-Somato-Visceral Reflexes

- The mind influences the body and vice versa via complex interconnections and interactions

- **The pain is reffered to a cutaneous site remote from the site of the lesion.**
- **The referred cutaneous site may be tender and painfull to touch.**
- **Examples:**

1) pain in the right shoulder region in cholecystitis;

2) pain caused by the stretching and irritation of the liver capsule may be referred to the right side of the neck, shoulder or scapula;

3) compression of the lower end of the spine causes pain to the pelvic region or upper leg;

4) pain in the left shoulder region or arm in heart diseases

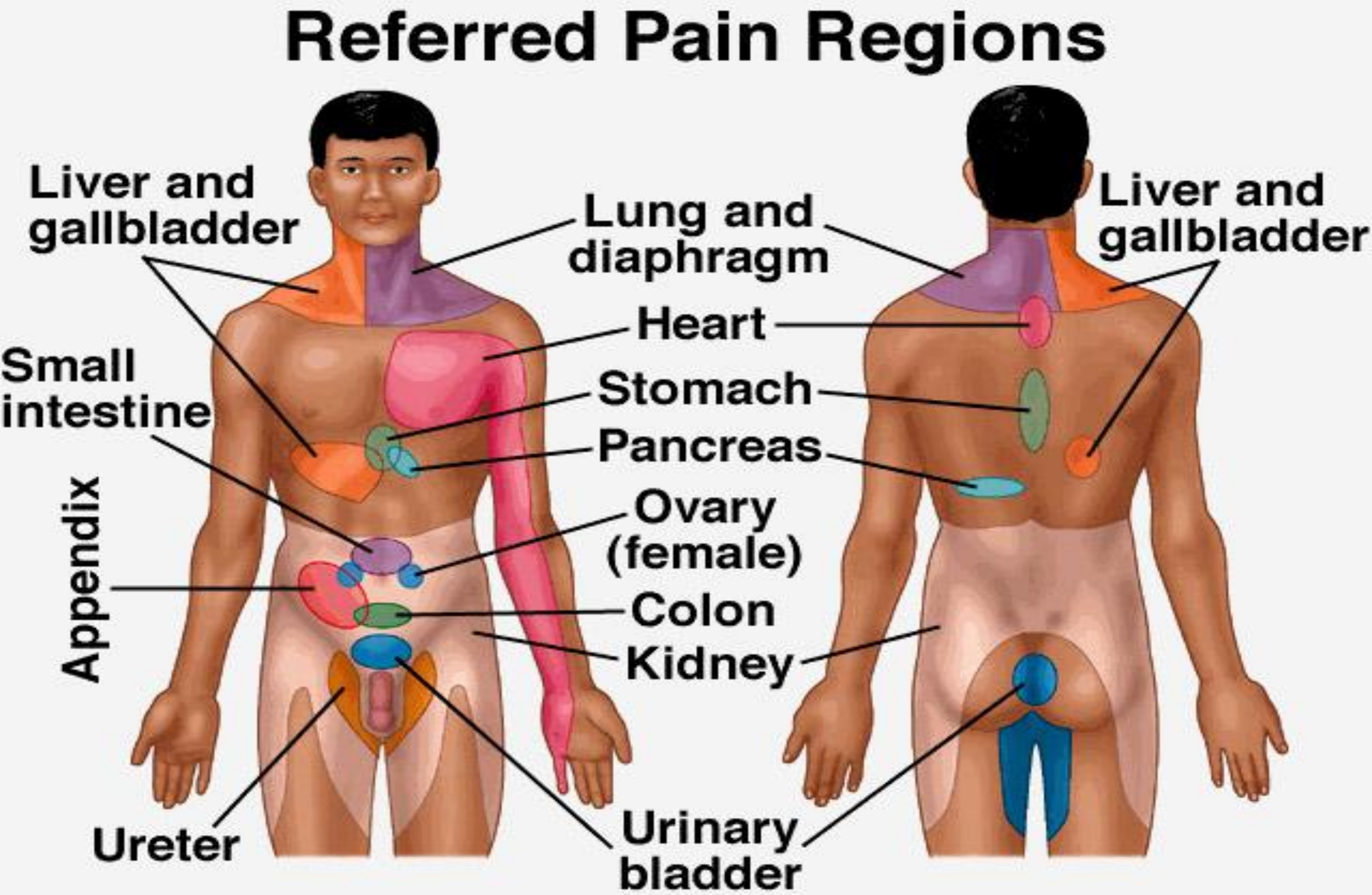
What Is Referred Pain?

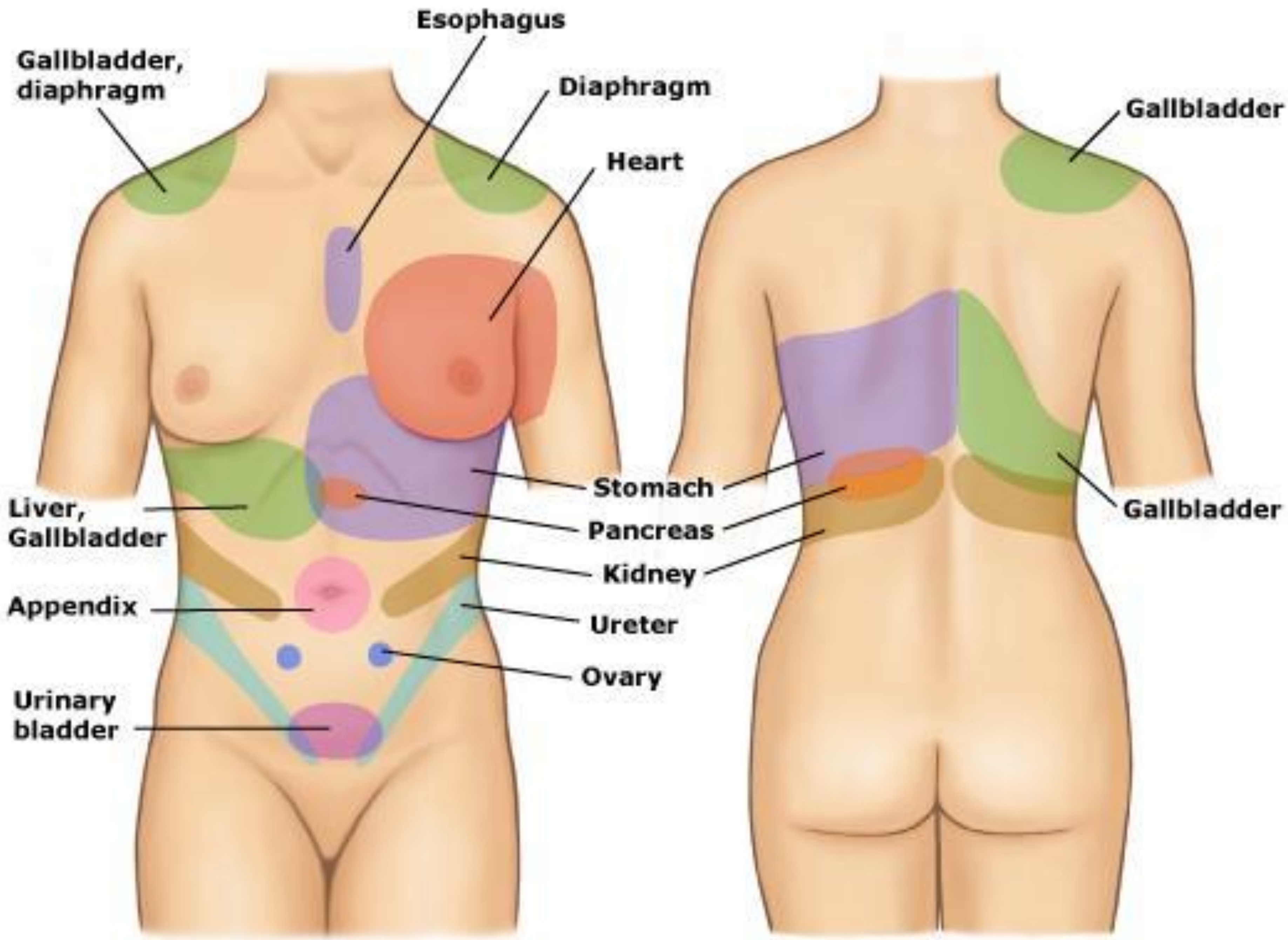
Referred pain has its source in one place but is felt in another.

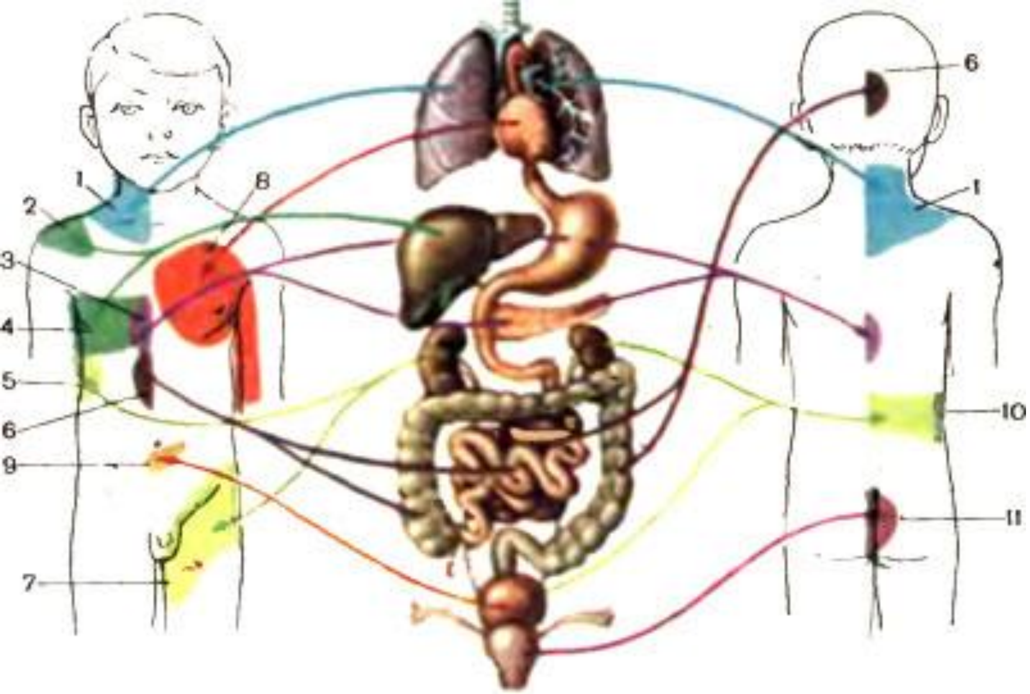
For example, pain behind the eyes may actually be caused by tense muscles in the neck and shoulders.

This means that the place that hurts may not be the part of the head that needs treatment.

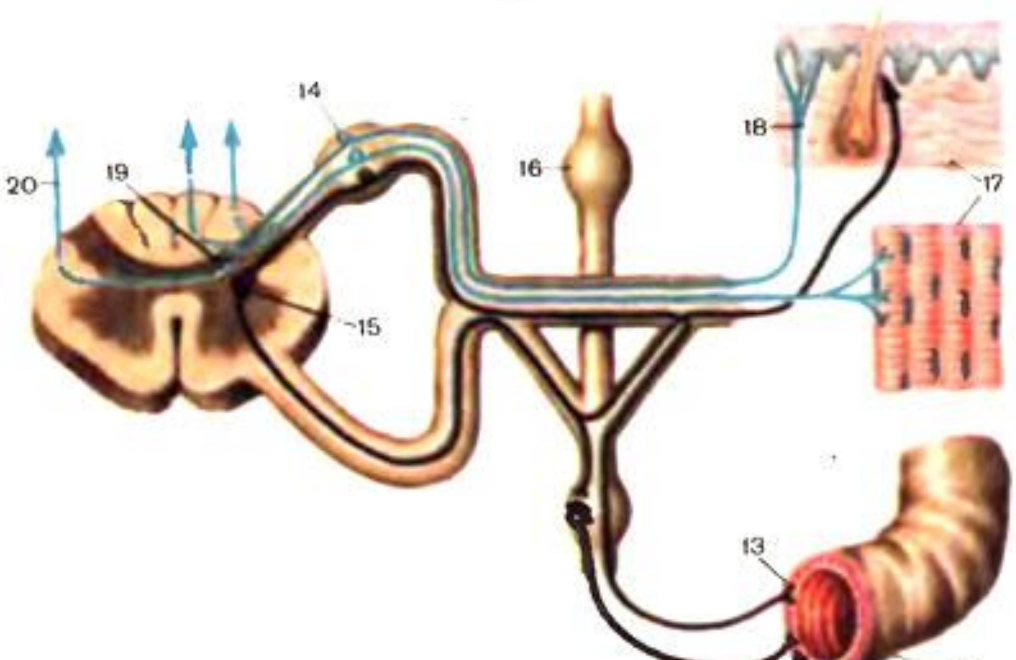
When a person has a heart attack where do they have pain?
The pain usually manifests in the left arm, chest, neck -Zakharyin-Head's areas




Esophagus
Gallbladder, diaphragm
Diaphragm
Heart
Gallbladder
Liver, Gallbladder
Stomach
Pancreas
Kidney
Gallbladder
Appendix
Ureter
Ovary
Urinary bladder



A



Б

A. Zakharyin-Head's areas regions :
1 — lungs; 2 — capsule of the liver; 3 — stomac; pancreas; 4 — liver; 5 — kidney; 6 — intestine; 7 — ureter; 8 — heart; 9 — urinary bladder; 10 — urogenital organs; 11 — uterus.

Б. Scheme of the viscero-cutaneus reflex : **12 —** affected internal organ**; 13 — interoreceptor; 14 — spinal ganglion; 15 — vegetative cell of the lateral horn; 16 — sympathetic chain; 17 — Zaharin-head region (**hyperesthesia and muscle tension**); 18 — exteroreceptor; 19 — sensory neuron of the posterior horn; 20 — lateral spino-thalamic pathway.**

TRIGGER POINTS & REFERRED PAIN

Myofascial trigger points are irritable tight spots in taut bands of muscle that are painful when pressed and may feel knotty to the touch.

Myofascial refers to the body's soft tissue, comprised of muscles and the muscle fascia (or skin), which covers bones, muscle fibers and groups of muscles. Myofascial pain is often misdiagnosed and mistreated because the cause is typically not located in the same place where the pain is felt - this is called referred pain.

Once myofascial trigger points are activated, they may causereferred pain and dysfunction in various and disparate parts of the body unless treated by myofascial trigger pointtherapy."

Here are a few of the most common conditions caused by trigger points and myofascial dysfunction:

The Trapezius is a major source of headache pain, typically the type of pain experienced as a "tension headache."

It can also be a cause of dizziness, jaw, and toothache pain.

Tightness felt in the neck and back of the skull often comes from Trigger Points in the Trapezius.

If neck massage does not relieve the sensation of tightness in the neck, Trigger Points in the Trapezius are the most likely culprit.

Computer users and others who use their arms for extended periods of time will recognize the burning pain between the shoulder blades.

Referred pain from the Trapezius can be found in such a wide variety of locations, that it commonly leads to misdiagnosis, including shoulder bursitis, headaches, disc compression, or a "pinched nerve." Using the Pressure Pointer may help alleviate symptoms.

Trapezius Muscle Location and Trigger Points

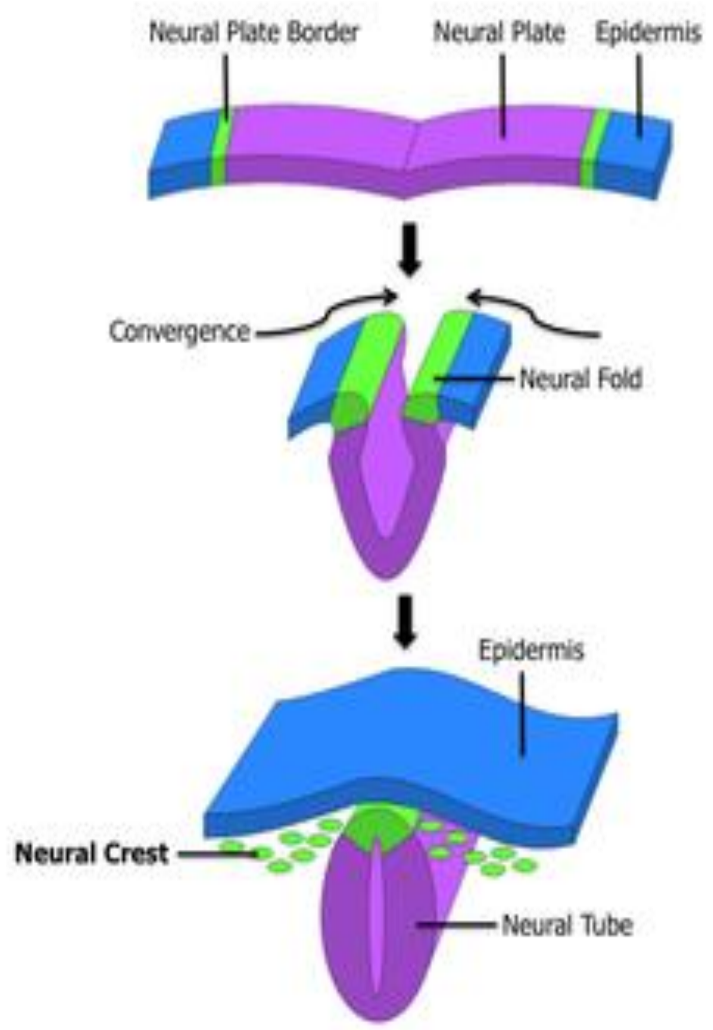
Development of the vegetative ganglia

The ganglion cells of the sympathetic system are derived from the cells of the neural crests.

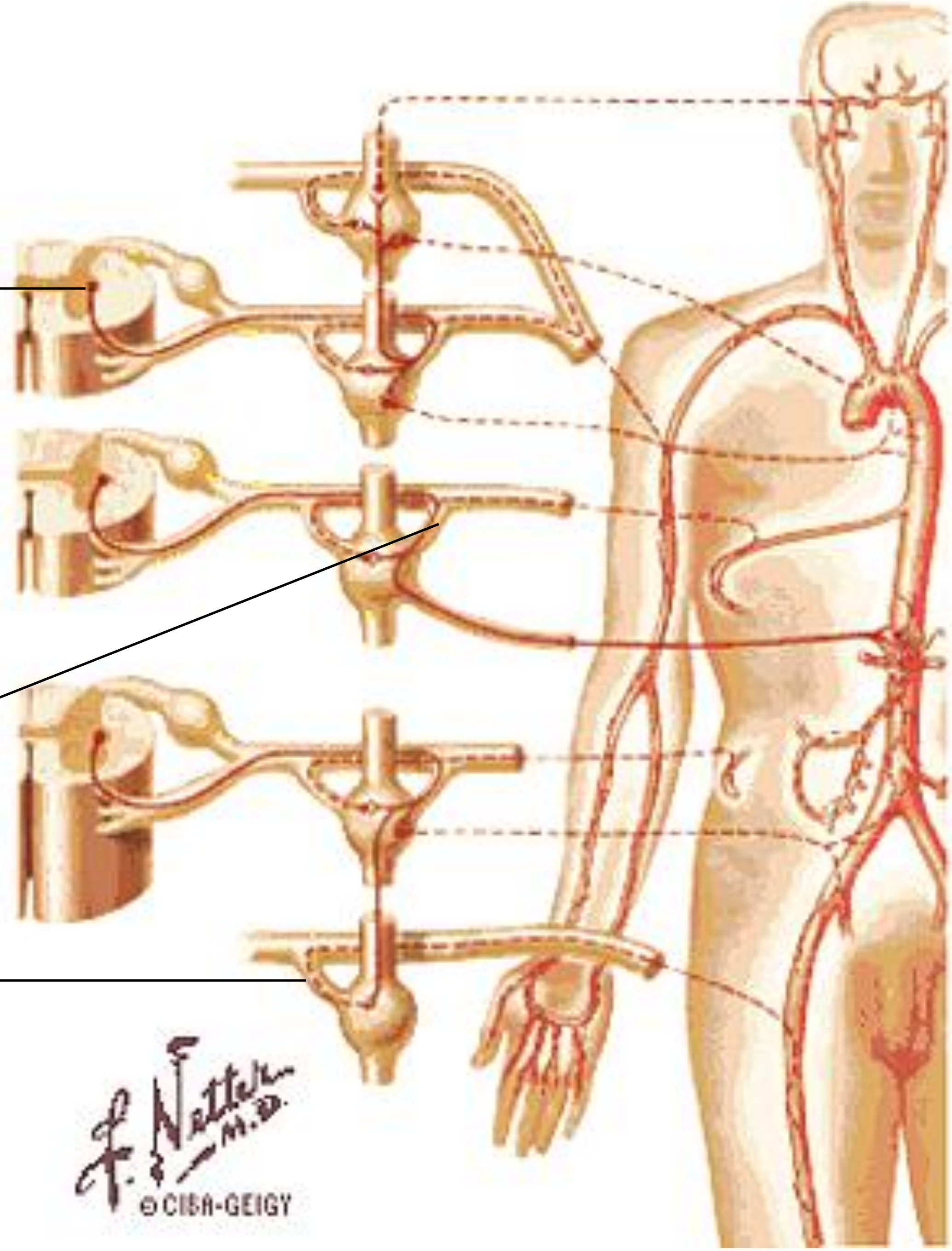
As these crests move forward along the sides of the neural tube and become segmented off to form the spinal ganglia,
certain cells detach themselves from the ventral margins of the crests and migrate toward the sides of the aorta, where some of them are grouped to form the ganglia of the sympathetic trunks, while others undergo a further migration and form the ganglia of the prevertebral and visceral plexuses.

The ciliary, sphenopalatine, otic, and submaxillary ganglia which are found on the branches of the trigeminal nerve are formed by groups of cells which have migrated from the part of the neural crest which gives rise to the semilunar or Gasser's ganglion.

Some of the cells of the ciliary ganglion are said to migrate from the neural tube along the oculomotor nerve.



End


Lateral gray column
White ramus communicans
Gray ramus communicans
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Principles of ANS function

As is often done when dealing with any fairly complex system, people have tried to extract simplifying principles. Here are a few (after Rang, Dale & Ritter**):**

Dale's principle is a gross oversimplification. This principle is that a mature neuron releases the same transmitter(s) at all of its synapses. Although generally true, we now know that not only is release of a 'cocktail' of neurotransmitters the rule rather than the exception, but also that the 'mix' may vary depending on stimulation frequency, and so on. (As an aside, neurones may during their lifetime also change the transmitters they release).

Cannon's law of denervation tells us that if a post-ganglionic neurone has it's pre-ganglionic input removed, then it will become super-sensitive to the normal neurotransmitters that mediate that pre-ganglionic input. There is a variety of reasons for this, including up-regulation of receptors for the neurotransmitter(s), post-receptor effects, and impaired removal of neurotransmitters from the synapse.

The modulation of transmission ('neuromodulation') at a synapse may be either at a presynaptic or postsynaptic level. Presynaptic modulation is discussed within the next section, and post-synaptic effects a bit later.