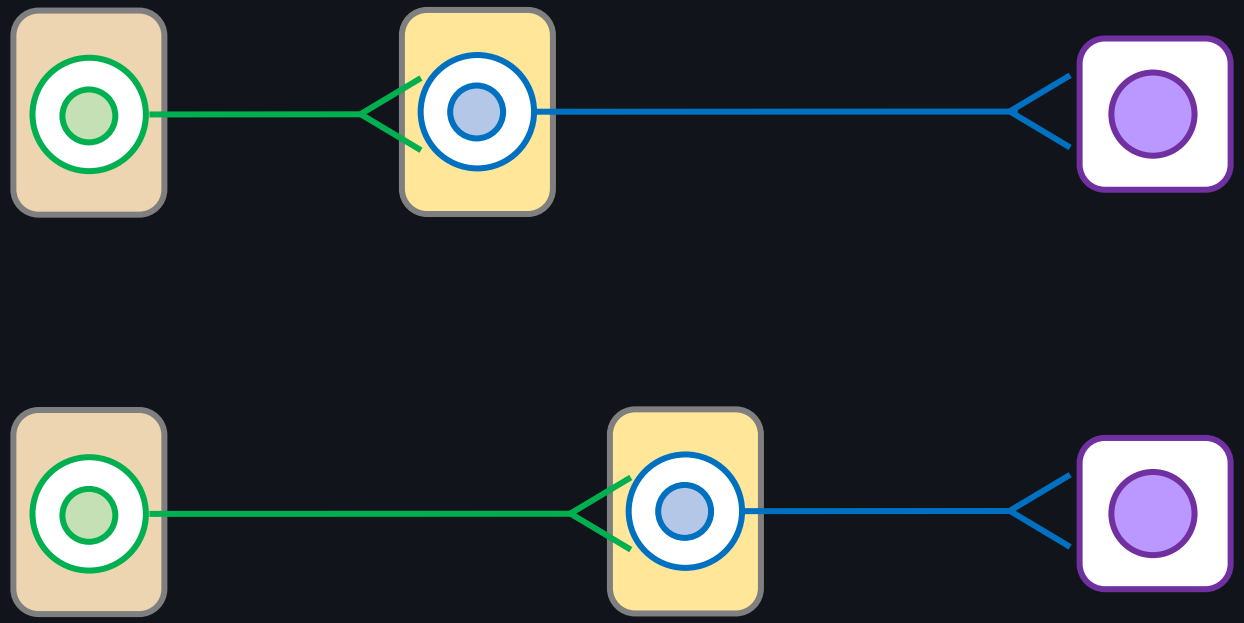
Department of Anatomy, Faculty of Dentistry, Mahidol University

DTAN 211: Gross Anatomy of Head and Neck in Dentistry

Autonomic Nervous System (ANS)



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ANS

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B.Sc. (Biology, 1st Class Honors), Ph.D. (Anatomy and Structural Biology)

Outline

Part I: Introduction of ANS

1. (Basic) Organization of ANS

Part II: Sympathetic

1. Sympathetic pathway
2. Sympathetic ganglion
3. Synapse patterns
4. Supplying areas
5. Sympathetic fibers --> (Nerve)

Part III: Parasympathetic

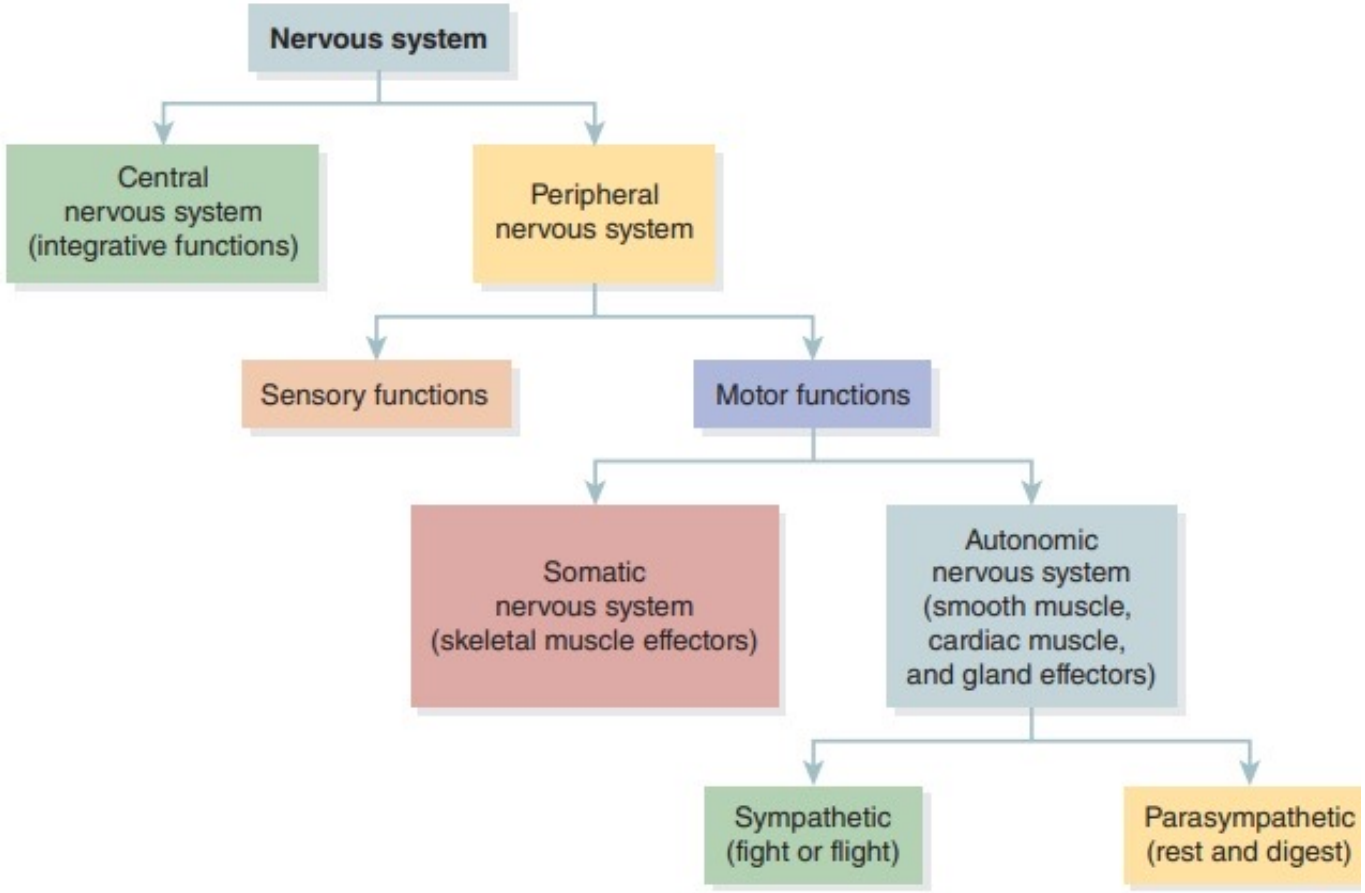
1. Parasympathetic pathway
2. Parasympathetic ganglion
3. Synapse patterns
4. Supplying areas
5. Parasympathetic fibers --> (Nerve)

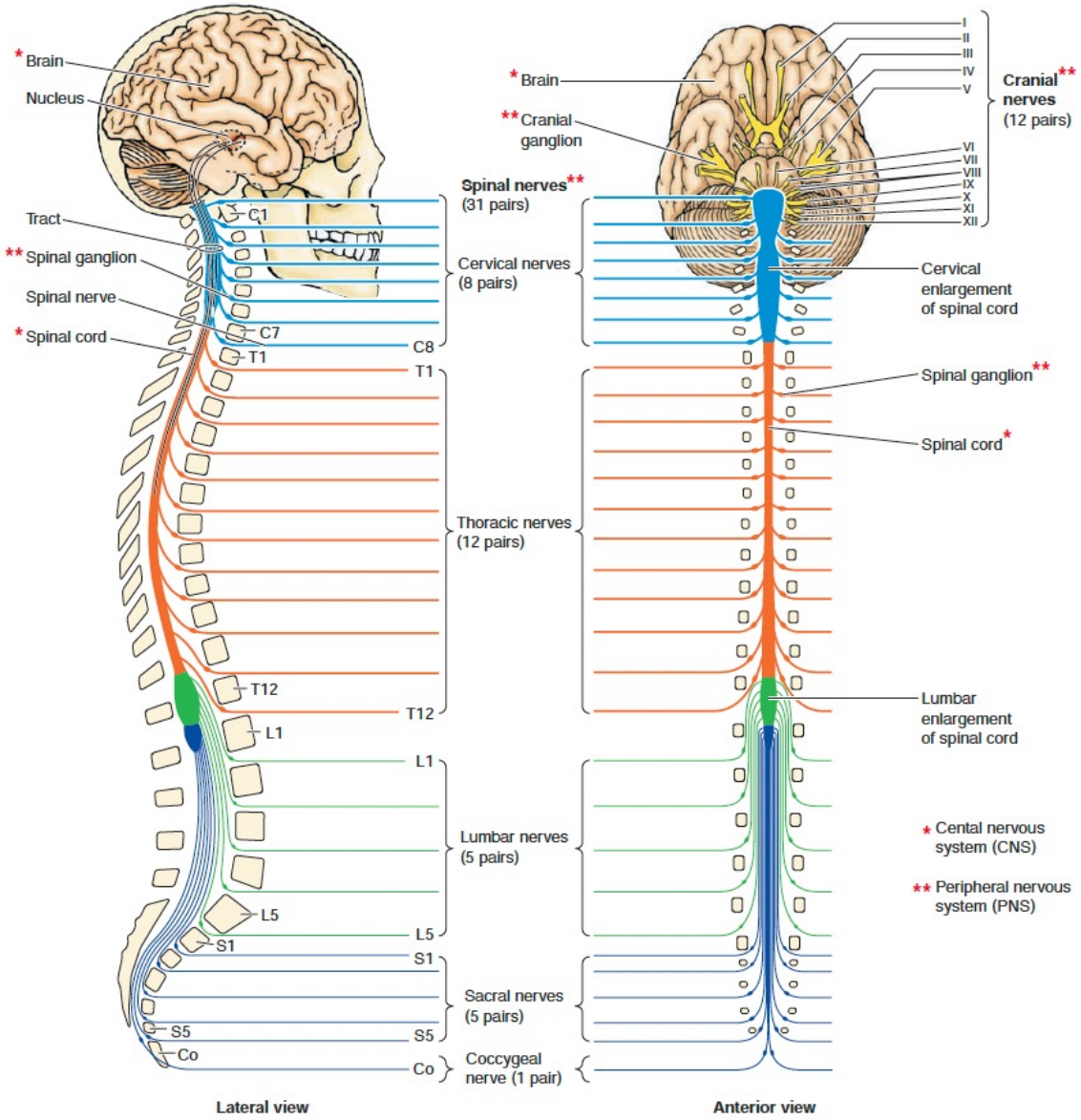
Part IV: ANS of glands

Learning objectives

1. Explain the organization of the sympathetic and parasympathetic nervous system.
2. Describe the pathways of the ANS of glands.
3. Compare the differences between the sympathetic and parasympathetic nervous system.

Part I: Introduction of ANS



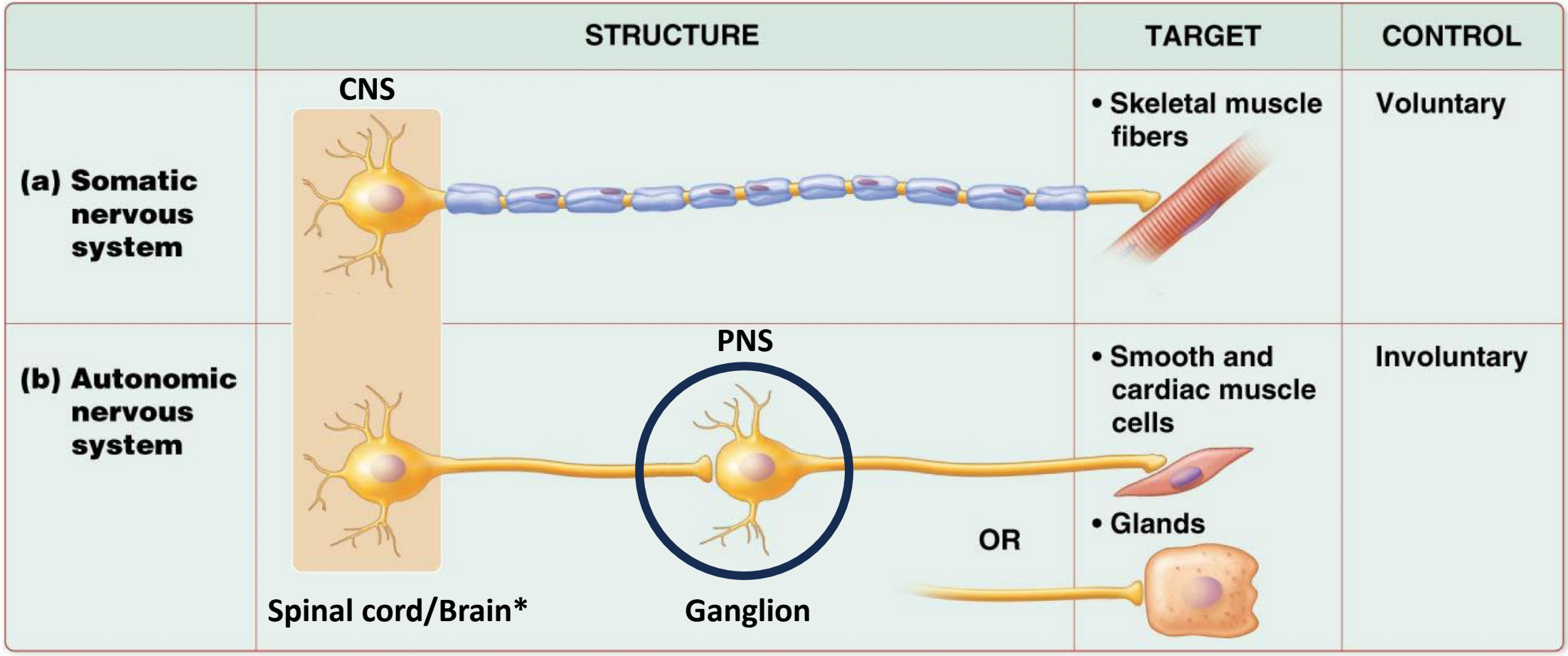


CNS **PNS**

- Brain -------> - Cranial nerves (CN) = 12 pairs
- Spinal cord -------> - Peripheral nerves (PN) = 31 pairs

Part I: Introduction of ANS

Motor function



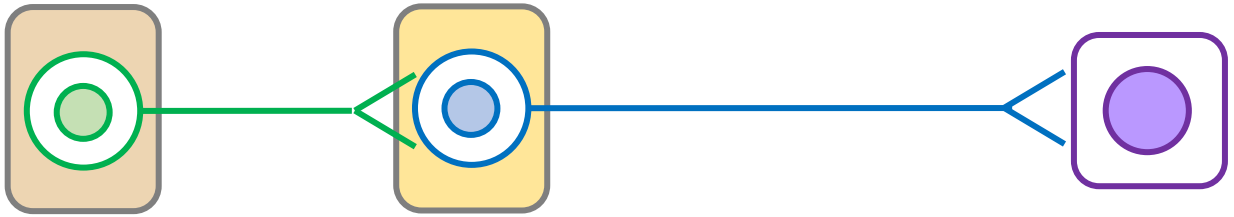
The number of neurons & cell compartment (House)

- Somatic = 1 neuron, House = Spinal cord
- Autonomic = 2 neurons,
  - House # 1 = Spinal cord/Brain*; House of = preganglionic neurons
  - House # 2 = Ganglion; House of = postganglionic neurons

Control & target

- Somatic = voluntary --> Skeletal m.
- Autonomic = involuntary --> Smooth m. Cardiac m. Glands

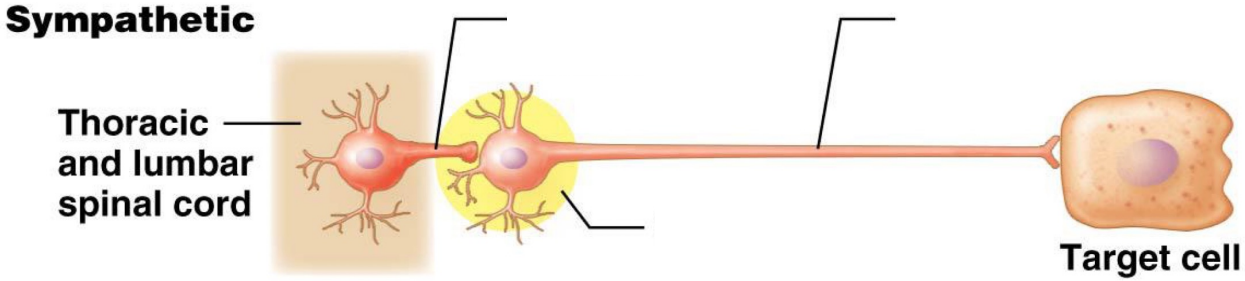
Part I: Introduction of ANS



	STRUCTURE	TARGET	CONTROL
(a) Somatic nervous system	CNS	• Skeletal muscle fibers	Voluntary
(b) Autonomic nervous system	Spinal cord/Brain* Ganglion OR	• Smooth and cardiac muscle cells • Glands	Involuntary

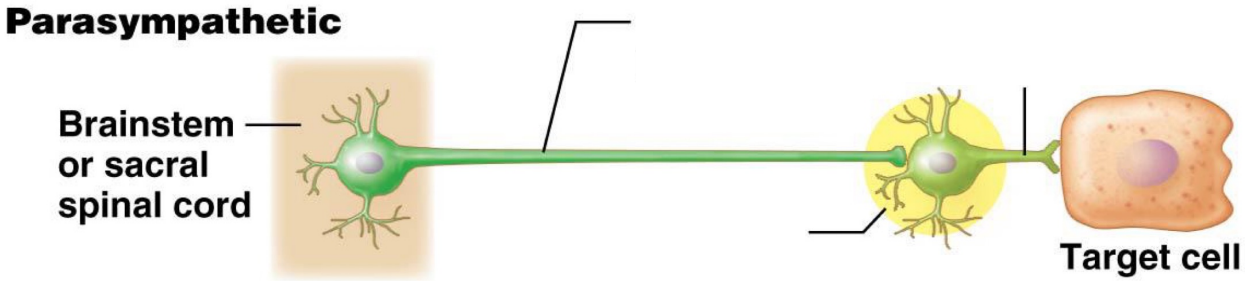
General term of ANS = 2 neurons,

- House # 1 = Spinal cord/Brain* (CNS)
  - House of = preganglionic (presynaptic) neuron
- House # 2 = (Autonomic) Ganglion
  - House of = postganglionic (postsynaptic) neurons



Sympathetic

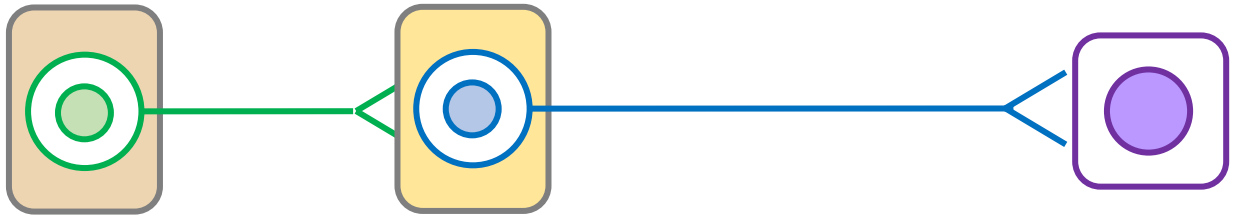
- House # 1 = Spinal cord @ Thoracic-lumbar
  - House of = preganglionic sympathetic neurons
- House # 2 = Sympathetic ganglion
  - House of = postganglionic sympathetic neurons

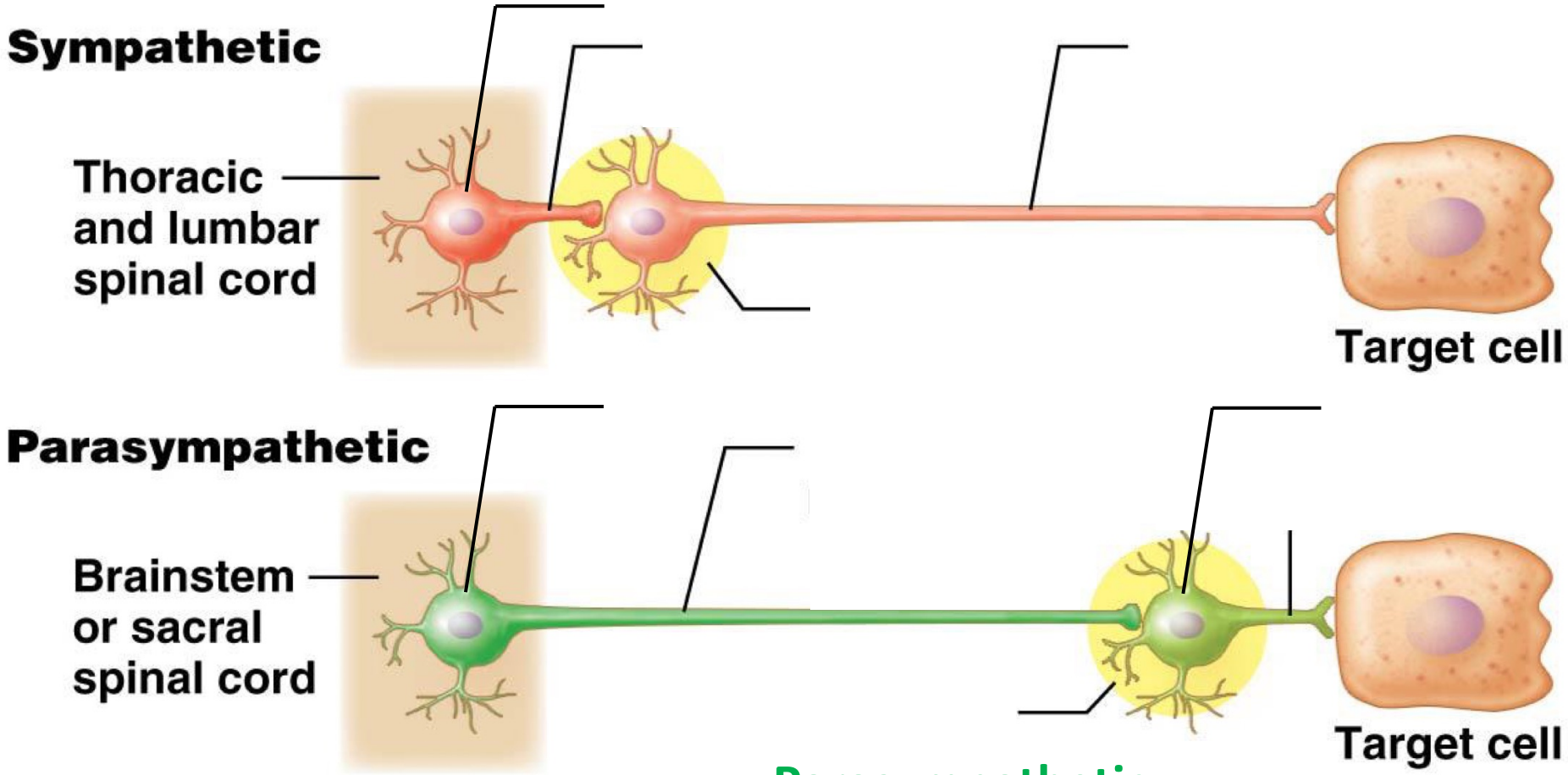


Parasympathetic

- House # 1 = Spinal cord @ Sacral, Brainstem
  - House of = preganglionic parasympathetic neurons
- House # 2 = Parasympathetic ganglion
  - House of = postganglionic parasympathetic neurons

Part I: Introduction of ANS





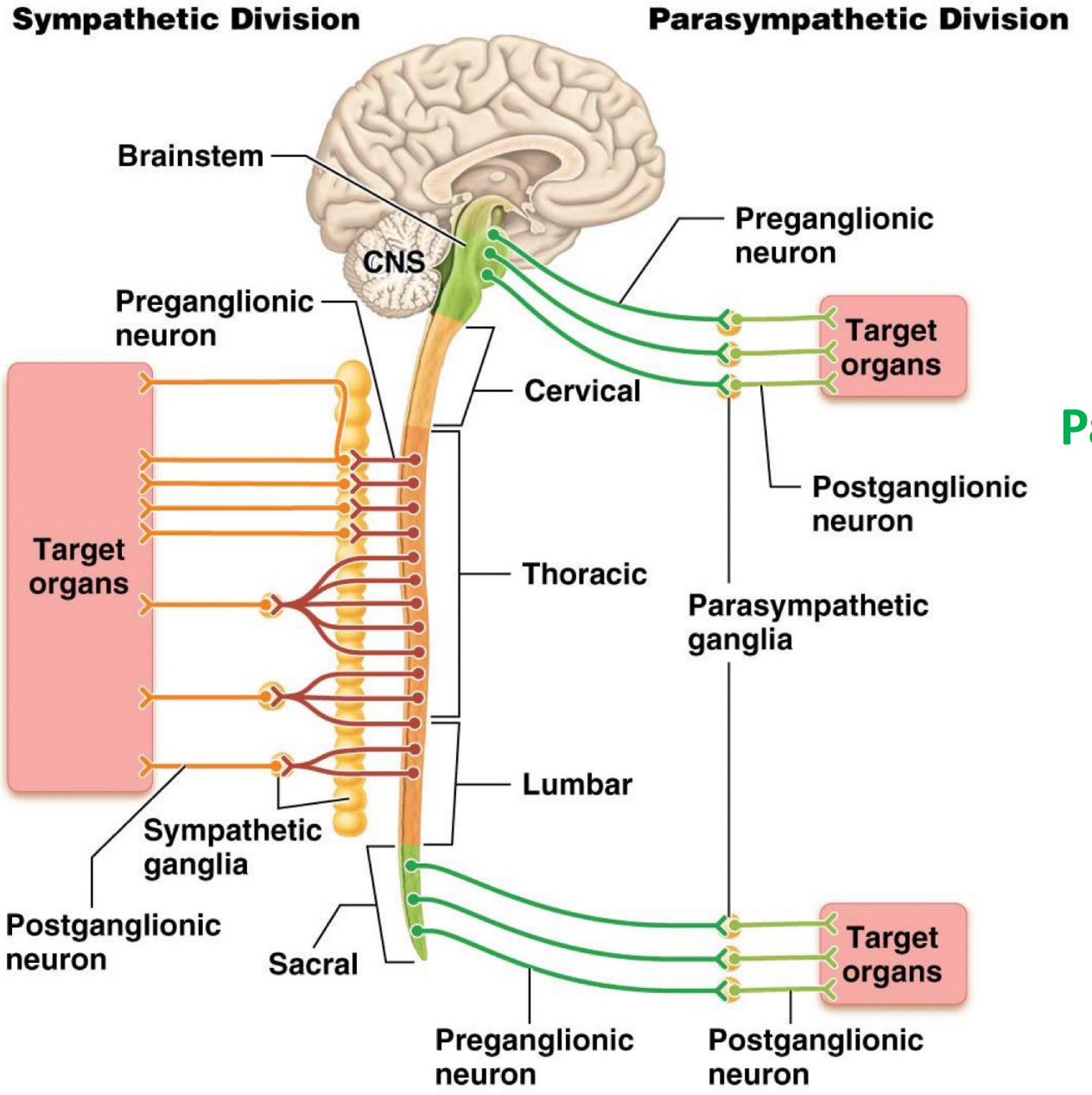
Sympathetic

- House # 1 = Spinal cord @ Thoracic & lumbar
  - House of = preganglionic sympathetic neurons
- House # 2 = Sympathetic ganglion
  - House of = postganglionic sympathetic neurons

Parasympathetic

- House # 1 = Spinal cord @ Sacral, Brainstem
  - House of = preganglionic parasympathetic neurons
- House # 2 = Parasympathetic ganglion
  - House of = postganglionic parasympathetic neurons

Part I: Introduction of ANS



Sympathetic (Fight/Flight)

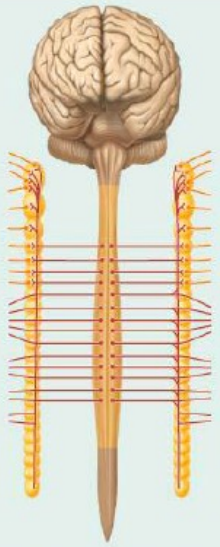
- House # 1 = Spinal cord @ Thoracic-lumbar
  "Thoracolumbar outflow" (T1 – L2)
  - House of = preganglionic sympathetic neurons
    - Shorter preganglionic sympathetic fibers
- House # 2 = Sympathetic ganglion
  - House of = postganglionic sympathetic neurons
  - 2.1 Paravertebral ganglion (Sympathetic chain/trunk)
  - 2.2 Prevertebral (Collateral) ganglion

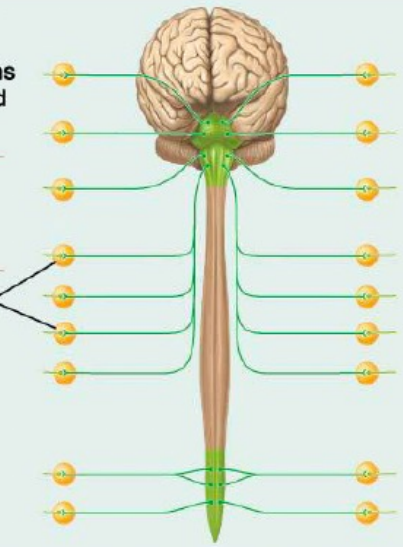
Parasympathetic (Rest/Digest)

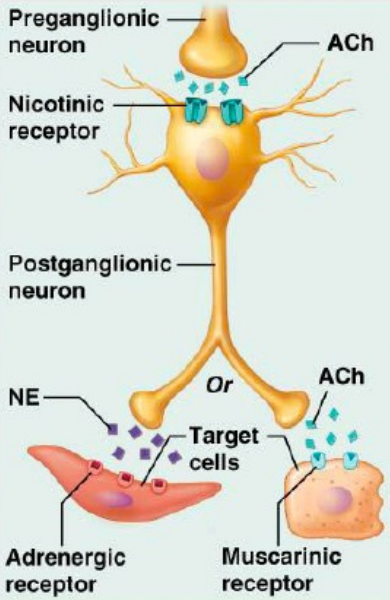
- House # 1 = Spinal cord @ Sacral, Brainstem
  "Craniosacral outflow"
  - House of = preganglionic parasympathetic neurons
    - Longer preganglionic parasympathetic fiber
  - 1.1 Cranial outflow = Brainstem nuclei (CN III, VII, IX, X)
  - 1.2 Sacral = S2 – S4
- House # 2 = Parasympathetic ganglion
  - House of = postganglionic parasympathetic neurons
  - 2.1 Ciliary ganglion
  - 2.2 Pterygopalatine ganglion
  - 2.3 Submandibular ganglion
  - 2.4 Otic ganglion
  - 2.5 Intrinsic ganglion (within/close to target organs)

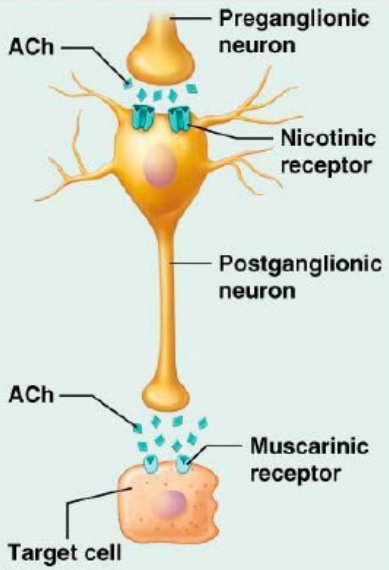
Part I: Introduction of ANS

SYMPATHETIC NERVOUS SYSTEM		PARASYMPATHETIC NERVOUS SYSTEM
"Fight or flight" — maintains homeostasis during exercise, emotion, and emergency	MAIN ROLE	"Rest and digest" — homeostasis of maintenance functions such as digestion and formation of urine
Thoracolumbar region of spinal cord	LOCATION OF PREGANGLIONIC CELL BODIES	Craniosacral region of spinal cord
Mostly in ganglia near the vertebral column	LOCATION OF POSTGANGLIONIC CELL BODIES	In ganglia near the target cell
Acetylcholine (ACh)	PREGANGLIONIC NEUROTRANSMITTERS	Acetylcholine (ACh)
Nicotinic	POSTGANGLIONIC RECEPTORS	Nicotinic
Norepinephrine (NE) Epinephrine ACh	POSTGANGLIONIC NEUROTRANSMITTERS	ACh
Adrenergic Muscarinic	TARGET CELL RECEPTORS	Muscarinic









Part II: Sympathetic nervous system

2A. Sympathetic pathways

Preganglionic sympathetic neuron

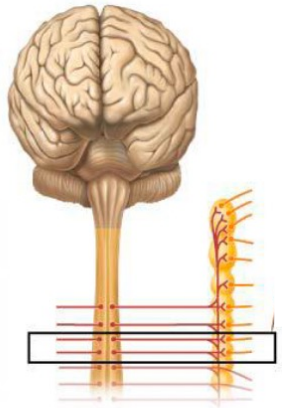
- Lateral horn of grey matter of spinal cord
- Anterior root
- Spinal nerve
- White rami communicans

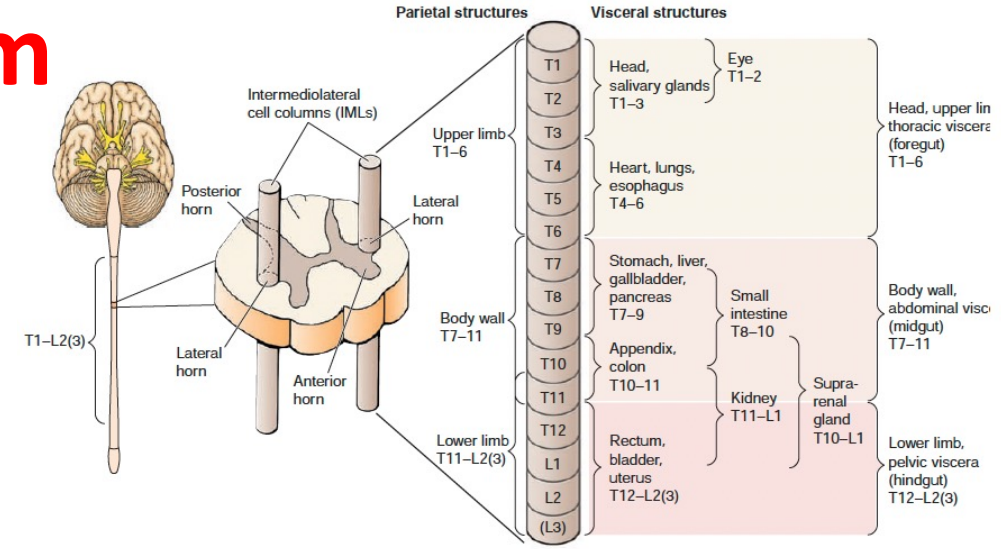
Thoracolumbar outflow

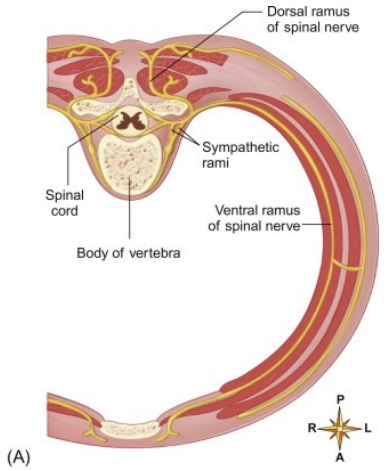
- Sympathetic ganglion

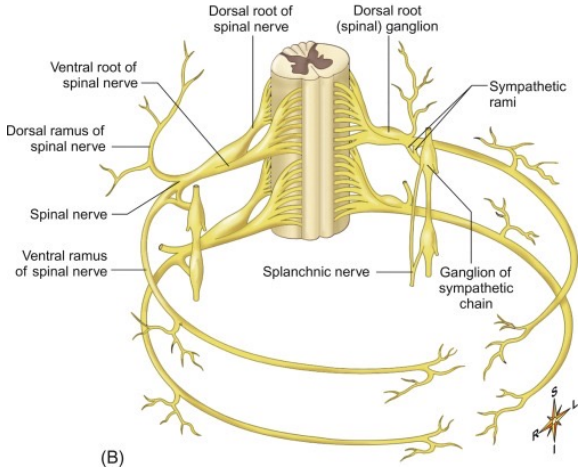
Postganglionic sympathetic neuron

- Grey rami communicans
- Anterior ramus of spinal nerve
- Target cells

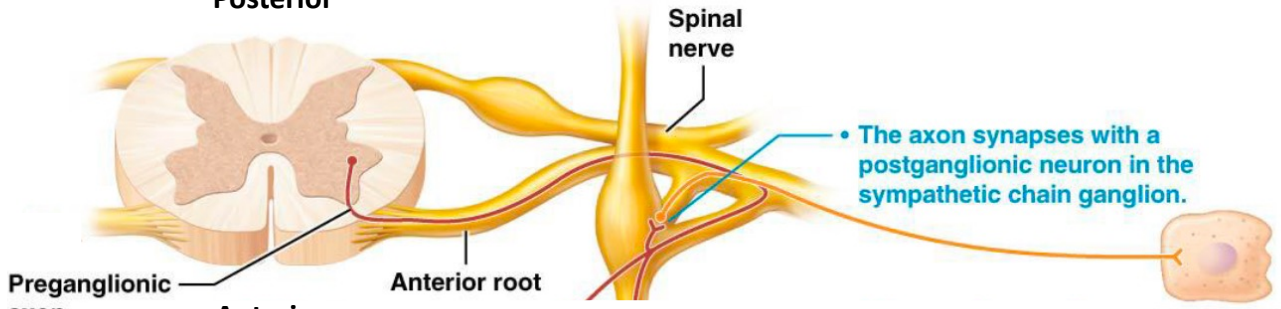








Posterior



Part II: Sympathetic nervous system

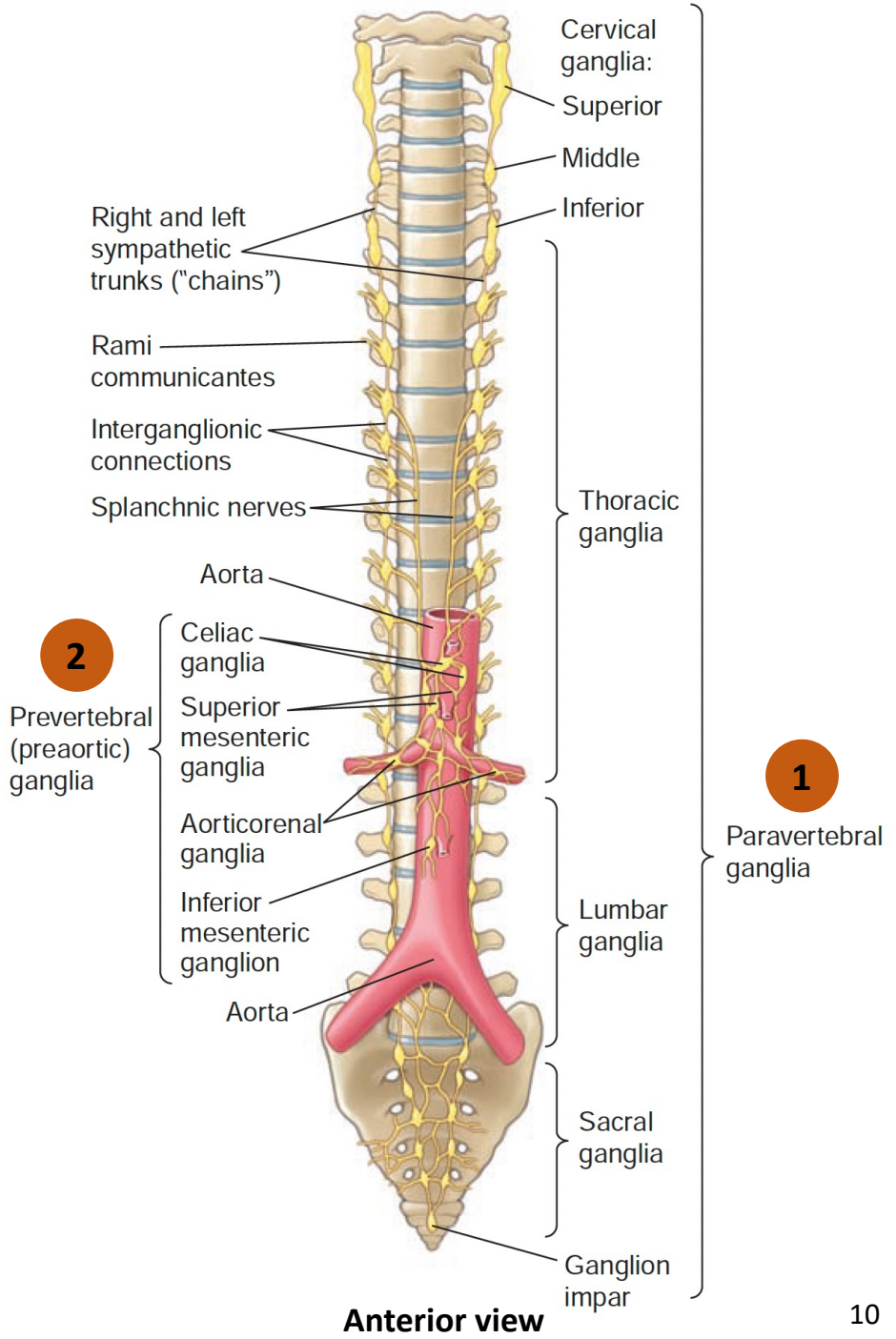
2B. Sympathetic ganglion

1. Paravertebral ganglion (sympathetic chain/trunk)

- 1.1 Cervical sympathetic ganglion (3)
  - 1.1.1 Superior cervical sympathetic ganglion
  - 1.1.2 Middle cervical sympathetic ganglion
  - 1.1.3 Inferior cervical sympathetic ganglion
- 1.2 Thoracic sympathetic ganglion (10-11)
- 1.3 Lumbar sympathetic ganglion (4)
- 1.4 Sacral sympathetic ganglion (4)
- 1.5 Ganglion impar

2. Prevertebral ganglion (Collateral/Preaortic ganglion)

- 2.1 Celiac ganglion
- 2.2 Superior mesenteric ganglion
- 2.3 Aorticorenal ganglion
- 2.4 Inferior mesenteric ganglion



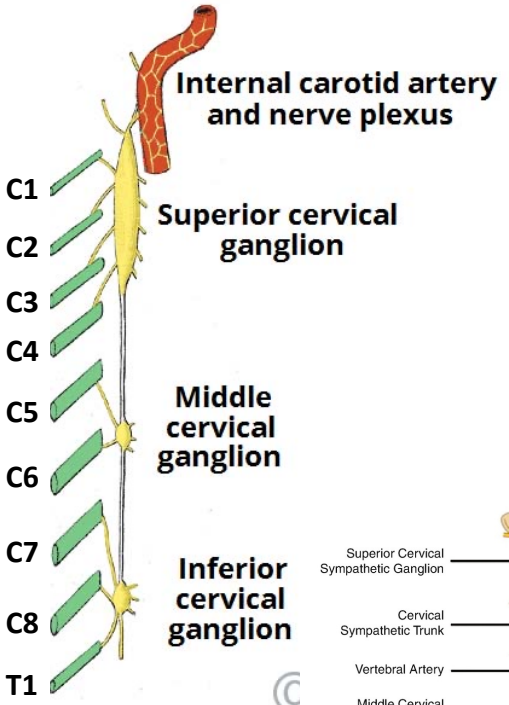
Part II: Sympathetic nervous system

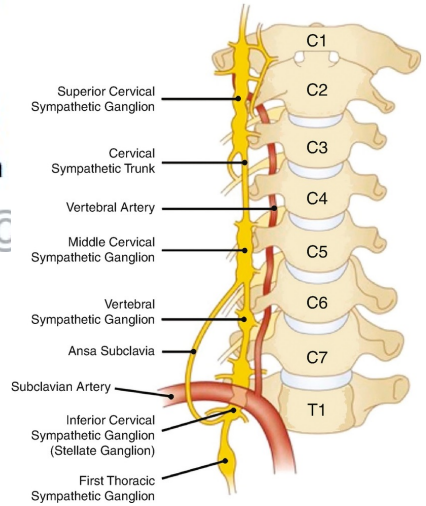
2B. Sympathetic ganglion

1. Paravertebral ganglion (sympathetic chain/trunk)

1.1 Cervical sympathetic ganglion (3)

No white ramus communicans (Slide: 2C)

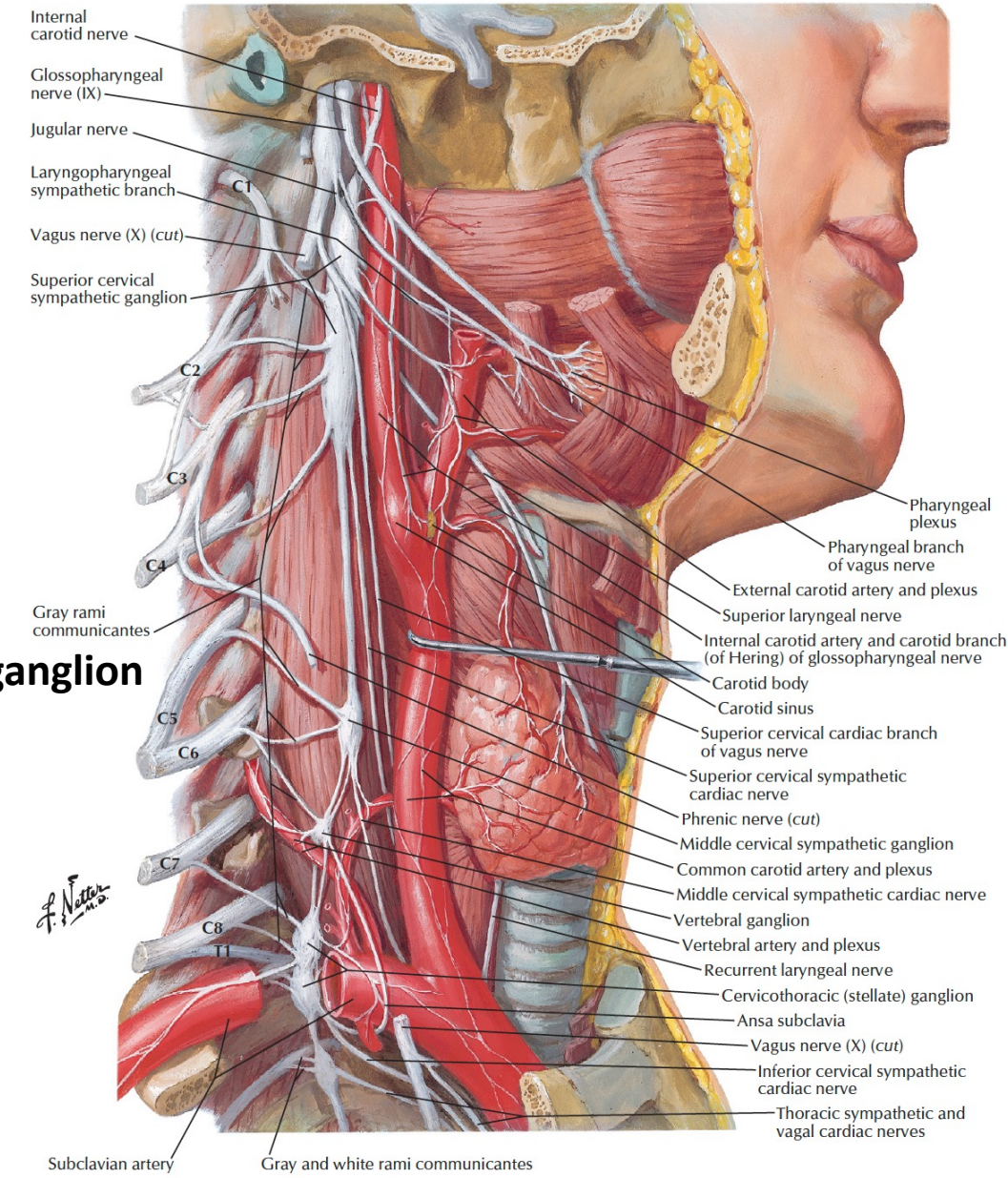




1.1.1 Superior cervical sympathetic ganglion
(Fused C1-C4 cervical ganglia)
@ Internal carotid artery,
Post' belly of digastric m.

1.1.2 Middle cervical sympathetic ganglion
(Fused C5-C6 cervical ganglia)
@ Inferior thyroid artery

1.1.3 Inferior cervical sympathetic (stellate) ganglion
(Fused C7-C8-T1 cervical ganglia)
@ Posterior to subclavian artery

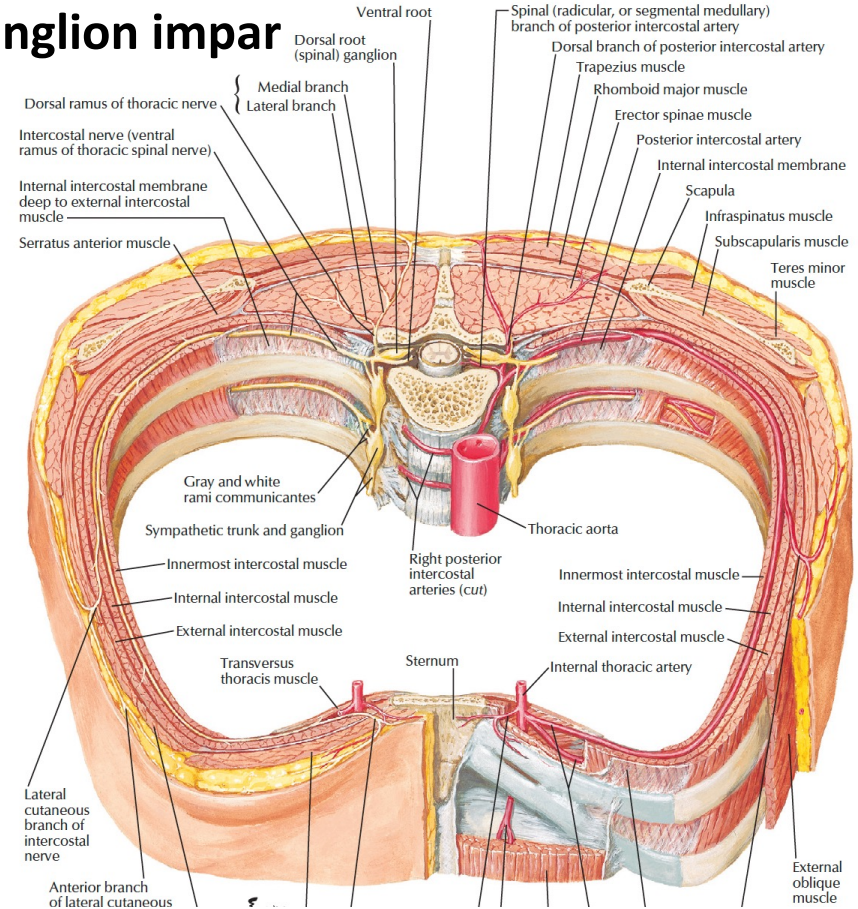


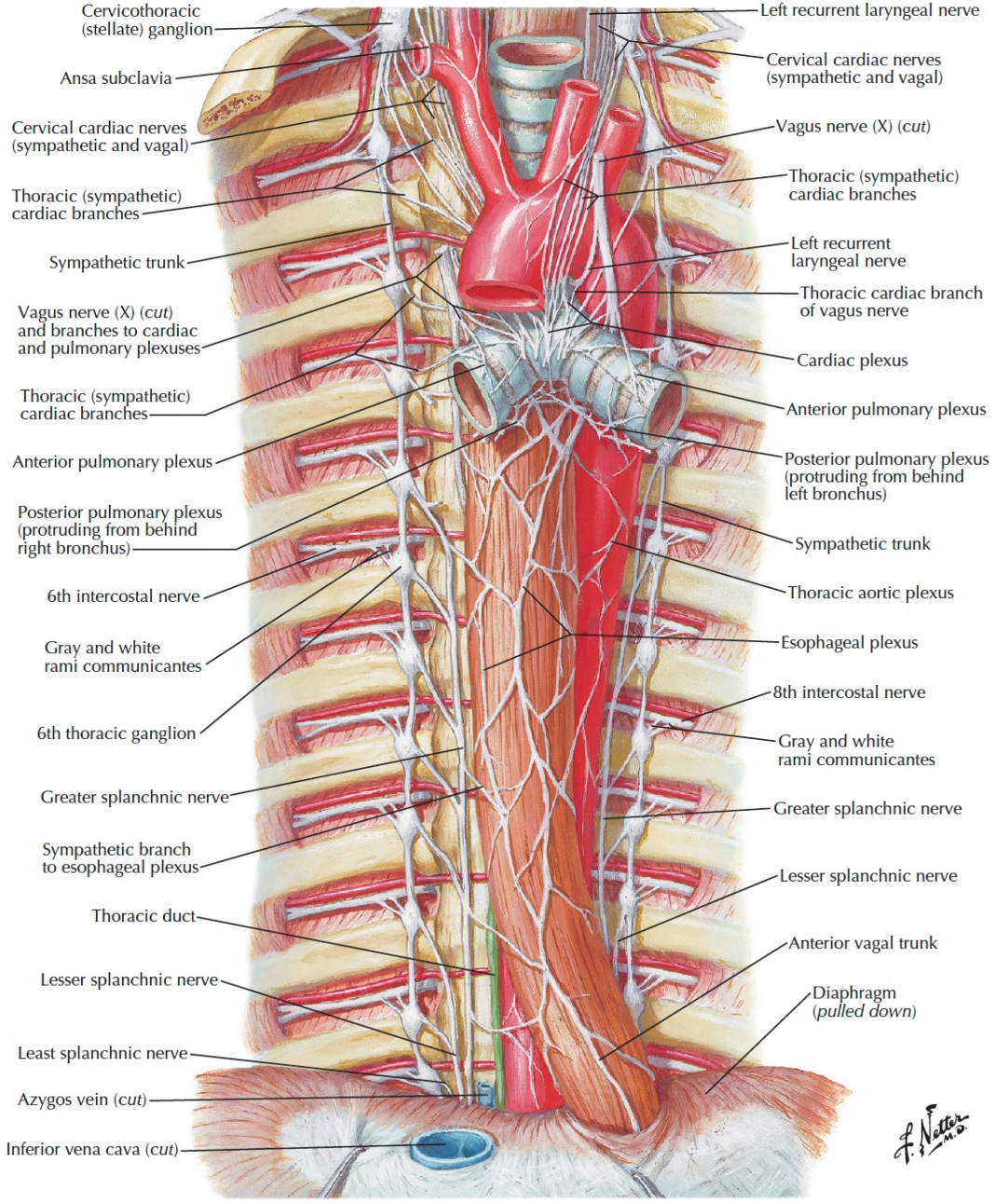
Part II: Sympathetic nervous system

2B. Sympathetic ganglion

1. Paravertebral ganglion (sympathetic chain/trunk)

- 1.1 Cervical sympathetic ganglion (3)
- 1.2 Thoracic sympathetic ganglion (10-11)
- 1.3 Lumbar sympathetic ganglion (4)
- 1.4 Sacral sympathetic ganglion (4)
- 1.5 Ganglion impar



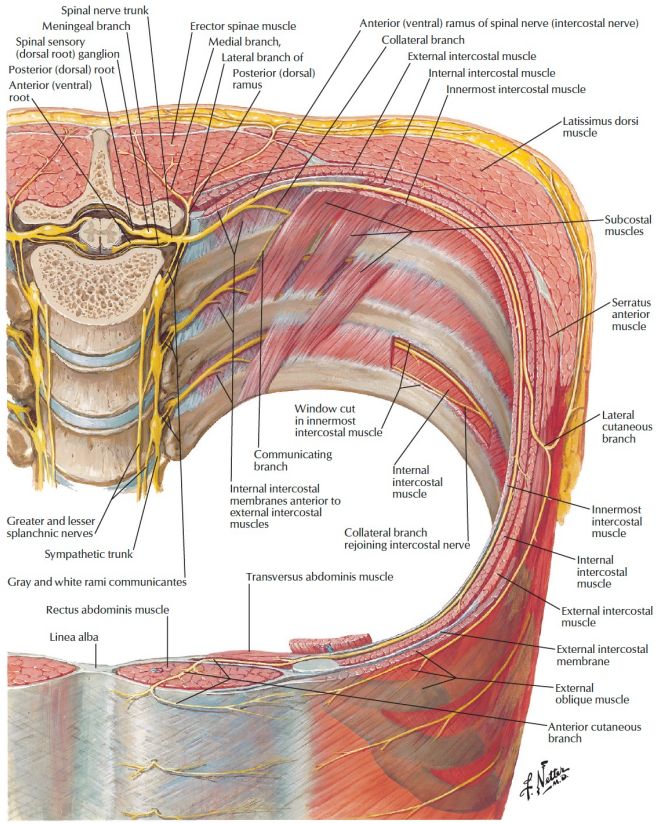


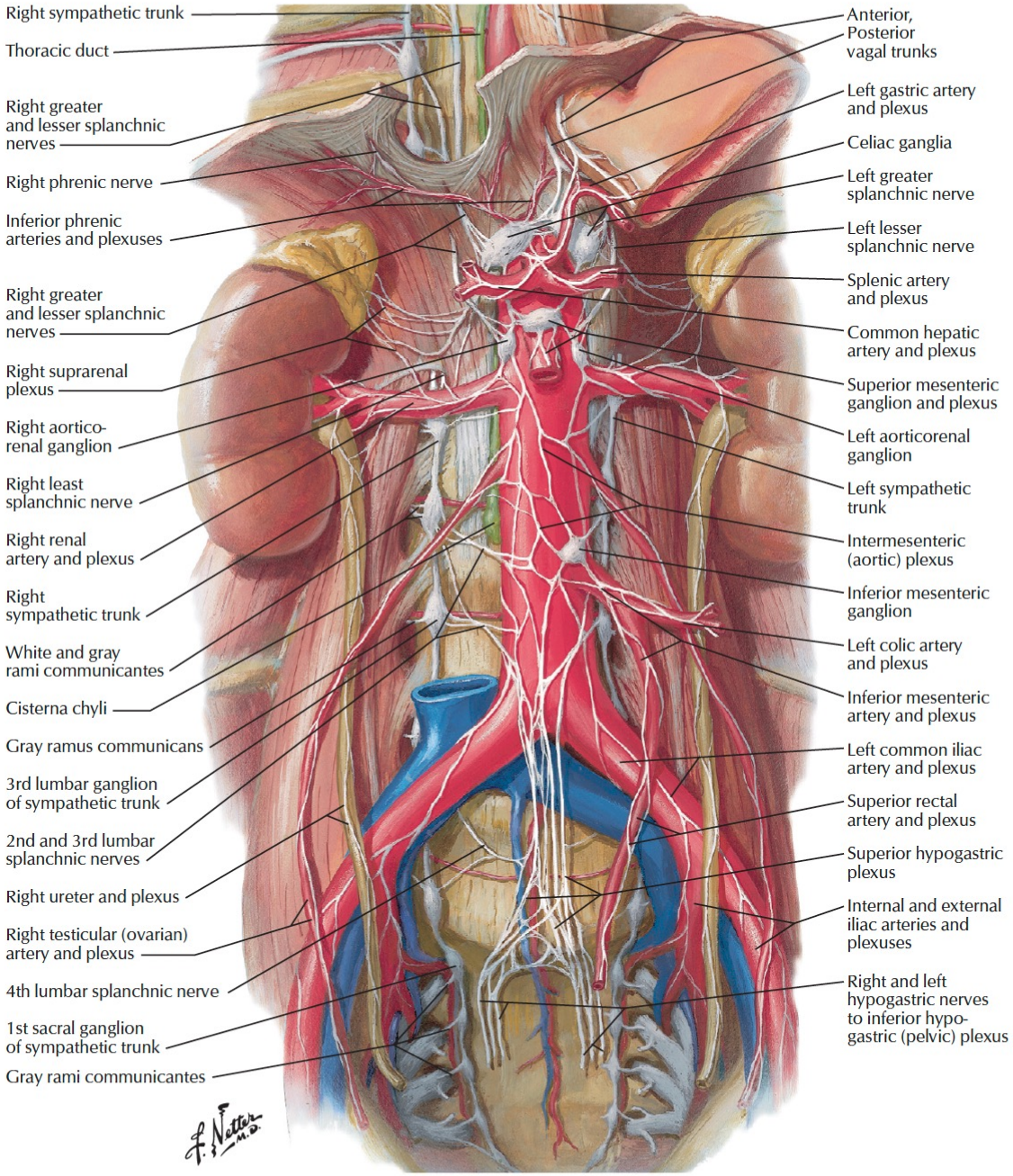
Part II: Sympathetic nervous system

2B. Sympathetic ganglion

1. Paravertebral ganglion (sympathetic chain/trunk)

- 1.1 Cervical sympathetic ganglion (3)
- 1.2 Thoracic sympathetic ganglion (10-11)
- 1.3 Lumbar sympathetic ganglion (4)
- 1.4 Sacral sympathetic ganglion (4)
- 1.5 Ganglion impar



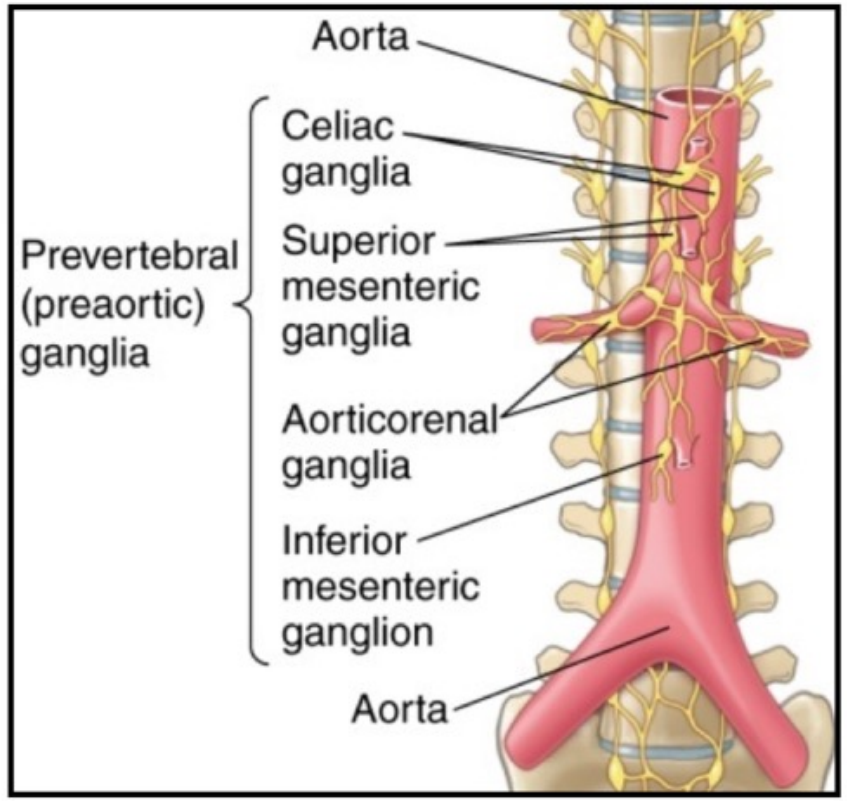


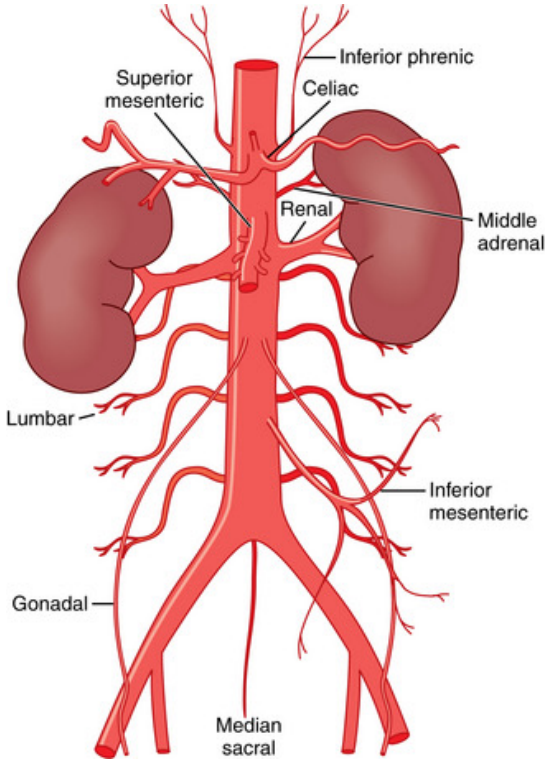
Part II: Sympathetic nervous system

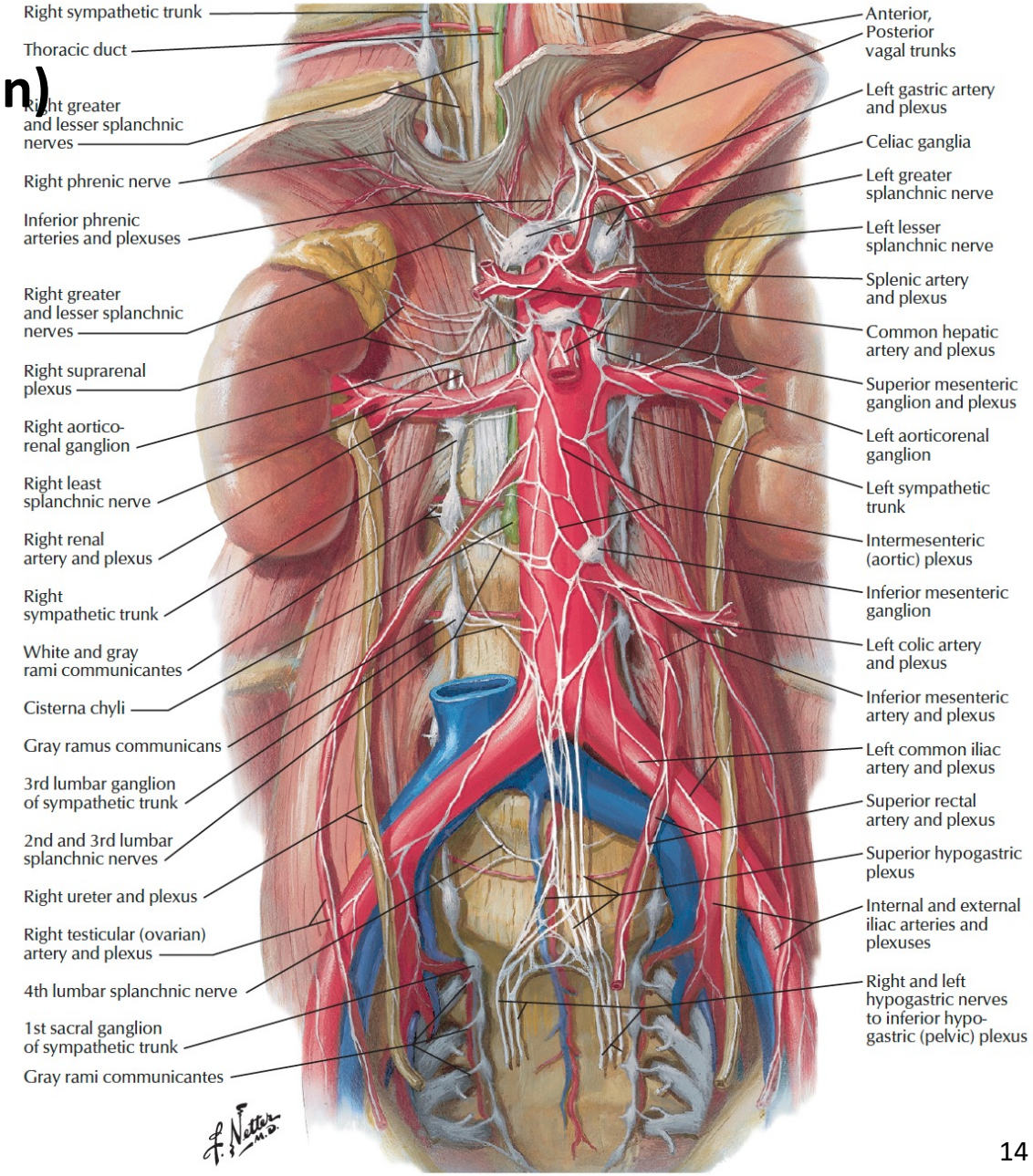
2B. Sympathetic ganglion

2. Prevertebral ganglion (Collateral/Preaortic ganglion)

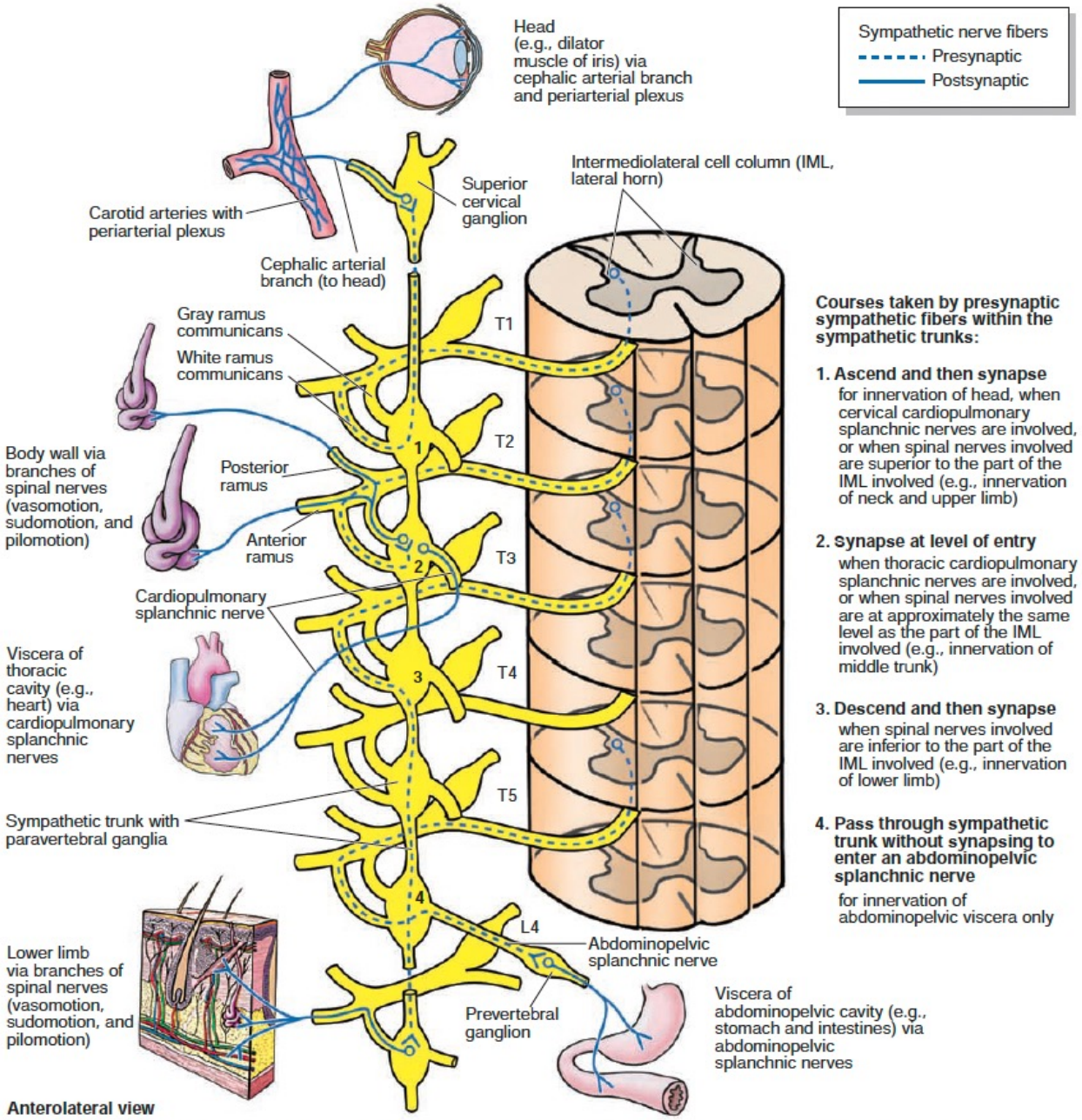
- 2.1 Celiac ganglion @ Celiac trunk of abdominal aorta
- 2.2 Superior mesenteric ganglion @ Superior mesenteric a.
- 2.3 Aorticorenal ganglion @ Renal artery
- 2.4 Inferior mesenteric ganglion @ Inferior mesenteric a.







Part II: Sympathetic nervous system



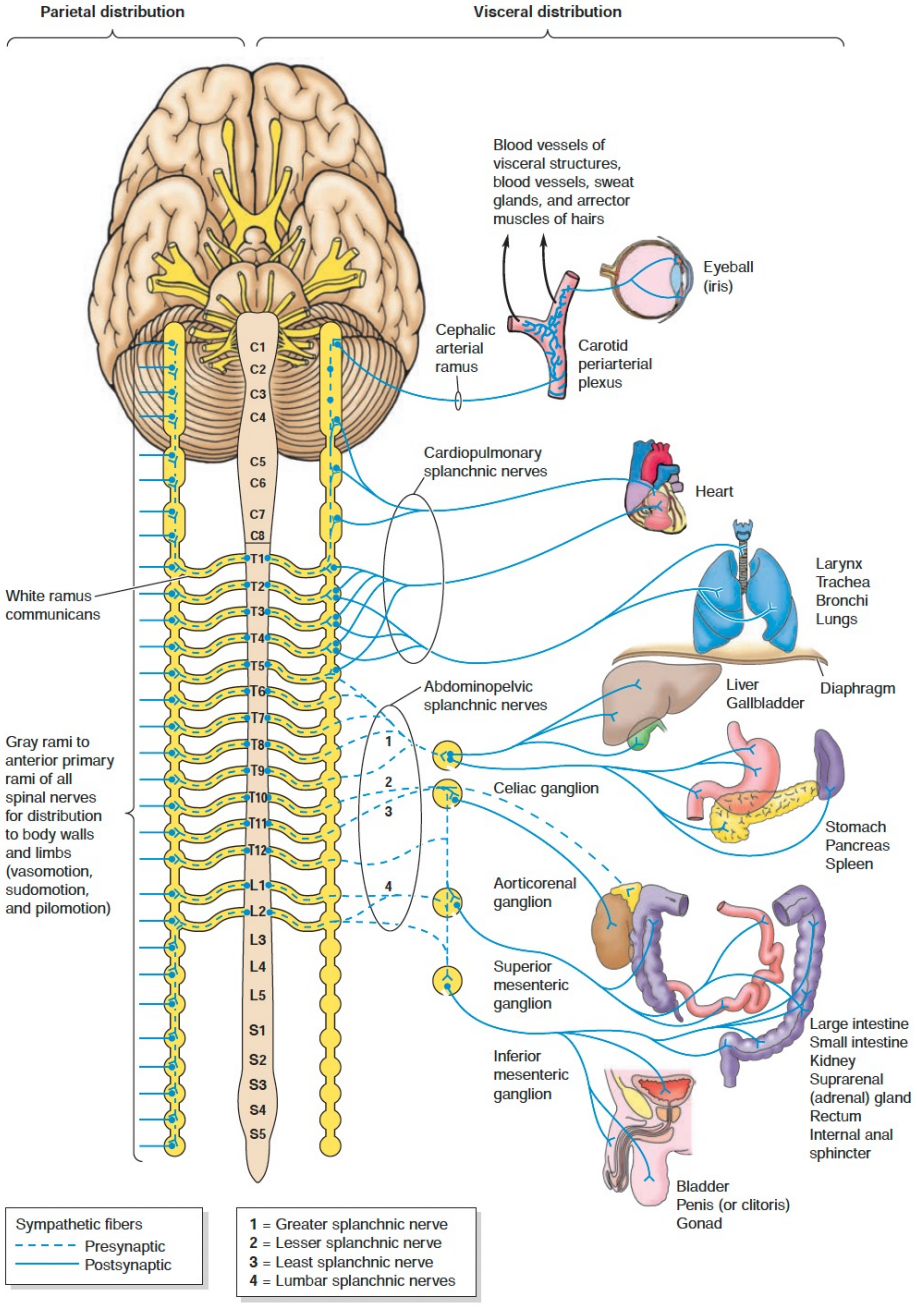
2C. Synapse patterns

1. Ascend level in sympathetic chain
2. Same level in sympathetic chain
3. Descend level in sympathetic chain
4. Pass through the sympathetic chain
   & synapse in collateral (prevertebral) ganglion

2D. Supplying areas

1. Parietal areas of body wall & limbs
   - Vasomotion --> enlargement of blood vessels
   - Sudomotion --> sweating (@sweat gland)
   - Pilomotion --> goosebumps (@arrector m.)
     1.1 Neck & upper limb by 2C1
     1.2 Middle trunk (Body) by 2C2
     1.3 Lower limb by 2C3
2. Visceral area
   2.1 Head & Neck by 2C1
   2.2 Thoracic by 2C2
   2.3 Abdomen & pelvic by 2C4

Part II: Sympathetic nervous system



2E. Sympathetic fibers = nerves

1. Post-synaptic (Postganglionic sympathetic fibers)

- 1.1 Cephalic arterial ramus
  - (Sup' cer' gg.) (synapse in ascend level)
- 1.2 Cardiopulmonary splanchnic nerves
  - 1.2.1 Cervical cardiopulmonary splanchnic nerves
    - (Sup' + Mid' + inf' cer' gg.) (synapse in ascend level)
  - 1.2.2 Thoracic cardiopulmonary splanchnic nerves
    - (T1-T5) (synapse in same/enter level)

2. Pre-synaptic (Preganglionic sympathetic fibers)

- 2.1 Abdominopelvic splanchnic nerves
  - (Pass through sympathetic chain --> synapse @ Collateral ganglions)
  - 2.1.1 Greater splanchnic nerves
    - (T5-T9) --> Celiac ganglion
  - 2.1.2 Lesser splanchnic nerves
    - (T10-T11) --> Aorticorenal ganglion & Superior mesenteric ganglion
  - 2.1.3 Least splanchnic nerves
    - (T12) --> Renal plexus*
  - 2.1.4 Lumbar splanchnic nerves
    - (L1-L2) --> Inferior mesenteric ganglion

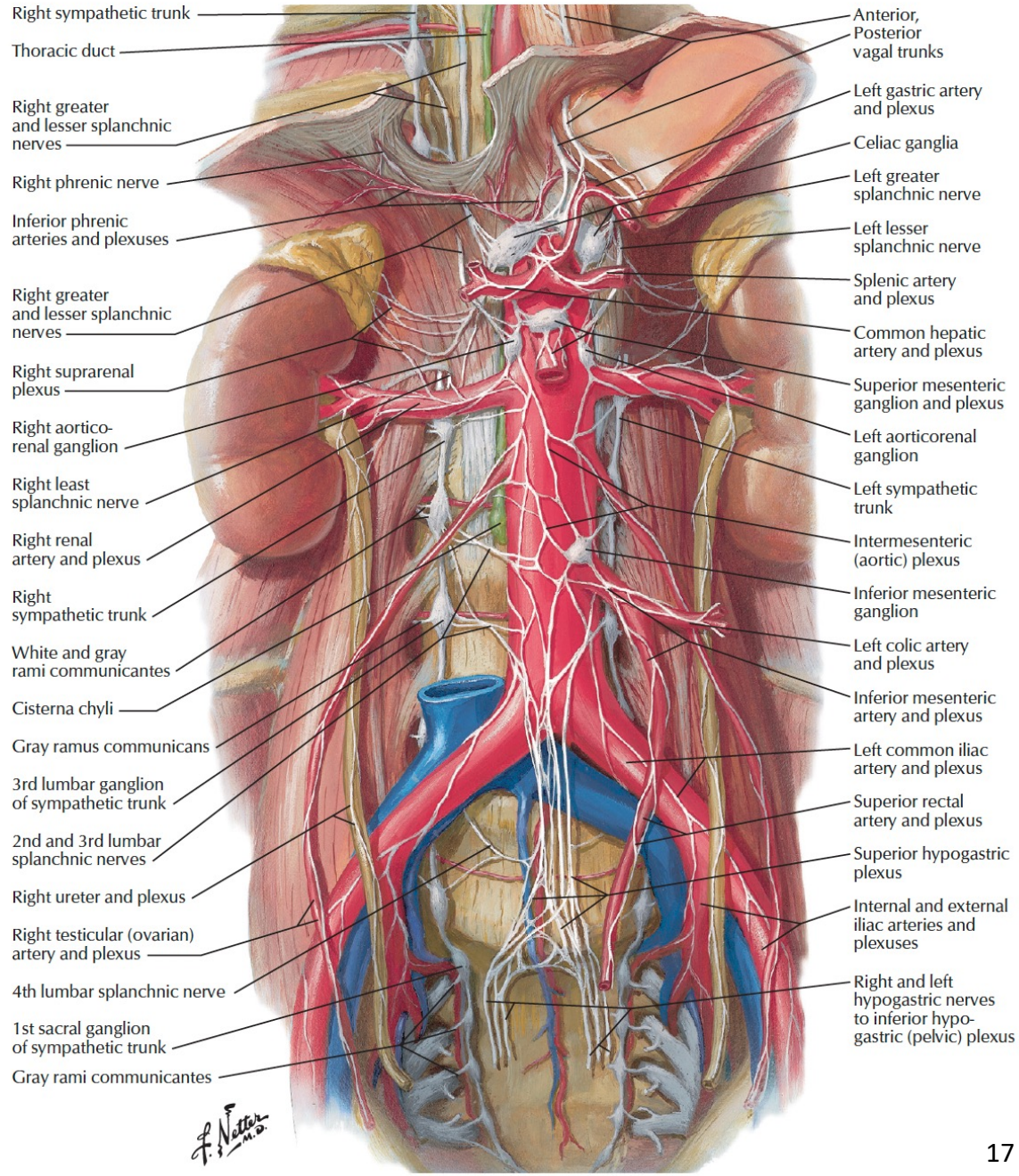
Part II: Sympathetic nervous system

2E. Sympathetic fibers = nerves

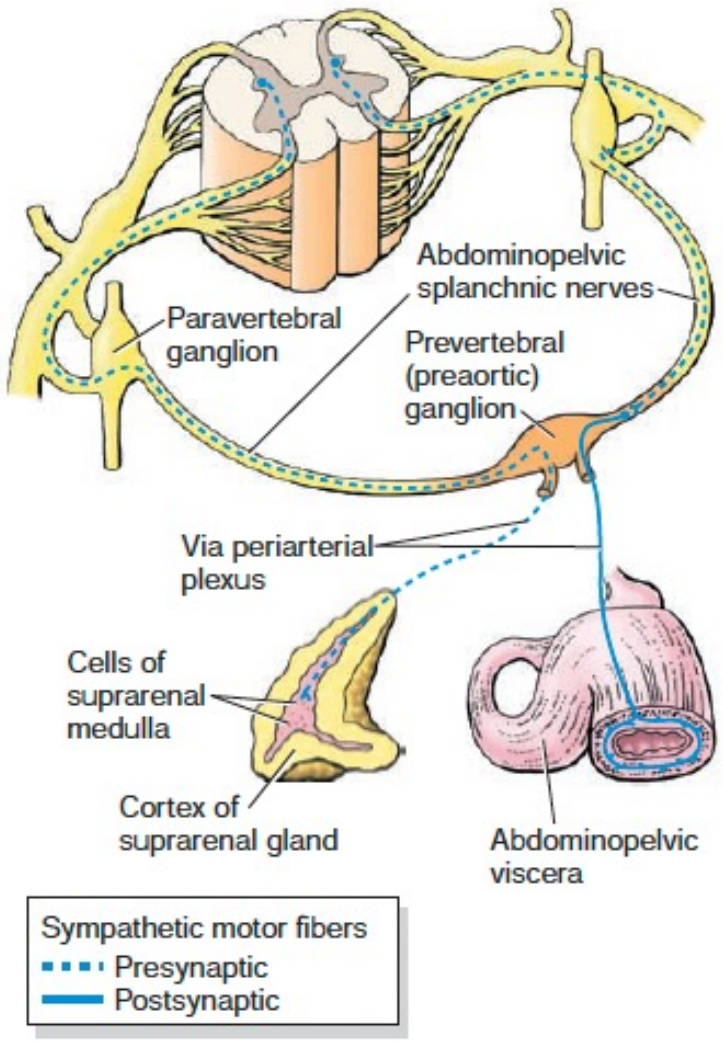
1. Post-synaptic (Postganglionic sympathetic fibers)
    - 1.1 Cephalic arterial ramus (Sup' cervical ganglion)
    - 1.2 Cardiopulmonary splanchnic nerves
        - 1.2.1 Cervical cardiopulmonary splanchnic nerves (Sup' + Mid' + inf' cervical ganglion)
        - 1.2.2 Thoracic cardiopulmonary splanchnic nerves (T1-T5)

2. Pre-synaptic (Preganglionic sympathetic fibers)
    - 2.1 Abdominopelvic splanchnic nerves

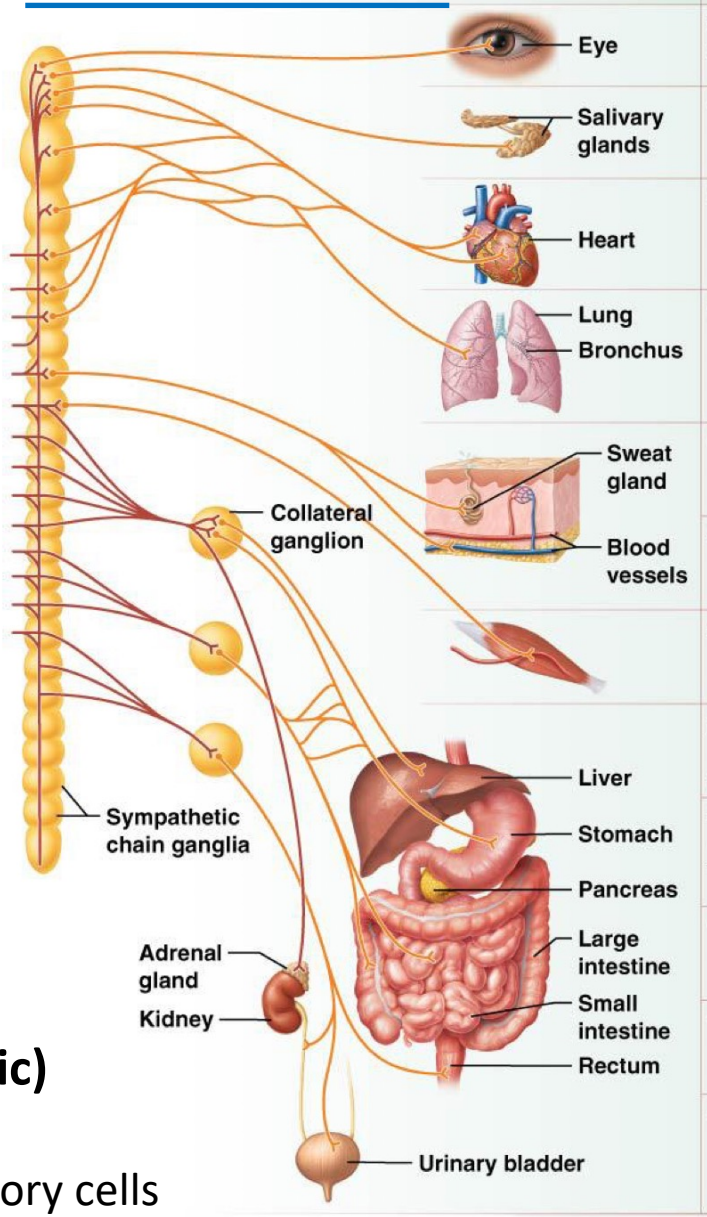
    (Pass through sympathetic chain --> synapse @ Collateral ganglions)
        - 2.1.1 Greater splanchnic nerves (T5-T9)
        - 2.1.2 Lesser splanchnic nerves (T10-T11)
        - 2.1.3 Least splanchnic nerves (T12)
        - 2.1.4 Lumbar splanchnic nerves (L1-L2)



Part II: Sympathetic nervous system



2E. Main effects



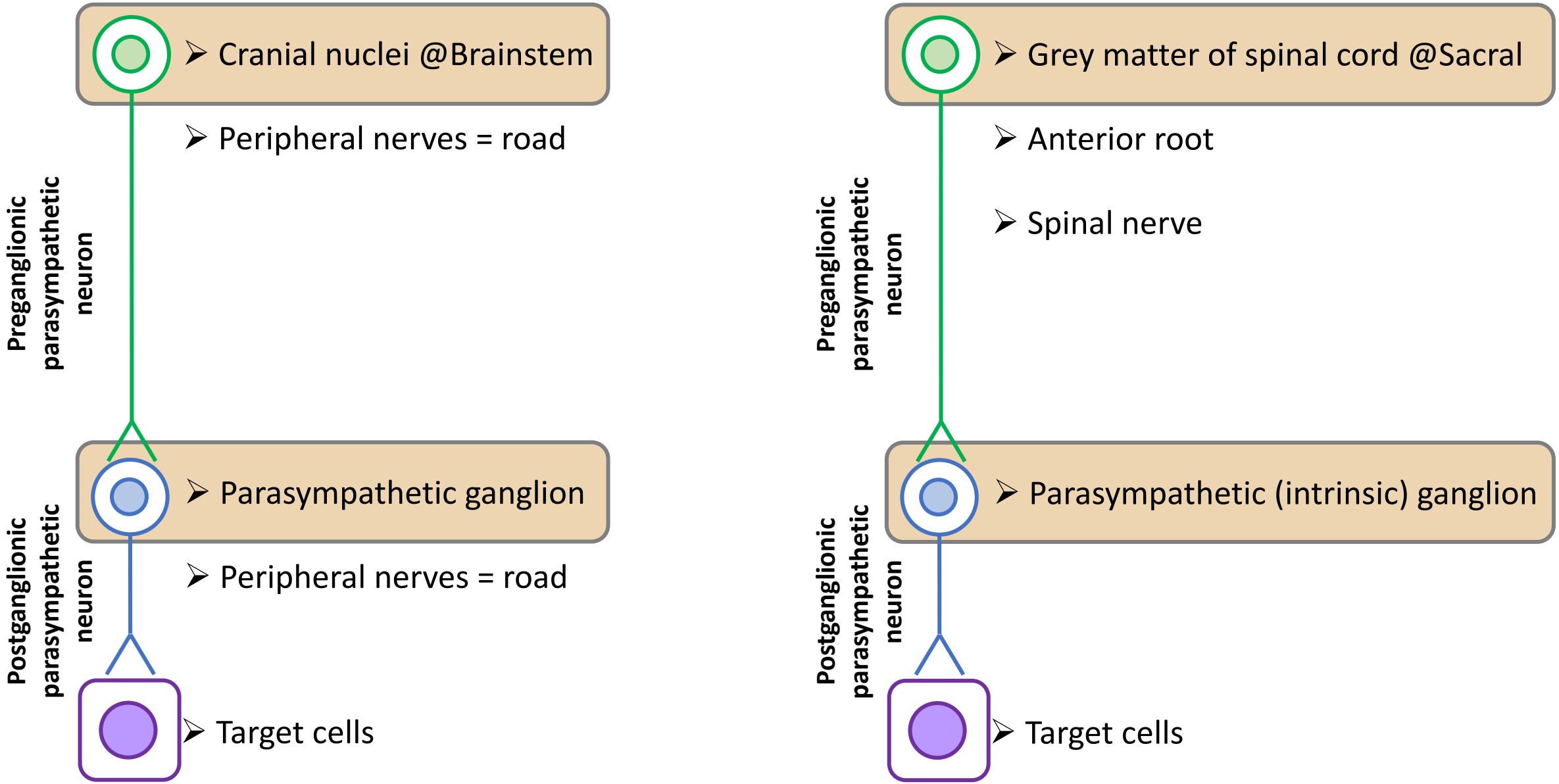
TARGET	NT	RECEPTOR	MAIN EFFECTS
Smooth muscle cells around pupil	NE	α_1	Dilation of pupil
Cells of salivary glands	NE	β_1 and β_2	Increase in secretion in certain cells
Cardiac muscle cells	NE	β_1	Increase in heart rate and force of contraction
Smooth muscle cells of bronchus	NE	β_2	Dilation of bronchioles (bronchodilation)
Cells of sweat glands	ACh	Muscarinic	Increase in secretion
Smooth muscle cells of blood vessels to skin	NE	α_1	Constriction of blood vessels (vasoconstriction)
Smooth muscle cells of blood vessels to skeletal muscles	NE	β_2	Dilation of blood vessels (vasodilation)
Smooth muscle cells of blood vessels to digestive and urinary organs	NE	α_1	Vasoconstriction
Smooth muscle cells of digestive and urinary tracts and sphincters	NE	α_1 (sphincters) β_3 (digestive) β_2 (urinary)	Relaxation of digestive and urinary tracts, contraction of sphincters
Cells of digestive glands	NE	β_2	Decrease in secretion
Cells of pancreas and liver	NE	β_2	Increase in release of glucose
Cells of adrenal medulla	ACh	Nicotinic	Release of epinephrine and norepinephrine

Suprarenal gland (Exception of sympathetic)

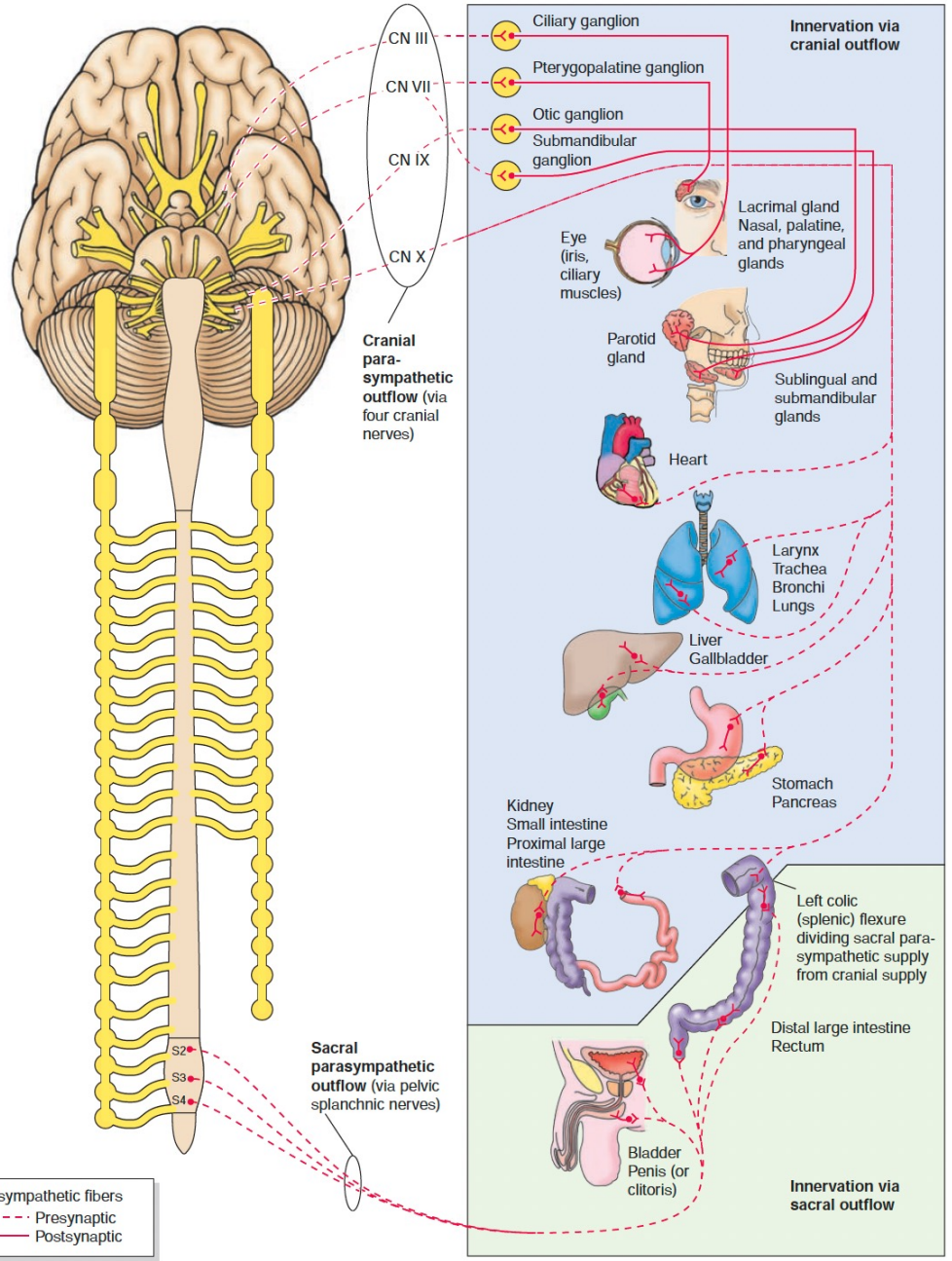
- Preganglionic sympathetic neurons
- Postganglionic sympathetic neurons = Secretory cells

Part III: Parasympathetic nervous system

3A. Parasympathetic pathways



Part III: Parasympathetic nervous system

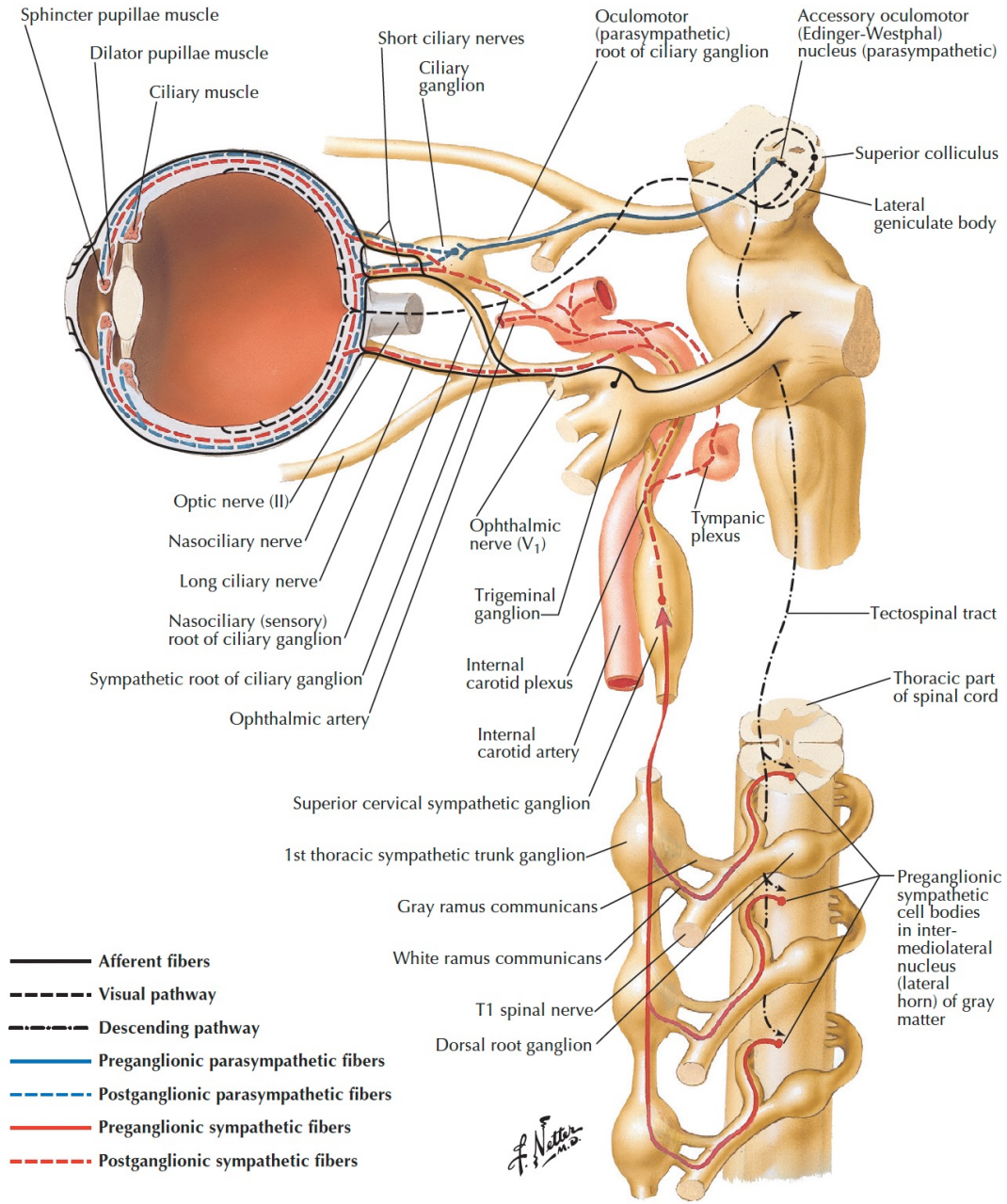


3B. Parasympathetic ganglions

- 2.1 Ciliary ganglion <--- CN III
- 2.2 Pterygopalatine ganglion <--- CN VII
- 2.3 Submandibular ganglion <--- CN VII
- 2.4 Otic ganglion <--- CN IX

- 2.5 Intrinsic ganglion <--- CN X
  (within/close to target organs)

Part III: Parasympathetic nervous system



3C. Synapse patterns & 3D. Supplying areas

House # 1 = Edinger-Westphal nucleus

@midbrain (brainstem) at superior colliculus level

House of = Preganglionic parasympathetic neurons

--> Preganglionic (presynaptic) parasympathetic fibers

Road = 1. Oculomotor nerve (CN III)

2. Root of ciliary ganglion

House # 2 = Ciliary ganglion (synapse!)

House of = Postganglionic parasympathetic neurons

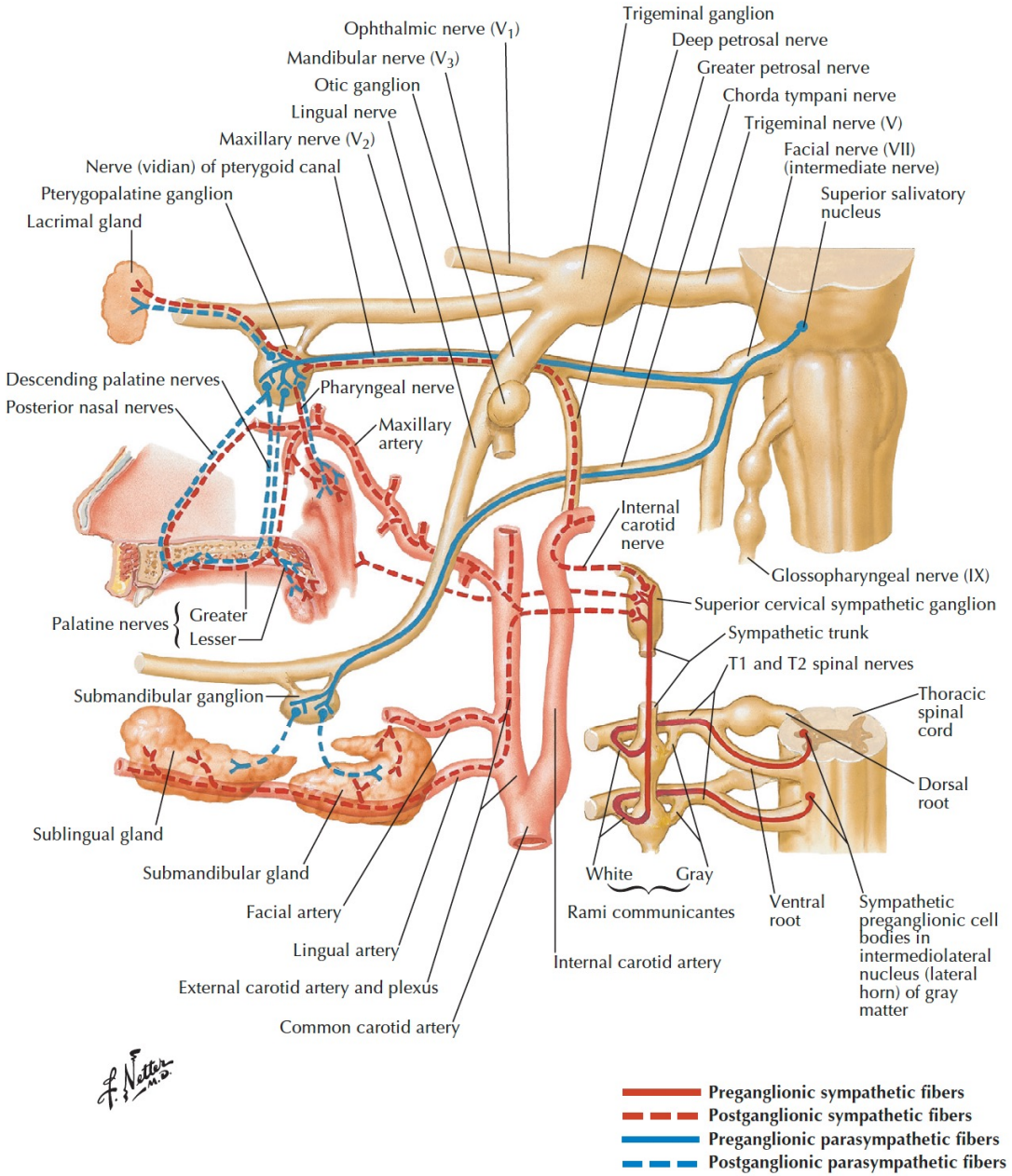
--> Postganglionic (postsynaptic) parasympathetic fibers

Road = 1. Short ciliary nerves

Targets

1. **Ciliary muscle**
2. **Sphincter pupilae muscle**

Part III: Parasympathetic nervous system



3C. Synapse patterns & 3D. Supplying areas

House # 1 = Superior salivatory nucleus

@Pons (brainstem)

House of = Preganglionic parasympathetic neurons

--> Preganglionic (presynaptic) parasympathetic fibers

Road = 1. Facial nerve (CN VII)

2.1 Greater petrosal nerve

3. Nerve of pterygoid canal

House # 2 = Pterygopalatine ganglion (synapse!)

House of = Postganglionic parasympathetic neurons

--> Postganglionic (postsynaptic) parasympathetic fibers

Road = 1.1 Posterior nasal nerves

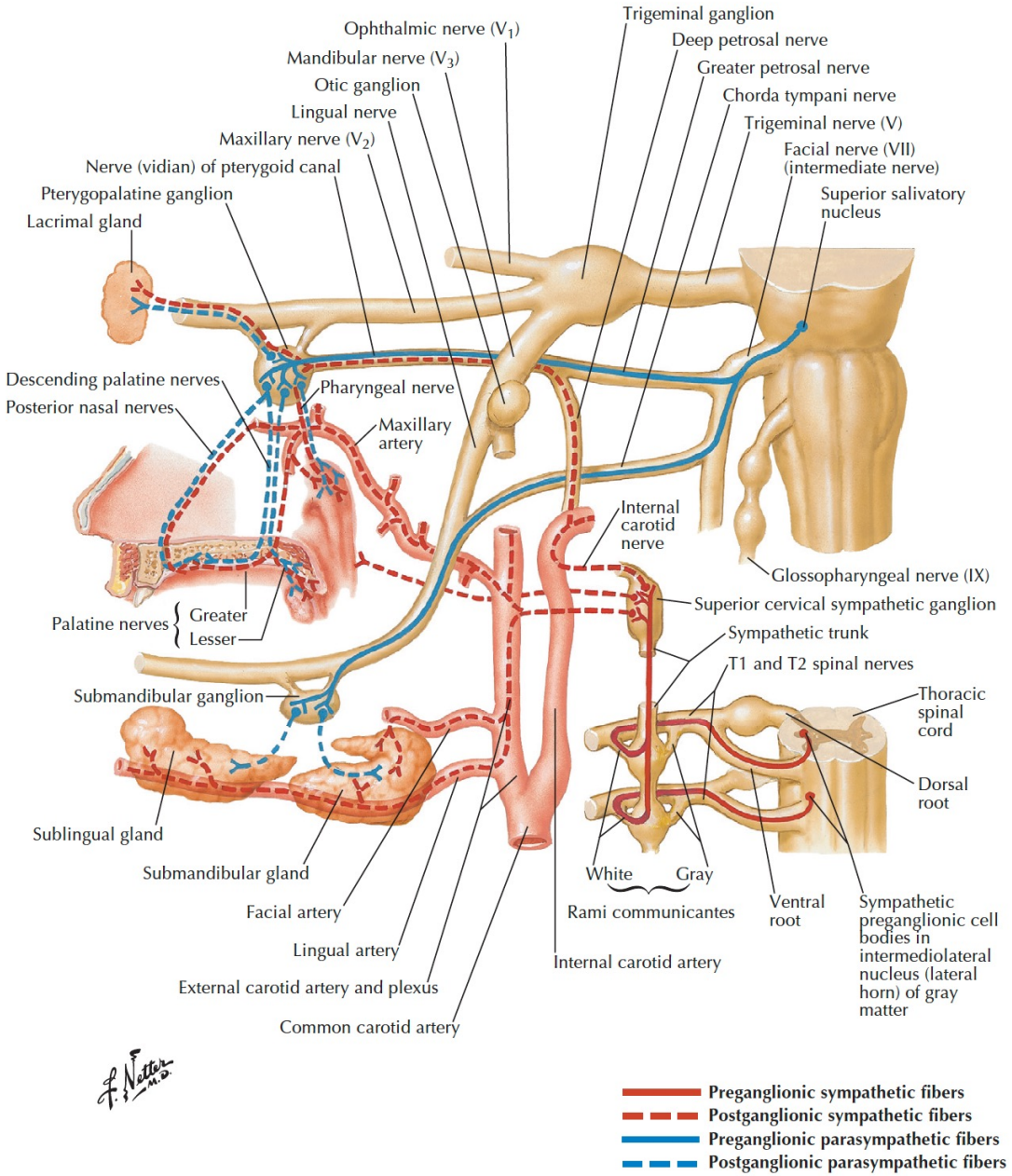
1.2 Descending palatine nerves

1.3 Pharyngeal nerve

Targets

1. **Mucous gland @ nasal, palatine, and pharyngeal**
2. **Lacrimal gland**

Part III: Parasympathetic nervous system



3C. Synapse patterns & 3D. Supplying areas

House # 1 = Superior salivatory nucleus

@Pons (brainstem)

House of = Preganglionic parasympathetic neurons

--> Preganglionic (presynaptic) parasympathetic fibers

Road = 1. Facial nerve (CN VII)

2.2 Chorda tympani nerve

3. Lingual nerve

House # 2 = Submandibular ganglion (synapse!)

House of = Postganglionic parasympathetic neurons

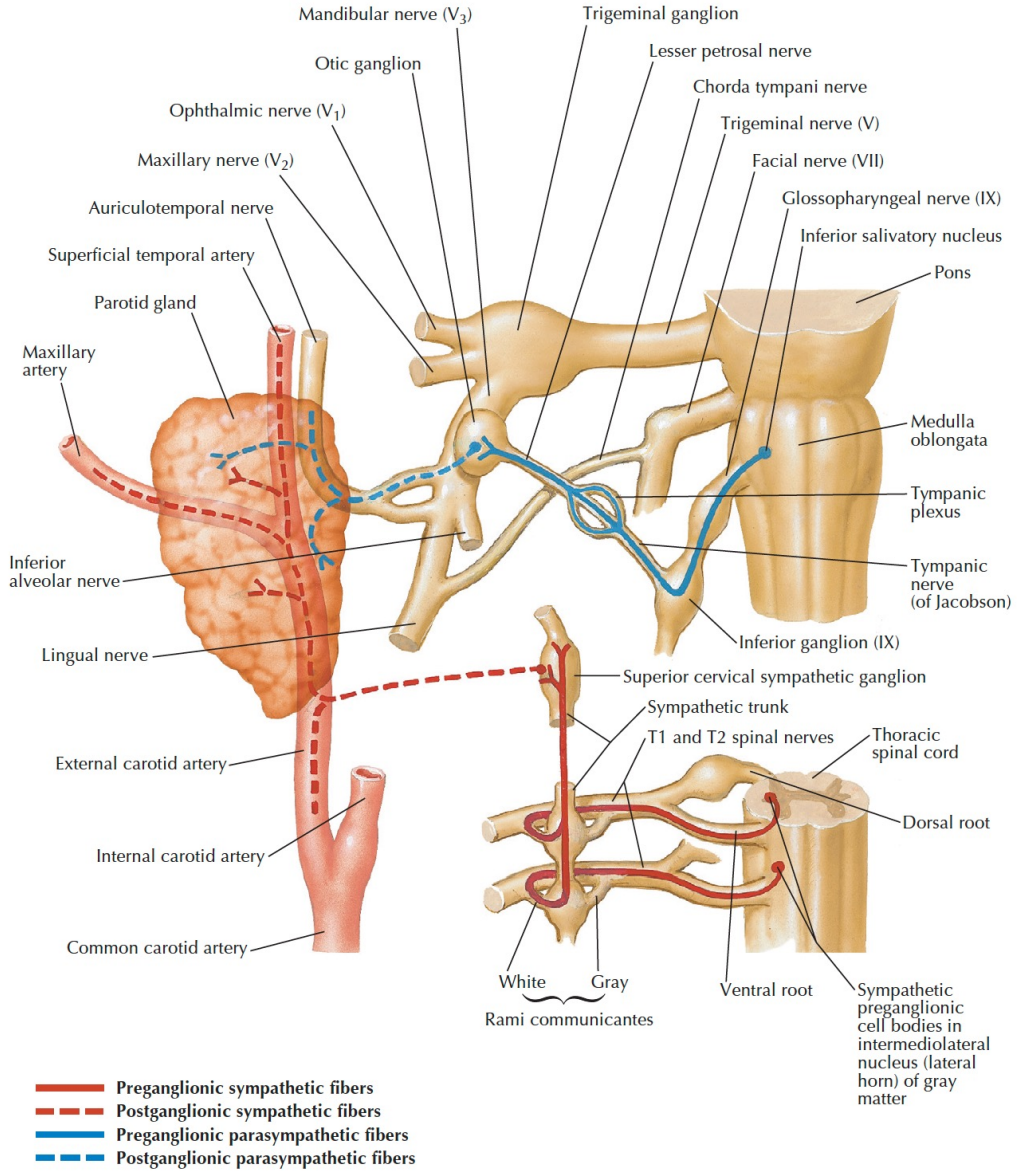
--> Postganglionic (postsynaptic) parasympathetic fibers

Road = N/A

Targets

1. **Sublingual (salivary) gland**
2. **Submandibular (salivary) gland**

Part III: Parasympathetic nervous system



3C. Synapse patterns & 3D. Supplying areas

House # 1 = Inferior salivatory nucleus

@Medulla oblongata (brainstem)

House of = Preganglionic parasympathetic neurons

--> Preganglionic (presynaptic) parasympathetic fibers

Road = 1. Glossopharyngeal nerve (CN IX)

2. Inferior ganglion (IX) (pass through)

3. Tympanic plexus

4. Lesser petrosal nerve

House # 2 = Otic ganglion (synapse!)

House of = Postganglionic parasympathetic neurons

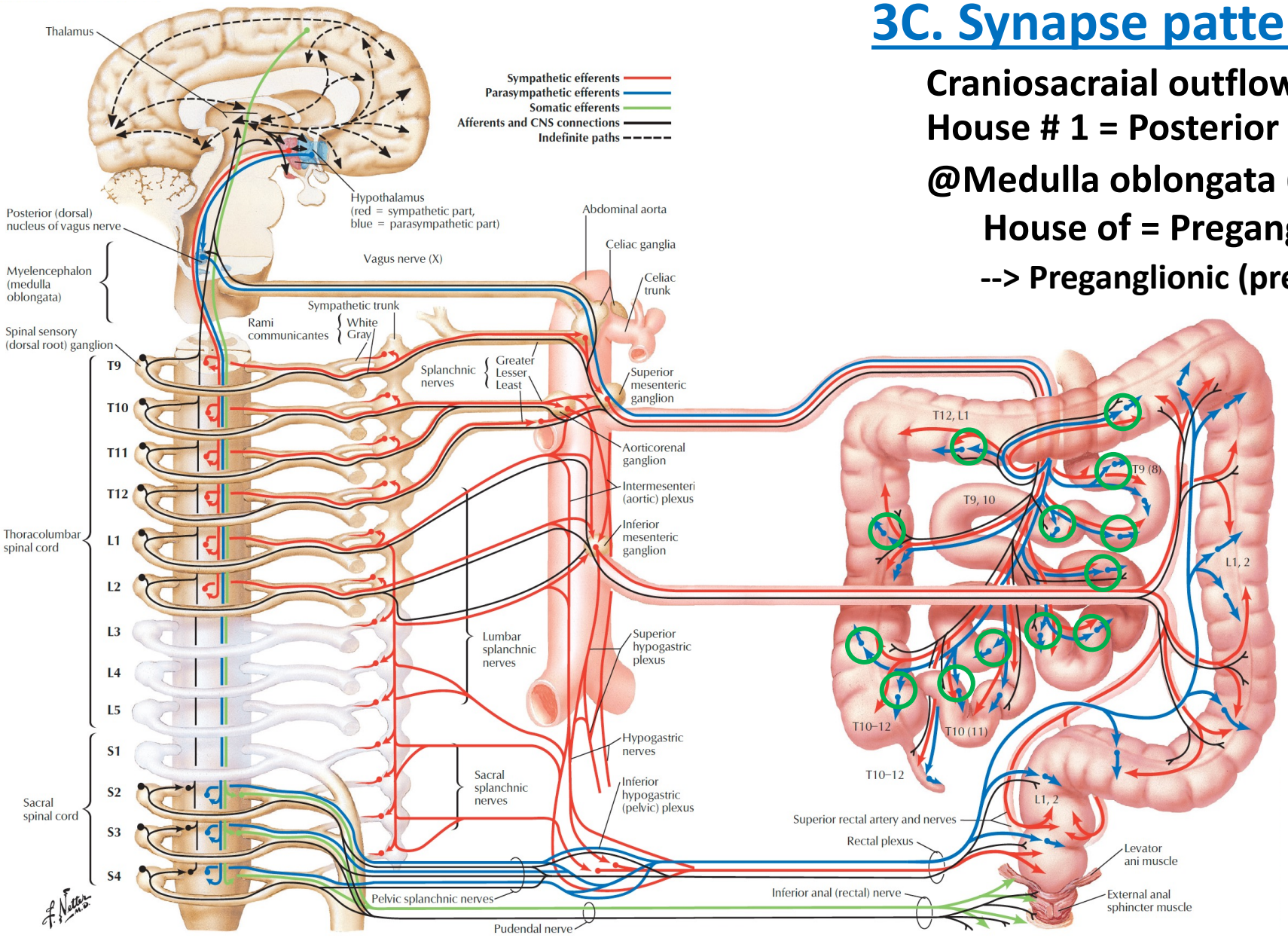
--> Postganglionic (postsynaptic) parasympathetic fibers

Road = Auriculotemporal nerve

Targets

1. Parotid (salivary) gland

Part III: Parasympathetic nervous system



3C. Synapse patterns & 3D. Supplying areas

Craniosacraial outflow = Cranial part

House # 1 = Posterior (dorsal) nucleus of Vagus nerve

@Medulla oblongata (brainstem)

House of = Preganglionic parasympathetic neurons

--> Preganglionic (presynaptic) parasympathetic fibers

Road = 1. Vagus nerve (CN X)

2. Celiac ganglion (pass)

3. Superior mesenteric gg. (pass)

House # 2 = Intrinsic ganglion (synapse!)

House of = Postganglionic parasympathetic neurons

--> Postganglionic (postsynaptic) parasympathetic fibers

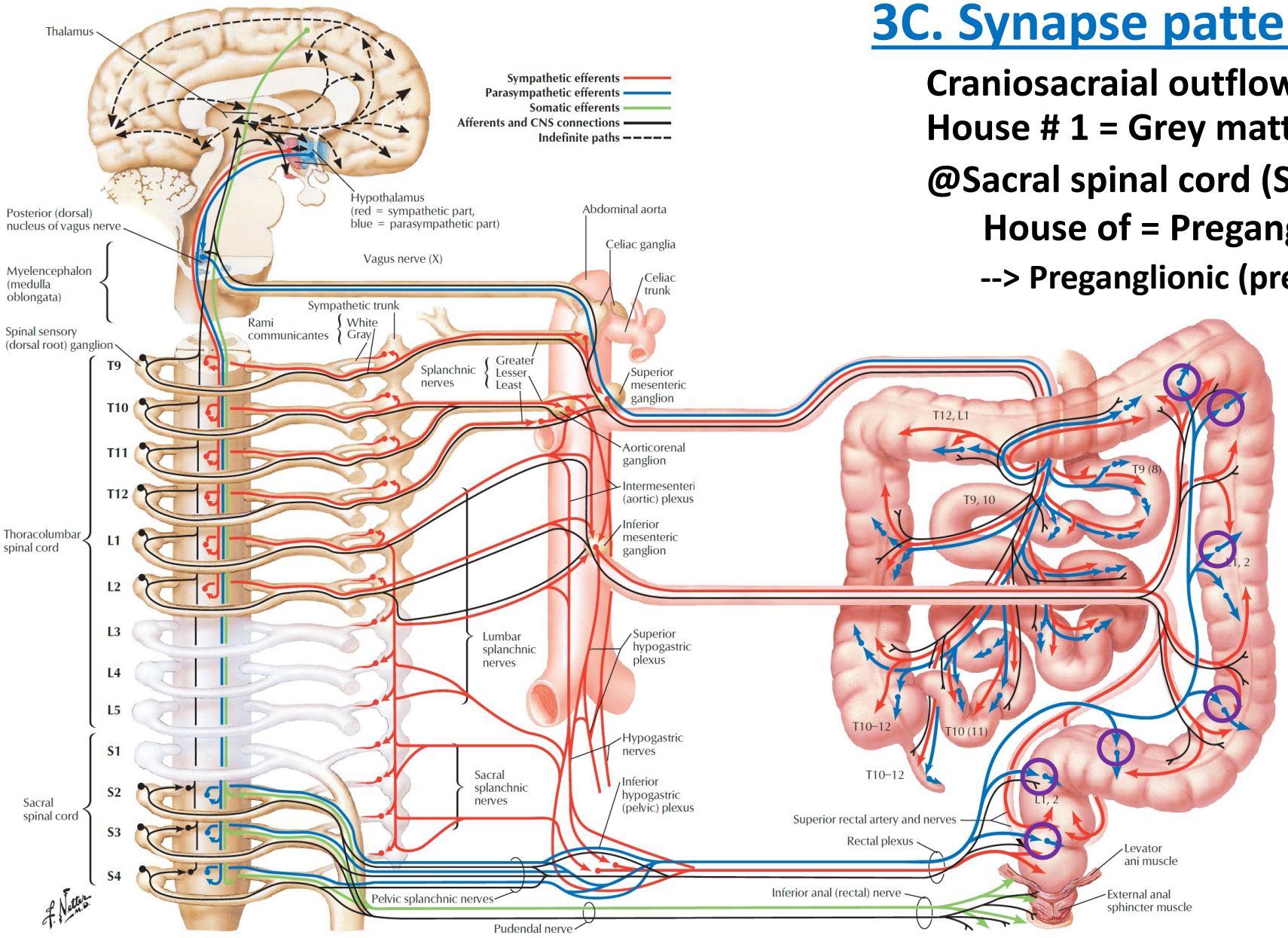
Road = N/A (short, near the target organ)

Target

1. **Thoracic visceral organs**
2. **Abdominal visceral organs (until transverse colon)**

Part III: Parasympathetic nervous system

3C. Synapse patterns & 3D. Supplying areas



Craniosacraial outflow = Sacral part

House # 1 = Grey matter

@Sacral spinal cord (S2-S4)

House of = Preganglionic parasympathetic neurons

--> Preganglionic (presynaptic) parasympathetic fibers

Road = 1. Anterior root
2. Spinal nerve
3. Pelvis splanchnic nerve

House # 2 = Intrinsic ganglion (synapse!)

House of = Postganglionic parasympathetic neurons

--> Postganglionic (postsynaptic) parasympathetic fibers

Road = N/A (short, near the target organ)

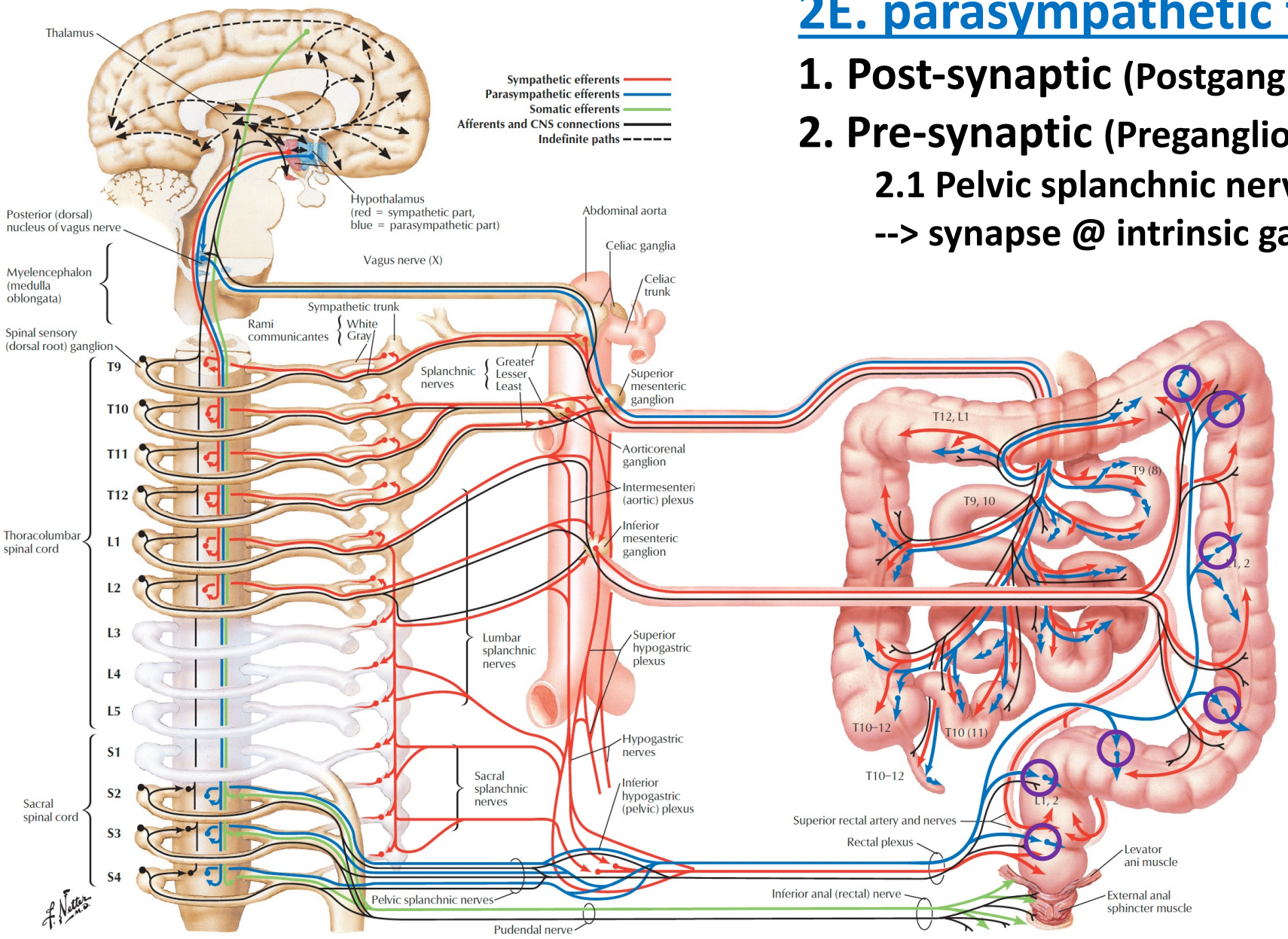
Target

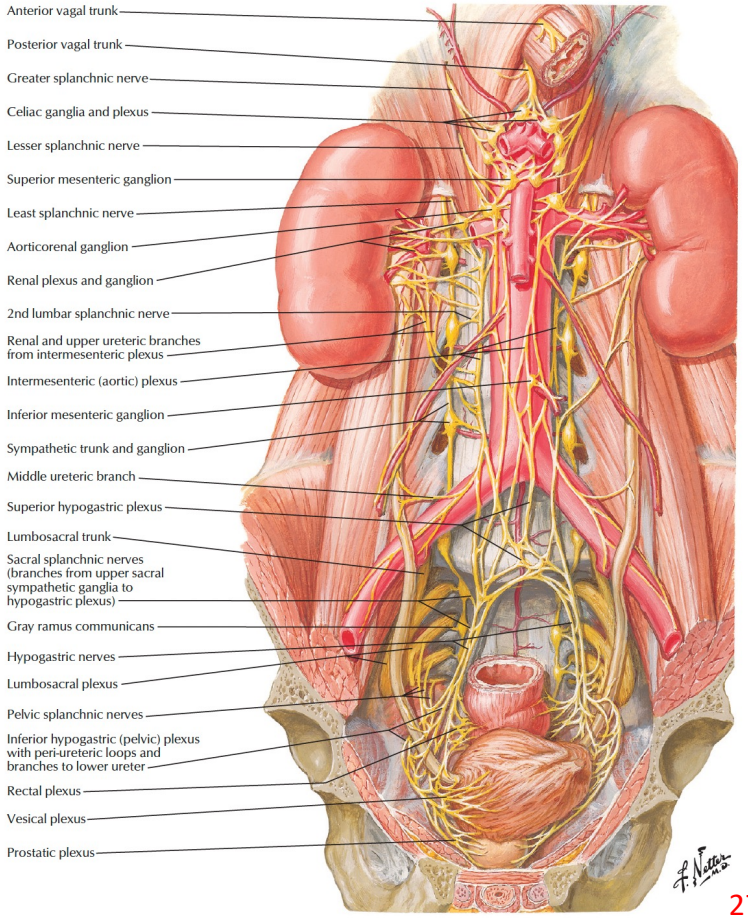
1. **Abdominal visceral organs (Descending colon to rectum)**
2. **Pelvic visceral organs**

Part III: Parasympathetic nervous system

2E. parasympathetic fibers = nerves

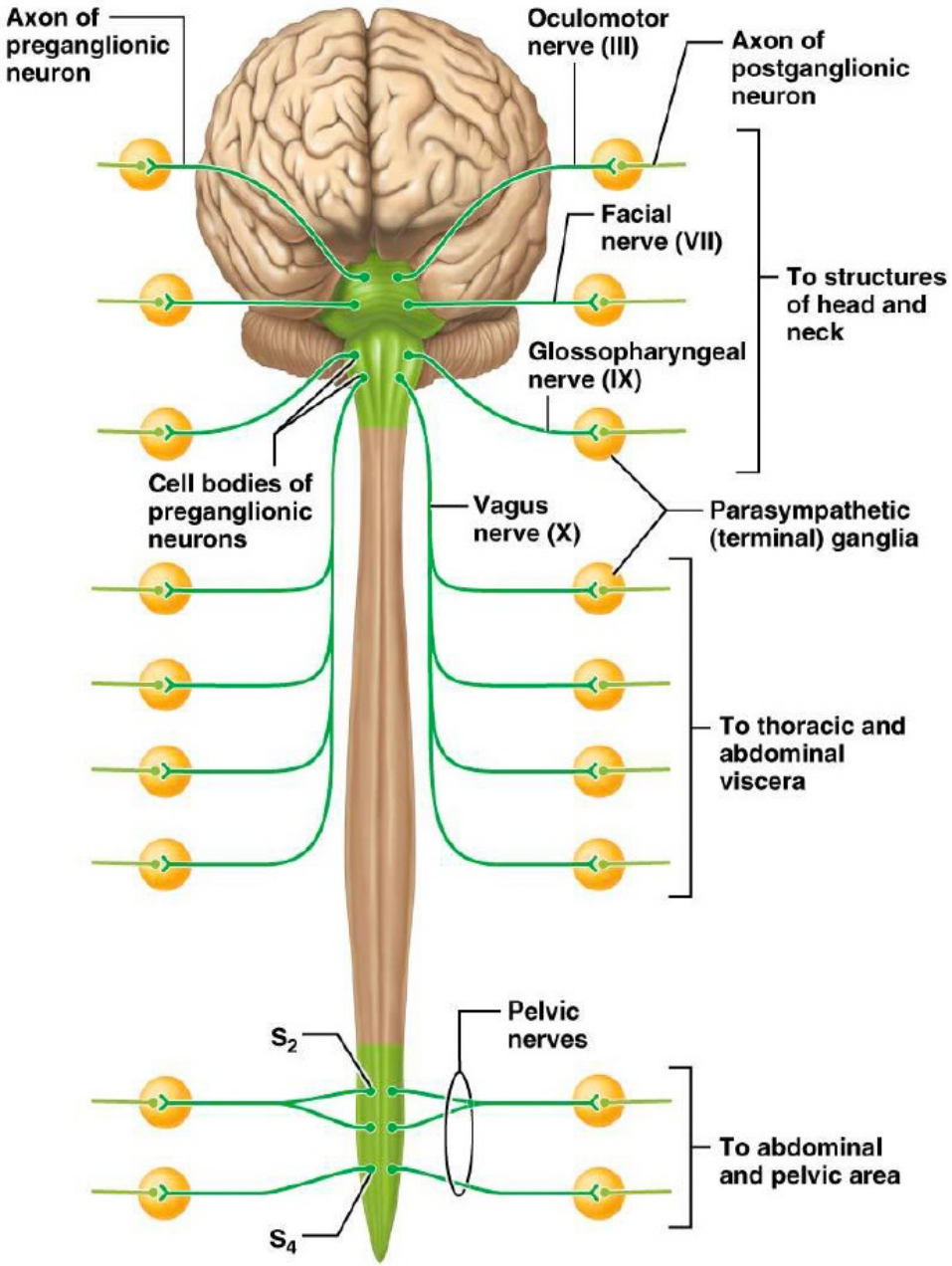
1. **Post-synaptic** (Postganglionic parasympathetic fibers) **No!**
2. **Pre-synaptic** (Preganglionic parasympathetic fibers)
   - 2.1 Pelvic splanchnic nerves (S2 – S4)
   - --> synapse @ intrinsic ganglions

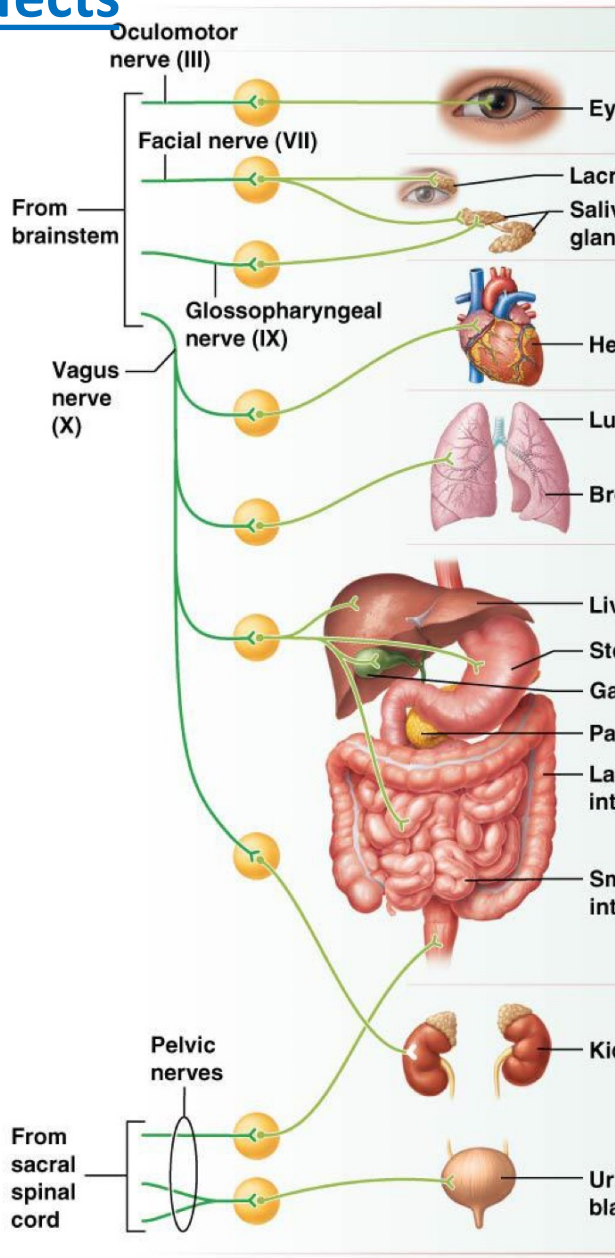




Part III: Parasympathetic nervous system

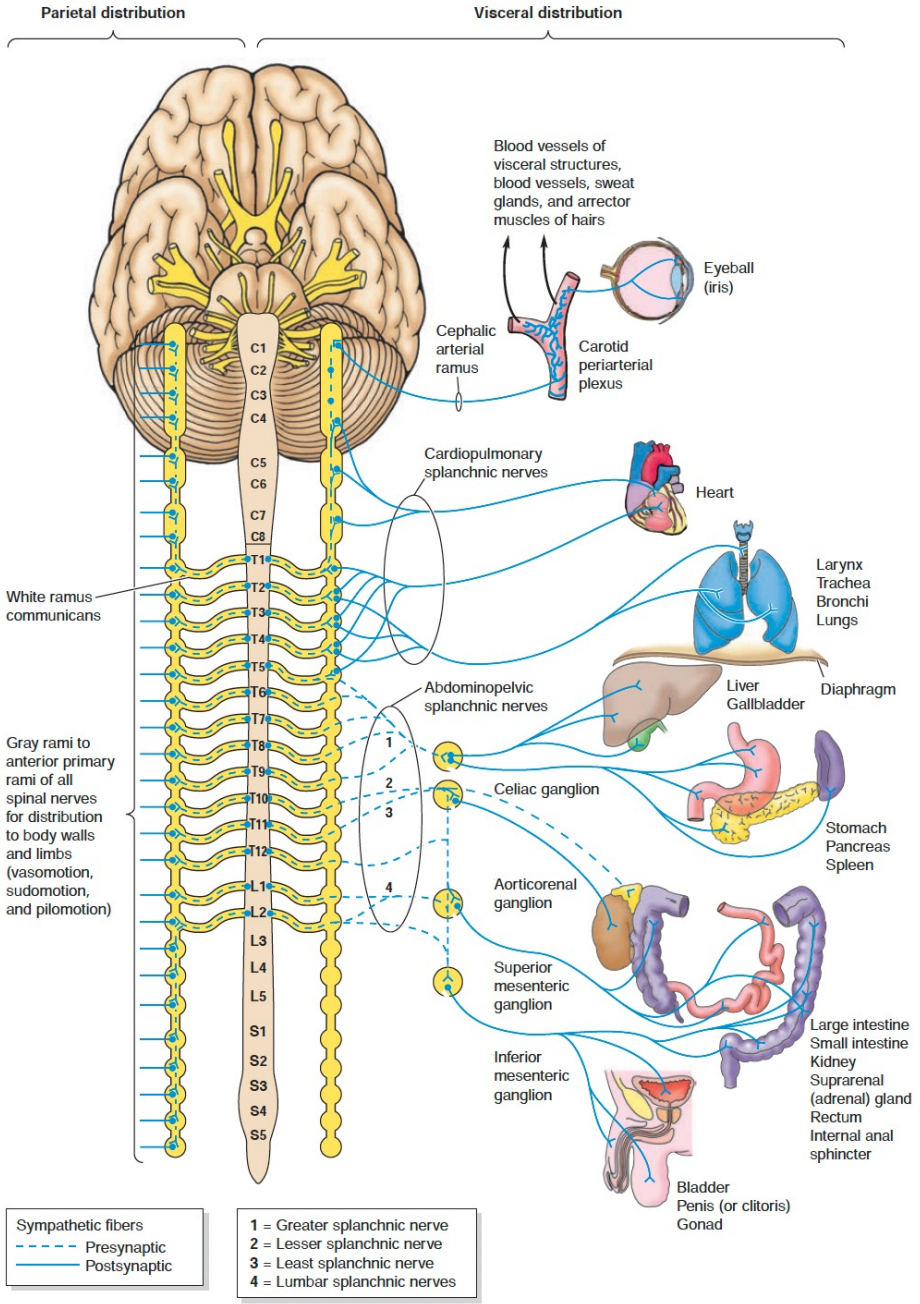
3E. Main effects

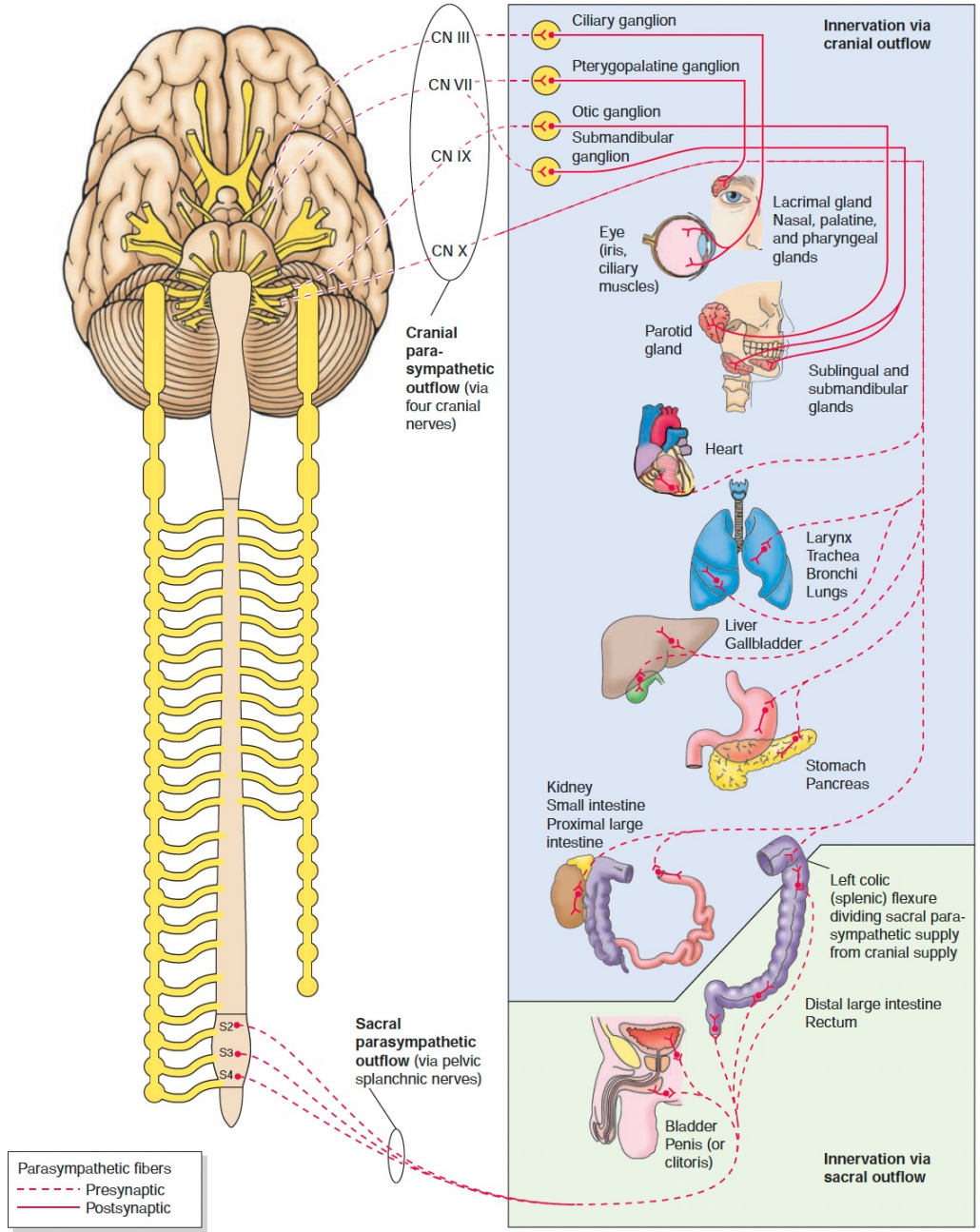




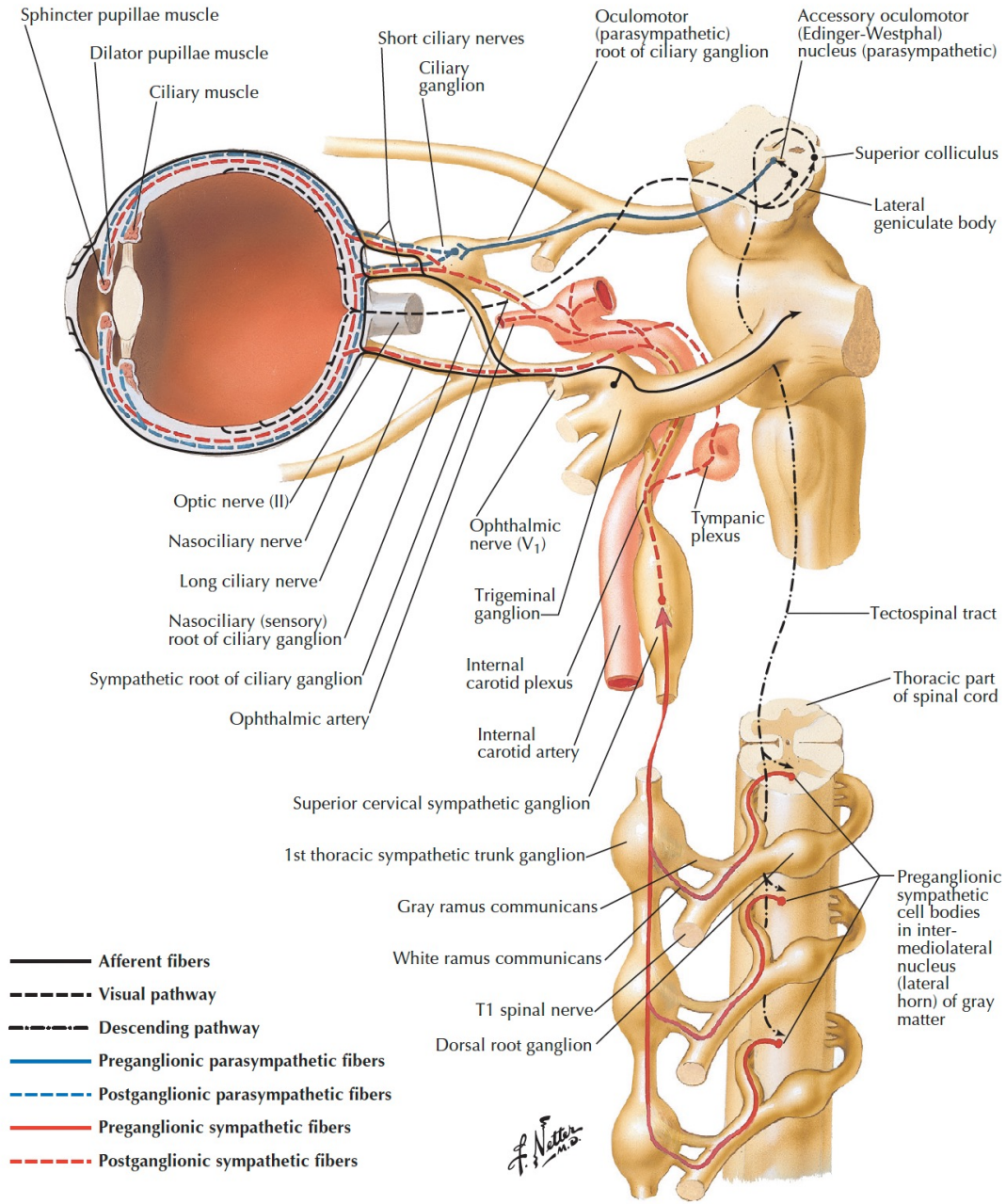
	TARGET	MAIN EFFECTS
Eye	Smooth muscle cells around pupil and lens	Constriction of pupil, adjustment of lens for near vision
Lacrimal gland, Salivary glands	Cells of lacrimal and salivary glands	Increase in secretions
Heart	Cardiac muscle cells	Decrease in heart rate
Lung, Bronchiole	Smooth muscle cells of bronchioles	Bronchoconstriction
Liver, Stomach, Gallbladder, Pancreas, Large intestine	Smooth muscle cells of digestive tract and sphincters	Contraction of digestive tract smooth muscle, relaxation of sphincters
Small intestine	Cells of digestive glands	Increase in secretions
Kidney	Smooth muscle cells of urinary sphincters	Relaxation of sphincters
Urinary bladder		

Part IV: ANS of glands





Part IV: ANS of eyes



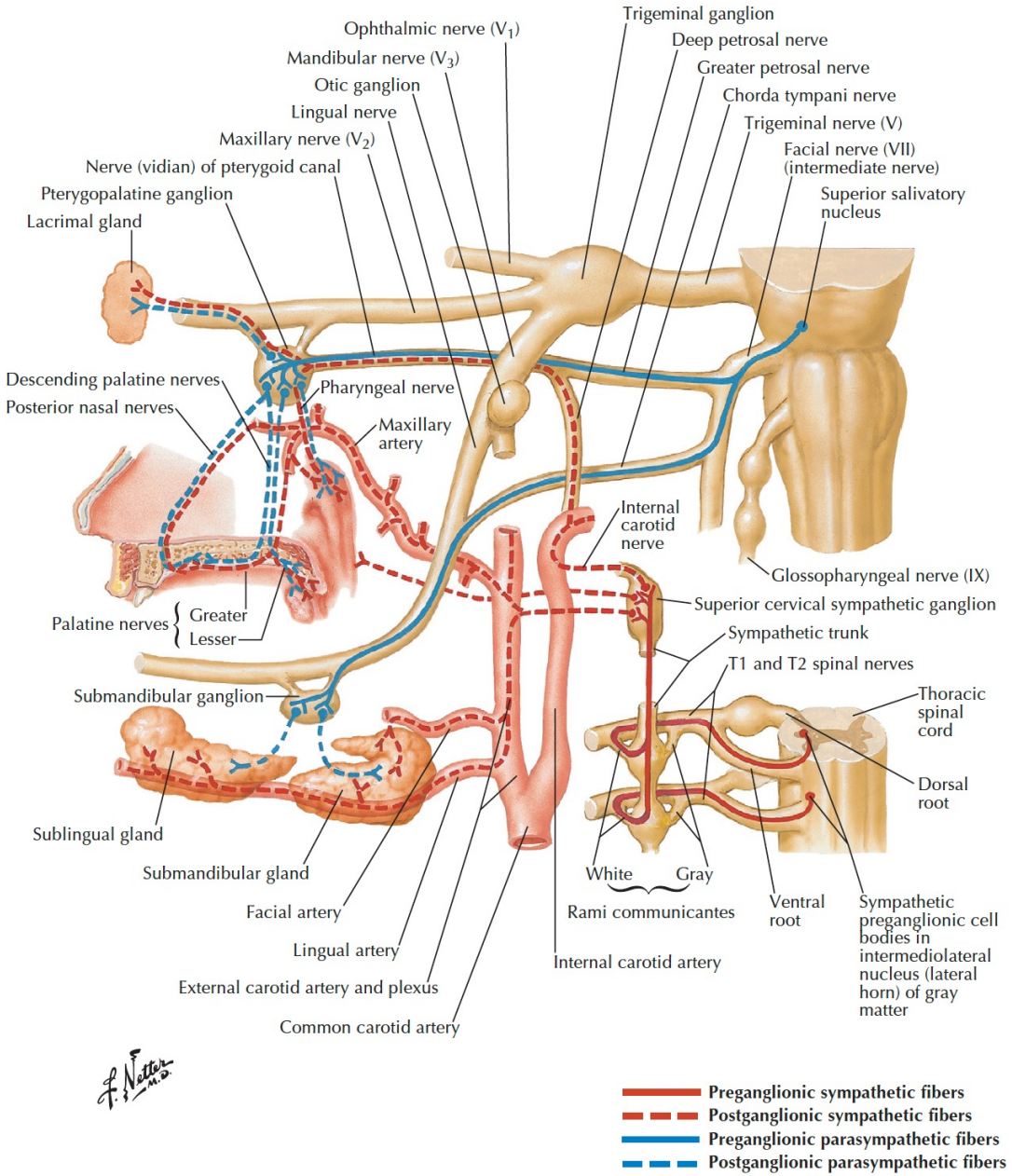
Sympathetic nervous system

House # 1 = lateral horn of grey matter
@thoracolumbar outflow (thoracic)
House of = Preganglionic sympathetic neurons
--> Preganglionic (presynaptic) sympathetic fibers
Road = 1. Anterior root
2. Spinal nerve
3. White ramus communicans
4. Sympathetic trunk

House # 2 = Superior cervical sympathetic ganglion (synapse!)
House of = Postganglionic sympathetic neurons
--> Postganglionic (postsynaptic) sympathetic fibers
Road = 1. Internal carotid plexus @Internal carotid artery
2.1 Long ciliary nerve
2.2 Sympathetic root of ciliary ganglion
1. Ciliary ganglion (pass)
2. Short ciliary nerves

Targets
1. Ciliary muscle
2. Dilator pupilae muscle

Part IV: ANS of Lacrimal & Mucous gland



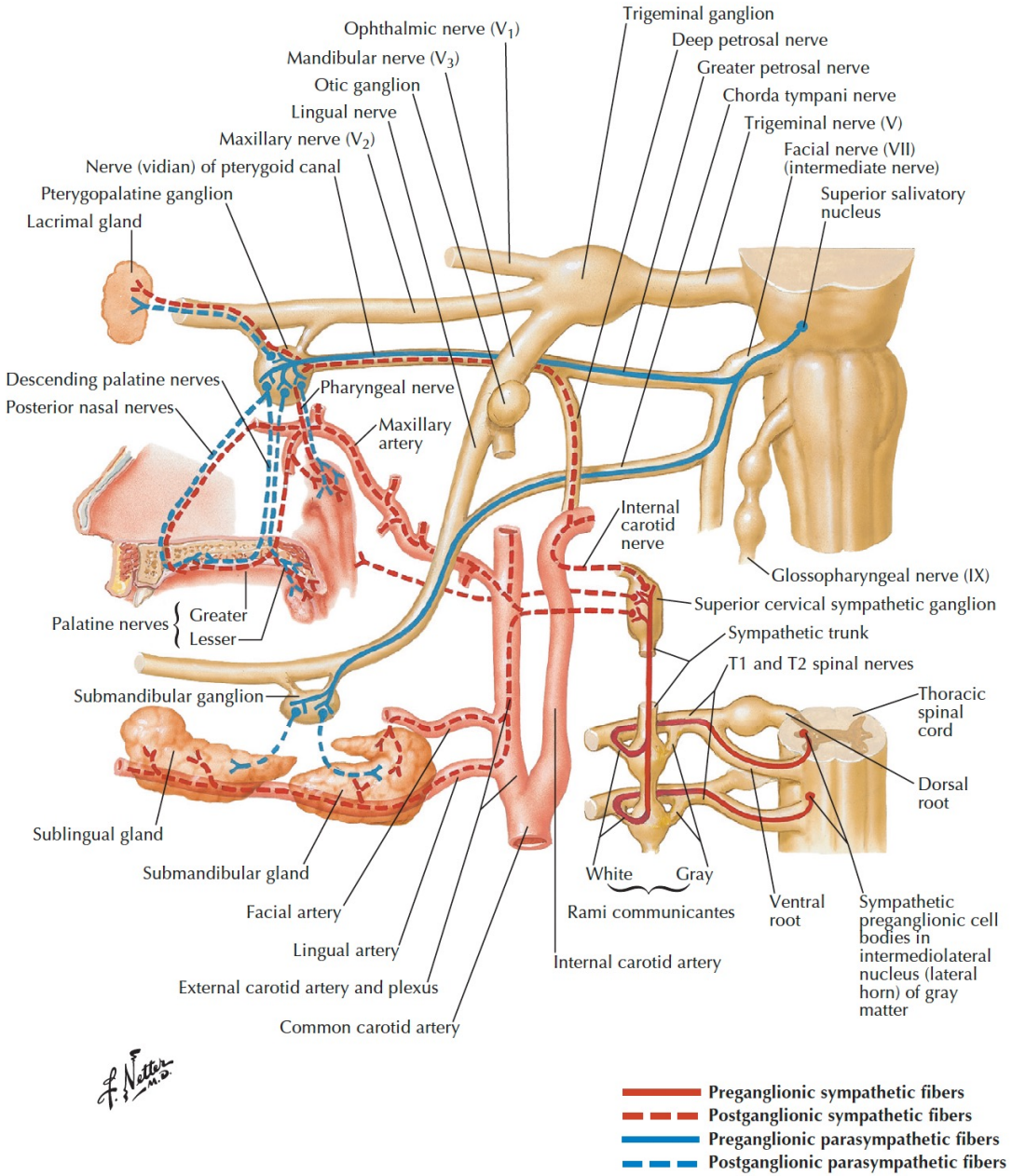
Sympathetic nervous system

House # 1 = lateral horn of grey matter
@thoracolumbar outflow (thoracic)
House of = Preganglionic sympathetic neurons
--> Preganglionic (presynaptic) sympathetic fibers
Road = 1. Anterior root
2. Spinal nerve
3. White ramus communicans
4. Sympathetic trunk

House # 2 = Superior cervical sympathetic ganglion (synapse!)
House of = Postganglionic sympathetic neurons
--> Postganglionic (postsynaptic) sympathetic fibers
Road = 1. Internal carotid nerve
2.1 Deep petrosal nerve ---> lacrimal gland
3. Nerve (vidian) of pterygoid canal
4. Pterygopalatine ganglion (pass)
2.2 External carotid plexus @External carotid artery
---> Mucous gland @ nasal, palatine, and pharyngeal
3. Maxillary artery

Targets

Part IV: ANS of sublingual & submandibular (salivary) gland



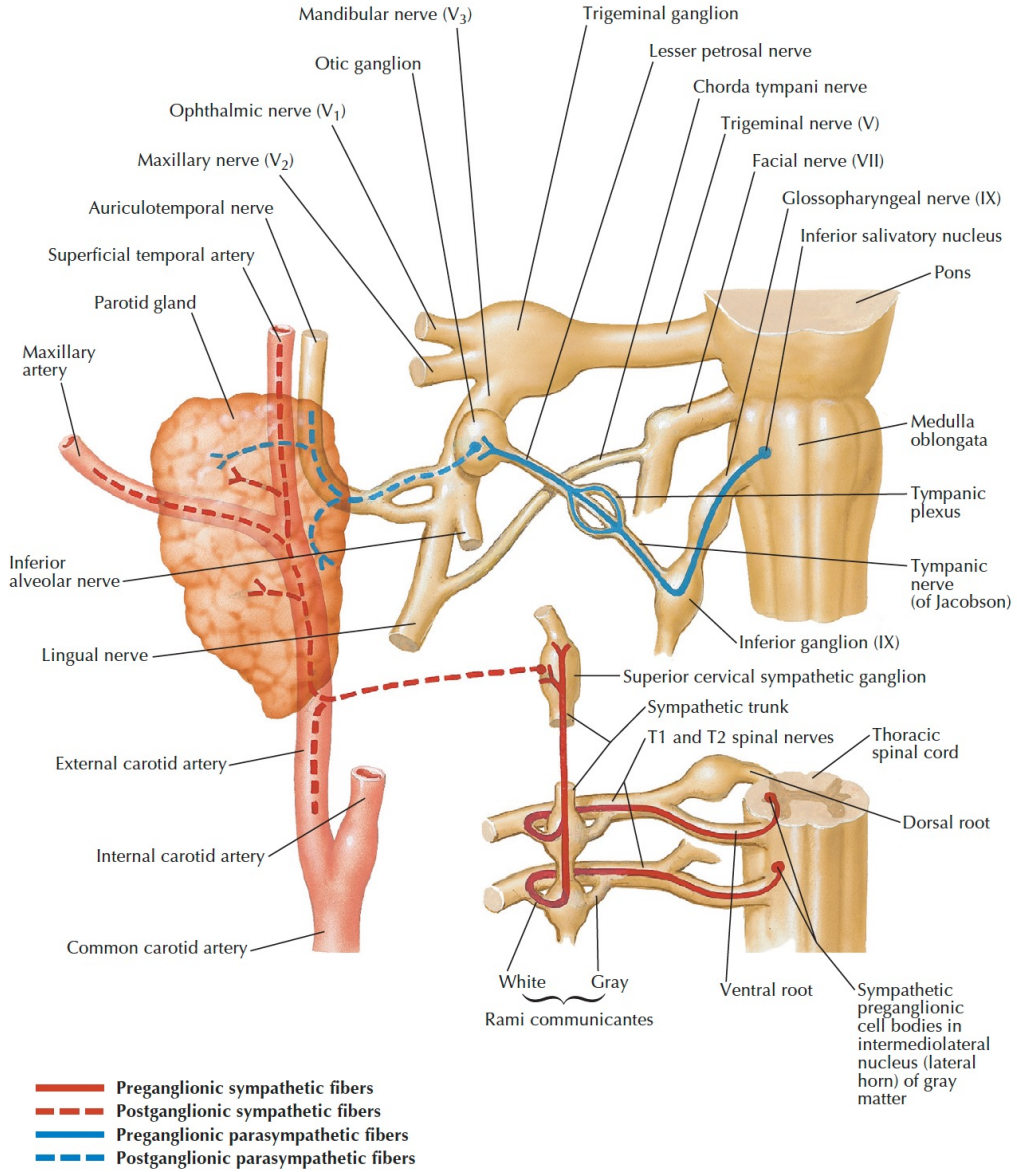
Sympathetic nervous system

House # 1 = lateral horn of grey matter
@thoracolumbar outflow (thoracic)
House of = Preganglionic sympathetic neurons
--> Preganglionic (presynaptic) sympathetic fibers
Road = 1. Anterior root
2. Spinal nerve
3. White ramus communicans
4. Sympathetic trunk

House # 2 = Superior cervical sympathetic ganglion (synapse!)
House of = Postganglionic sympathetic neurons
--> Postganglionic (postsynaptic) sympathetic fibers
Road = 1. Internal carotid nerve
2. External carotid plexus @External carotid artery
3.1 Facial artery ---> submandibular only
3.2 Lingual artery

Targets
1. Sublingual (salivary) gland
2. Submandibular (salivary) gland

Part IV: ANS of parotid (salivary) gland



Sympathetic nervous system

House # 1 = lateral horn of grey matter

@thoracolumbar outflow (thoracic)

House of = Preganglionic sympathetic neurons

--> Preganglionic (presynaptic) sympathetic fibers

Road = 1. Anterior root

2. Spinal nerve

3. White ramus communicans

4. Sympathetic trunk

House # 2 = Sup' cervical sympathetic ganglion (synapse!)

House of = Postganglionic sympathetic neurons

--> Postganglionic (postsynaptic) sympathetic fibers

Road = 1. External carotid artery

2.1 Maxillary artery

2.2 Superficial temporal artery

Targets

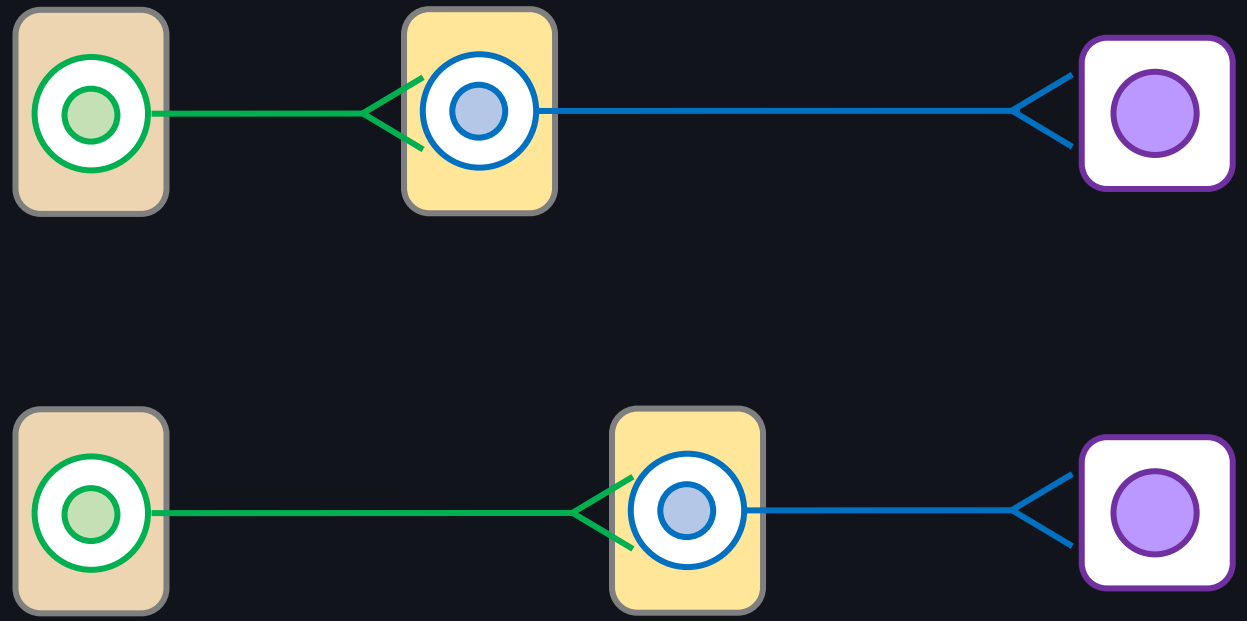
1. Parotid (salivary) gland

Department of Anatomy, Faculty of Dentistry, Mahidol University

DTAN 211: Gross Anatomy of Head and Neck in Dentistry

Autonomic Nervous System (ANS)

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