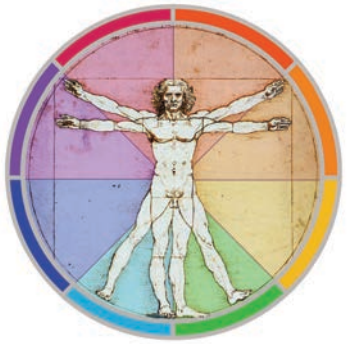
HUBS191 Lecture Material

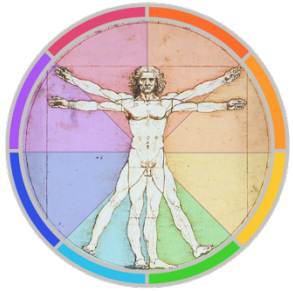
This pre-lecture material is to help you prepare for the lecture and to assist your note-taking within the lecture,

it is NOT a substitute for the lecture !



Please note that although every effort is made to ensure this pre-lecture material corresponds to the live-lecture there may be differences / additions.

Dr Christine Jasoni
Department of Anatomy



HUBS 191

Human Movement and Sensation

Theme 2: Integrating and coordinating roles of the nervous system

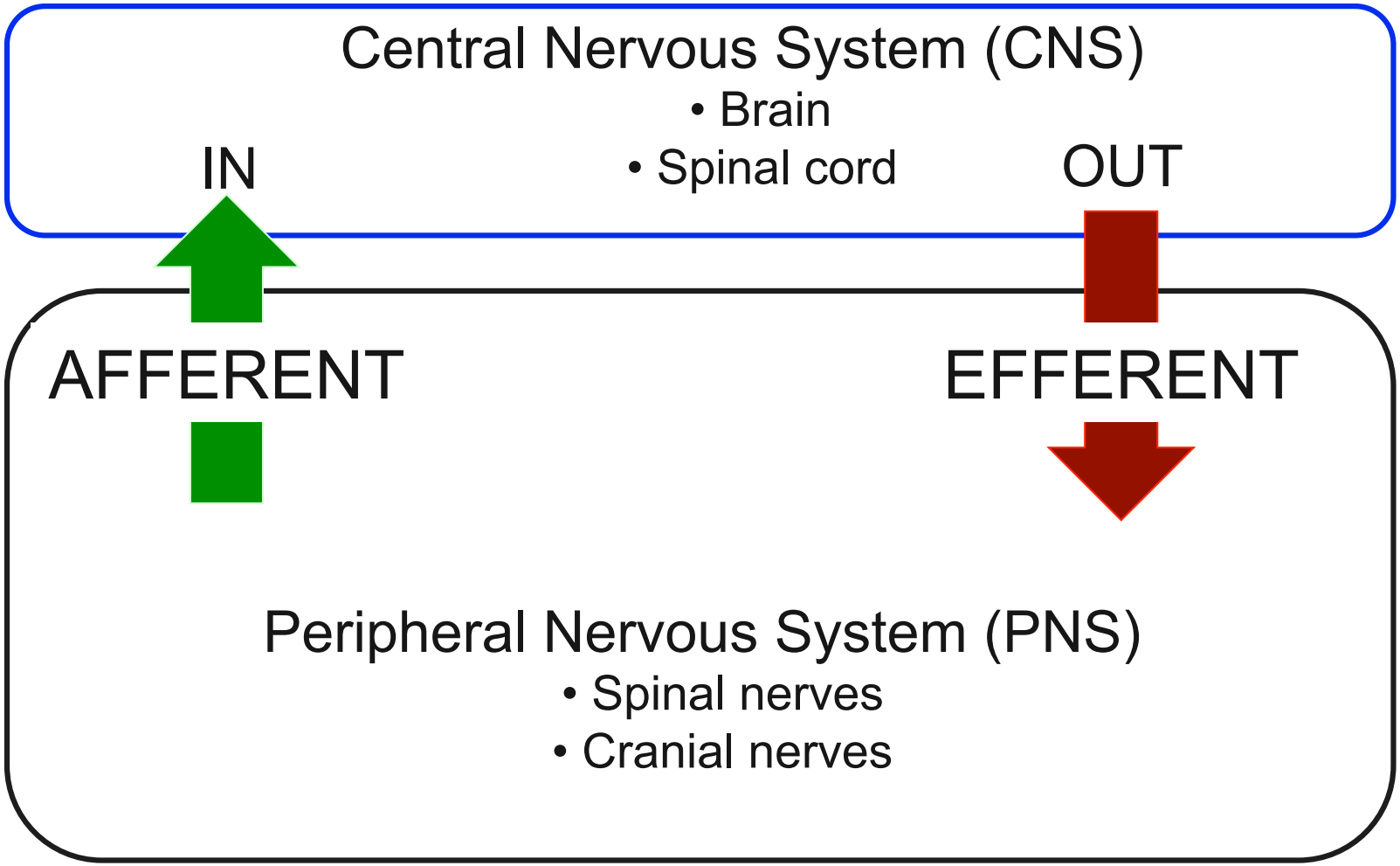
Lecture 17: Divisions of the nervous system

27 March 2017

Lecture 17: Learning objectives

- Understand the types of information transmitted in the nervous system and how the nervous system is divided based on these
- Understand the anatomical organisation of the somatic efferent division of the nervous system
- Understand how neurons communicate with effector cells in the somatic efferent division of the nervous system
- Understand the anatomical oraganisation of the autonomic nervous system
- Understand how autonomic neurons communicate with effector cells
- Understand the anatomical and functional differences between the sympathetic and parasympathetic divisions of the autonomic nervous system

Divisions of the nervous system: I. Based on direction of information flow



Types of information transmitted

- **Somatic** = the stuff we are aware of, have control over
  - Voluntary muscle control
    - SOMATIC EFFERENT (motor)
  - Sensory information we are aware of
    - SOMATIC AFFERENT (sensory)

http://blogs.reeths-puffer.org/gearhartg/#/category/physical-science/

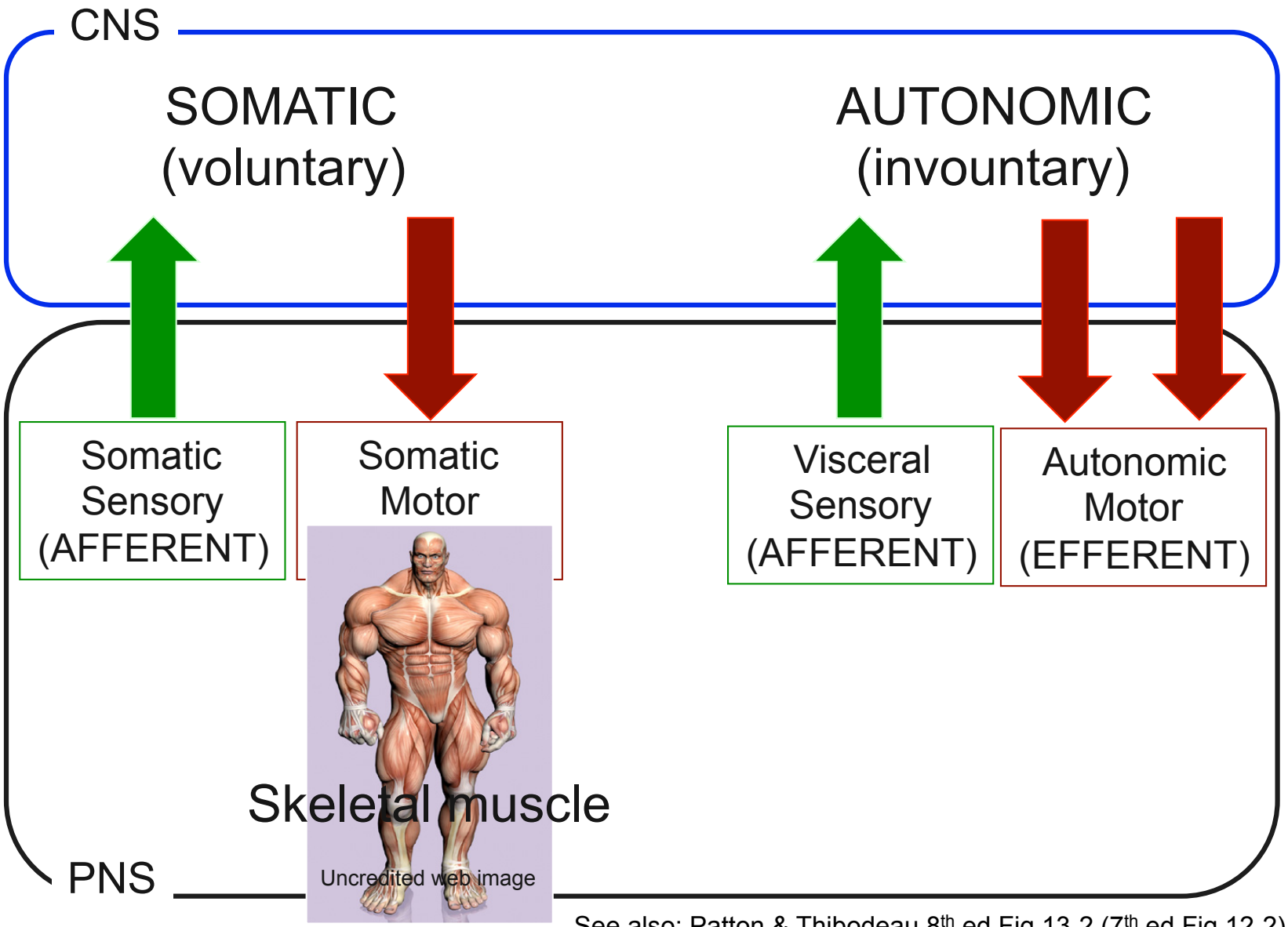
http://toastyart.com/content/colorfull-eye

- **Autonomic** = the stuff we are not aware of, have no control over
  - Involuntary muscle control
    - AUTONOMIC EFFERENT (motor)
  - Sensory information that we don't know about
    - AUTONOMIC AFFERENT (sensory)

http://healthtrick.com/health/heartbeat-can-describe-someones-personality.html

http://topnews.net.nz/content/217985-medical-professional-phobia-might-lead-faulty-blood-pressure-results

Divisions of the nervous system:
I. Based on type of information transmitted



See also: Patton & Thibodeau 8th ed Fig 13-2 (7th ed Fig 12-2)

Somatic Motor (EFFERENT) Division

5 Features

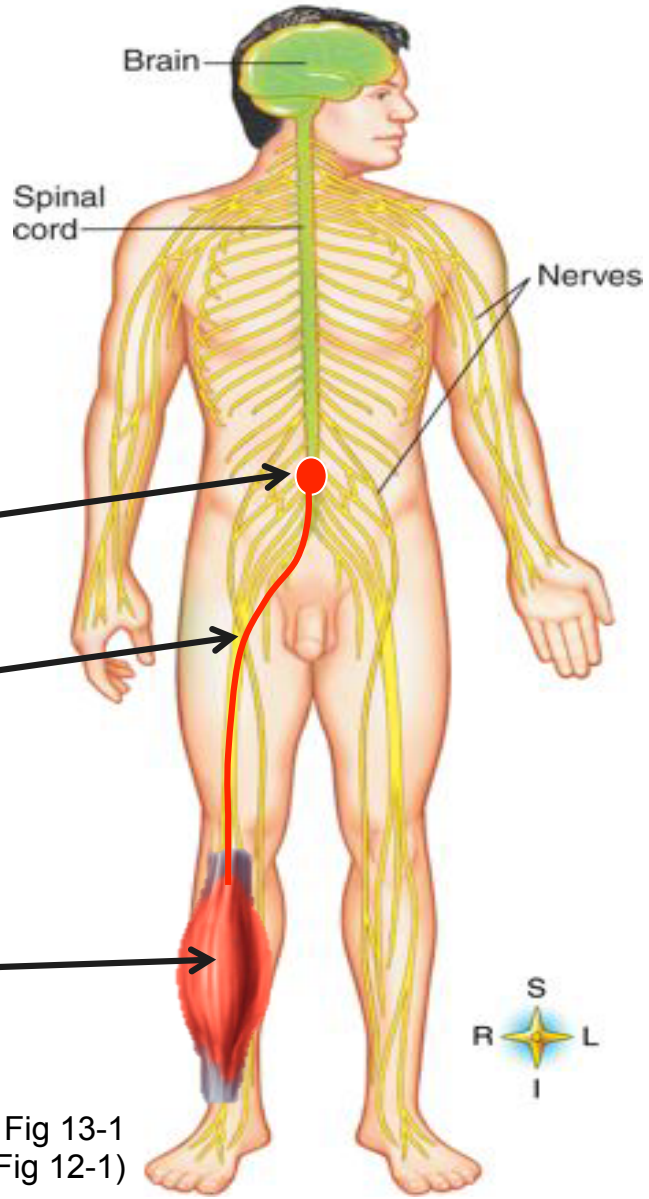
- Voluntary control

- *One* neuron between CNS and effector (e.g. muscle)

- Cell body in spinal cord (CNS)

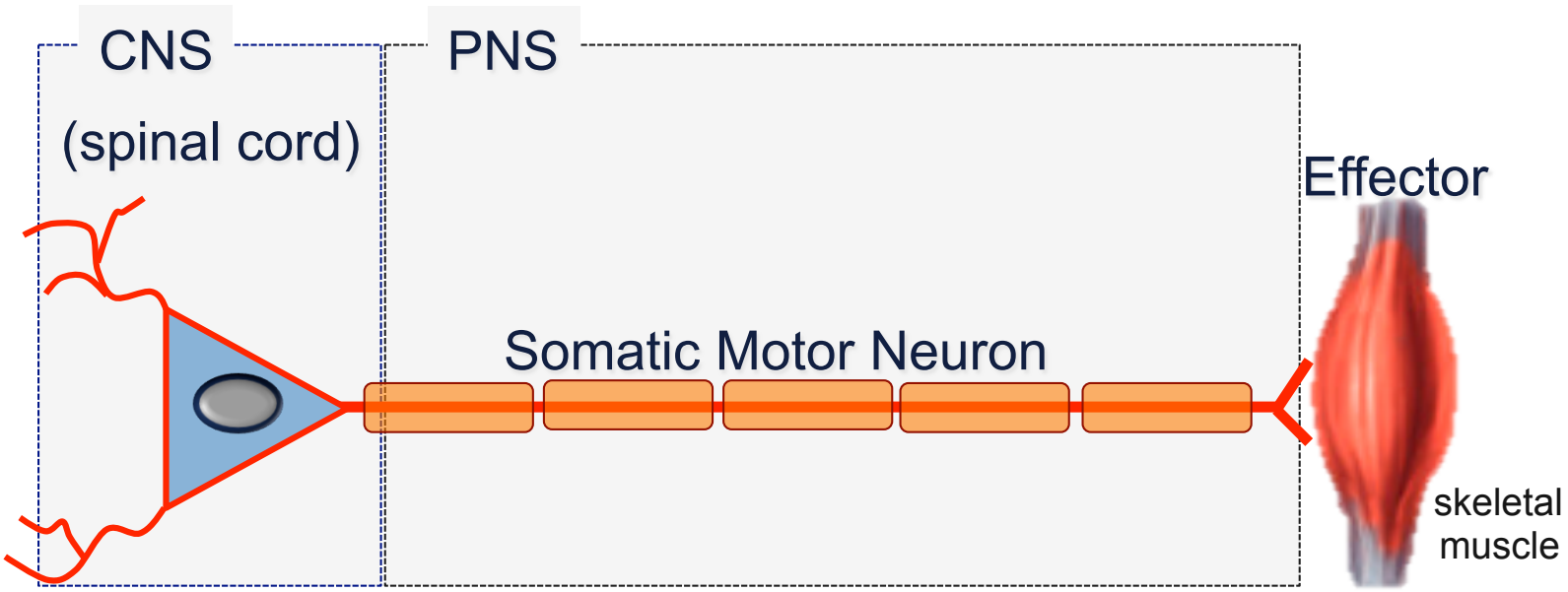
- Axon in spinal nerves (PNS)

- Effectors (= things the nerves go to and control) skeletal muscle fibres



Modified from: Patton & Thibodeau 8th ed Fig 13-1
(7th ed Fig 12-1)

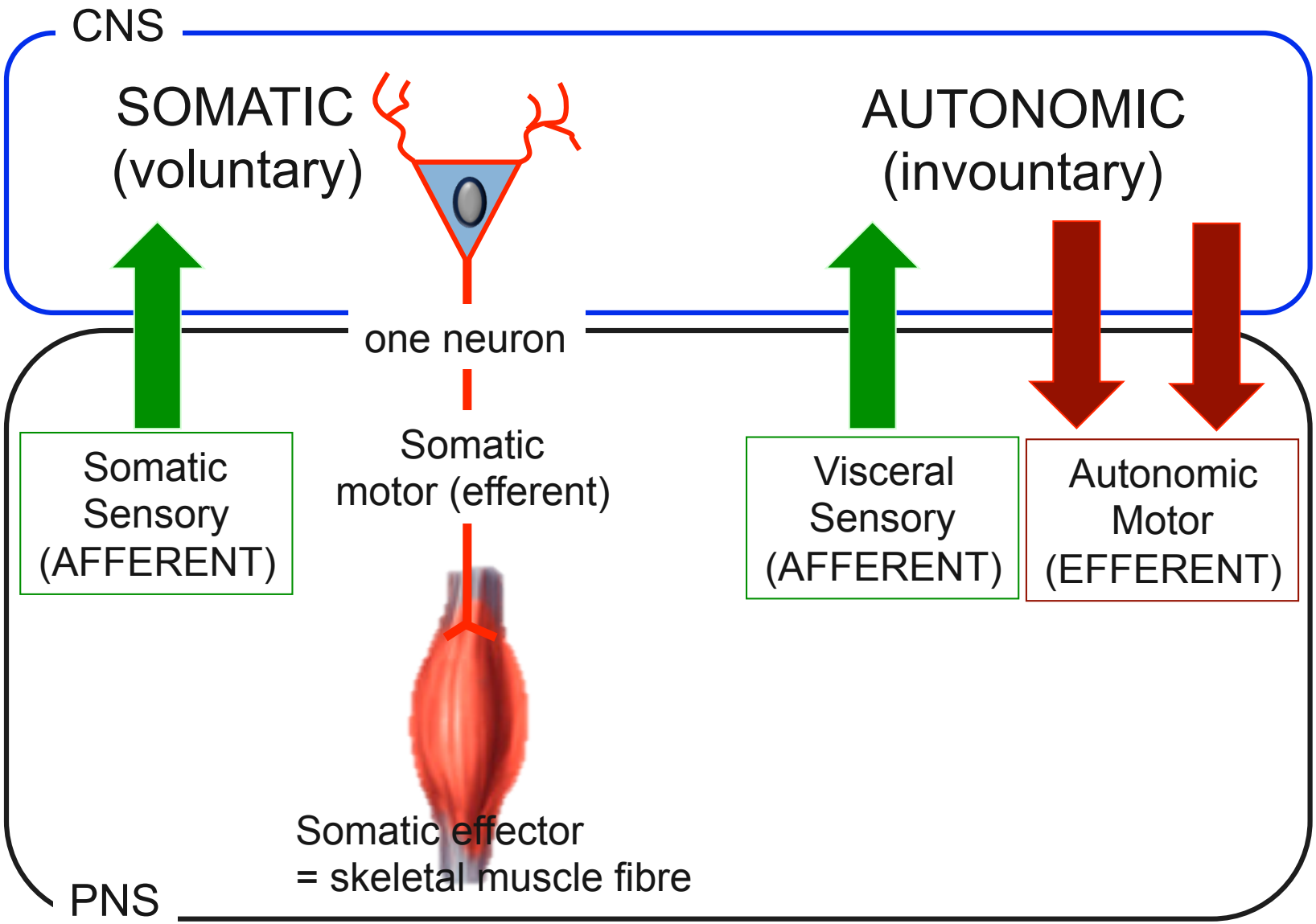
Anatomical organisation: Somatic motor (efferent)



- One motor neuron between the CNS and the effector
- *Single* motor neuron has its cell body in the spinal cord (CNS) and its axon in a spinal nerve (PNS)

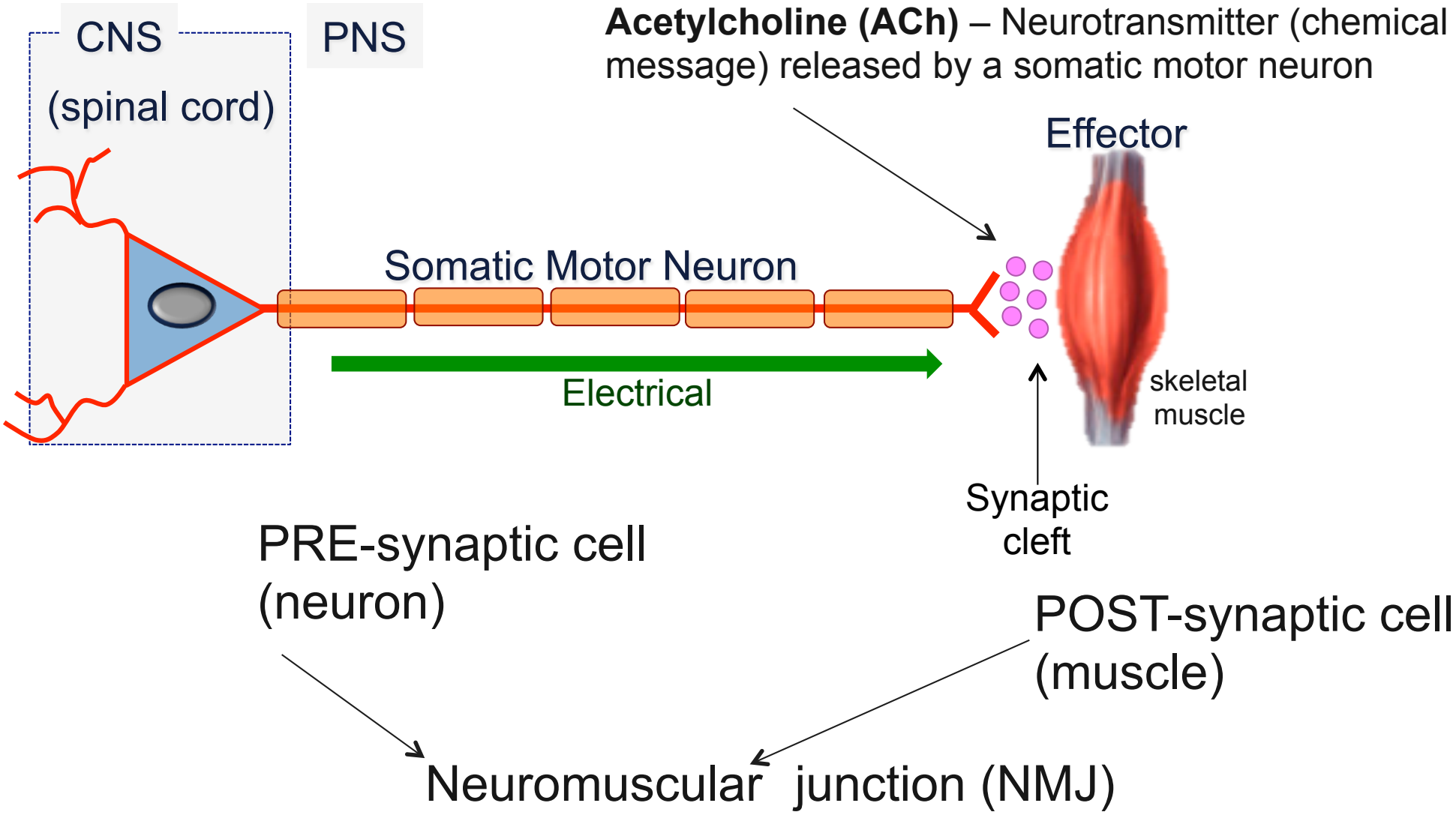
Imagine how long a single axon must be?

Divisions of the nervous system: I. Somatic motor



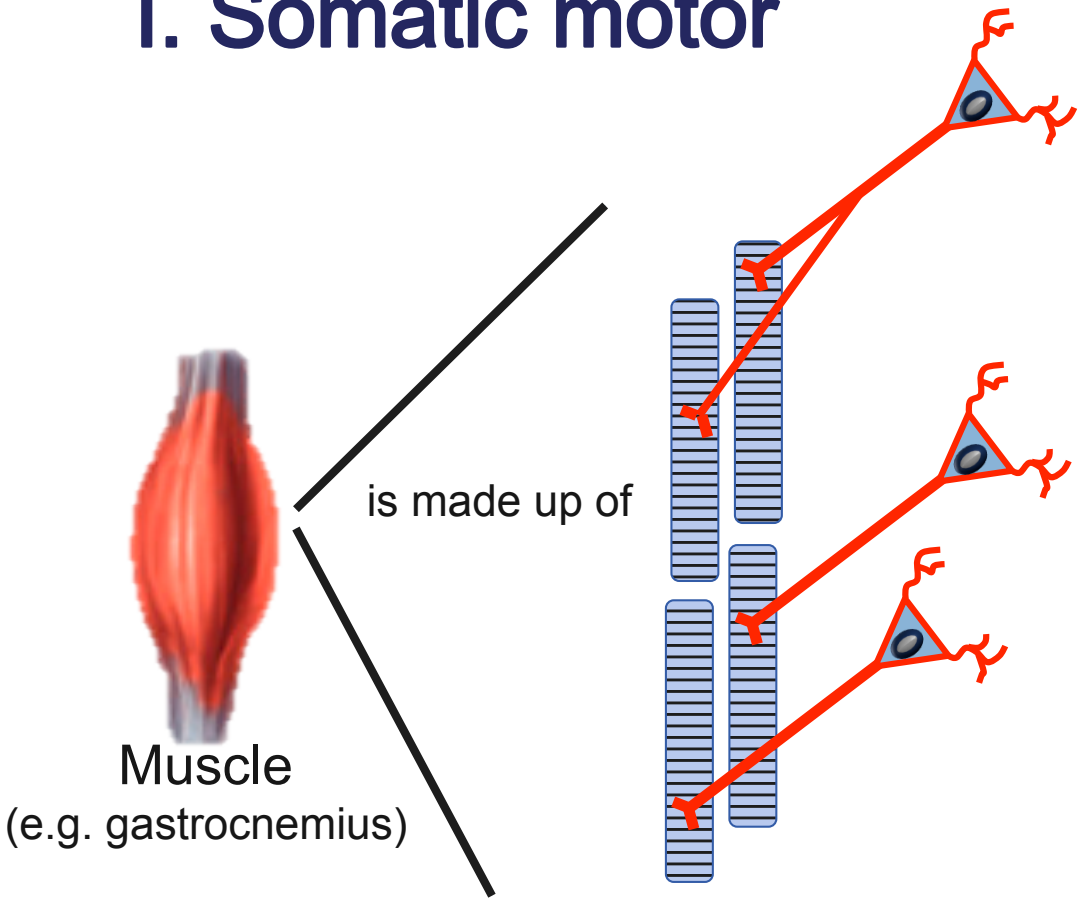
See also: Patton & Thibodeau 8th ed Fig 13-2 (7th ed Fig 12-2)

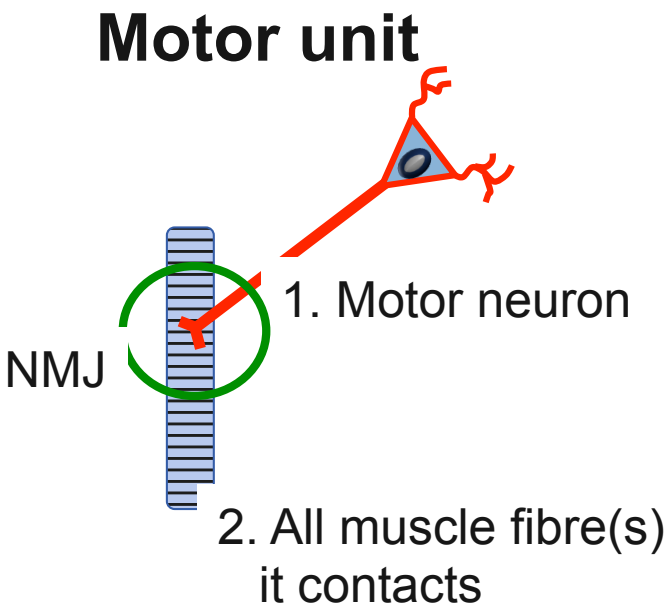
Anatomical organisation: Somatic motor (efferent) SYNAPSE



Divisions of the nervous system:

I. Somatic motor

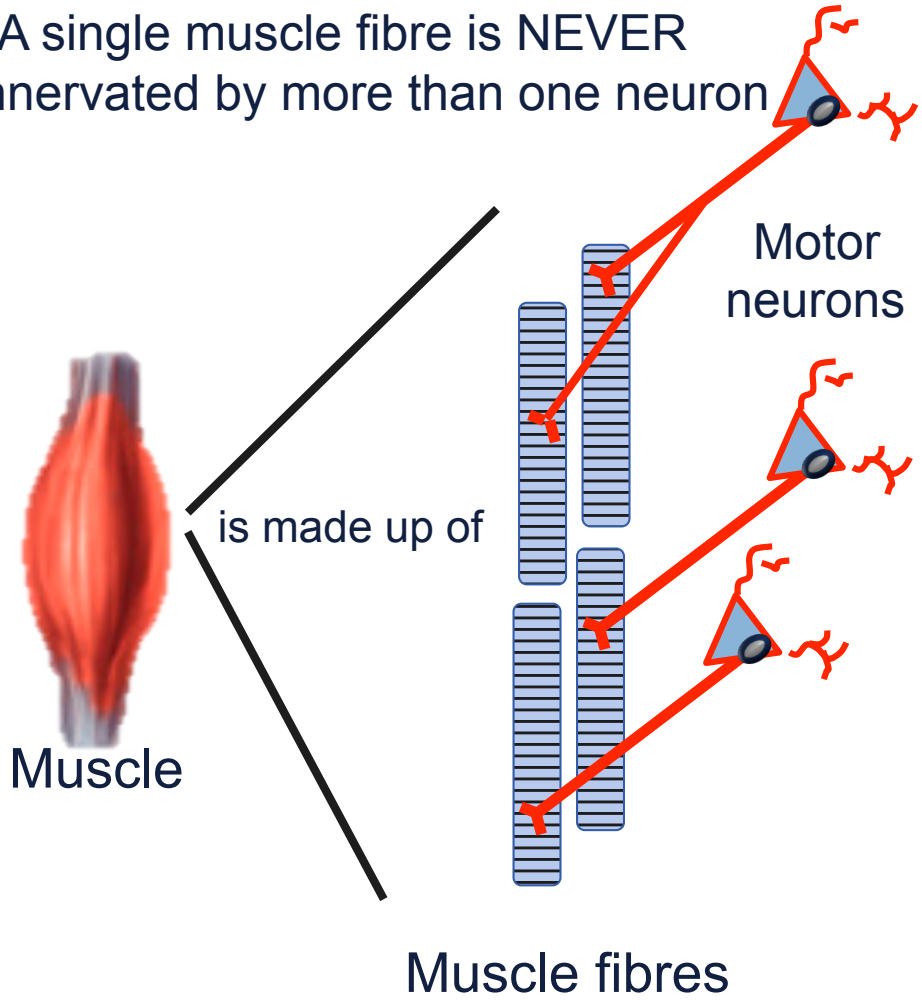




Motor unit

- A single neuron makes contact with one or several muscle fibres

- A single muscle fibre is NEVER innervated by more than one neuron



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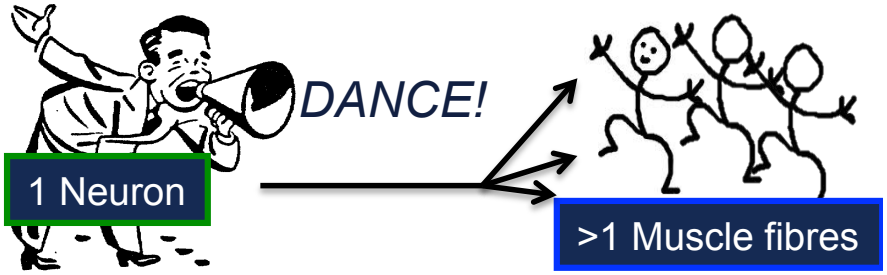
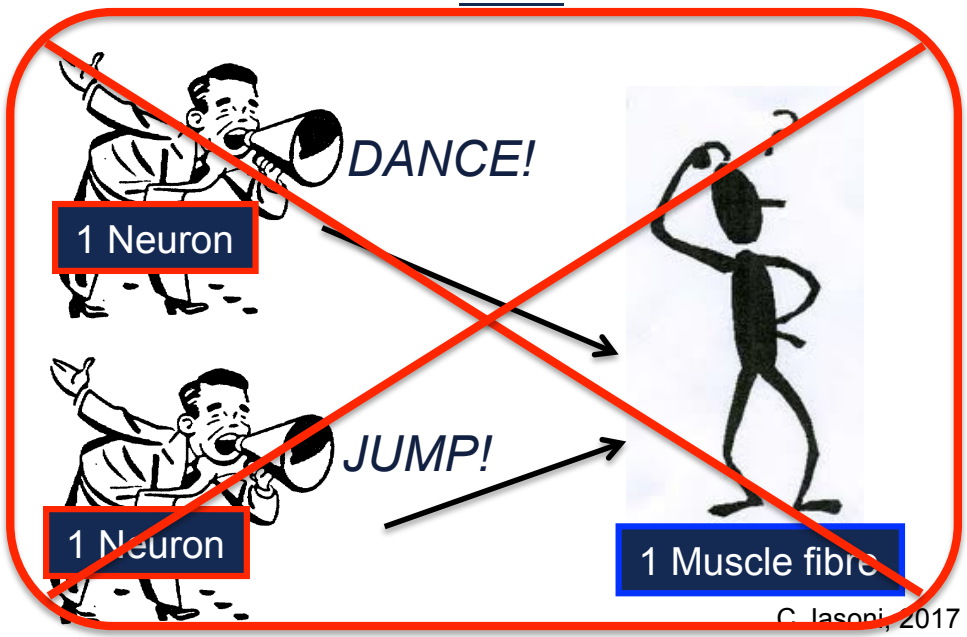


NOT

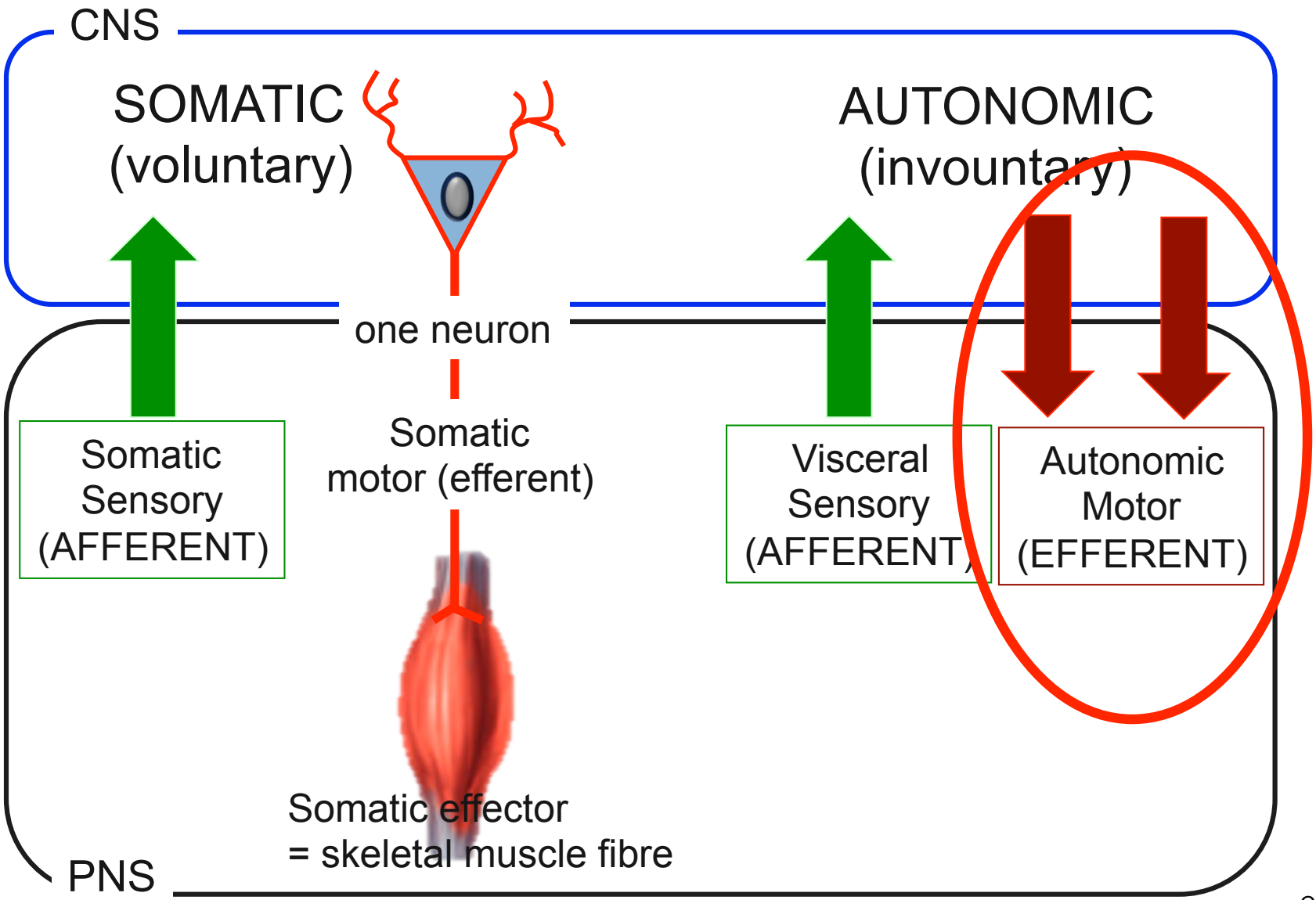


Summary: Somatic motor division

- Voluntary movement
- Efferent - information flow *AWAY* from CNS
- One neuron transmits the information to one motor unit (= 1 or more muscle fibres)
- Cell body in CNS (spinal cord)
- Axon is myelinated
- Neurotransmitter = Acetylcholine (ACh)

http://blogs.reeths-puffer.org/gearhartg/#/category/physical-science/

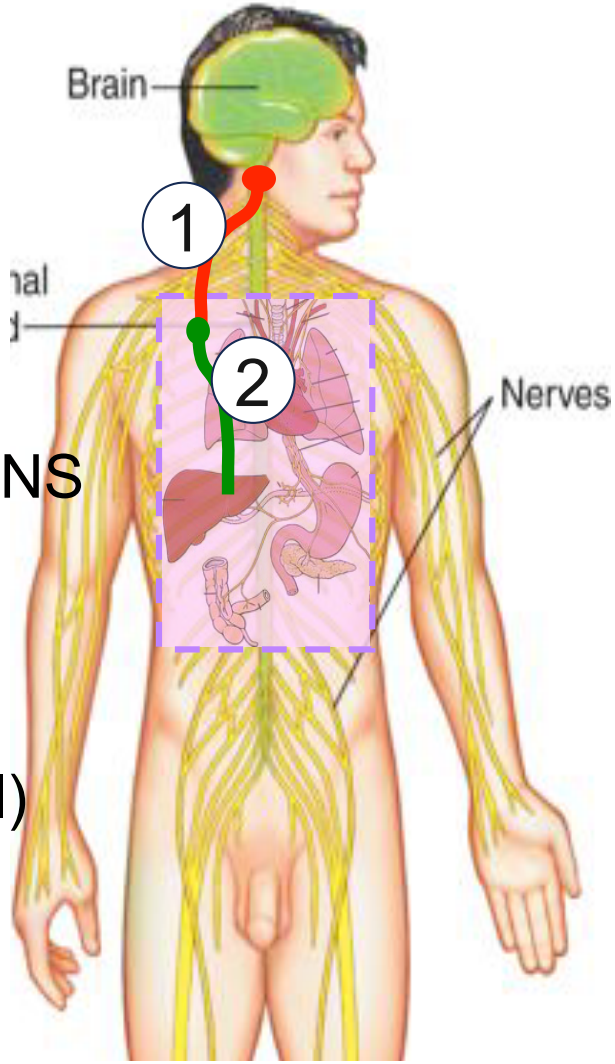
Divisions of the nervous system:
II. Autonomic motor (efferent)



See also: Patton & Thibodeau 8th ed Fig 13-2 (7th ed Fig 12-2)

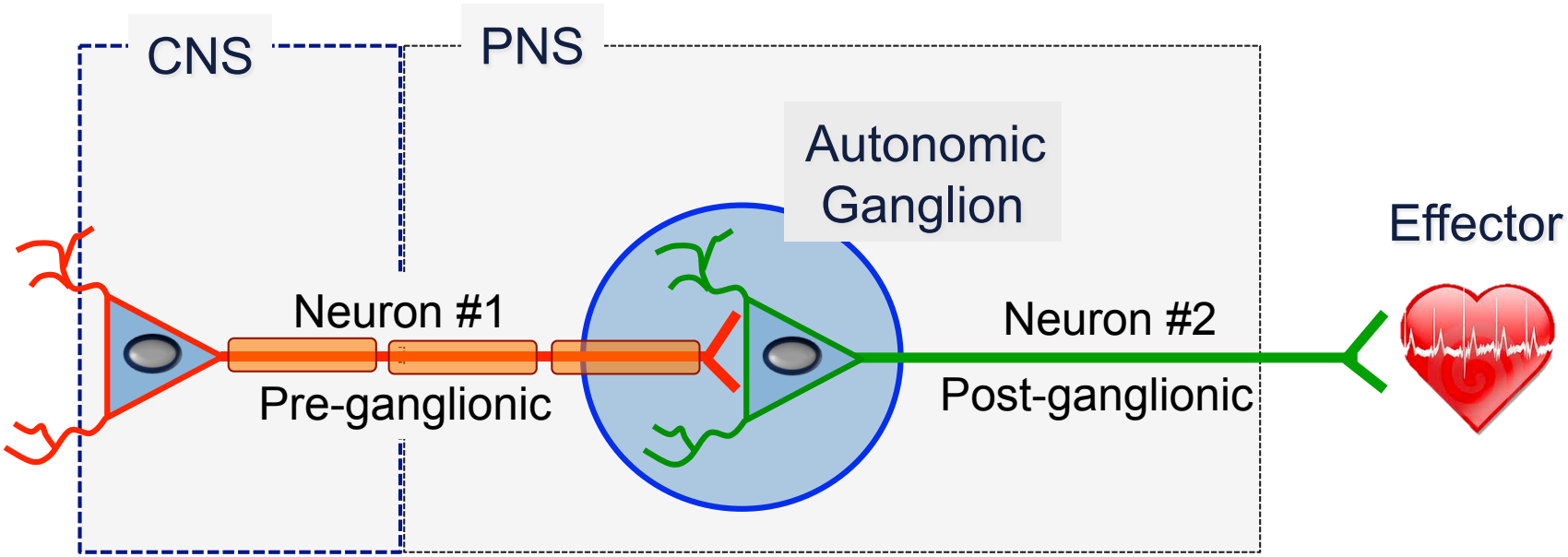
Autonomic Nervous System

- Involuntary control
- *Two* neurons between CNS and effector
- Neuron #1 has cell body in CNS and axon in PNS
- Neuron #2 has cell body and axon in PNS
- Effectors (= things the nerves go to and control)
  i) smooth muscle, ii) cardiac muscle, iii) glands, iv) adipose (fat) tissue



Modified from: Patton & Thibodeau 8th ed Fig 13-1 (7th ed Fig 12-1)

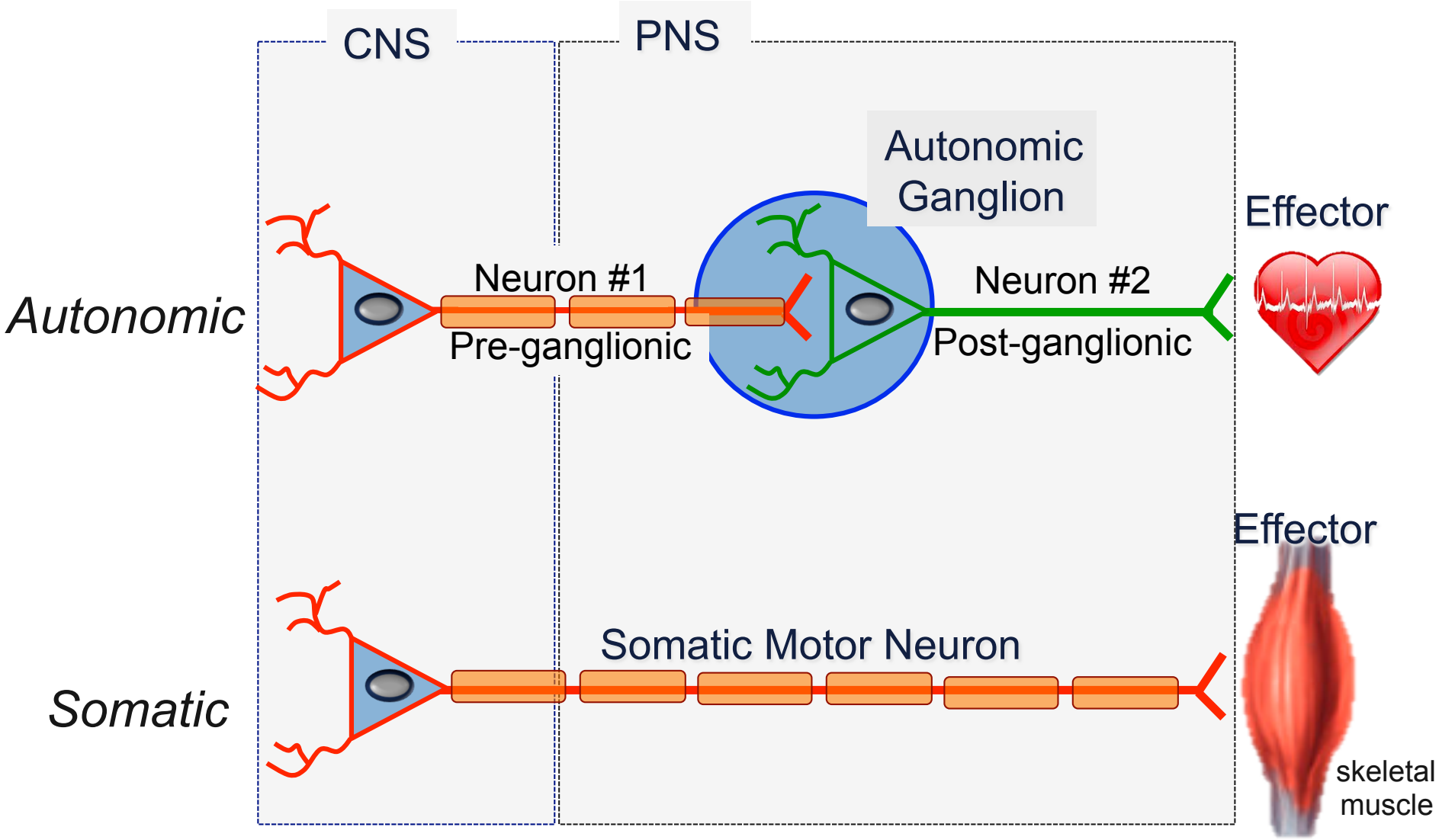
Autonomic nervous system: Basic anatomical features



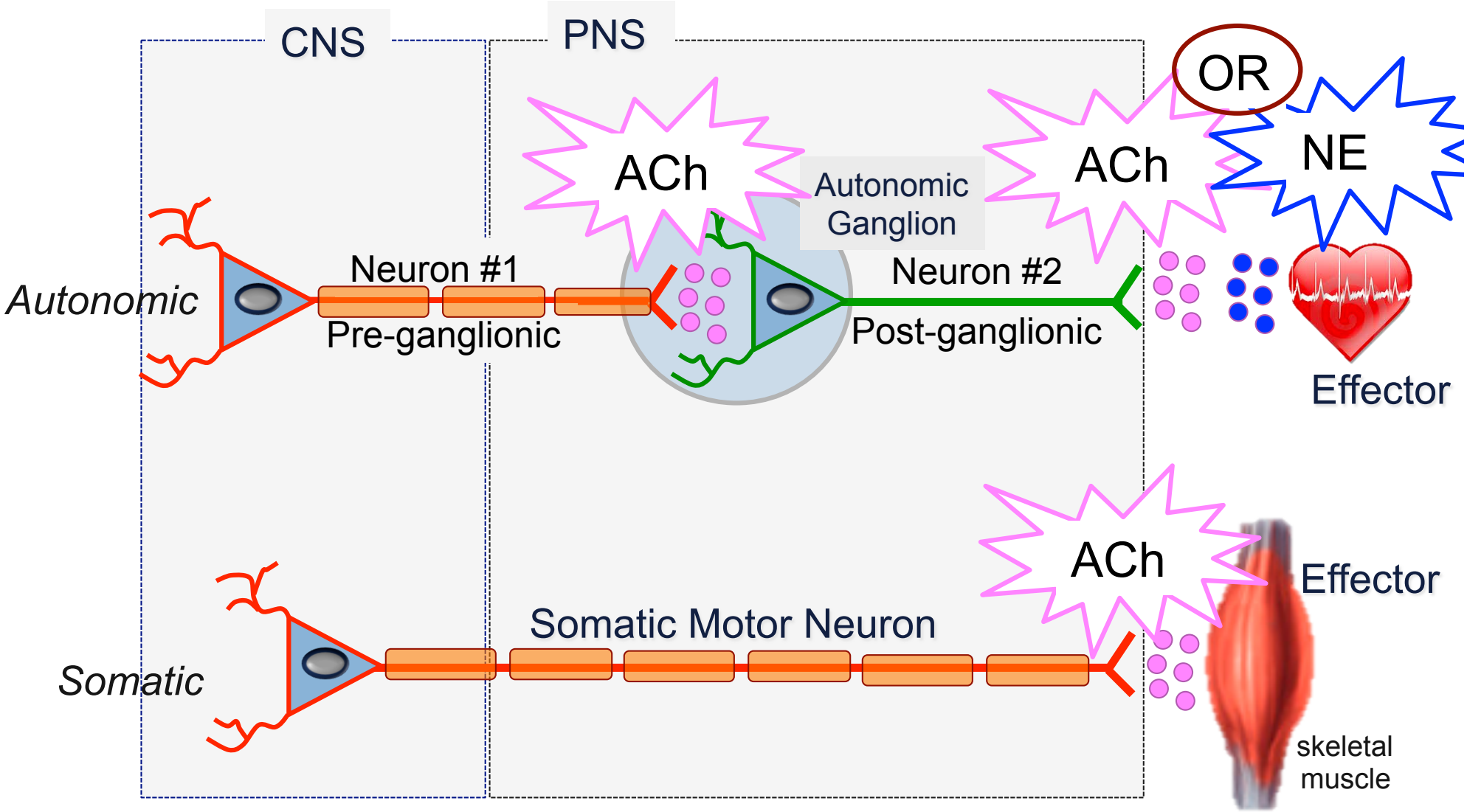
Neuron #1:
- Cell body in CNS
- Axon extends outside CNS
- Synapse in Autonomic Ganglion
- Pre-ganglionic neuron
- Neurotransmitter = acetylcholine (ACh)
- Myelinated

Neuron #2:
- Cell body in PNS, autonomic ganglion
- Axon extends to effector organ
- Synapse on effector organ
- Post-ganglionic neuron
- Neurotransmitter = acetylcholine (ACh) OR noradrenaline (NE)
- Unmyelinated

Structural differences between Somatic and Autonomic efferent pathways

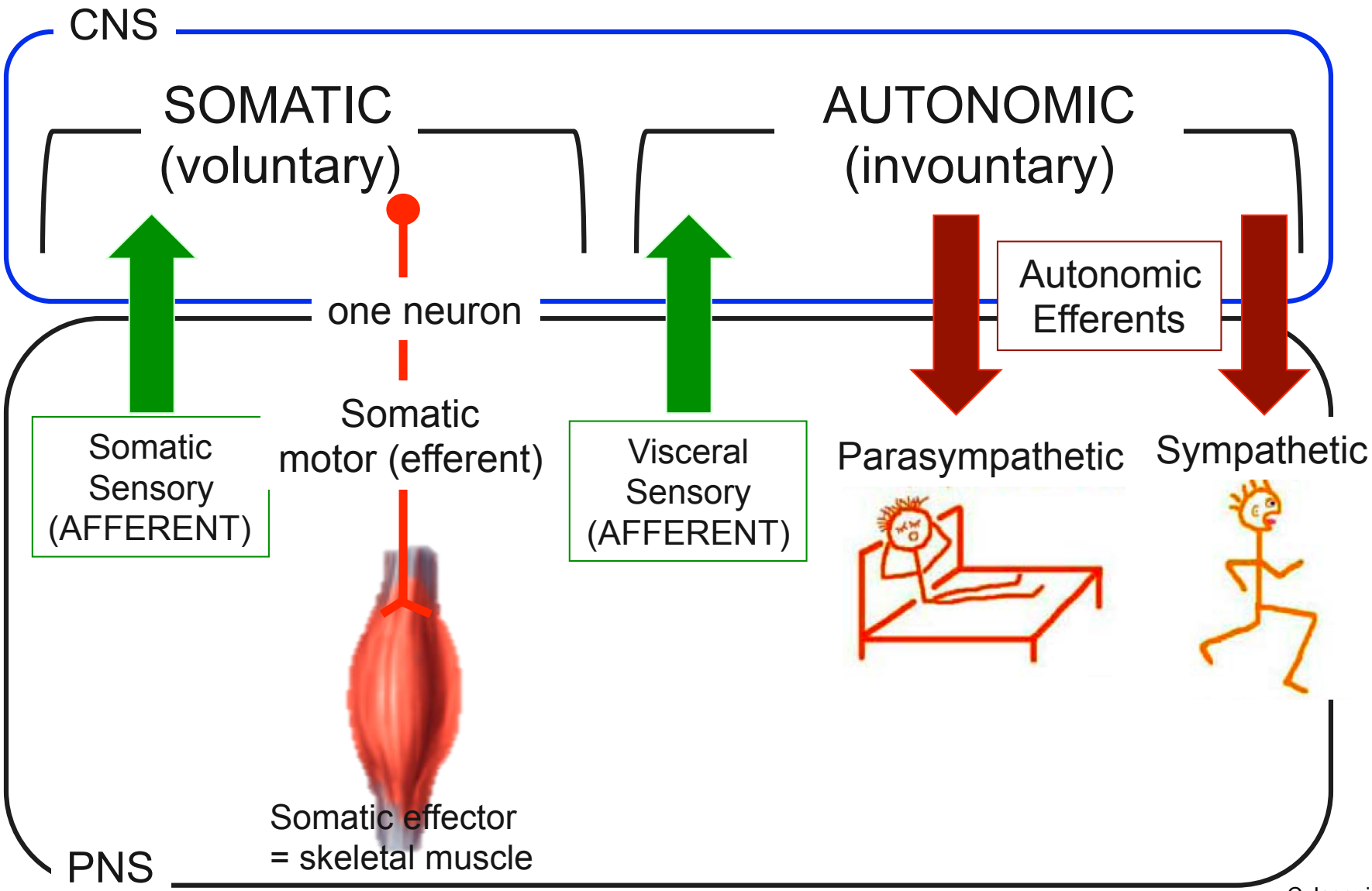


Neurotransmitter differences between Somatic and Autonomic efferent pathways



NE = norepinephrine (also called noradrenaline)

Divisions of the nervous system: II. Autonomic nervous system



See also: Patton & Thibodeau 8th ed Fig 13-2 (7th ed Fig 12-2)

Subdivisions of the autonomic nervous system

SYMPATHETIC

- Prepares the body for acute/stress responses
- ”Fight or Flight" system.
- Effects include:
  - increased (↑) heart rate
  - constricting blood vessels to skin and viscera (↑ blood flow to muscles)
  - ↓ gastric motility
  - ↓ salivation
  - ↑ pupil size
  - ↑ sweating

PARASYMPATHETIC

- Prepares the body for restful situations:
- “REST AND DIGEST” system.
- Effects include:
  - decreased (↓) heart rate
  - ↑ gastric motility
  - ↓ pupil size
  - ↑ salivation.

Subdivisions of the autonomic nervous system

SYMPATHETIC

- Prepares the body for acute/stress responses
- ”Fight or Flight" system.
- Effects include:
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- Effects include:
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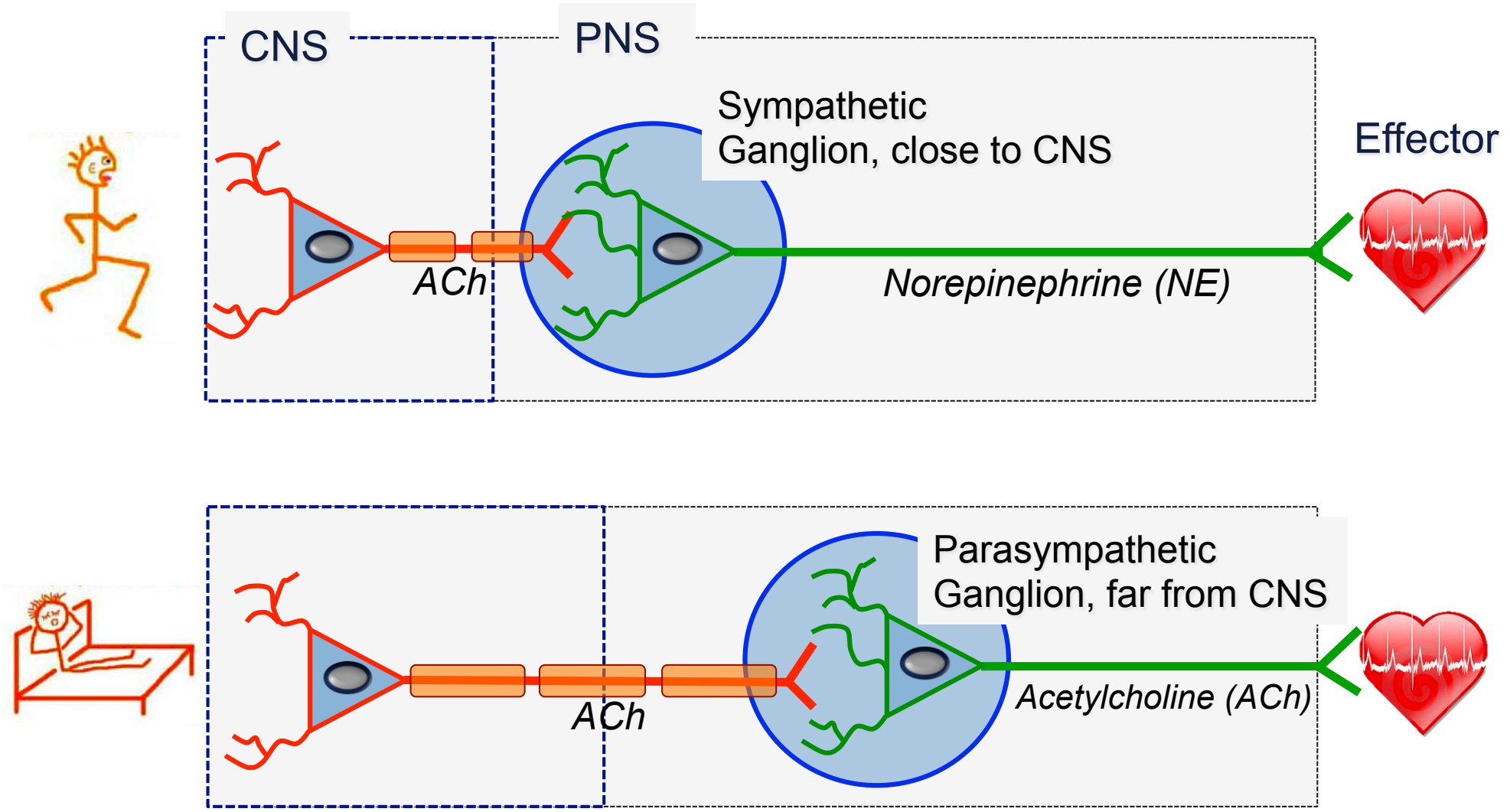
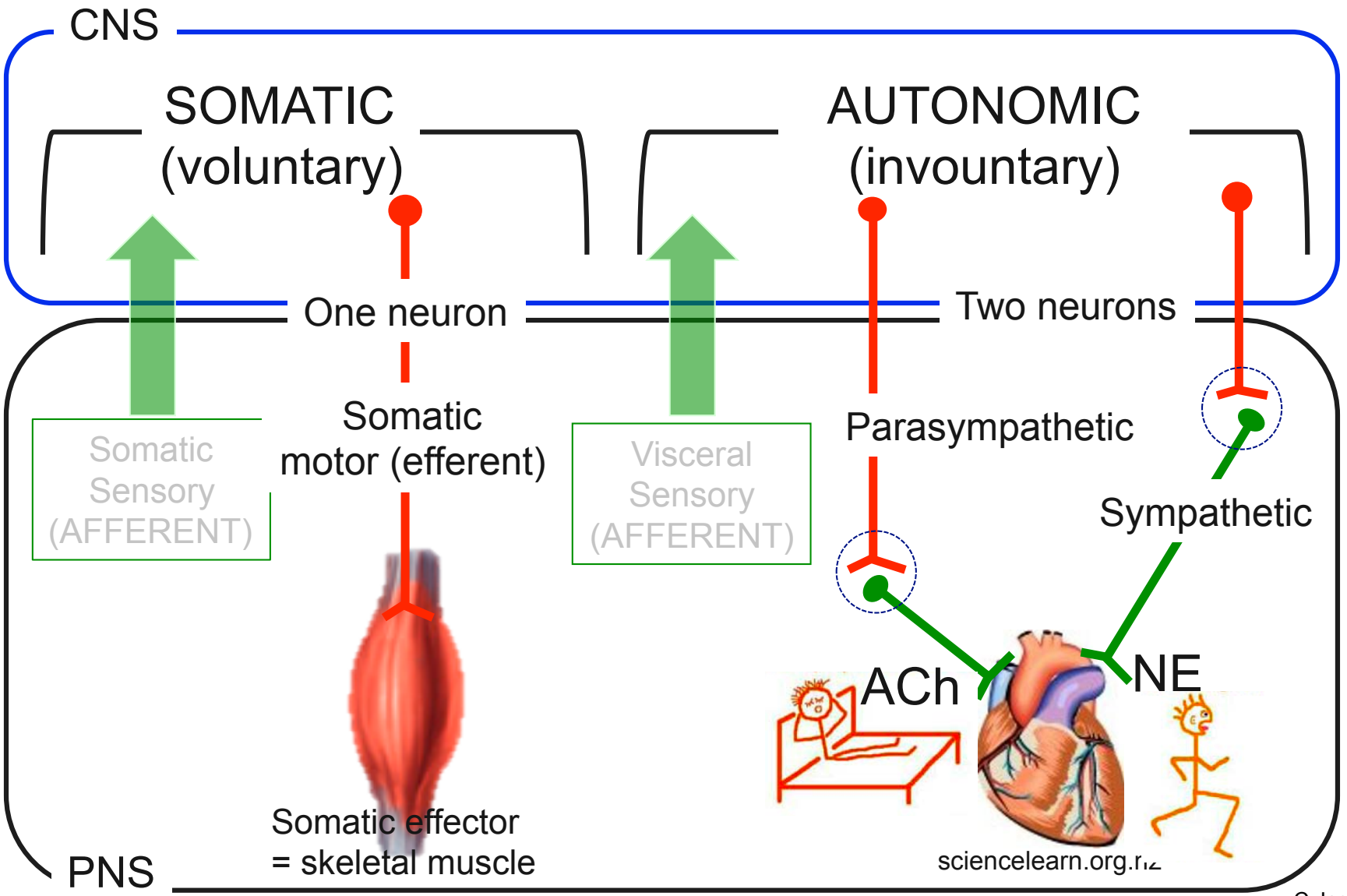
Structural and neurotransmitter differences between sympathetic and parasympathetic nervous systems



Divisions of the nervous system:
II. Autonomic nervous system



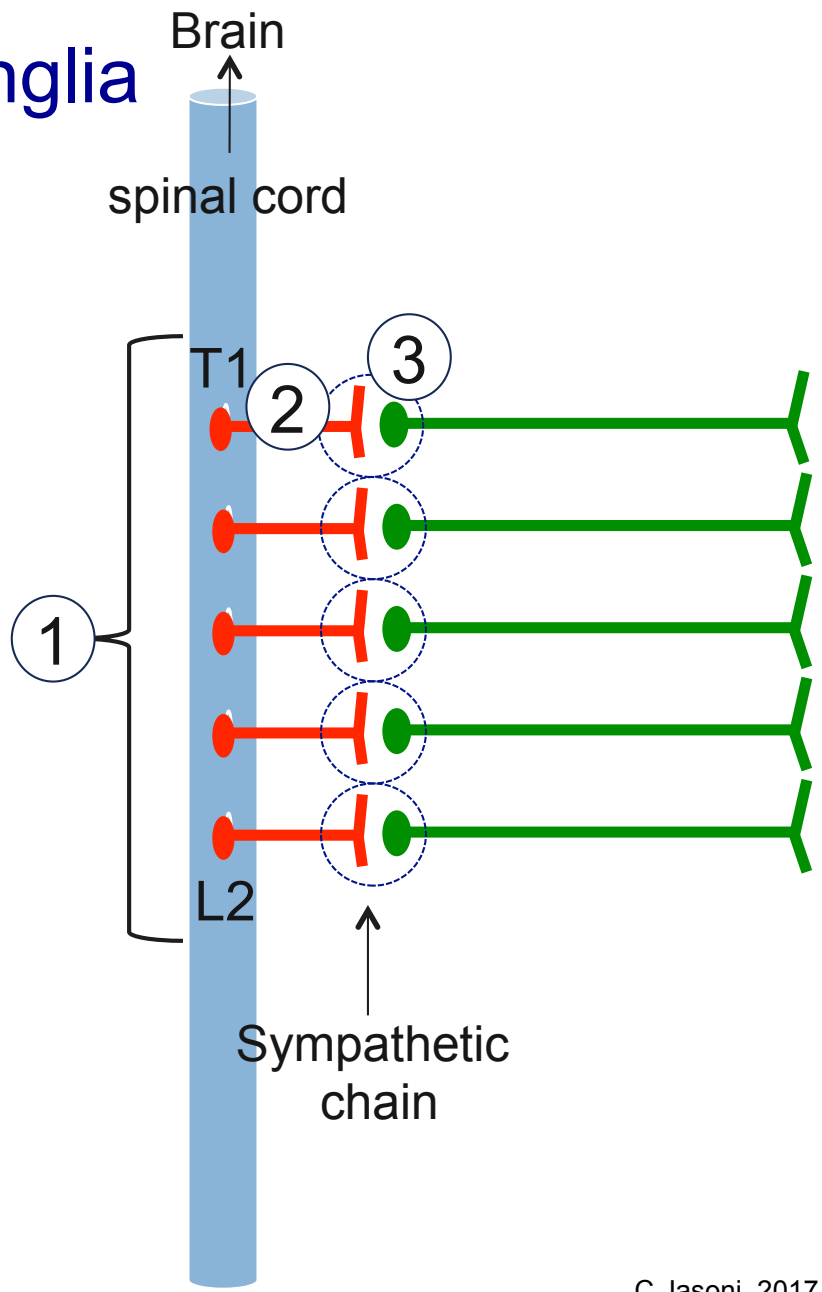
See also: Patton & Thibodeau 8th ed Fig 13-2 (7th ed Fig 12-2)

Sympathetic nervous system: Exit from CNS and position of ganglia

(1) Axon of preganglionic neurons leaves CNS at ***thoracolumbar*** levels (spinal cord)

(2) Axon extends a short distance

(3) Synapse and cell body of post-ganglionic neuron are in ***sympathetic ganglion***

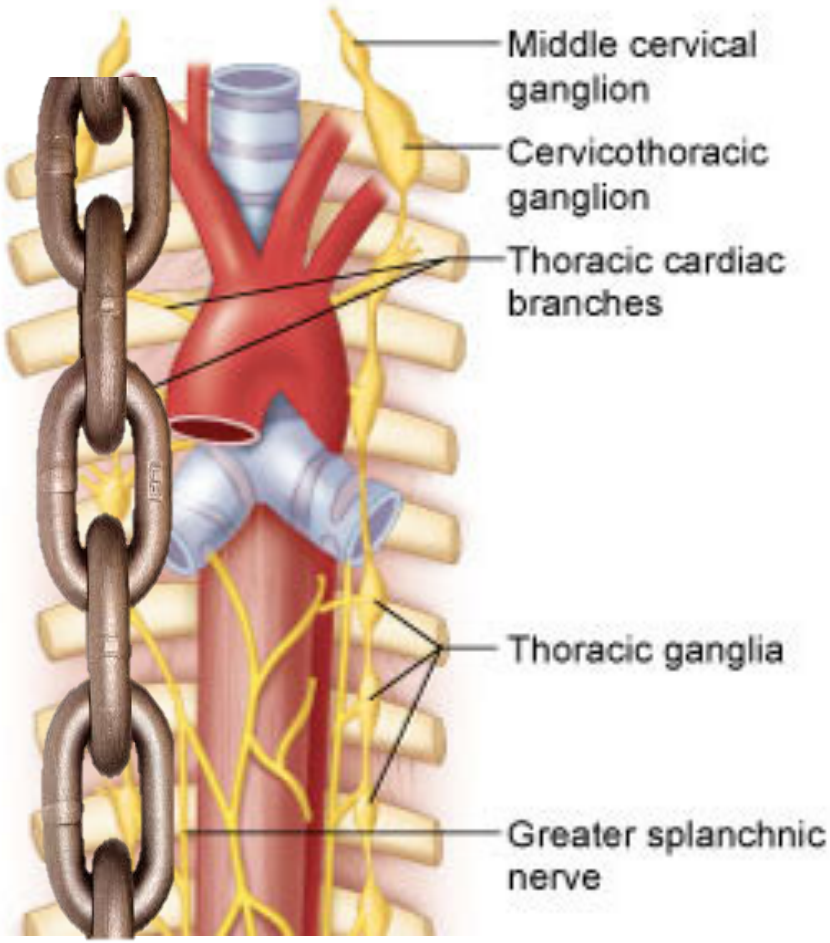


See also: Patton & Thibodeau 8th ed Fig 16-4 (7th ed Fig 14-18)

Sympathetic chain ganglia

- 21-23 pairs
- Alongside vertebral column
- Place where preganglionic (neuron #1) axons *synapse*

→ onto postganglionic (neuron #2) input zone



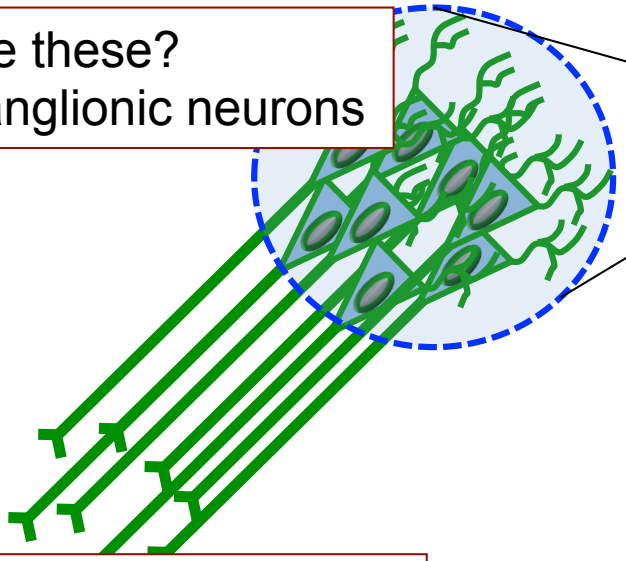
Patton & Thibodeau 8th ed Fig 16-3 (7th ed Fig 14-17)

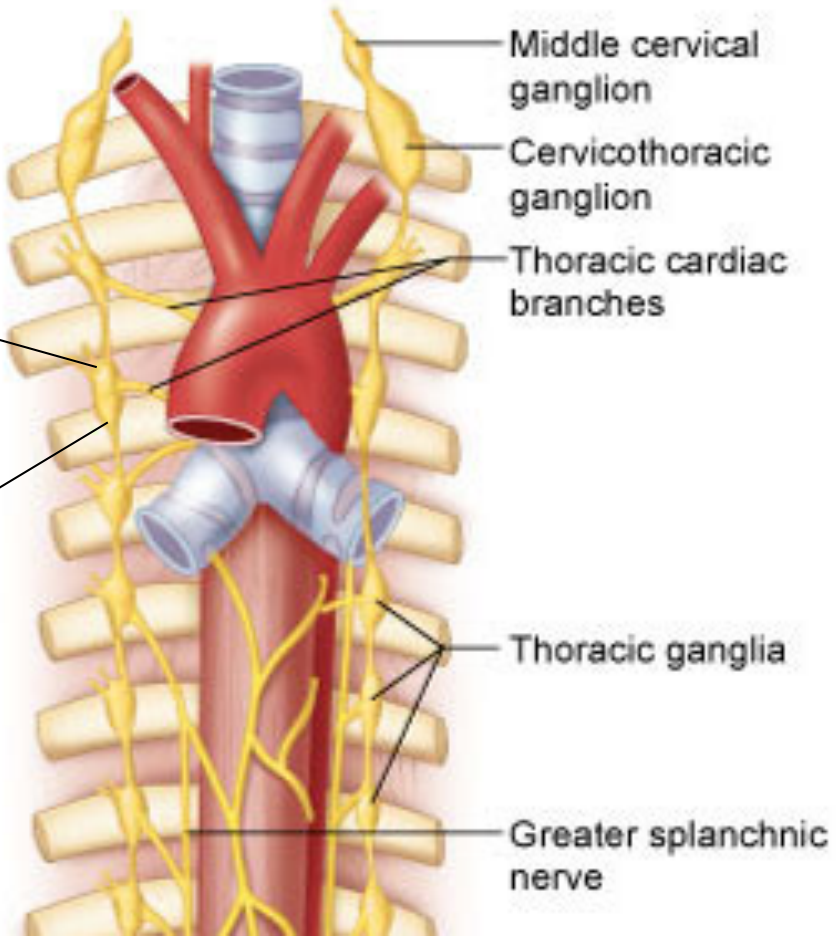
Sympathetic chain ganglia

Sympathetic Ganglion, close to CNS

What cell bodies are these?
_(pre?/post?)__-ganglionic neurons

What neurotransmitter is being used at these axon terminals?





Patton & Thibodeau 8th ed Fig 16-3 (7th ed Fig 14-17)

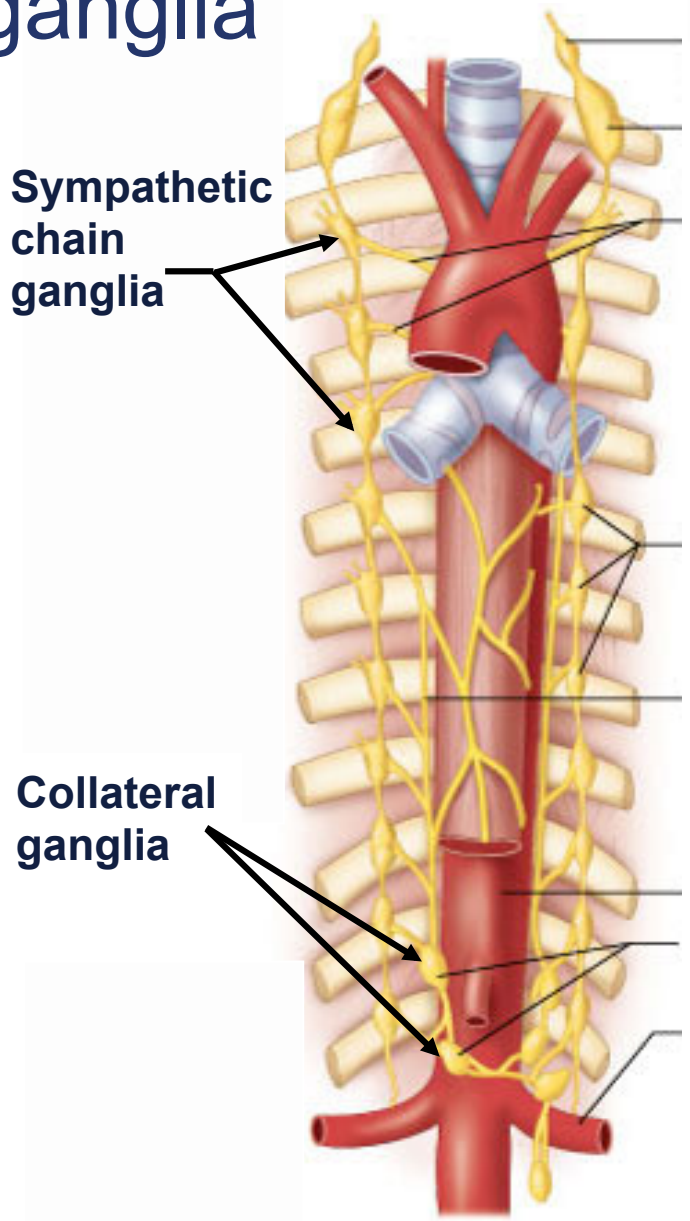
Two types of sympathetic ganglia

CHAIN GANGLIA:

- 21-23 pairs
- Alongside vertebral column
- Place where preganglionic (neuron #1) axons synapse

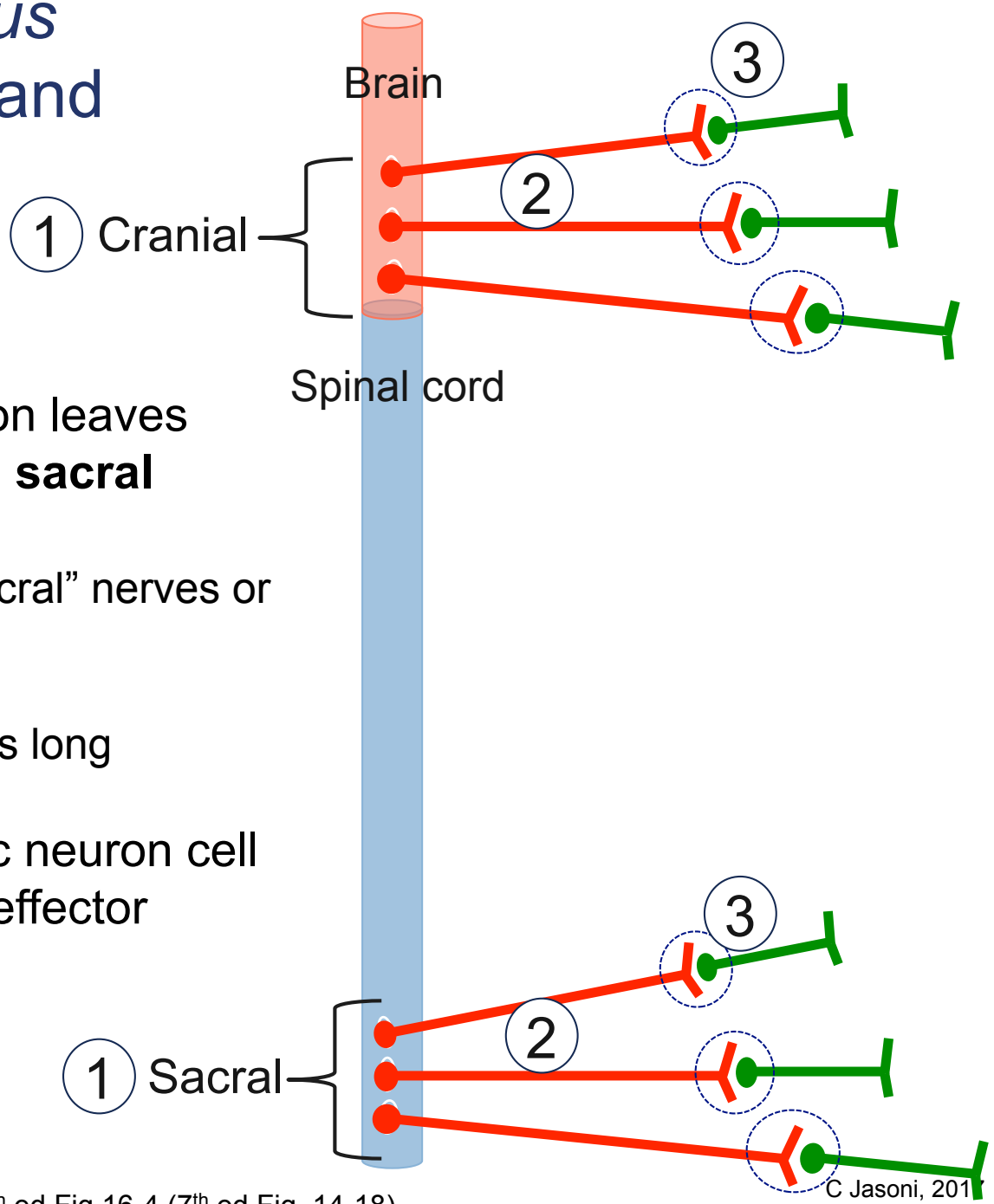
COLLATERAL GANGLIA:

- 3 main collateral ganglia
- Contain preganglionic axons that did not make synapses in chain ganglia



Patton & Thibodeau 8th ed Fig 16-3 (7th ed Fig 14-17)

Parasympathetic nervous system: Exit from CNS and position of ganglia



(1) Axon of preganglionic neuron leaves CNS at **cranial** (brainstem) and **sacral** (spinal cord) levels

- Sometimes called "craniosacral" nerves or nervous system

(2) Axon of preganglionic neurons is long

(3) Synapse and post-ganglionic neuron cell body in ganglion in or near the effector organs

See also: Patton & Thibodeau 8th ed Fig 16-4 (7th ed Fig 14-18)

Summary of sympathetic vs parasympathetic pathways (Table 14-5, P&T)

	Feature	Sympathetic	Parasympathetic
Preganglionic neuron	*Cell body location in CNS:*	-Thoracolumbar: (spinal cord T1 to L2)	-Craniosacral: (brainstem and sacral spinal cord)
	Synapse in:	-Sympathetic chain or collateral ganglion	-Parasymp. ganglion in or near effector
	Length of fibres:	-Relatively short	-Relatively long
	Neurotransmitter:	-Acetylcholine	-Acetylcholine
Postganglionic neuron	*Cell body location:*	-Sympathetic chain or collateral ganglion	-Parasymp. ganglion in or near effector
	Length of fibres:	-Relatively long	-Relatively short
	Neurotransmitter:	-Noradrenaline (most)	-Acetylcholine

Lecture 17: Post-lecture quiz

- What neurotransmitter is used by a somatic efferent neuron?
  (a) Acetylcholine; (b) Norepinephrine; (c) Both; (d) Neither

- Which of the following is true about the sympathetic chain ganglia.

(a) The preganglionic neurons are unmyelinated;

(b) They contain the axons of postganglionic neurons

(c) They contain cell bodies that utilise norepinephrine

(d) They contain cell bodies that give rise to myelinated axons

- If you were told that your craniosacral nervous system were activated, does that mean that you are: (a) relaxed; (b) thoughtful; (c) hyperactive; (d) sympathetic

- Which statement is true of a post-ganglionic parasympathetic neuron

(a) It is myelinated; (b) It receives input from an unmyelinated axon; (c) Its cell body resides distant from the CNS; (d) Its cell body can be found in the collateral ganglion

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