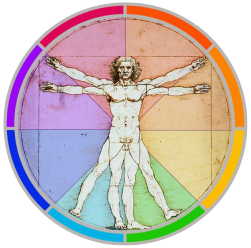
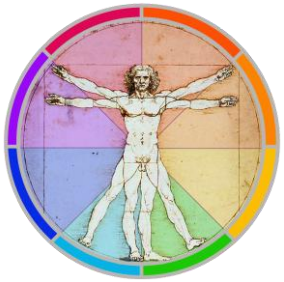
HUBS191 Lecture Material

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.

University of Otago
ŌTĀKOU WHAKAIHU WAKA



HUBS 191

Human Movement and Sensation

Theme 2: Integrating and coordinating roles of the nervous system

Lecture 17: Functional Information Flow

Dr. Rob Munn, Director of Neuroscience
Department of Anatomy

Lecture 16: Post-lecture quiz

1. The myelin sheath in the CNS is made by:
   (A) Schwann cells (B) Oligodendrocytes
   (C) Astrocytes (D) Ependymal cells

1. The part of neurotransmission that is carried out through a chemical signal is called:
   (A) Synapse (B) Node (C) Ganglion (D) Action potential

2. Information that travels into the CNS is called:
   (A) Efferent (B) Afferent (C) Ascending
   (D) Descending (E) A & C (F) B & C

3. The part of a neuron that makes the decision about whether to propagate an action potential in response to inputs is called:
   (A) Axon hillock (B) Node of Ranvier
   (C) Axon terminal (D) Synapse

Lecture 17: Learning objectives

After reviewing and studying this lecture, you should understand and be able to describe:

1. The types of information transmitted in the nervous system and how the nervous system is divided based on these

2. The anatomical organisation of the somatic efferent division of the nervous system

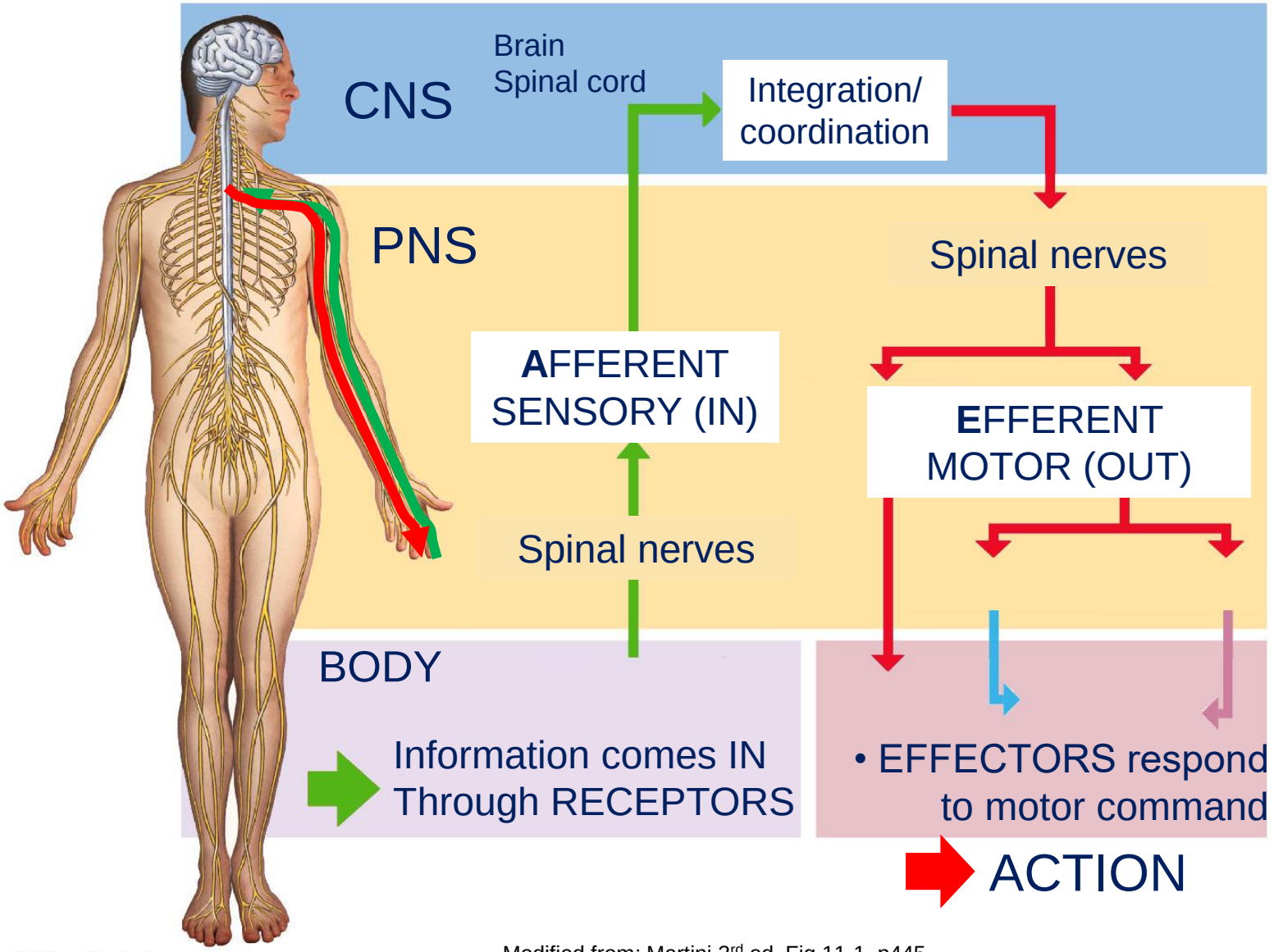
3. How somatic efferent neurons communicate with effector cells

4. The anatomical organisation of the autonomic nervous system

5. How autonomic neurons communicate with effector cells

6. The anatomical and functional differences between the sympathetic and parasympathetic divisions of the autonomic nervous system

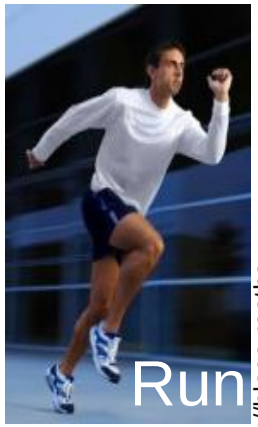
Divisions of the nervous system:
I. Based on direction of information flow



Modified from: Martini 3rd ed, Fig 11-1, p445

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/

See

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)

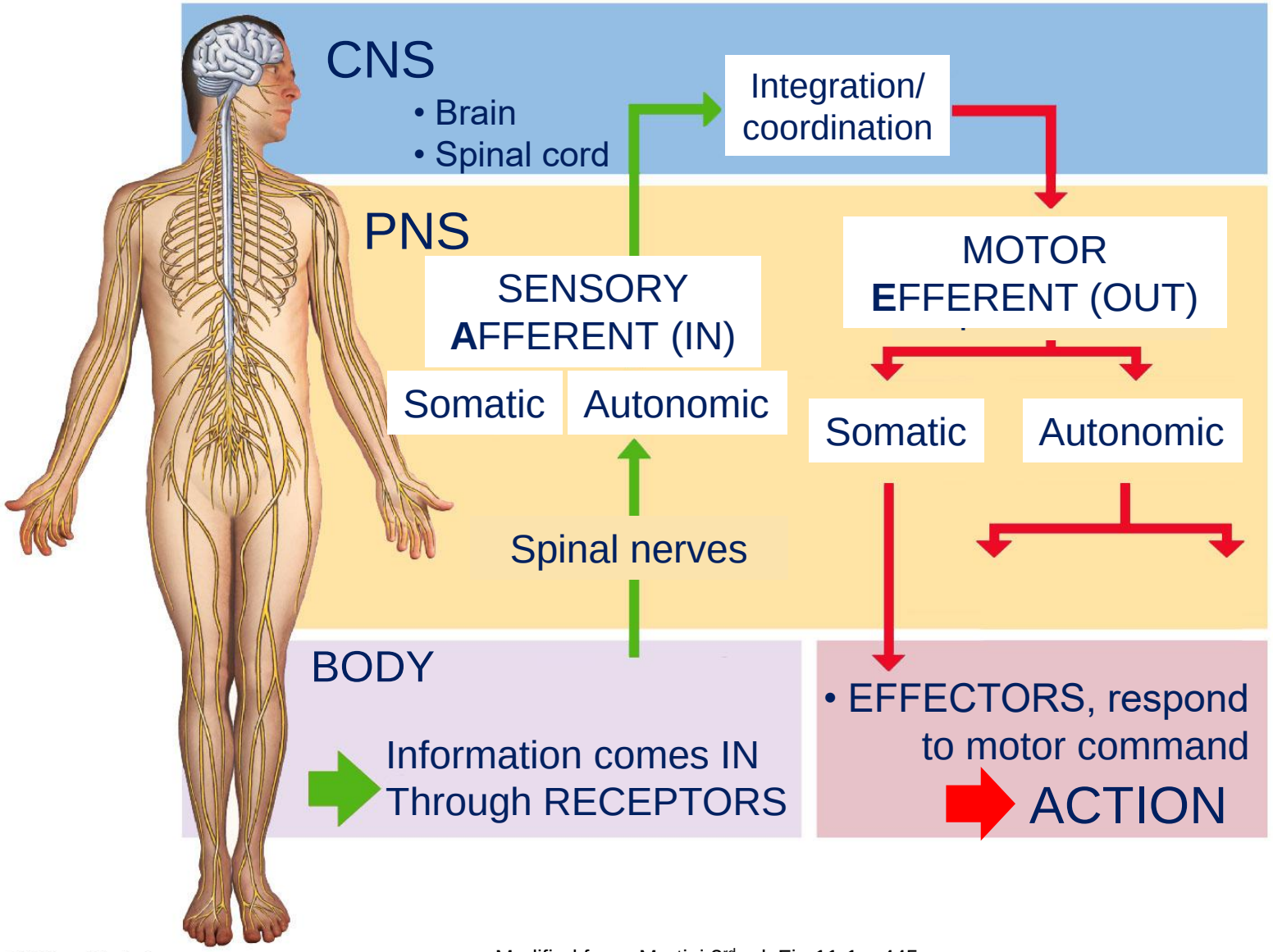
Heartbeat

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

Blood pressure

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

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



Modified from: Martini 3rd ed, Fig 11-1, p445

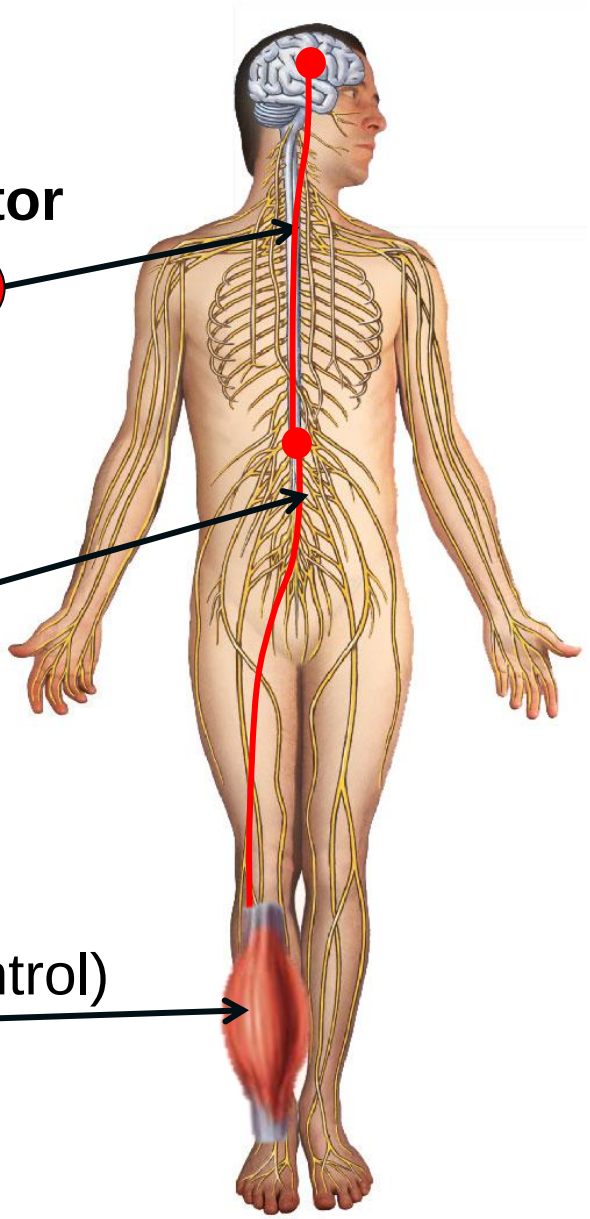
Somatic Efferent Division

Two neurons between brain and effector

1. *Upper motor neuron*
   - Cell body in brain,
   - Axon in spinal cord

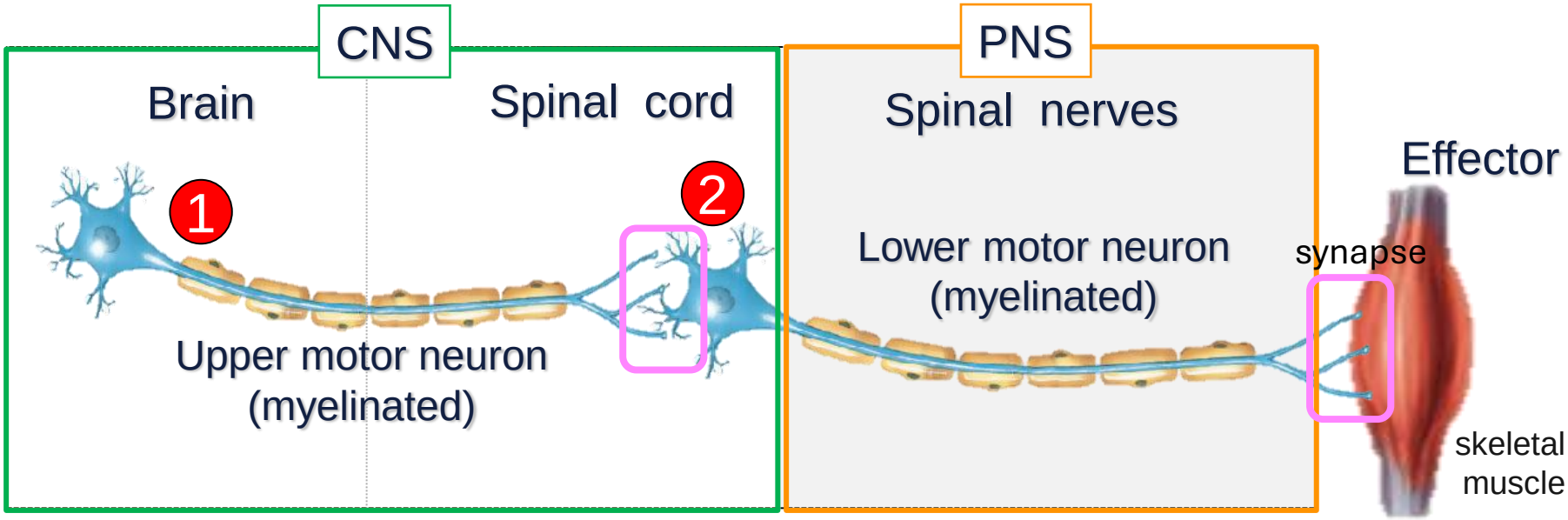
2. *Lower motor neuron*
   - Cell body in spinal cord,
   - Axon in spinal nerve

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



Modified from: Martini

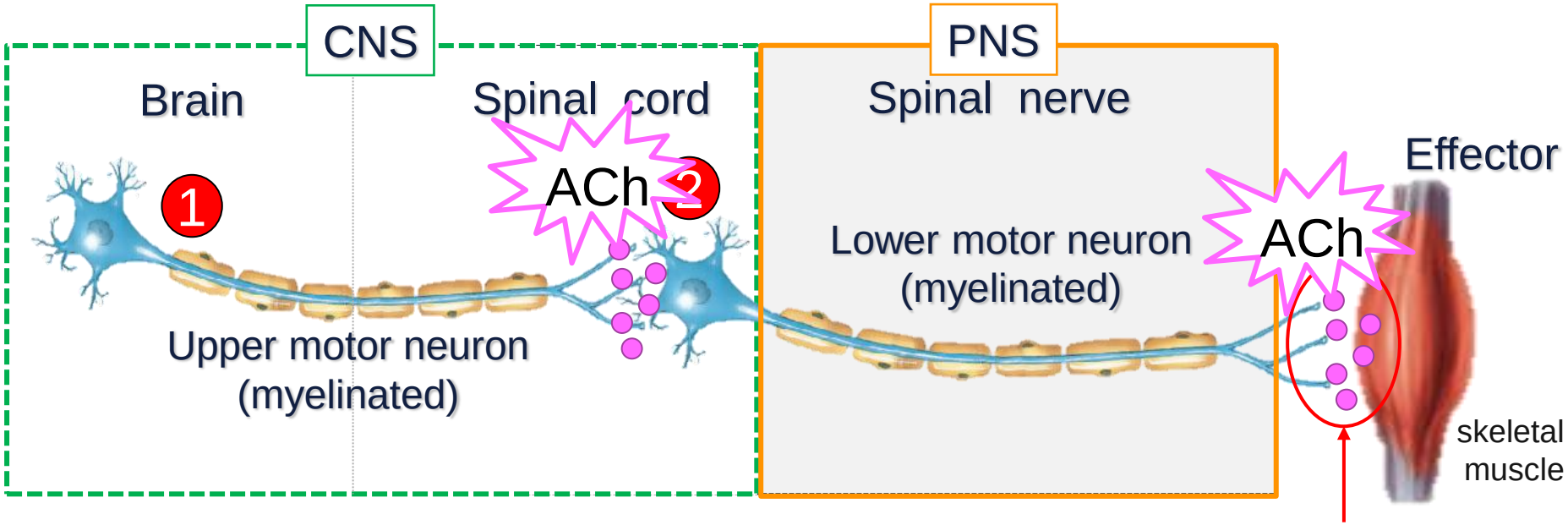
Somatic Efferent: Anatomical Organisation



1. *Upper motor neuron* = Cell body in brain, axon in spinal cord
   - Axon is myelinated.

2. *Lower motor neuron* = Cell body in spinal cord, axon in spinal nerve
   - Axon is myelinated

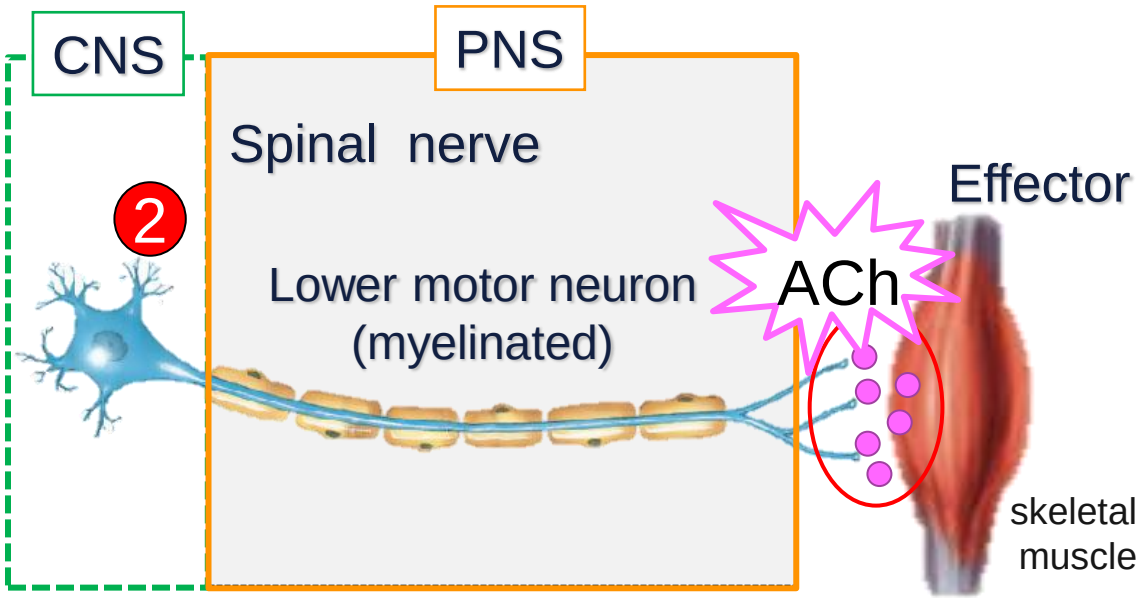
Somatic Efferent: Communication with Effector cells



- Synaptic cleft

- Neurotransmitter = Acetylcholine (Ach)

Somatic Efferent: Communication with Effector cells



PRE-synaptic cell
(lower motor neuron)

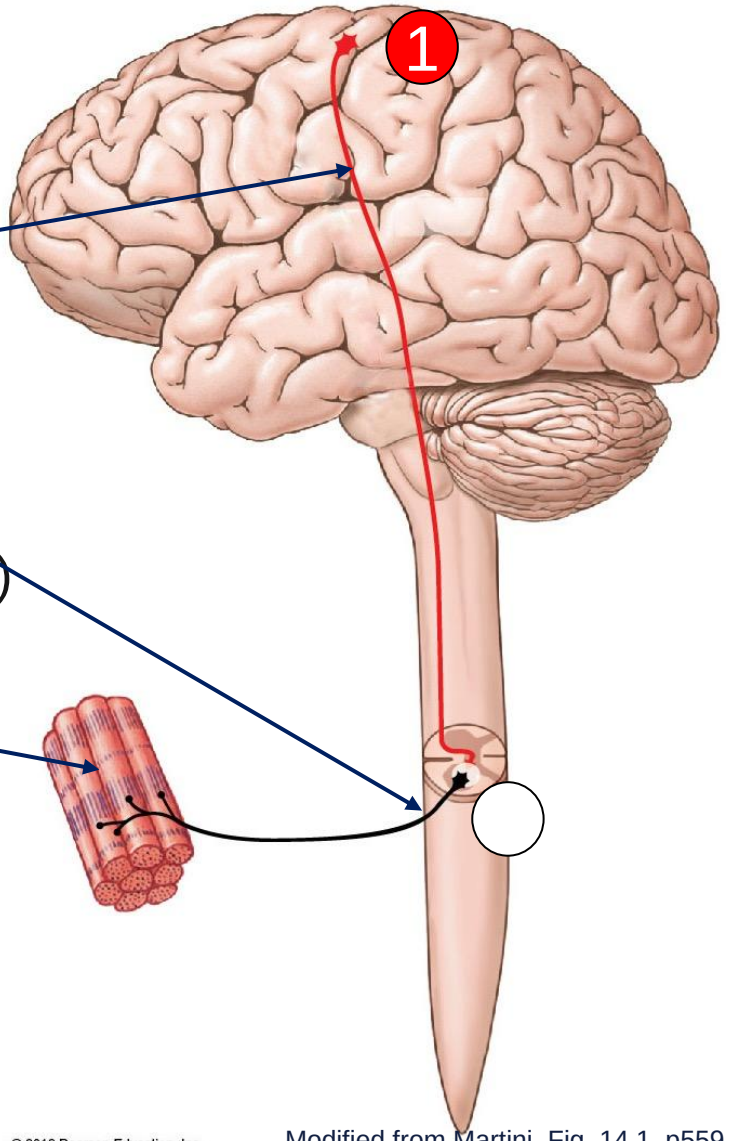
POST-synaptic cell
(effector, muscle)

REVIEW &
INTEGRATION

Neuro- muscular junction

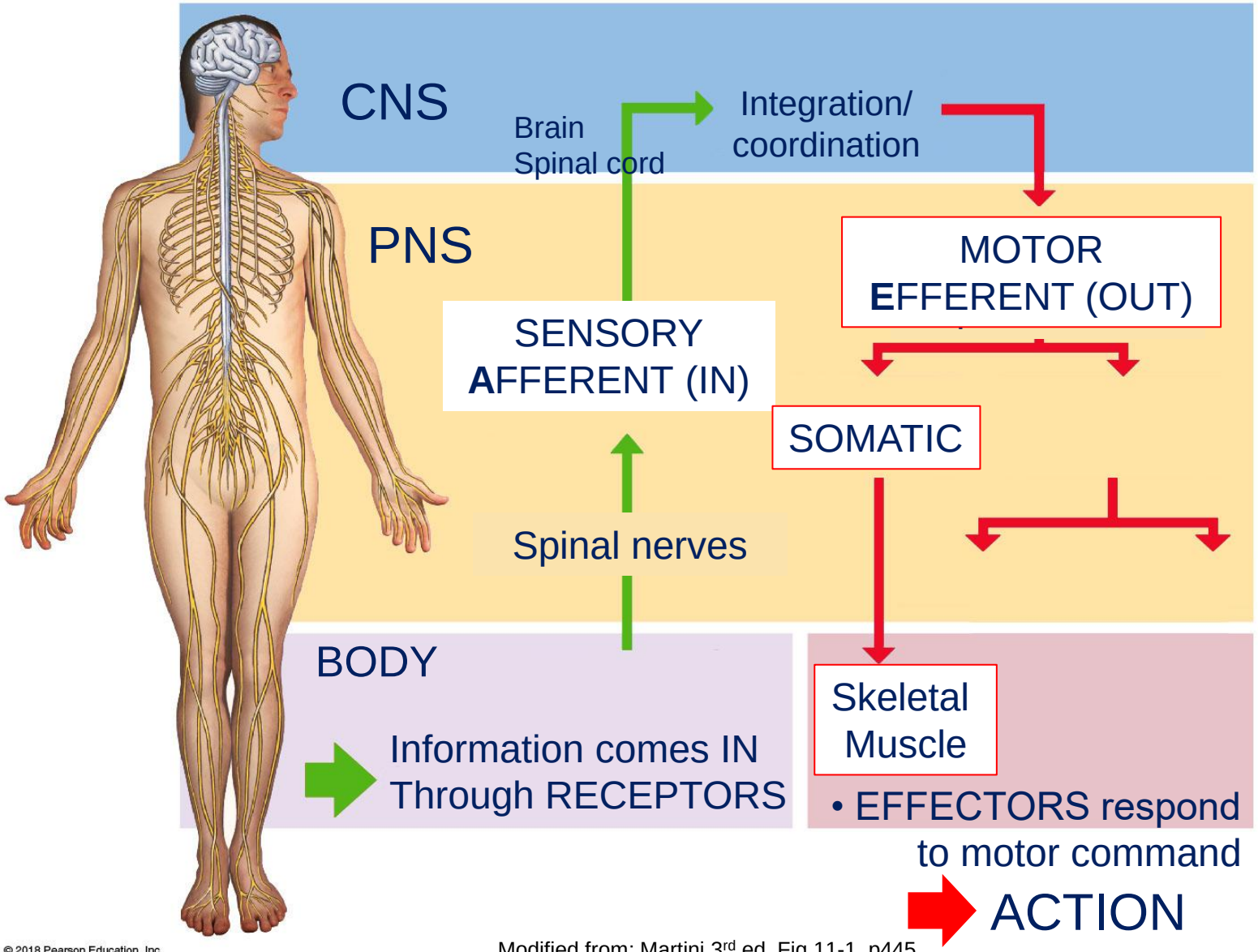
Summary: Somatic Efferent division

- Voluntary movement
- Two neurons between brain & effector
  1. UPPER motor neuron
  2. LOWER motor neuron
- Axons are myelinated
- Neurotransmitter = Acetylcholine (ACh)
- Effector = skeletal muscle



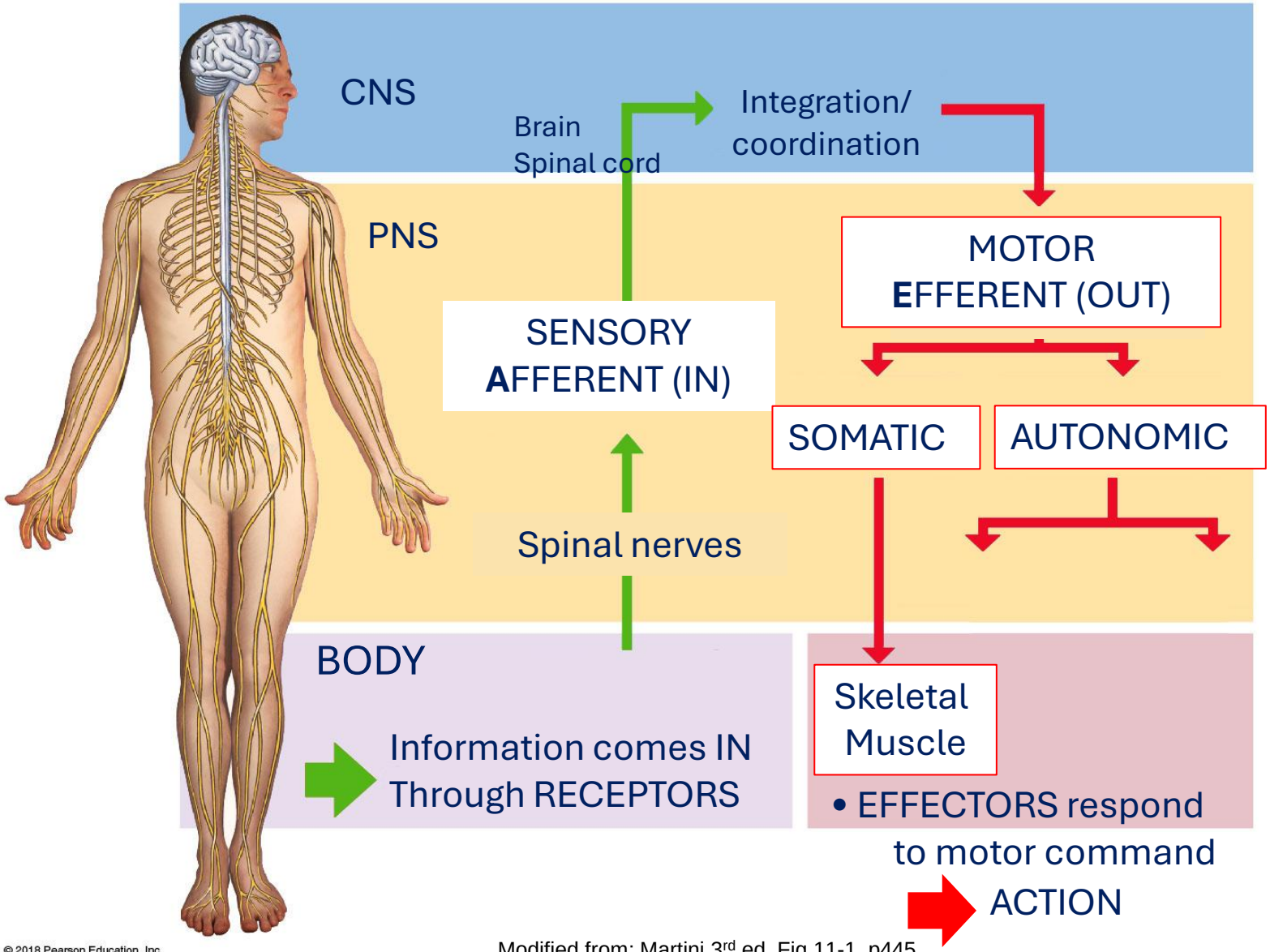
Modified from Martini, Fig. 14.1, p559

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



Modified from: Martini 3rd ed, Fig 11-1, p445

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



Modified from: Martini 3rd ed, Fig 11-1, p445

Autonomic Efferent Nervous System

- Involuntary control
- Two divisions
  - Sympathetic
  - Parasympathetic
- Effectors

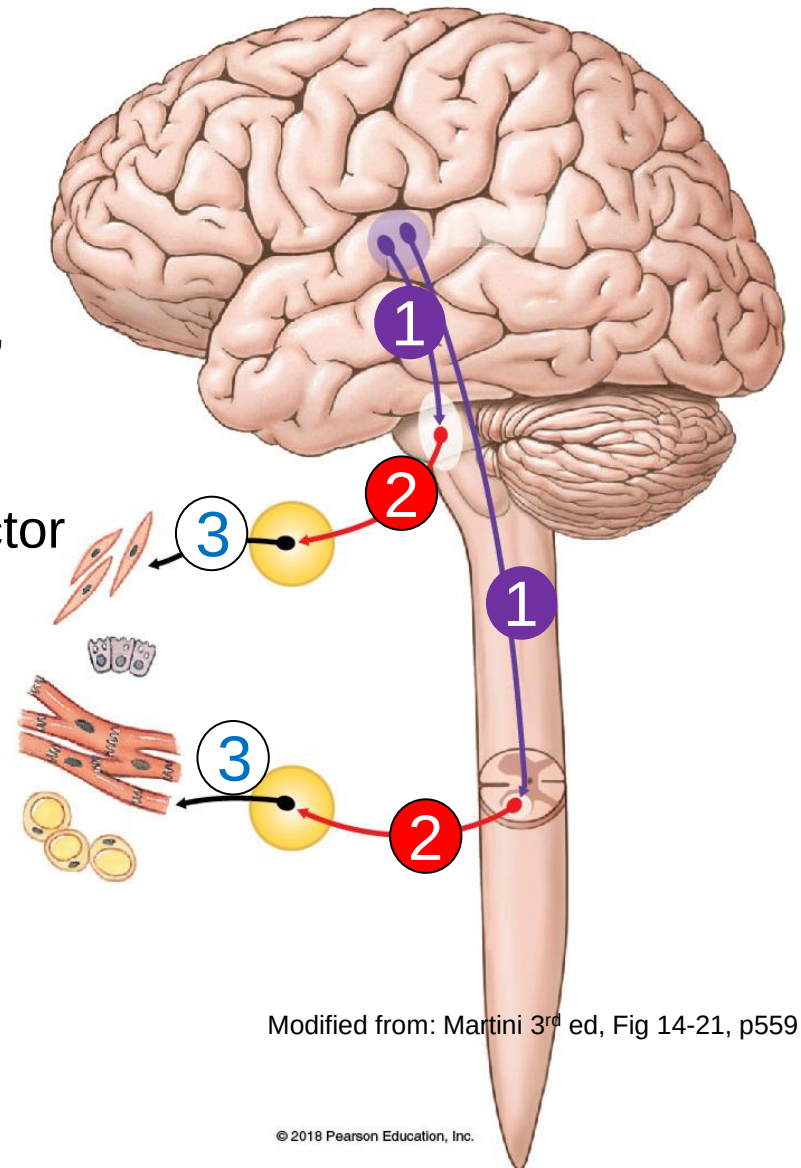
  i) smooth muscle, ii) cardiac muscle,
  iii) glands, iv) adipose (fat) tissue

- *Three* neurons between brain and effector

  Neuron #1
  - Cell body in brain
  - Axon in brain or spinal cord (CNS)

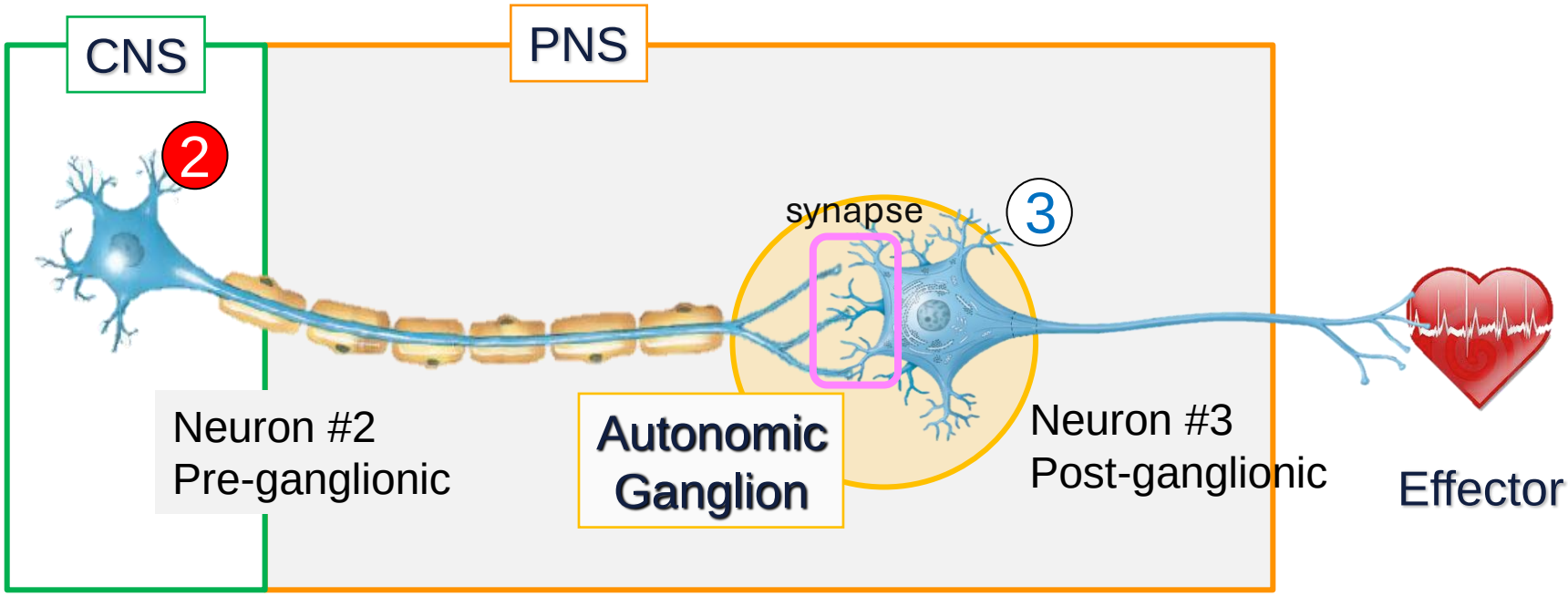
  Neuron #2
  - Cell body in brain or spinal cord (CNS)
  - Axon in PNS

  Neuron #3
  - Cell body in PNS
  - Axon in PNS



Modified from: Martini 3rd ed, Fig 14-21, p559

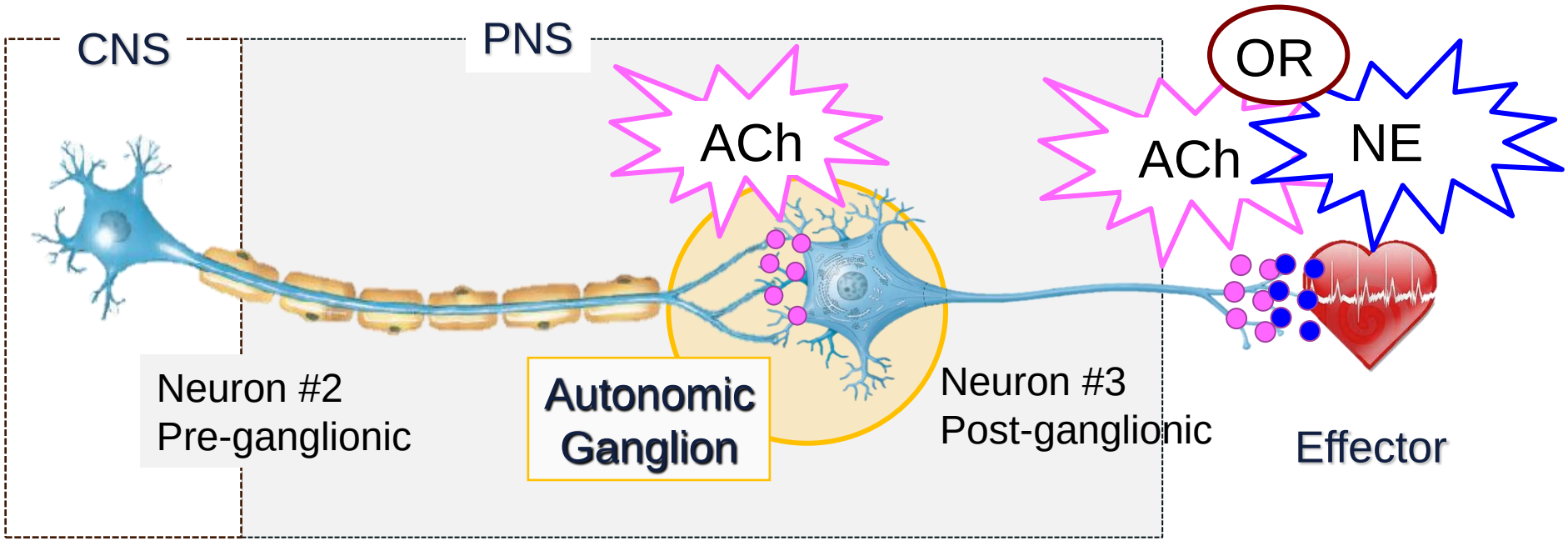
Autonomic nervous system: Basic anatomical features (Neurons 2 & 3)



Neuron #2:
- Cell body in CNS
- Axon extends in PNS
- Myelinated
- Synapse in Autonomic Ganglion
- Pre-ganglionic neuron

Neuron #3:
- Cell body in PNS, autonomic ganglion
- Axon extends in PNS, to effector organ
- Unmyelinated
- Synapse on effector organ
- Post-ganglionic neuron

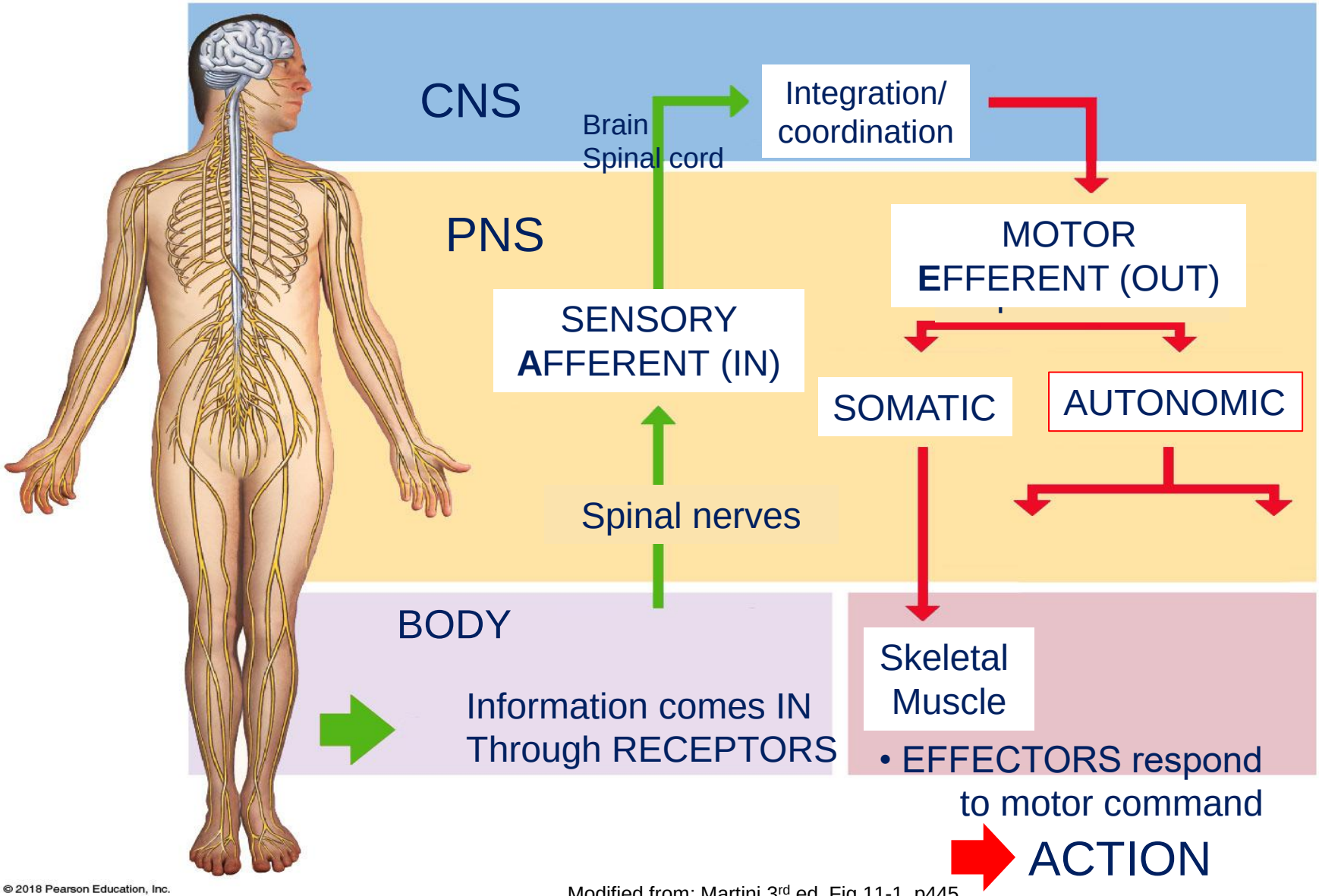
Autonomic nervous system: Synaptic Neurotransmitters (Neurons 2 & 3)



Neuron #2:
- Cell body in CNS
- Axon extends in PNS
- Myelinated
- Synapse in Autonomic Ganglion
- Pre-ganglionic neuron
- Neurotransmitter = acetylcholine (ACh)

Neuron #3:
- Cell body in PNS, autonomic ganglion
- Axon extends in PNS, to effector organ
- Unmyelinated
- Synapse on effector organ
- Post-ganglionic neuron
- Neurotransmitter = ACh or norepinephrine

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



Modified from: Martini 3rd ed, Fig 11-1, p445

Subdivisions of the autonomic nervous system

NE

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

ACh

PARASYMPATHETIC

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

Or, in meme format...

SYMPATHETIC

PARASYMPATHETIC

Subdivisions of the autonomic nervous system

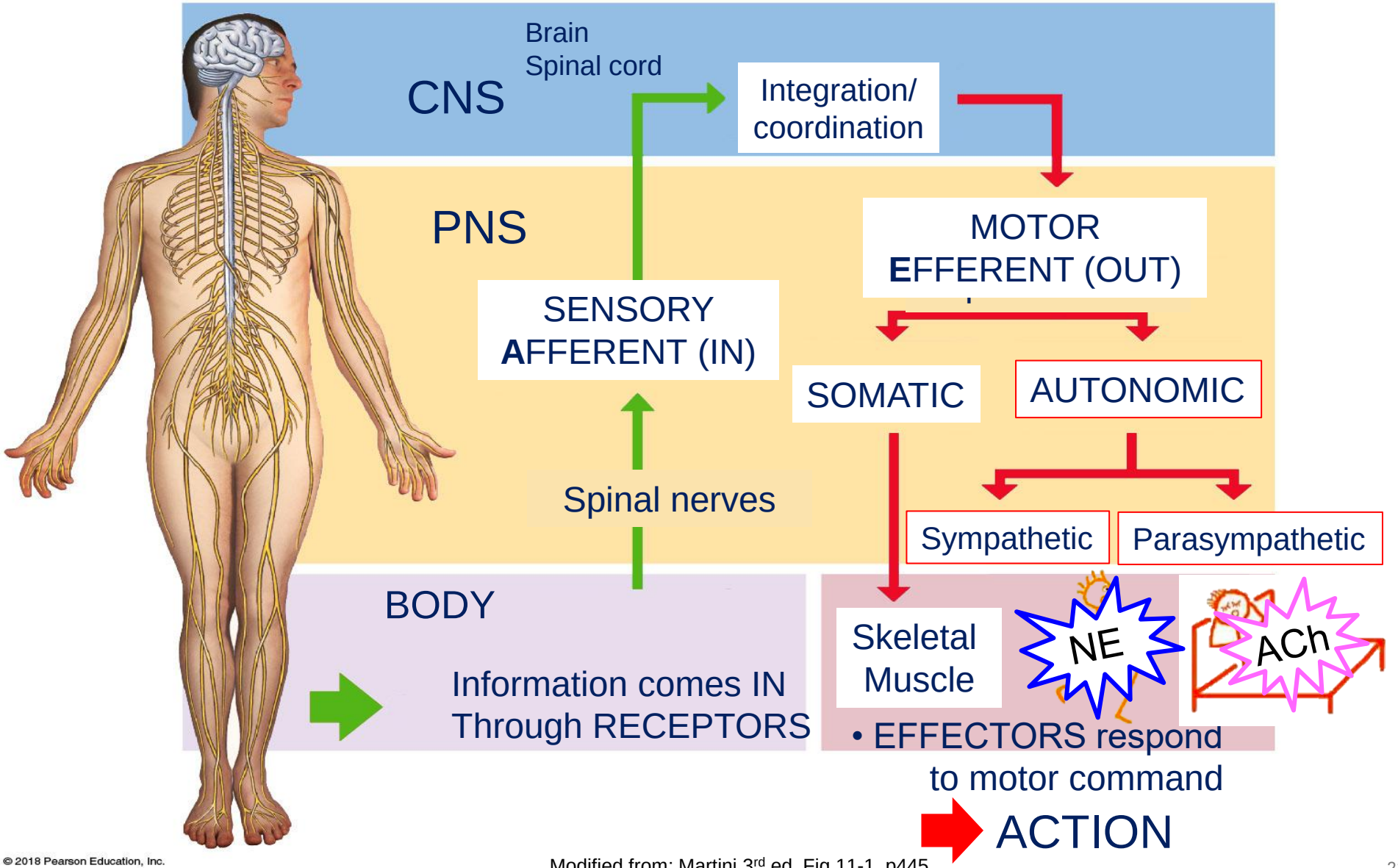
SYMPATHETIC

Python (monty) Pictures Limited

PARASYMPATHETIC

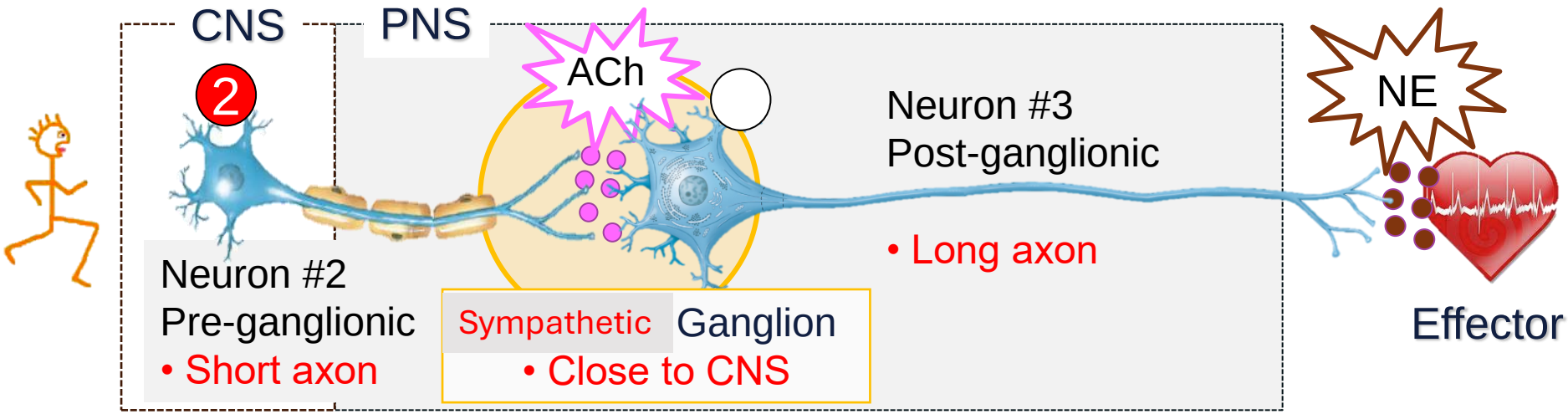
Muppets Studio (Disney)

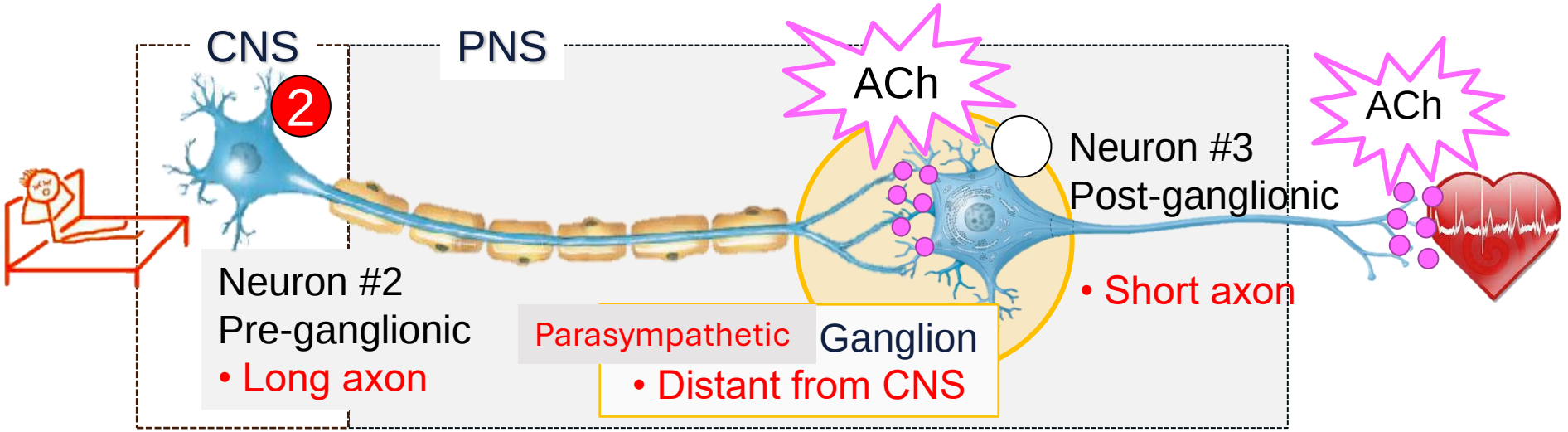
Divisions of the nervous system:
II. Based on type of information transmitted



Modified from: Martini 3rd ed, Fig 11-1, p445

Structural differences between sympathetic and parasympathetic nervous systems (neurons #2 and #3 only)





Sympathetic nervous system: Exit from CNS and position of ganglia

Preganglionic neuron

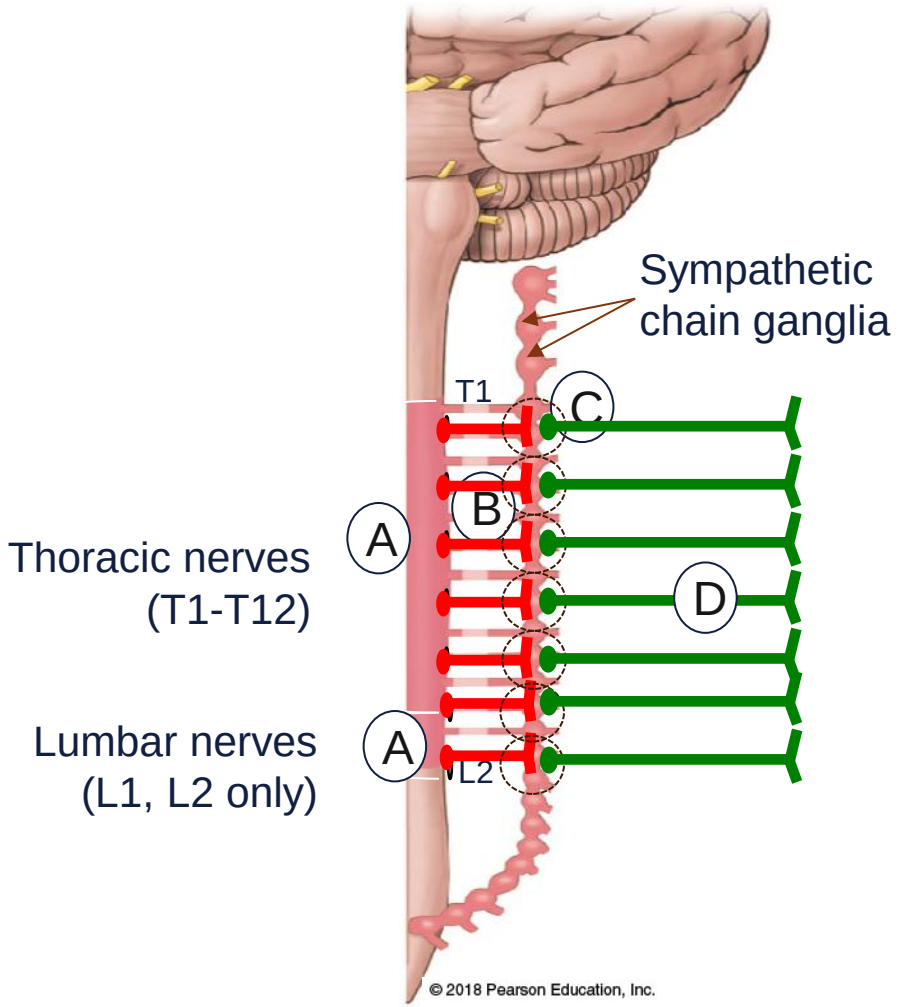
(A) Cell body in thoracolumbar levels of spinal cord (CNS)

(B) Axon is **short**

(C) Axon terminals and synapse in sympathetic ganglion

Post-ganglionic neuron

(D) Axon is **long**

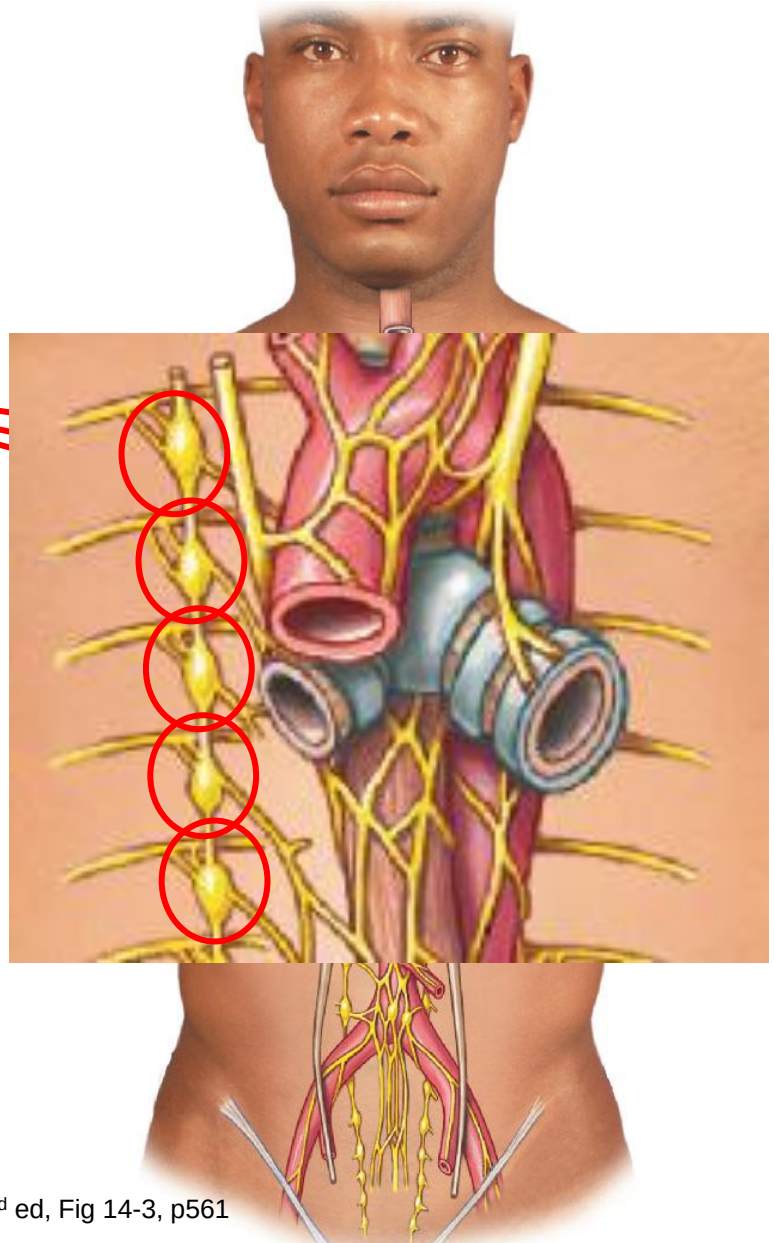


Modified from: Martini 3rd ed, Fig 14-2, p560

Sympathetic chain ganglia

- On either side of the vertebral column
- 21-23 pairs (usually 22)
- Place where preganglionic (neuron #2) axons *synapse*

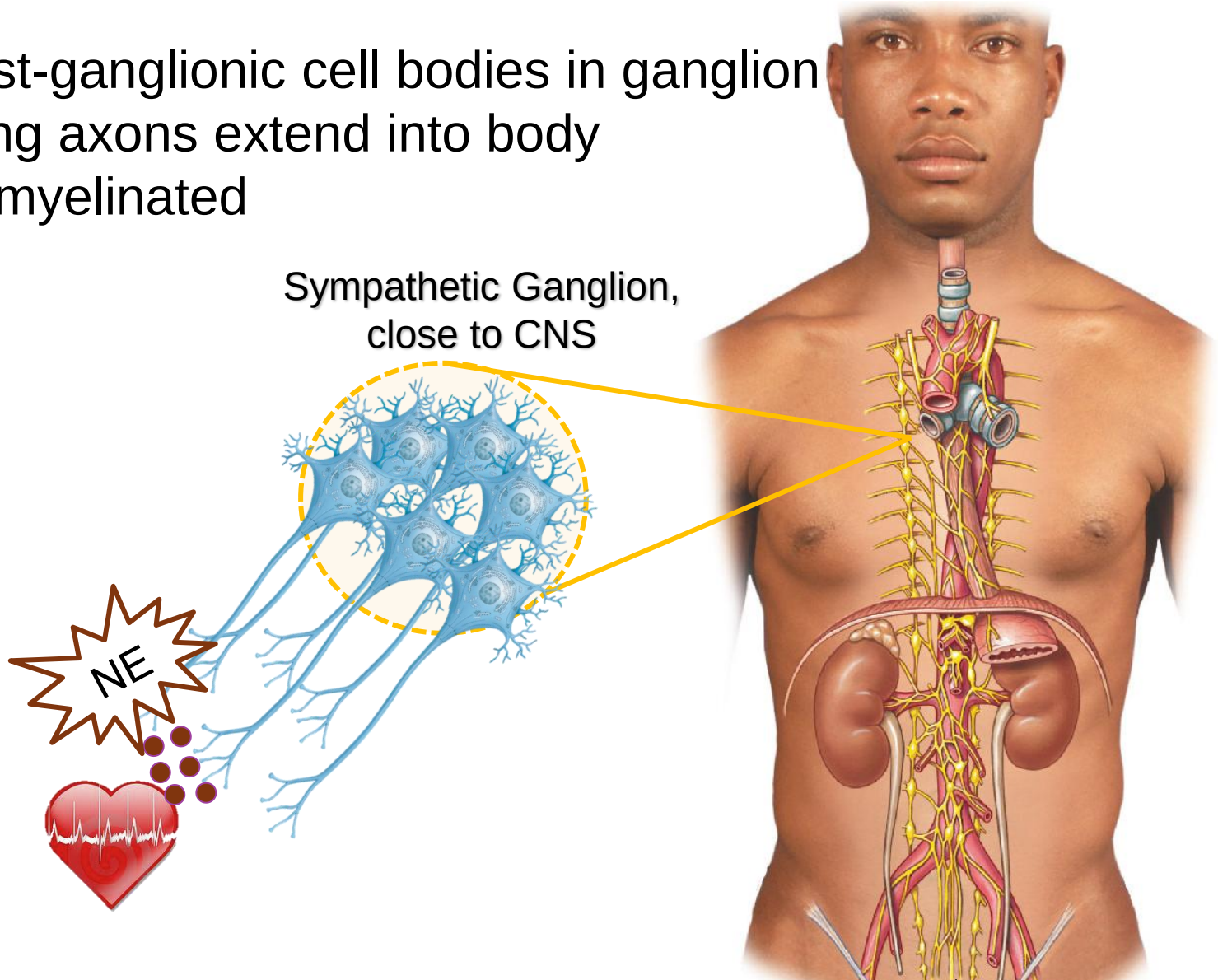
→ onto postganglionic (neuron #3) input zone



Modified from: Martini 3rd ed, Fig 14-3, p561

Sympathetic chain ganglia

1. Post-ganglionic cell bodies in ganglion
2. Long axons extend into body
3. Unmyelinated



Modified from: Martini 3rd ed, Fig 14-3, p561

Parasympathetic nervous system: Exit from CNS and position of ganglia

Preganglionic neuron

(A) Cell bodies in **cranial** (brainstem) and **sacral** (spinal cord) levels

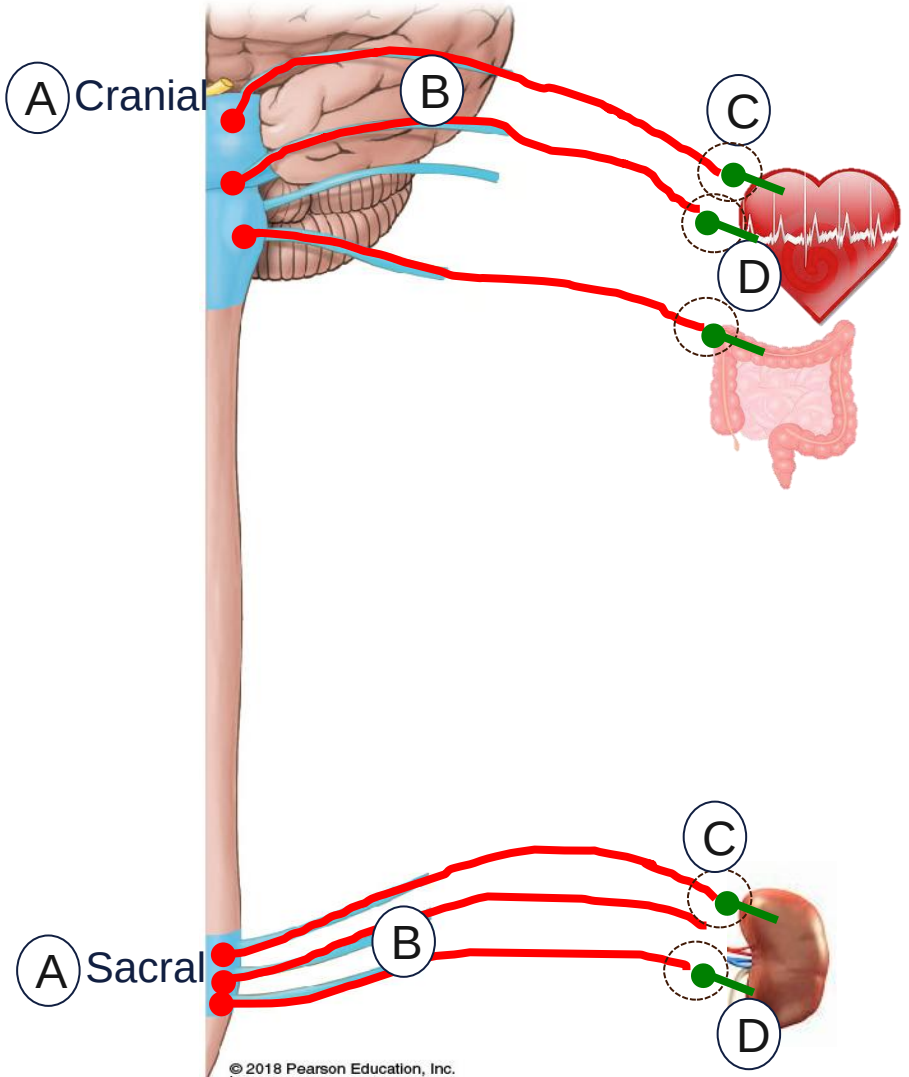
(B) Axon is **long**

(C) Axon terminals and synapse in parasympathetic ganglia (in or near effector)

Postganglionic neuron

(C) Cell body in parasympathetic ganglia in or near the effector organs

(D) Axon is **short**



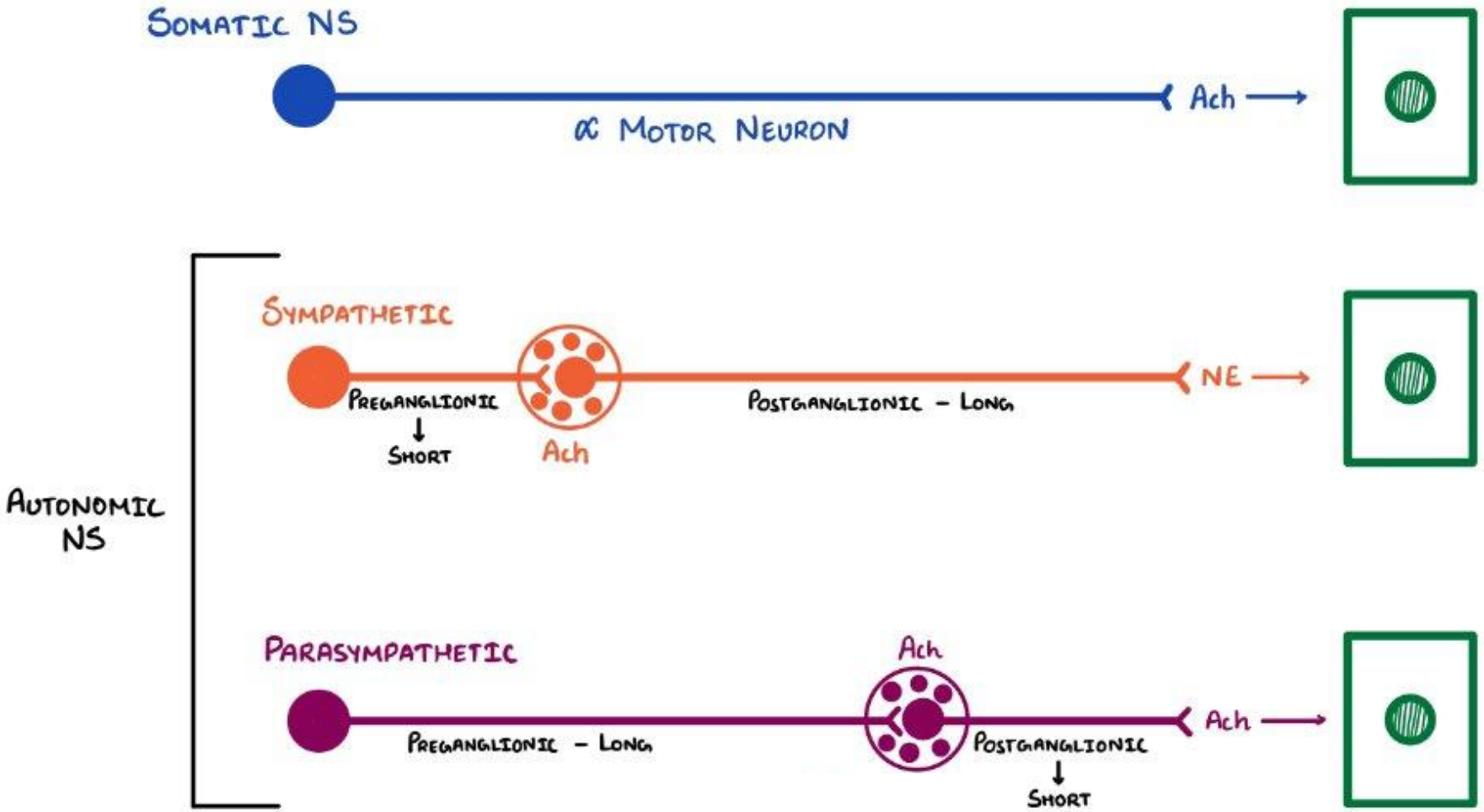
Modified from: Martini 3rd ed, Fig 14-2, p560

Summary of sympathetic vs parasympathetic pathways

	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

See also Martini p566, 567, tables 2 and 3.

… And a helpful diagram!



Some Helpful Mnemonics!

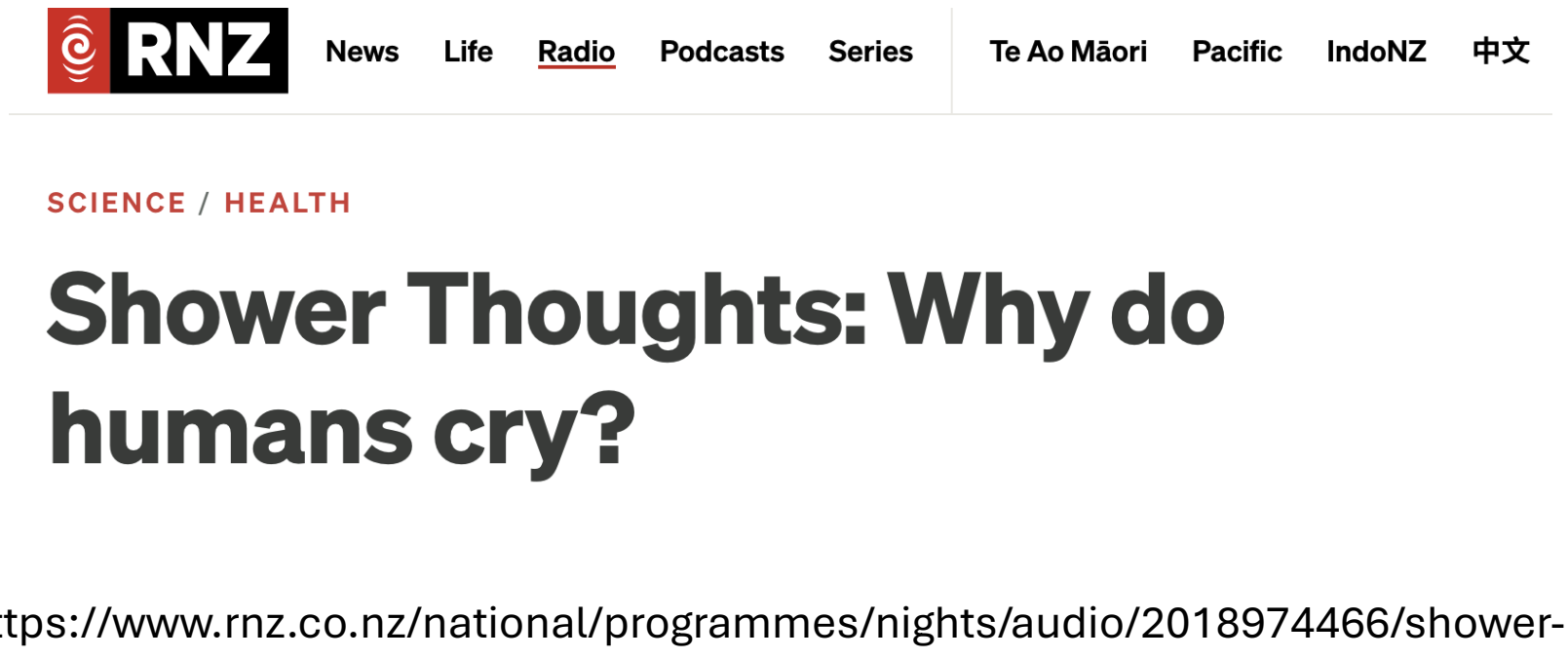
Steve **A**lways **T**alks **L**oudly, **C**hild

Sympathetic, **A**ctivating, exits from CNS are **T**horacic and **L**umbar, Ganglion is **C**lose to CNS

Pete **D**oesn't **C**all **S**undays, **F**rustratingly

Parasympathetic, **D**eactivating, exits from CNS are **C**ranial and **S**acral, Ganglion is **F**ar from CNS

If you’re interested in hearing more from me about the (para)sympathetic nervous system..



https://www.rnz.co.nz/national/programmes/nights/audio/2018974466/shower-thoughts-why-do-humans-cry

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

HUBS191