INTRODUCTION TO ANS

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Autonomic Nervous System (ANS)

- The ANS consists of motor neurons that:
  - Innervate smooth and cardiac muscle and glands
  - Make adjustments to ensure optimal support for body activities
  - Operate via subconscious control
  - Have viscera as most of their effectors

ANS Versus Somatic Nervous System (SNS)

- The ANS differs from the SNS in the following three areas
  - Effectors
  - Efferent pathways
  - Target organ responses

Effectors

- The effectors of the SNS are skeletal muscles
- The effectors of the ANS are cardiac muscle, smooth muscle, and glands

Efferent Pathways

- Heavily myelinated axons of the somatic motor neurons extend from the CNS to the effector
- Axons of the ANS are a two-neuron chain
  - The *preganglionic neuron* has a lightly myelinated axon
  - The *postganglionic neuron* extends to an effector organ
  - The pre- and postganglionic neurons synapse IN a ganglion

Neurotransmitter Effects

- All somatic motor neurons release Acetylcholine (ACh), which has an excitatory effect
- In the ANS:
  - All preganglionic fibers release ACh
  - Postganglionic fibers release
    - Norepinephrine (sympathetic postganglionic)
    - ACh (parasympathetic postganglionic)
  - ANS effect on the target organ is dependent upon
    - The neurotransmitter released
    - The receptor type of the effector (more important)

Comparison of Somatic and Autonomic Systems

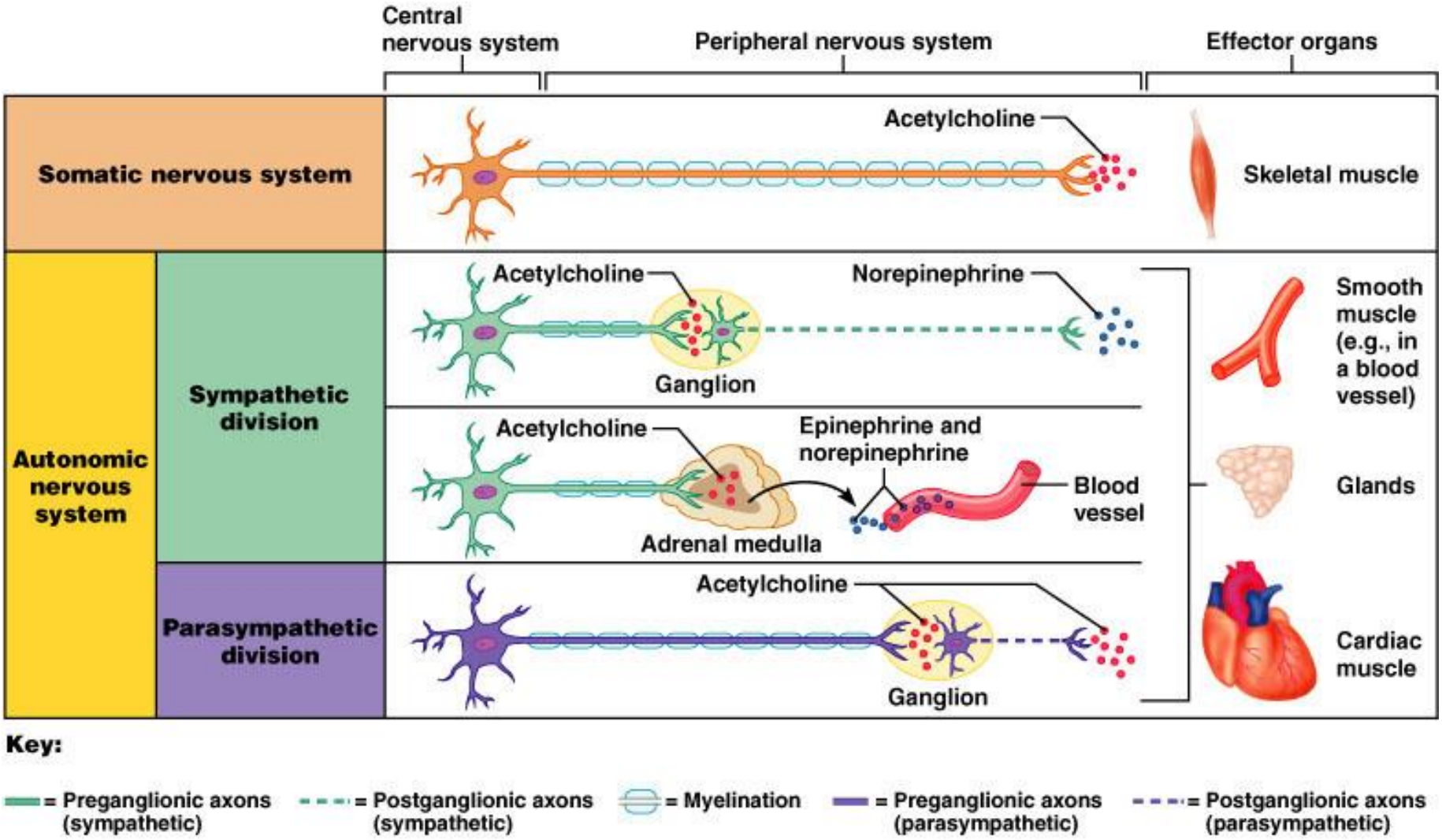


Figure 14.2

Somatic and Autonomic Nervous Systems

Somatic

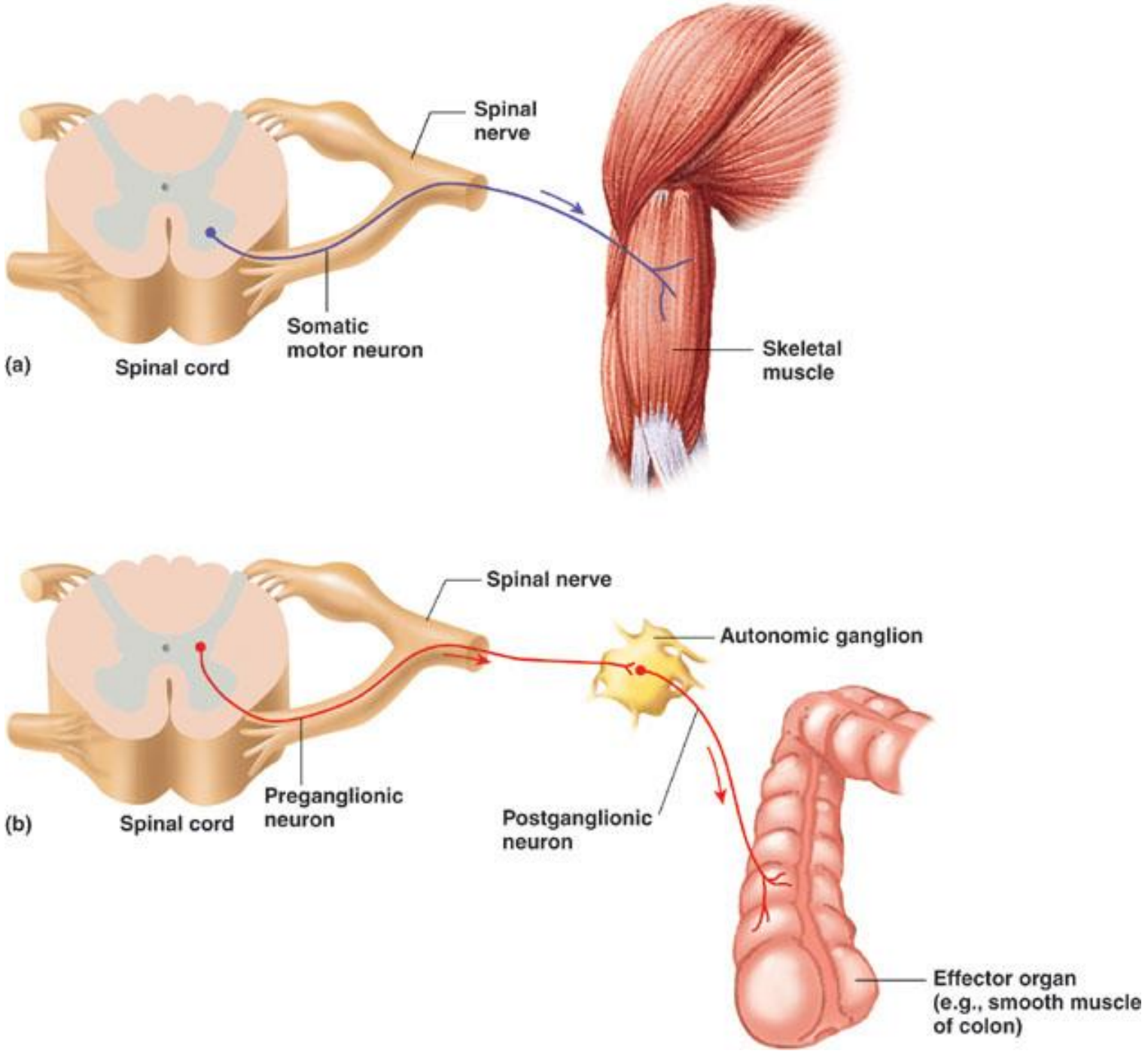
- Skeletal muscle
- Conscious and unconscious movement
- Skeletal muscle contracts
- One synapse
- Acetylcholine
- Receptor molecules: nicotinic

Autonomic

- Smooth and cardiac muscle and glands
- Unconscious regulation
- Target tissues stimulated or inhibited
- Two synapses
- Acetylcholine by **preganglionic neurons** and ACh or norepinephrine by **postganglionic neurons**
- Receptor molecules: varies with synapse and neurotransmitter

Table 16.1 Comparison of the Somatic and Autonomic Nervous Systems

Features	Somatic Nervous System	Autonomic Nervous System
Target tissues	Skeletal muscle	Smooth muscle, cardiac muscle, and glands
Regulation	Controls all conscious and unconscious movements of skeletal muscle	Unconscious regulation, although influenced by conscious mental functions
Response to stimulation	Skeletal muscle contracts	Target tissues are stimulated or inhibited
Neuron arrangement	One neuron extends from the central nervous system (CNS) to skeletal muscle	Two neurons in series; the preganglionic neuron extends from the CNS to an autonomic ganglion, and the postganglionic neuron extends from the autonomic ganglion to the target tissue
Neuron cell body location	Neuron cell bodies are in motor nuclei of the cranial nerves and in the ventral horn of the spinal cord	Preganglionic neuron cell bodies are in autonomic nuclei of the cranial nerves and in the lateral part of the spinal cord; postganglionic neuron cell bodies are in autonomic ganglia
Number of synapses	One synapse between the somatic motor neuron and the skeletal muscle	Two synapses; first is in the autonomic ganglia; second is at the target tissue
Axon sheaths	Myelinated	Preganglionic axons are myelinated; postganglionic axons are unmyelinated
Neurotransmitter substance	Acetylcholine	Acetylcholine is released by preganglionic neurons; either acetylcholine or norepinephrine is released by postganglionic neurons
Receptor molecules	Receptor molecules for acetylcholine are nicotinic	In autonomic ganglia, receptor molecules for acetylcholine are nicotinic; in target tissues, receptor molecules for acetylcholine are muscarinic, whereas receptor molecules for norepinephrine are either α- or β-adrenergic



Autonomic Division:

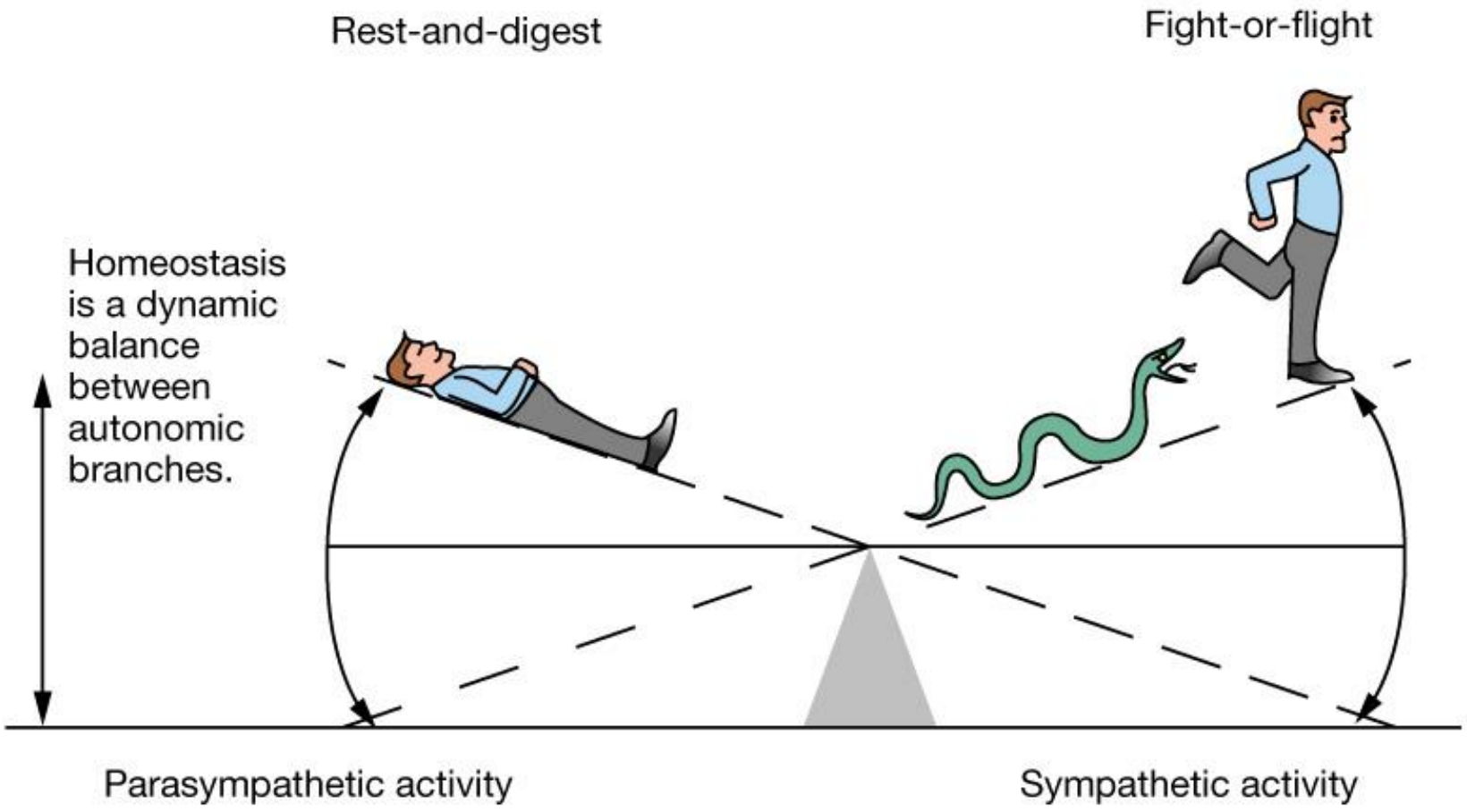


Figure 11-1: Homeostasis and the autonomic division

Divisions of the ANS

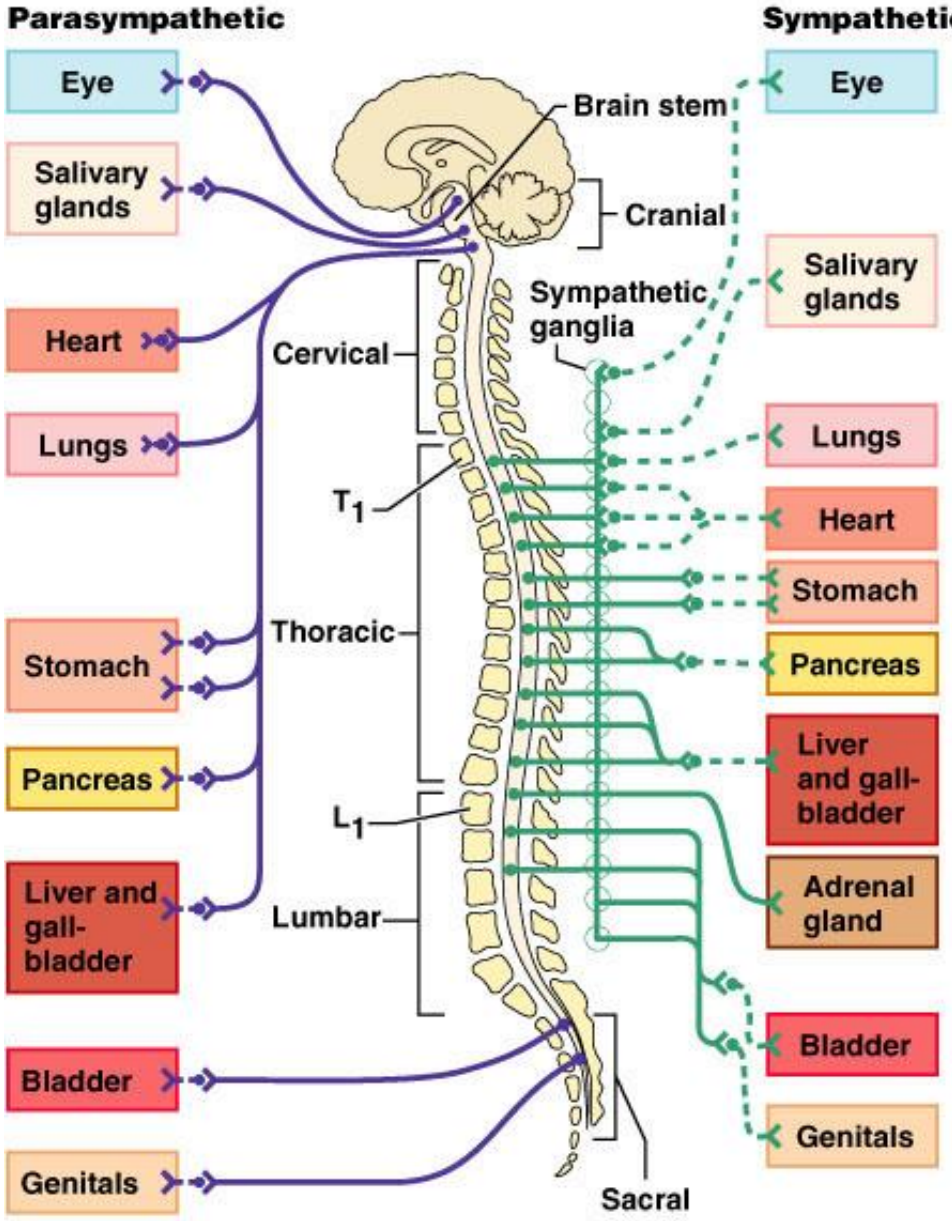
- The two divisions of the ANS
  - The sympathetic division
  - The parasympathetic division
- The sympathetic mobilizes the body during extreme situations
- The parasympathetic performs maintenance activities and conserves body energy
- The two divisions counterbalance each other's activity

Anatomy of ANS

Division	Origin of Fibers	Length of Fibers	Location of Ganglia
Sympathetic "Thoracolumbar Division"	Thoracolumbar region of the spinal cord (T_1 - L_2)	Short preganglionic Long postganglionic	Close to the spinal cord
Parasympathetic "Craniosacral Div."	Brain and sacral region of spinal cord	Long preganglionic Short postganglionic	In the visceral effector organs

Anatomy of ANS

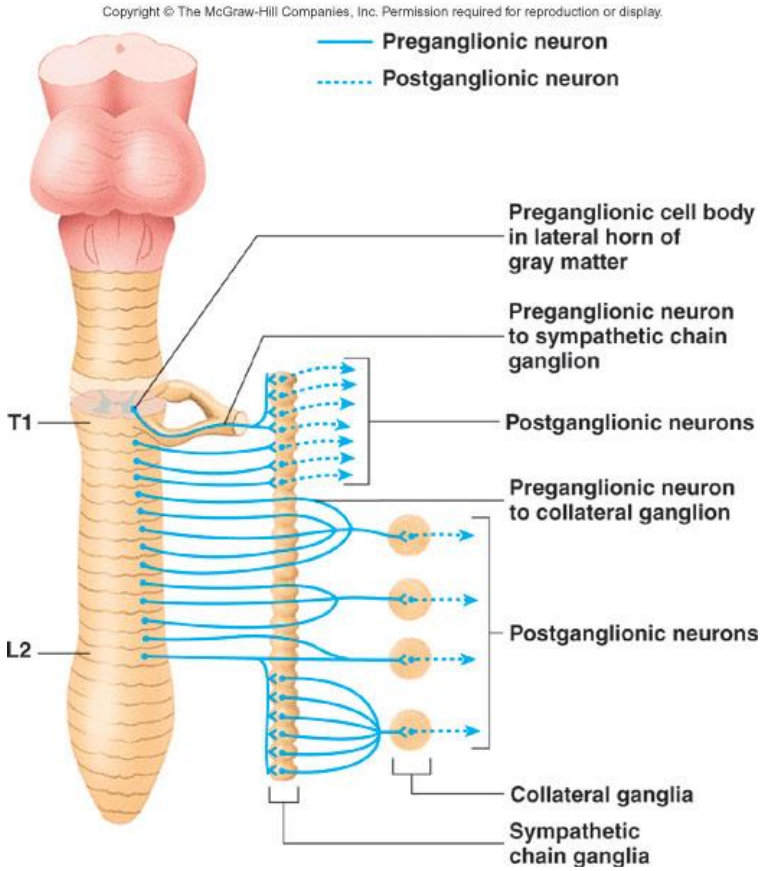
Note the *origin* of the preganglionic neuron in the brain-stem.



Note the origin of the preganglionic neuron in the T_1-L_2 region of the S.C.

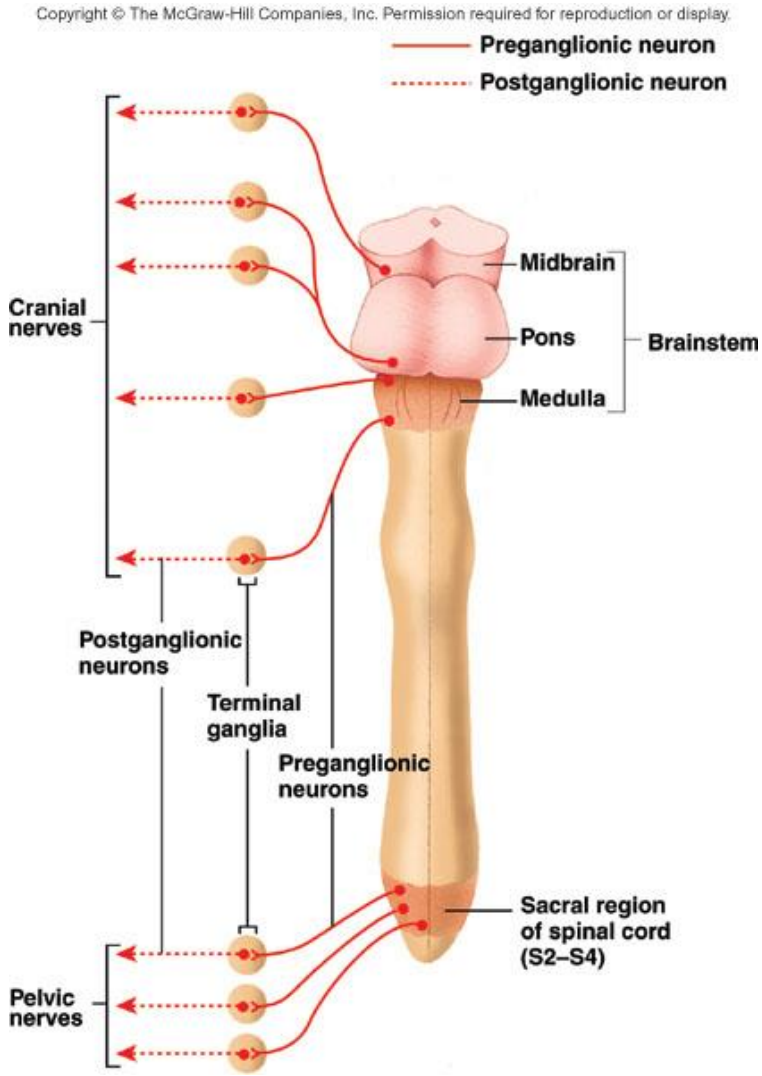
Figure 14.3

Sympathetic (Thoracolumbar) Division



- Preganglionic cell bodies in lateral horns of spinal cord T1-L2: thoracolumbar
- Preganglionic axons pass through ventral roots to **white rami communicantes** to the retroperitoneal **sympathetic chain ganglia**.

Parasympathetic (Craniosacral) Division



- Preganglionic cell bodies in nuclei of brainstem or lateral parts of spinal cord gray matter from S2-S4
  - Preganglionic axons from brain pass to terminal ganglia through cranial nerves III, VII, IX and X
  - Preganglionic axons from sacral region pass through **pelvic nerves** to terminal ganglia
- **Terminal ganglia** located near organ innervated or embedded in wall of organ

Table 16.2 Comparison of the Sympathetic and Parasympathetic Divisions

Features	Sympathetic Division	Parasympathetic Division
Location of preganglionic cell body	Lateral horns of spinal cord gray matter (T1–L2)	Brainstem and lateral parts of spinal gray matter (S2–S4)
Outflow from the CNS	Spinal nerves Sympathetic nerves Splanchnic nerves	Cranial nerves Pelvic nerves
Ganglia	Sympathetic chain ganglia along spinal cord for spinal and sympathetic nerves; collateral ganglia for splanchnic nerves	Terminal ganglia near or on effector organ
Number of postganglionic neurons for each preganglionic neuron	Many (much divergence)	Few (less divergence)
Relative length of neurons	Short preganglionic Long postganglionic	Long preganglionic Short postganglionic

Role of the Parasympathetic Division

- Concerned with keeping body energy use low
- Involves the **D** activities – digestion, defecation, and diuresis
- Its activity is illustrated in a person who relaxes after a meal
  - Blood pressure, heart rate, and respiratory rates are low
  - Gastrointestinal tract activity is high
  - The skin is warm and the pupils are constricted

Role of the Sympathetic Division

- The sympathetic division is the "fight-or-flight" system
- Involves **E** activities – exercise, excitement, emergency, and embarrassment
- Promotes adjustments during exercise – blood flow to organs is reduced, flow to muscles is increased
- Its activity is illustrated by a person who is threatened
  - Heart rate increases, and breathing is rapid and deep
  - The skin is cold and sweaty, and the pupils dilate

Responses to Exercise (Fight or Flight Response)

- Increased heart rate and force of contraction
- Blood vessel dilation in skeletal and cardiac muscles
- Dilation of air passageways
- Energy sources availability increased
  - Glycogen to glucose
  - Fat cells break down triglycerides
- Muscles generate heat, body temperature increases
- Sweat gland activity increases
- Decrease in nonessential organ activities

THANK YOU