Autonomic Nervous System

- A. Comparison of somatic and autonomic nervous systems
- B. Anatomy of autonomic motor pathways
    1. Overview
        a. Preganglionic neurons
        b. Autonomic ganglia
        c. Postganglionic neurons
- C. Physiological effects of ANS
    1. ANS neurotransmitters
    2. Parasympathetic and sympathetic responses

ANS regulates activities of cardiac muscle, smooth muscle, and glands.

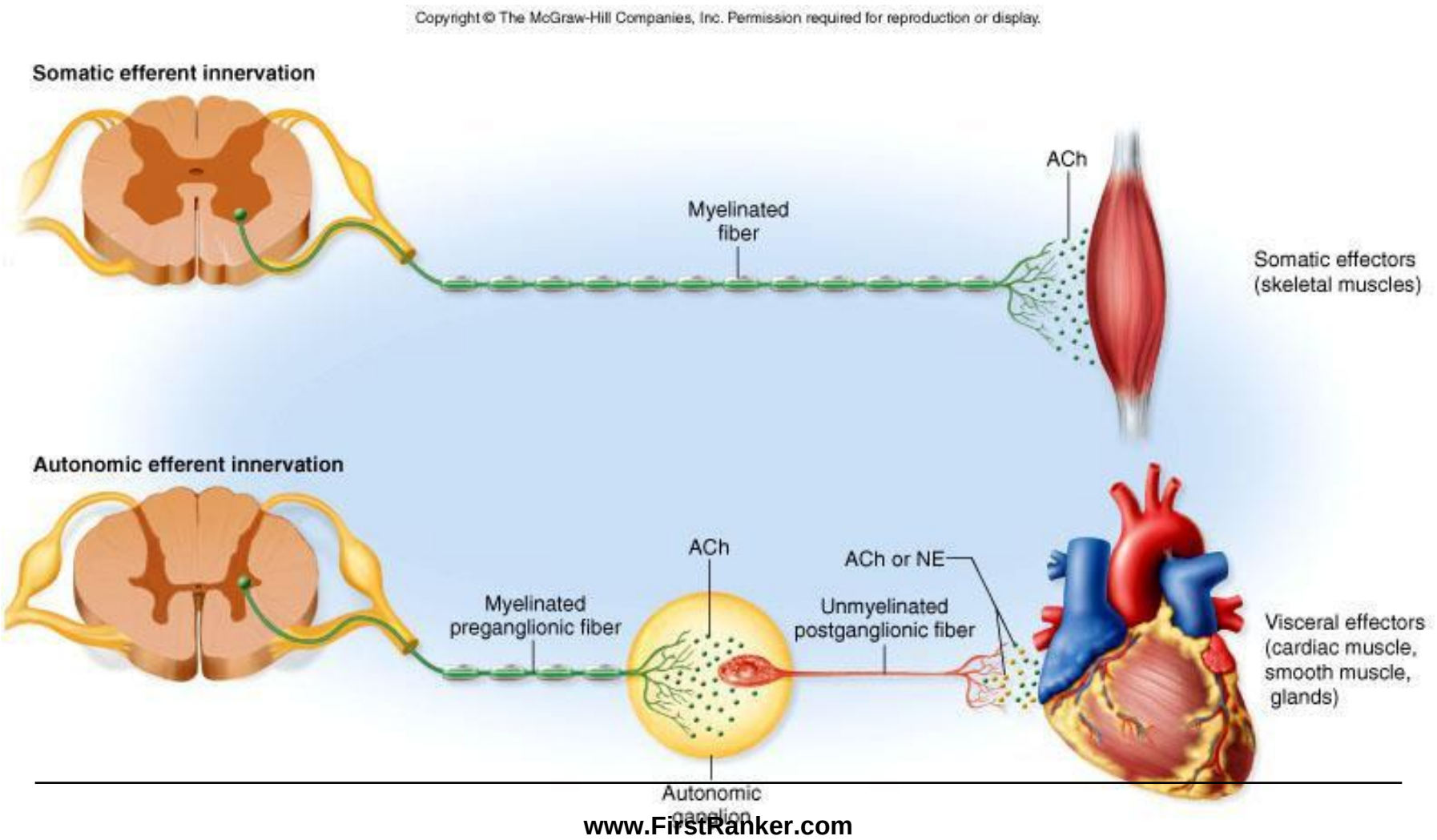
- Structurally, ANS consists of two main components:
    1. visceral **afferent** neurons
    2. visceral **efferent** neurons

- Functionally, the ANS operates:
    1. without conscious control
    2. reflex arc dependent
    3. medulla and hypothalamus over ride

Somatic & Autonomic Nervous Systems

Somatic	Autonomic
cutaneous receptors proprioceptors special senses	chemoreceptors baroreceptors mechanoreceptors
may become conscious	unconscious
excitatory for skeletal muscles	excitatory or inhibitory for cardiac muscle, smooth muscles, and glands
single motor neuron	two motor neurons

Somatic and Autonomic Efferent Pathways



Overview of Autonomic Pathways

- Preganglionic neuron

- 1. first of two autonomic motor neurons
- 2. cell body located in gray matter of spinal cord (lateral column) or brain
- Thoraco lumbar – sympathetic & Craniosacral –parasympathetic
- 3. preganglionic axon passes from CNS in a spinal or cranial nerve
- 4. axon terminates in a ganglion

Overview of Autonomic Pathways

- Ganglion

- 1. collection of nerve cell bodies located in a specific site outside CNS
- 2. cell bodies give rise to postganglionic neurons

Overview of Autonomic Pathways

- Postganglionic neuron

- 1. second of two autonomic motor neurons
- 2. cell body located in ganglion
- 3. postganglionic axon passes from ganglion to effector Organ
- 4. peripheral effector is either stimulated or inhibited

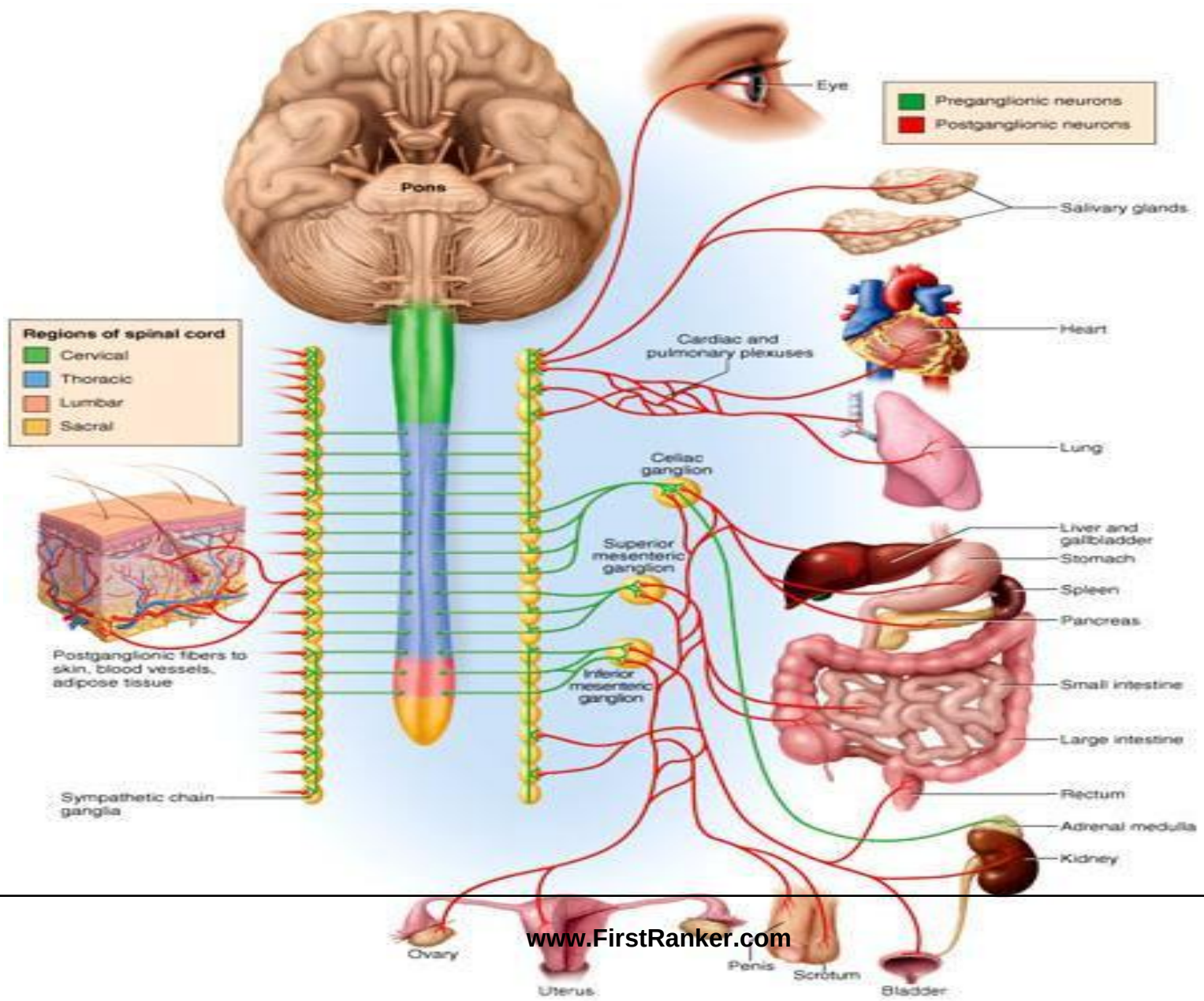
TABLE 15.3 Comparison of the Sympathetic and Parasympathetic Divisions

Feature	Sympathetic	Parasympathetic
Origin in CNS	Thoracolumbar	Craniosacral
Location of ganglia	Paravertebral ganglia adjacent to spinal column and prevertebral ganglia anterior to it	Terminal ganglia near or within target organs
Fiber lengths	Short preganglionic Long postganglionic	Long preganglionic Short postganglionic
Neuronal divergence	Extensive (about 1:17)	Minimal (about 1:2)
Effects of system	Often widespread and general	More specific and local

Sympathetic Nervous System

- 1. lateral gray horns (T1-L2)
- 2. Thoracolumbar outflow
- 3. ganglia
    a. sympathetic trunk (paravertebral)
    b. Prevertebral (collateral)
- 4. preganglionic axons short
- 5. postganglionic axons long

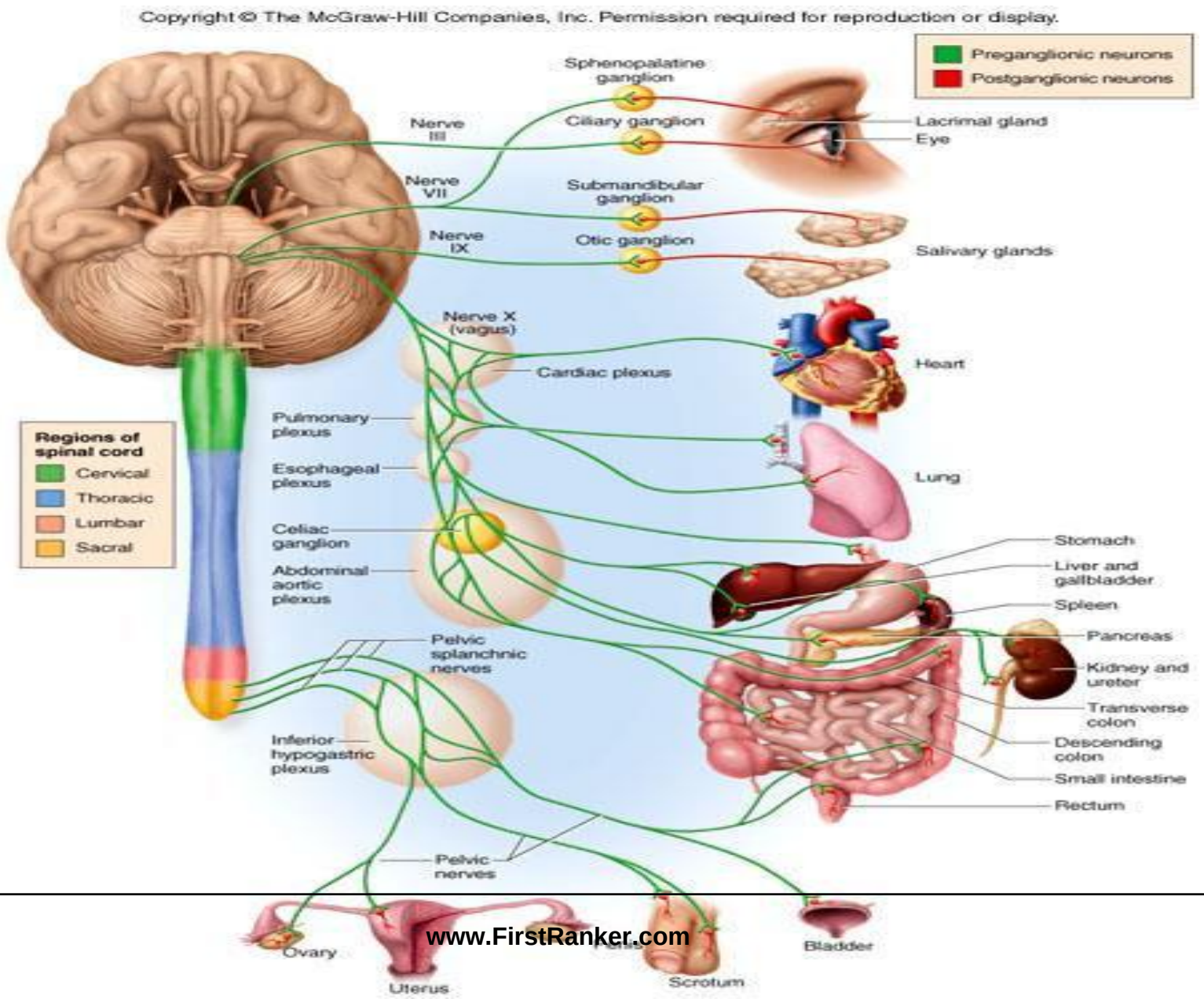
Sympathetic Nervous System



Parasympathetic Nervous System

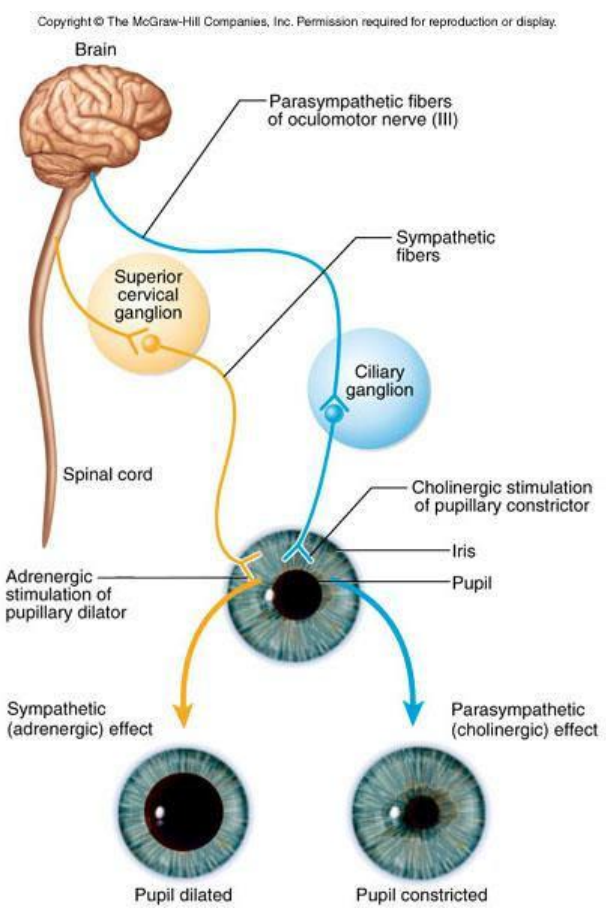
- 1. lateral gray horns (S2-4)
- 2. cranial gray matter
  (III, VII, IX, X)
- 3. Craniosacral outflow
- 4. terminal ganglia
- 5. preganglionic axons long
- 6. postganglionic axons short

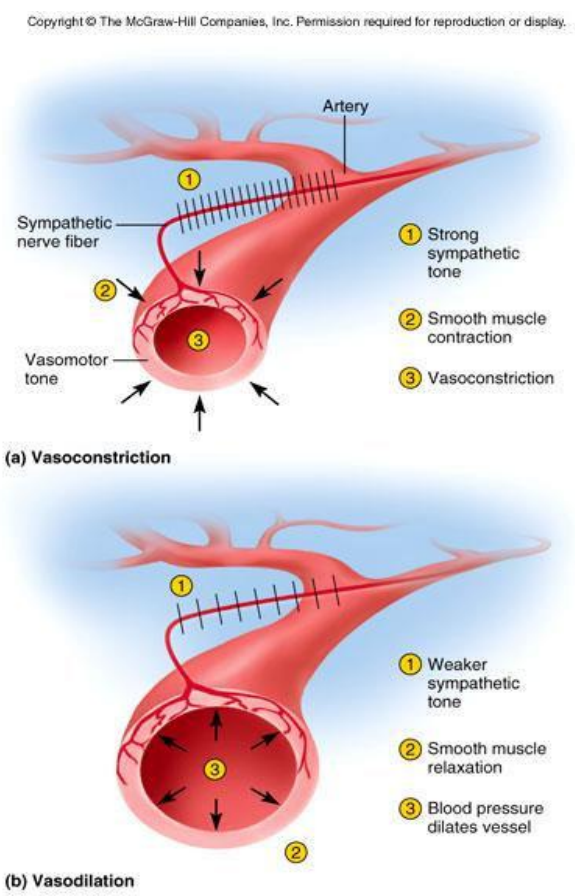
Parasympathetic Nervous System



Physiological Effects of ANS

- 1. dual (duel?) innervation
- 2. different neurotransmitters
- 3. parasympathetic tone

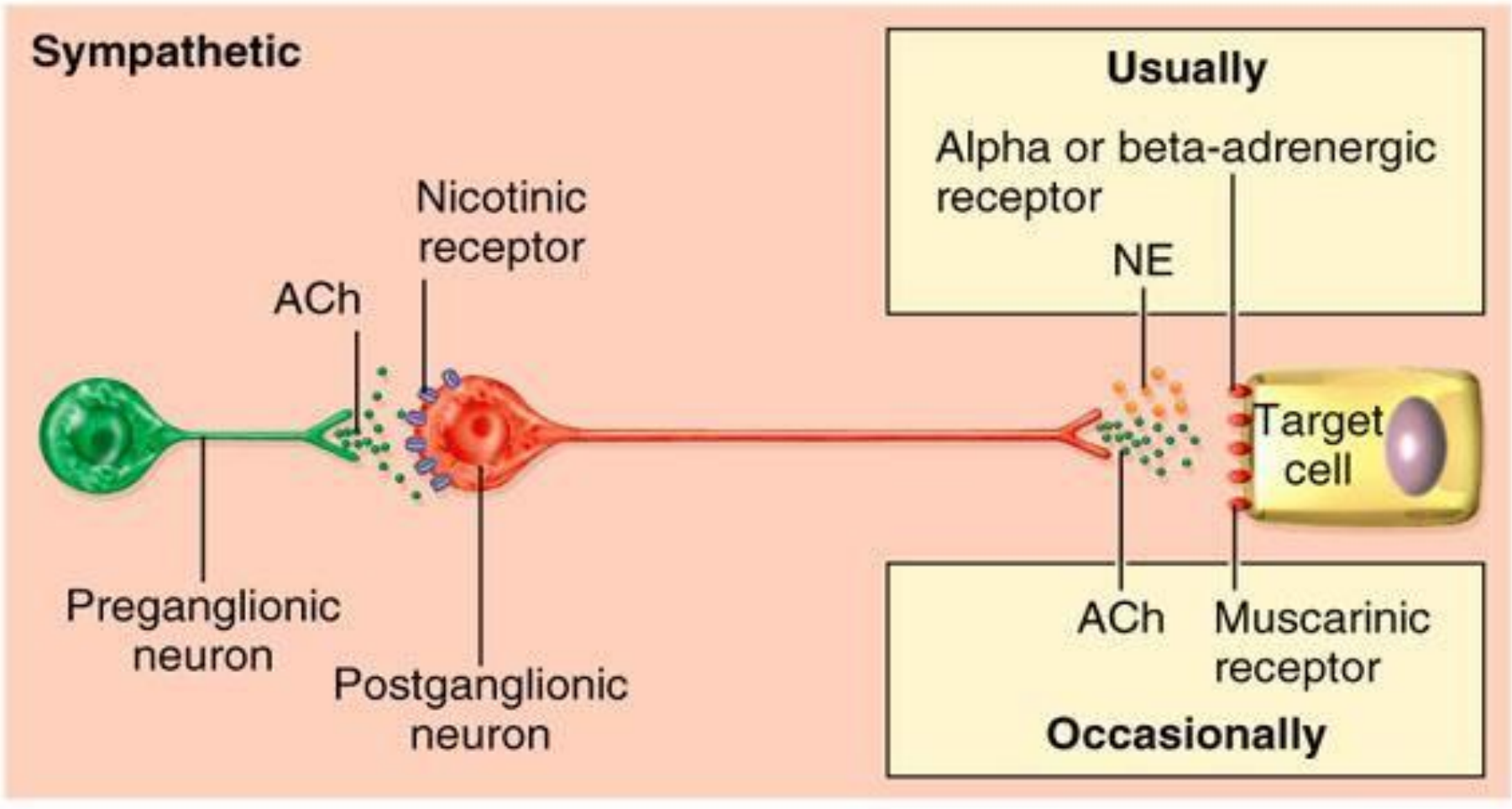




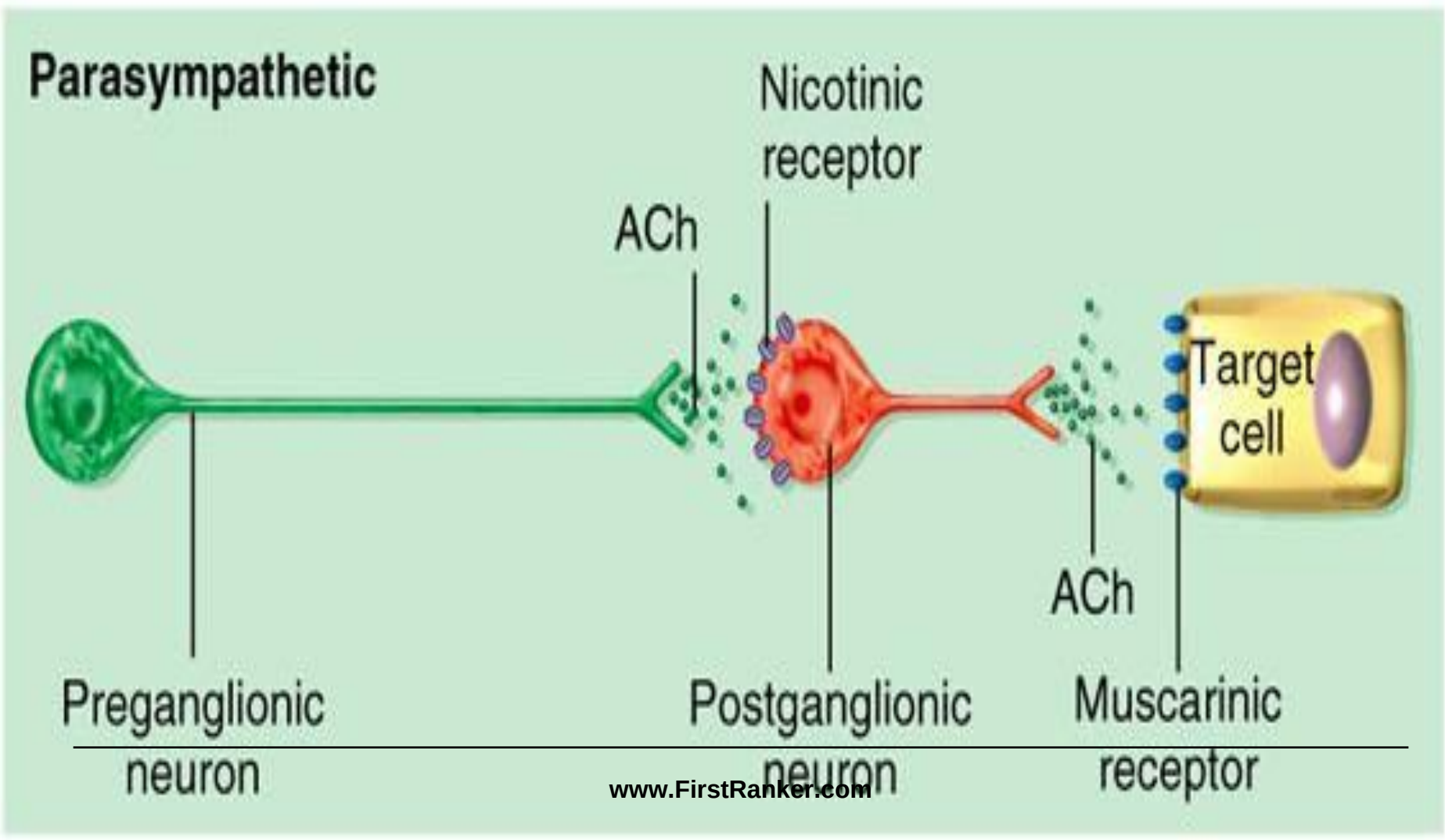
ANS Neurotransmitters

Cholinergic	Adrenergic
acetylcholine	norepinephrine
all preganglionic neurons all postganglionic parasympathetic & few postganglionic sympathetic neurons	most postganglionic sympathetic neurons
acetylcholinesterase transferase	catechol-O-methyl monoamine oxidase

Autonomic Nervous System - Neurotransmitters & Receptors – Sympathetic arm



Autonomic Nervous System - Neurotransmitters & Receptors – Parasympathetic arm



Sympathetic System

- 1. energy expenditure system
- 2. fight-or-flight response
- 3. dominates parasympathetic NS
- 4. effects

Parasympathetic System

- 1. energy conservation-restoration system
- 2. rest-and-recovery
- 3. dominates sympathetic NS

TABLE 15.5 Effects of the Sympathetic and Parasympathetic Nervous Systems

Target	Sympathetic Effect and Receptor Type	Parasympathetic Effect (all muscarinic)
Eye		
Iris	Pupillary dilation (α_1)	Pupillary constriction
Ciliary muscle and lens	Relaxation for far vision (β_2)	Contraction for near vision
Lacrimal (tear) gland	None	Secretion
Integumentary System		
Merocrine sweat glands (cooling)	Secretion (muscarinic)	No effect
Apocrine sweat glands (scent)	Secretion (α_1)	No effect
Piloerector muscles	Hair erection (α_1)	No effect
Adipose Tissue	Decreased fat breakdown (α_2) Increased fat breakdown (α_1, β_1)	No effect
Adrenal Medulla	Hormone secretion (nicotinic)	No effect
Circulatory System		
Heart rate and force	Increased (β_1, β_2)	Decreased
Deep coronary arteries	Vasodilation (β_2) Vasoconstriction (α_1, α_2)	Slight vasodilation
Blood vessels of most viscera	Vasoconstriction (α_1)	Vasodilation
Blood vessels of skeletal muscles	Vasodilation (β_2)	No effect
Blood vessels of skin	Vasoconstriction (α_1, α_2)	Vasodilation, blushing
Platelets (blood clotting)	Increased clotting (α_2)	No effect
Respiratory System		
Bronchi and bronchioles	Bronchodilation (β_2)	Bronchoconstriction
Mucous glands	Decreased secretion (α_1) Increased secretion (β_2)	No effect

TABLE 15.5 Effects of the Sympathetic and Parasympathetic Nervous Systems (*cont.*)

Target	Sympathetic Effect and Receptor Type	Parasympathetic Effect (all muscarinic)
Urinary System		
Kidneys	Reduced urine output (α_1, α_2)	No effect
Bladder wall	No effect	Contraction
Internal urethral sphincter	Contraction, urine retention (α_1)	Relaxation, urine release
Digestive System		
Salivary glands	Thick mucous secretion (α_1)	Thin serous secretion
Gastrointestinal motility	Decreased (α_1, α_2, β_1, β_2)	Increased
Gastrointestinal secretion	Decreased (α_2)	Increased
Liver	Glycogen breakdown (α_1, β_2)	Glycogen synthesis
Pancreatic enzyme secretion	Decreased (α_1)	Increased
Pancreatic insulin secretion	Decreased (α_2) Increased (β_2)	No effect
Reproductive System		
Penile or clitoral erection	No effect	Stimulation
Glandular secretion	No effect	Stimulation
Orgasm, smooth muscle roles	Stimulation (α_1)	No effect
Uterus	Relaxation (β_2) Labor contractions (α_1)	No effect