The 9th lecture

In

Anatomy and Physiology

For the

1st Class

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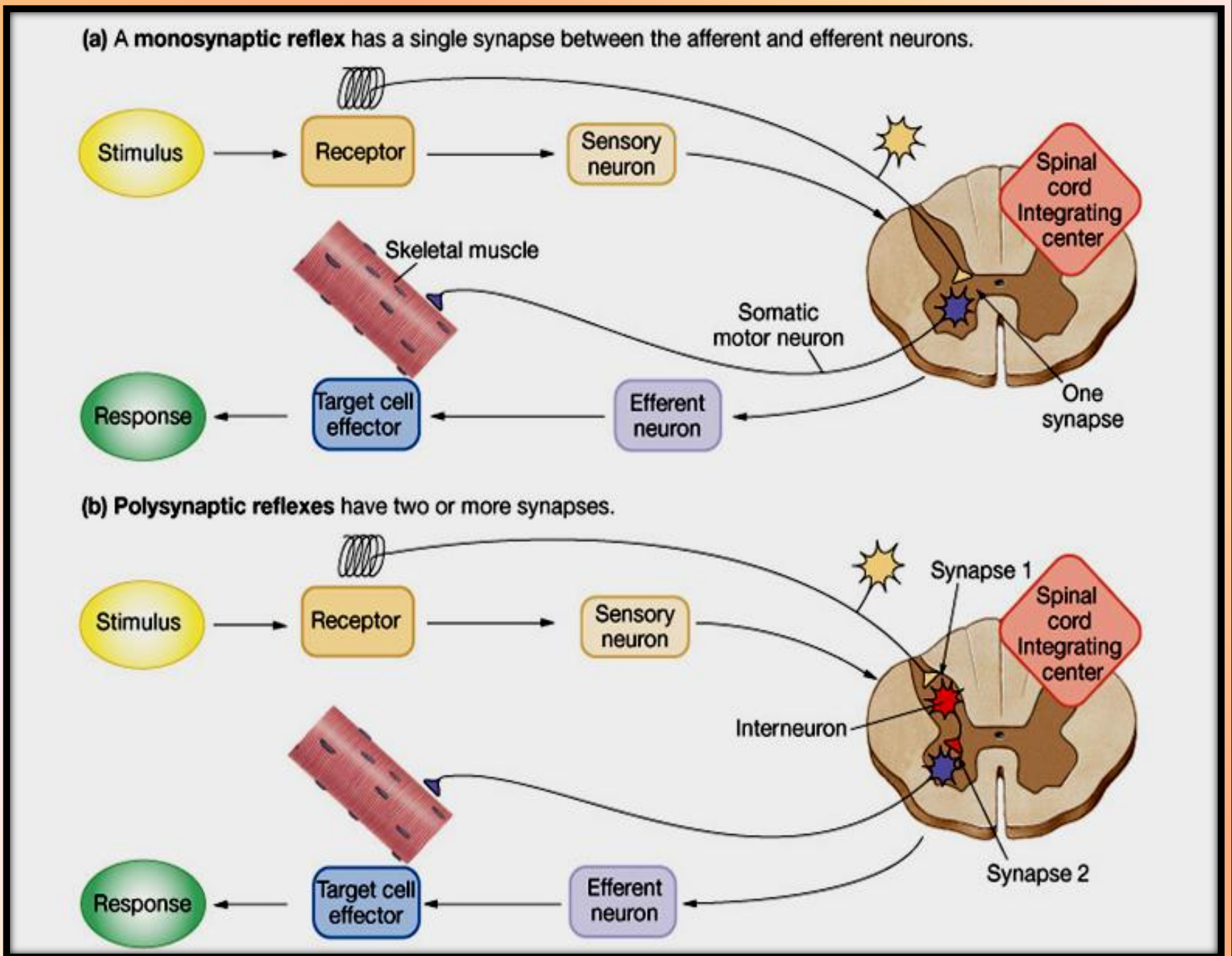
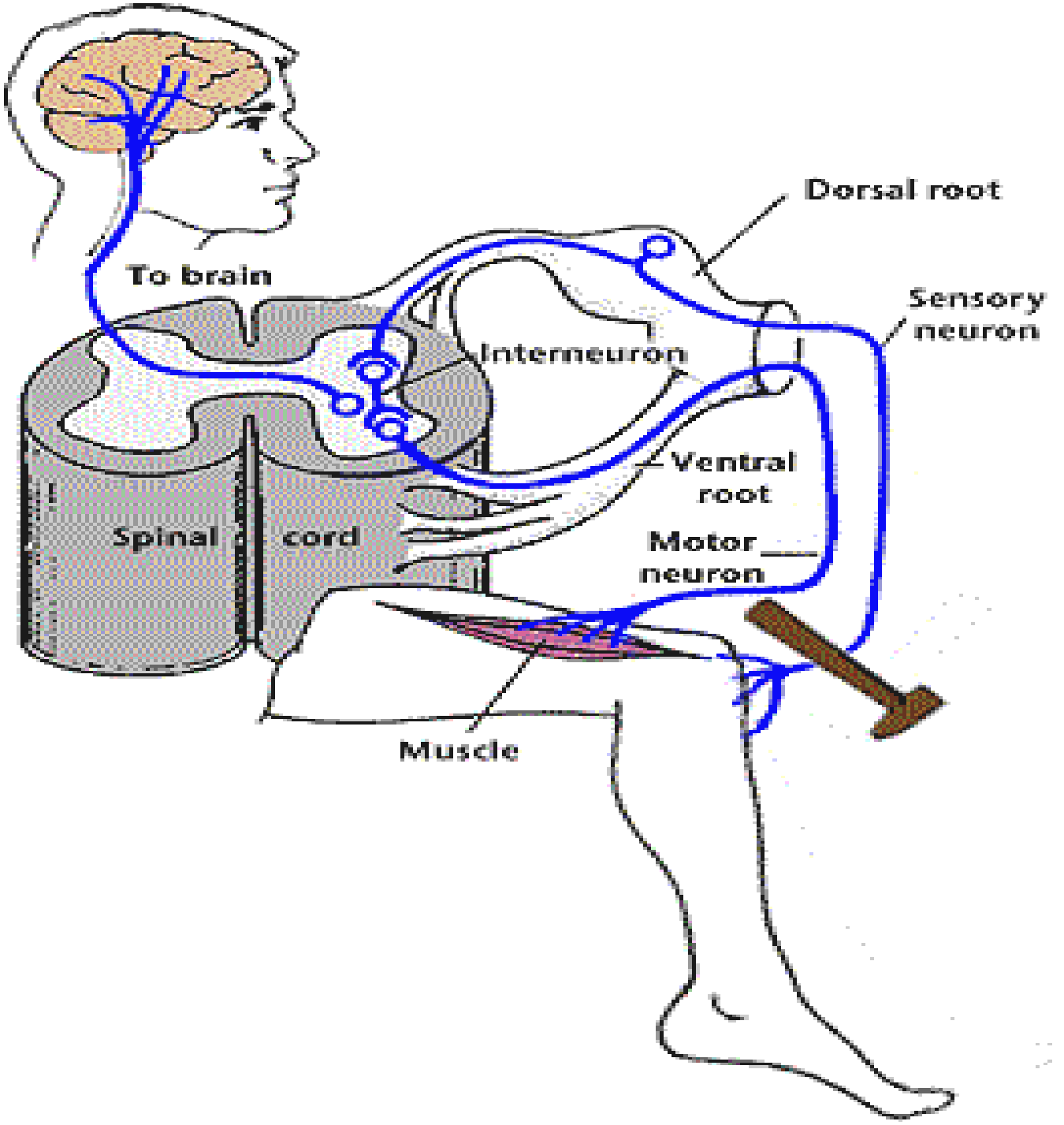
Nervous System (Part III)

The Peripheral Nervous System (PNS)

Peripheral Nervous System (PNS)

- All neuronal structures outside the central nervous system (the brain and the spinal cord) is called PNS.
- The main function of the PNS is to connect the CNS to the limbs and organs, by receiving data (such as sight or sounds) and sending it to the CNS for processing. The CNS in response to this data sends commends to respond to the input.


(a) A monosynaptic reflex has a single synapse between the afferent and efferent neurons.
Stimulus
Receptor
Sensory neuron
Spinal cord Integrating center
Skeletal muscle
Somatic motor neuron
Response
Target cell effector
Efferent neuron
One synapse
(b) Polysynaptic reflexes have two or more synapses.
Stimulus
Receptor
Sensory neuron
Synapse 1
Spinal cord Integrating center
Interneuron
Response
Target cell effector
Efferent neuron
Synapse 2



The stimulus conducts to the spinal cords by sensory neuron. In the spinal cord the stimulus is processed and transmitted to the skeletal muscle.

- The **afferent** division of the peripheral nerve fiber *delivers information to the CNS* and the **efferent** division *carries the motor commands to the organs systems and muscles of the body*.

- The PNS not protected by bone of spine and skull or by blood brain barrier.

- **PNS consists of the;**
    1. **Sensory Receptors.**
    2. **Peripheral nerve fibers.**
    3. **Ganglia.**
    4. **Effector organ (skeletal muscle, gland, smooth muscle, cardiac muscle).**

Sensory Receptors

- These are specialized receptors. Their function is to respond to **stimuli** (changes in their environment).
- Examples on sensory receptors are;

1. **Mechanoreceptors** – respond to *touch, pressure, itch* ….ect.
2. **Thermoreceptors** – sensitive to *changes into temperature.*
3. **Photoreceptors** – respond to *light.*
4. **chemoreceptors** – respond to *changes in blood chemistry, smell.*

Nerve

- A nerve is a cord composed of numerous nerve fibers (axons) bound together by connective tissue.
- Most nerves are mixtures of afferent and efferent fibers.
- Pure sensory (afferent) and pure motor (efferent) nerves are rare.
- Peripheral nerves classified as cranial or spinal nerves.

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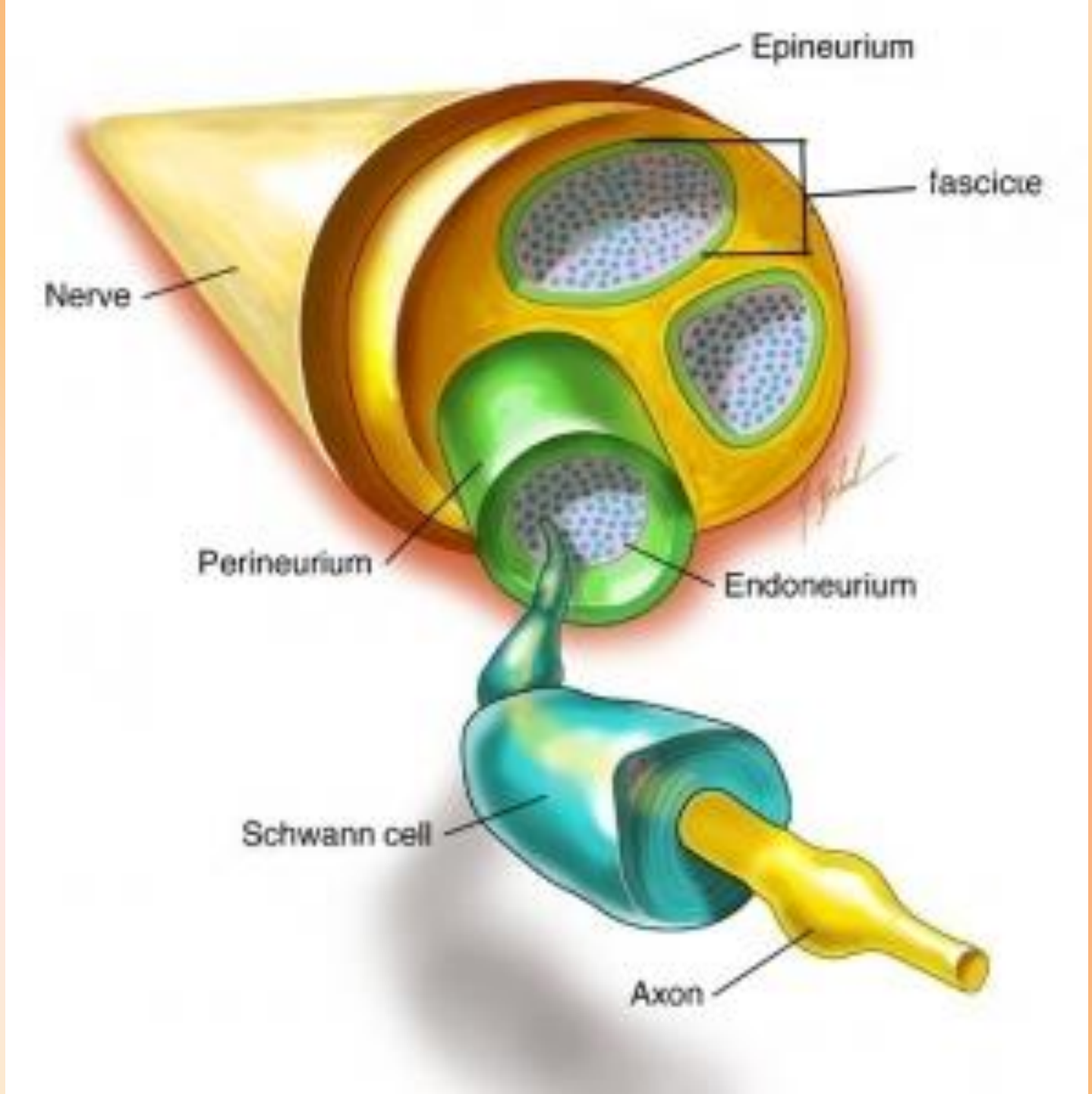
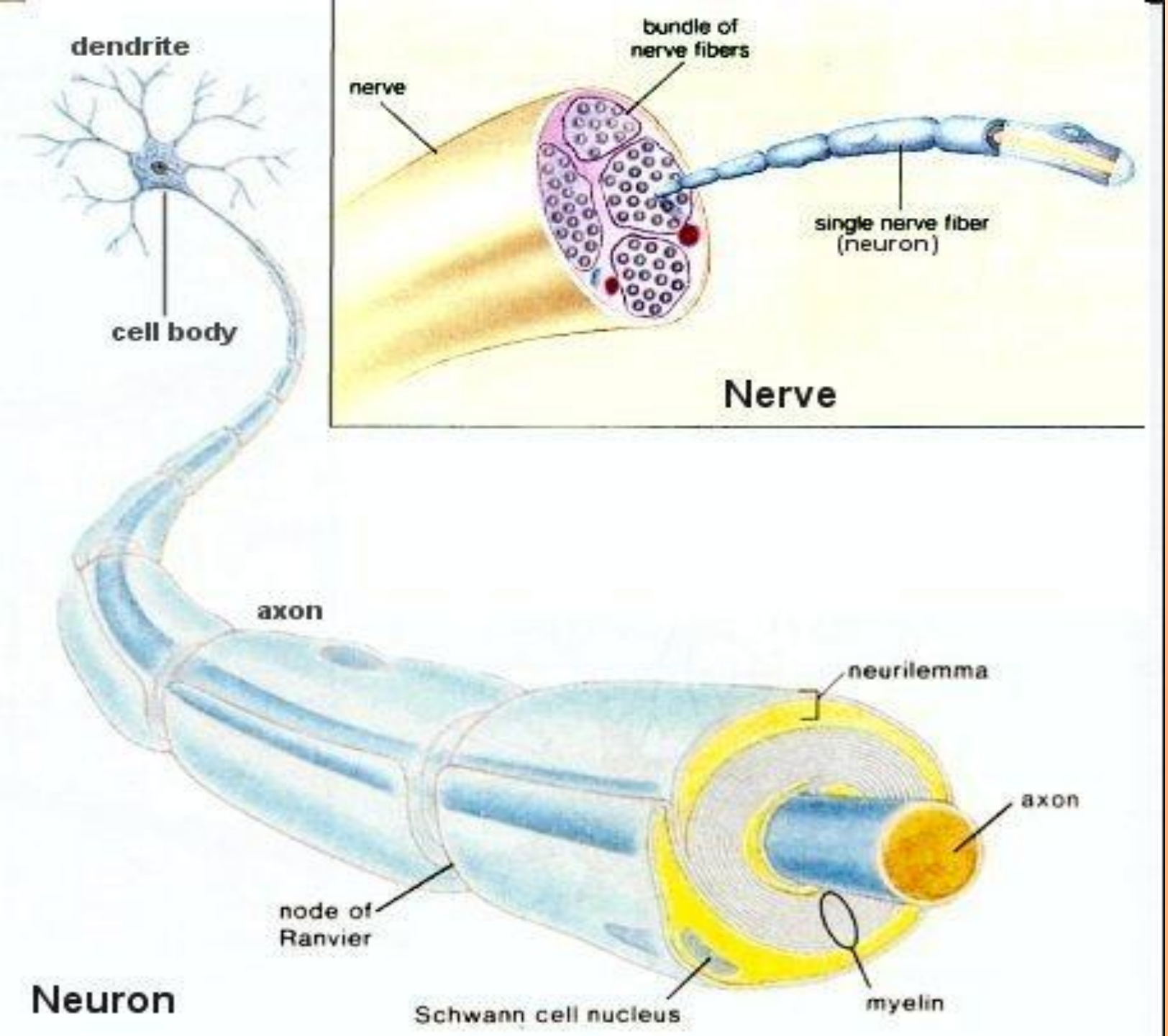

Epineurium
fascicle
Nerve
Perineurium
Endoneurium
Schwann cell
Axon

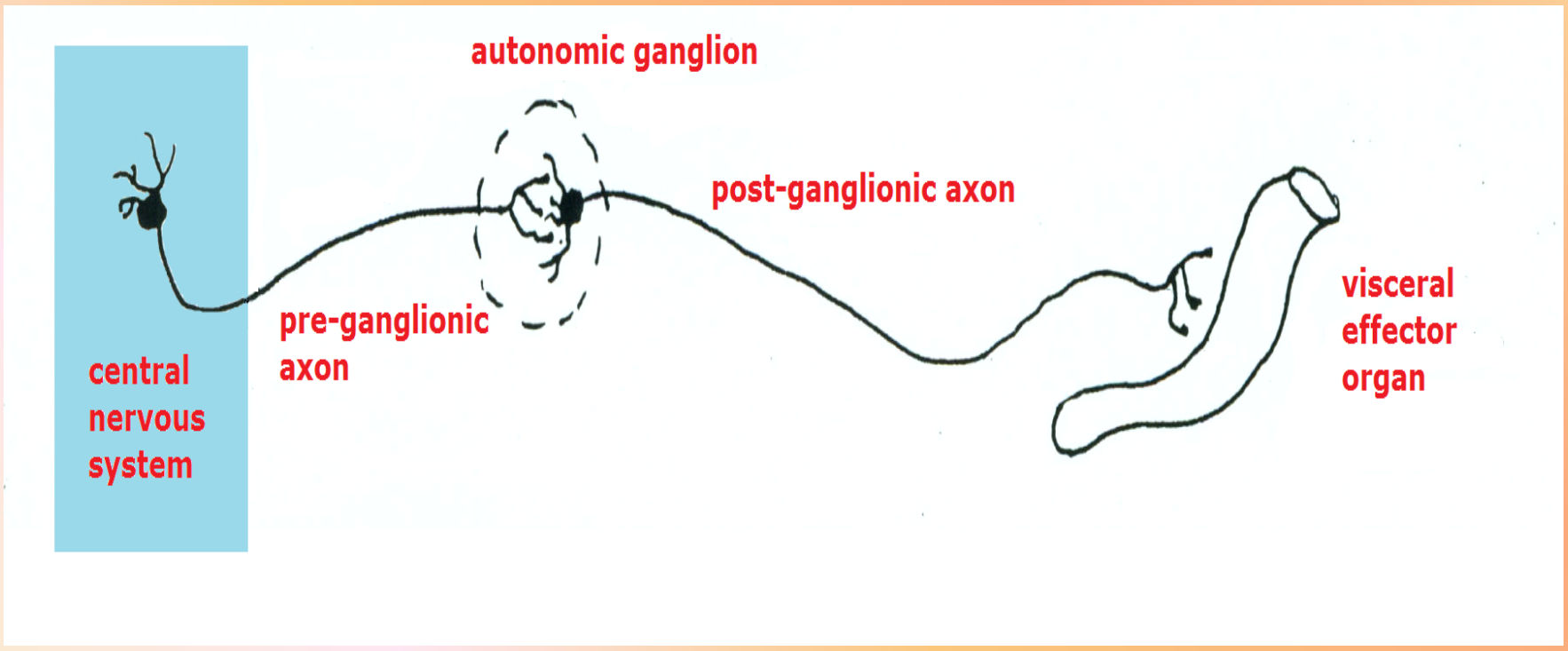
Nerve fiber


dendrite
cell body
axon
bundle of
nerve fibers
nerve
single nerve fiber
(neuron)
Nerve
neurilemma
axon
node of
Ranvier
Schwann cell nucleus
myelin
Neuron

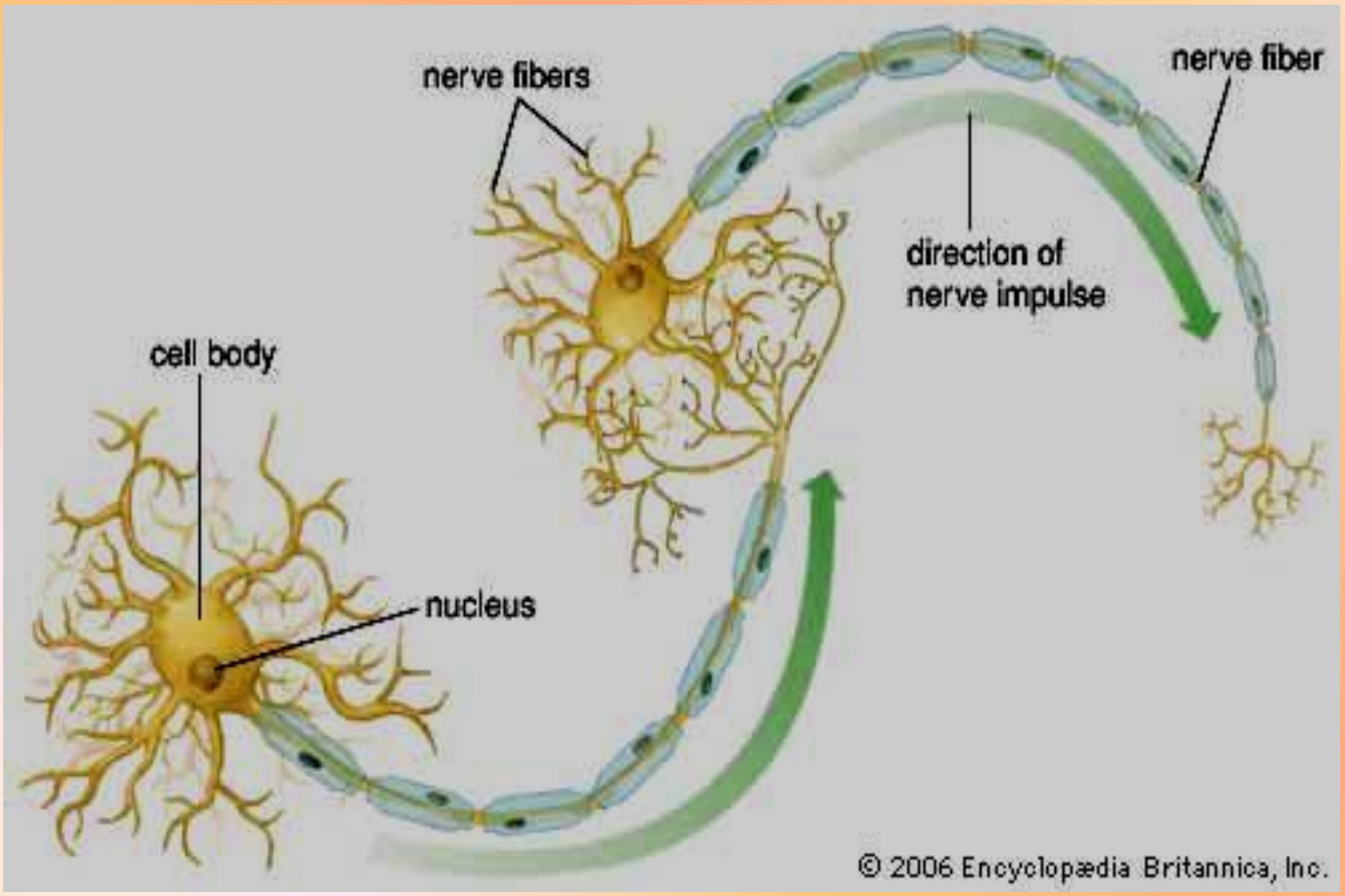
Nerve fiber

Ganglia

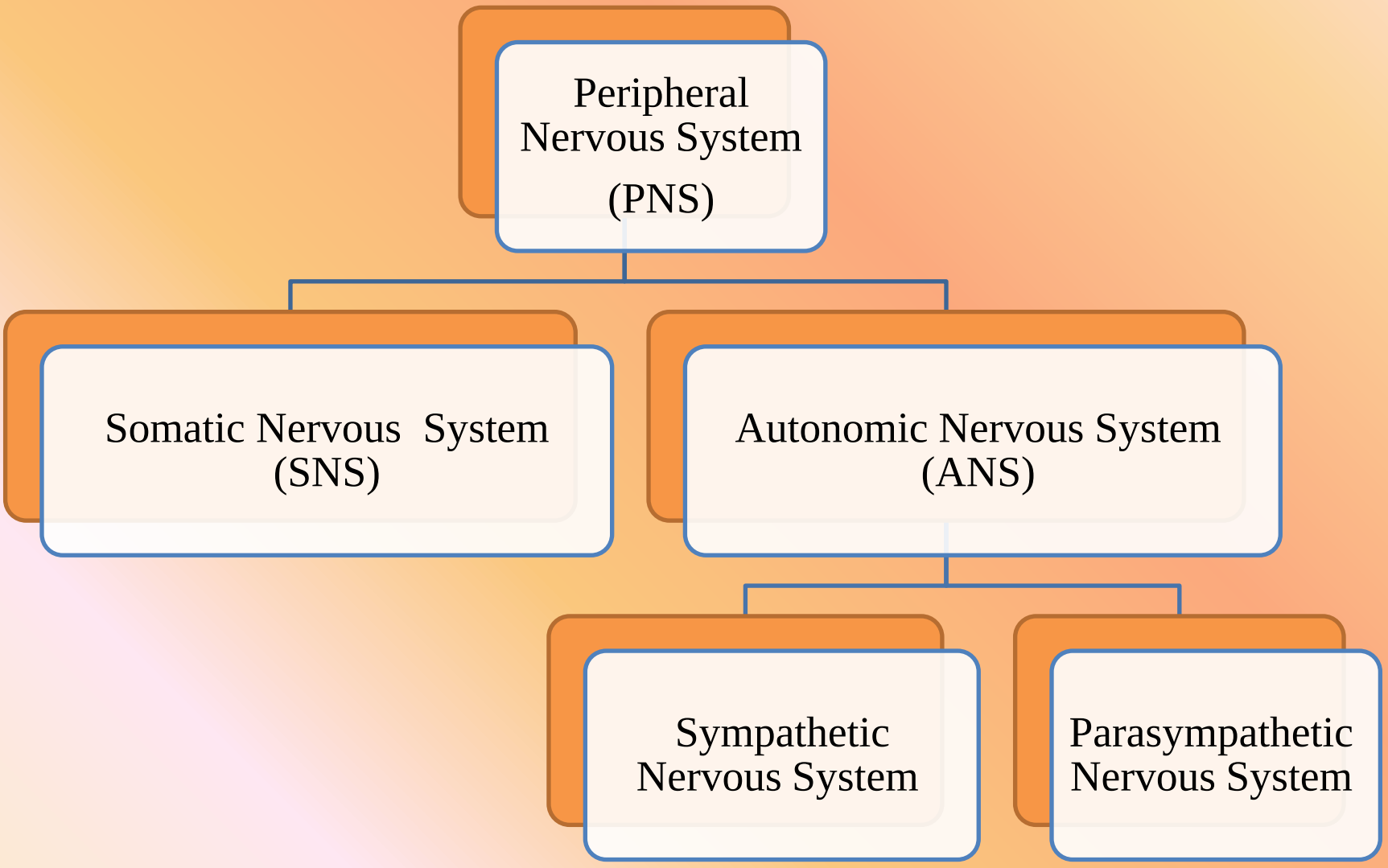
- **Synapse between nerve cells outside the CNS is called ganglion**



Synapse between two neurons



Parts of PNS


Peripheral Nervous System (PNS)
Somatic Nervous System (SNS)
Autonomic Nervous System (ANS)
Sympathetic Nervous System
Parasympathetic Nervous System

Somatic Nervous System (SNS)

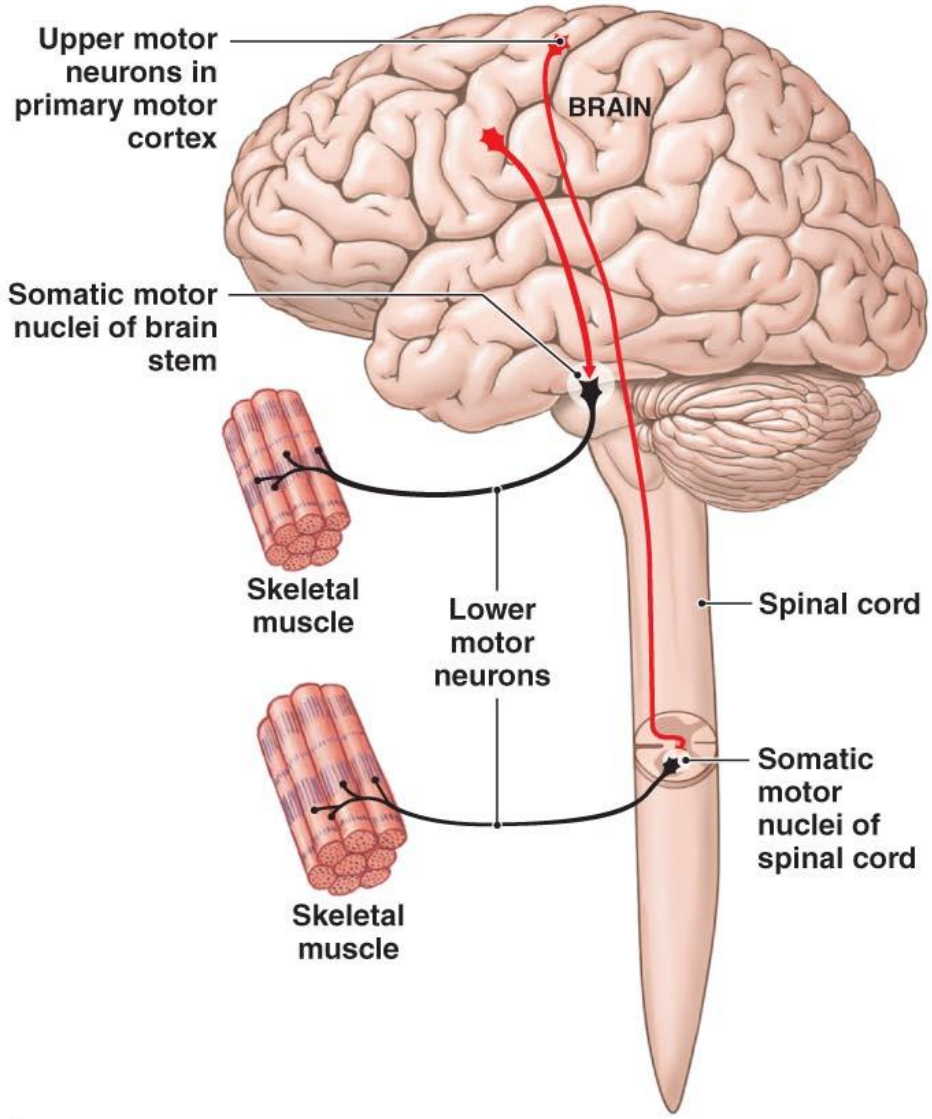
- Mediate bodily movement.
- The somatic system is **under conscious control** with signal that originate in the cortex.
- Innervate **skeletal muscles**.
- Also called involuntary nervous system, the somatic system includes many involuntary functions such as sensation and reflexes.
- Motor somatic neurons have **No intermediate synapses outside of CNS** (one neuron pathway i.e. there is **No ganglia**).

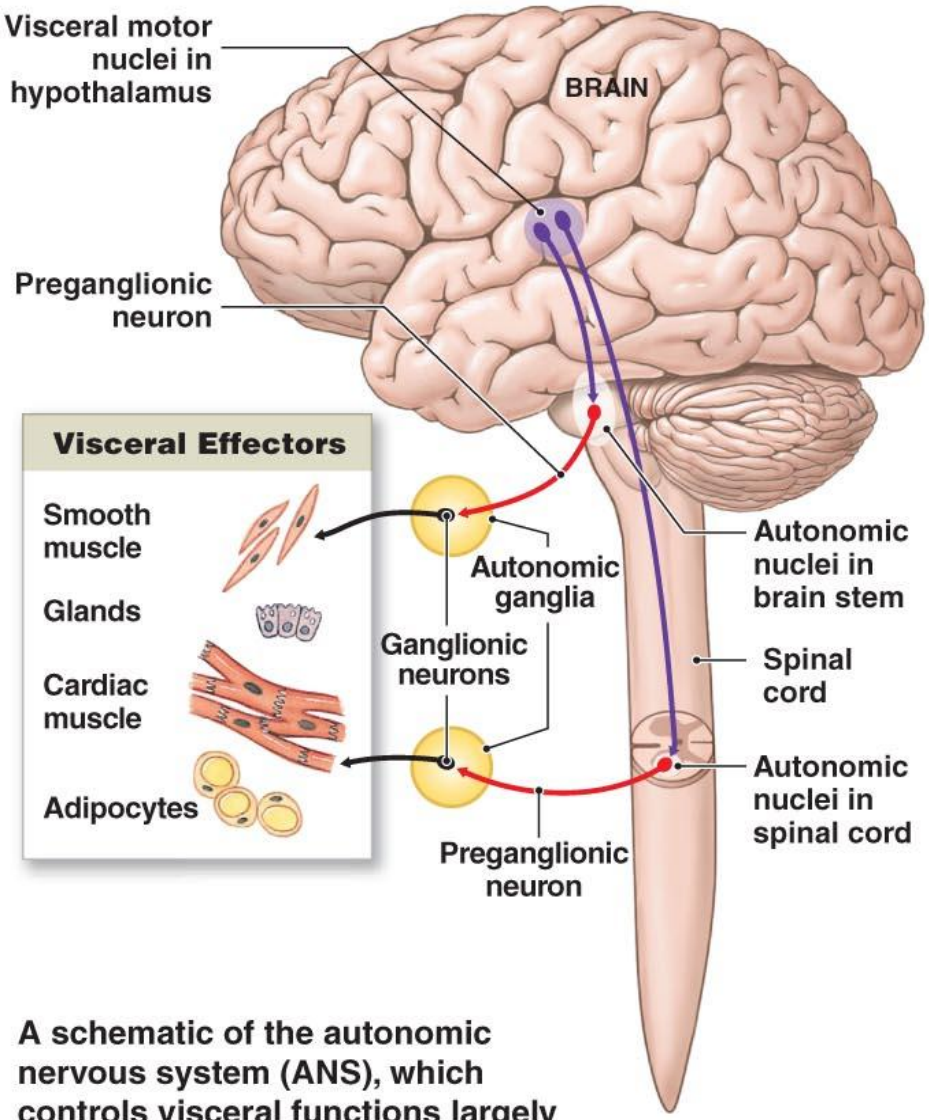
- Localized synapses are formed **at specific neuromuscular junction.**
- Activation of motor somatic nerve leads to **muscle contraction** (i.e. has **excitation effect** only).
- One type of neurotransmitter (**acetylcholine "Ach**") releases at neuromuscular junction

Autonomic Nervous System (ANS)

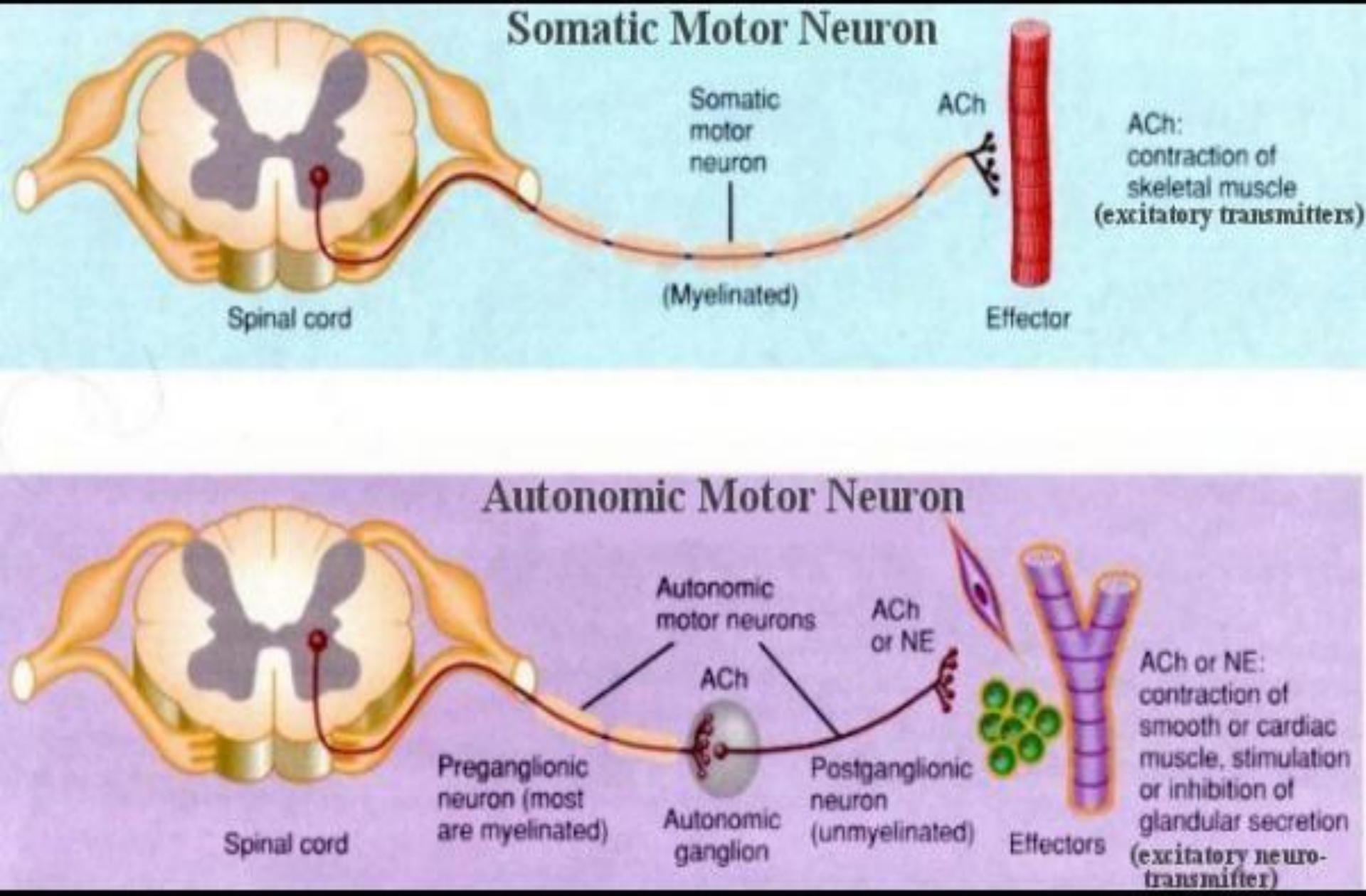
- Mediates control of the **internal organs**.
- The autonomic system is **largely involuntary**, its control originates in the brainstem and hypothalamus.
- Autonomic nervous system **innervates** the **heart, smooth muscles, organs and glands.**
- The autonomic system makes **one ganglion** after leaving the CNS. The post ganglionic cell then makes contact with target organ (**two neuron pathway**).
- Stimulation can cause **either excitation** or **inhibition** of the target tissue.
- Use several types of neurotransmitter like **norepinephrine** (NE) and **Ach**.

A schematic of the somatic nervous system (SNS), which provides conscious and sub-conscious control over skeletal muscles

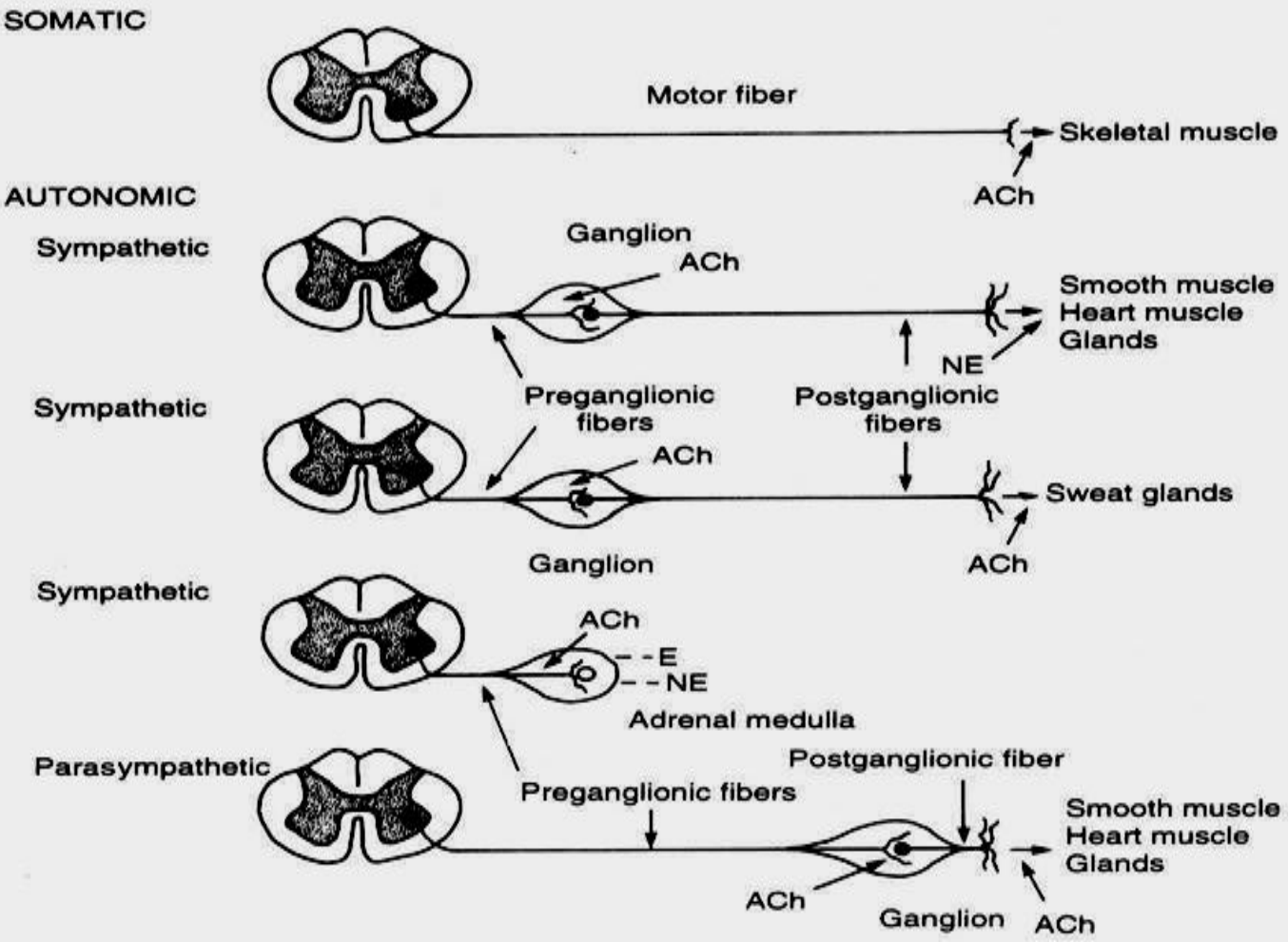




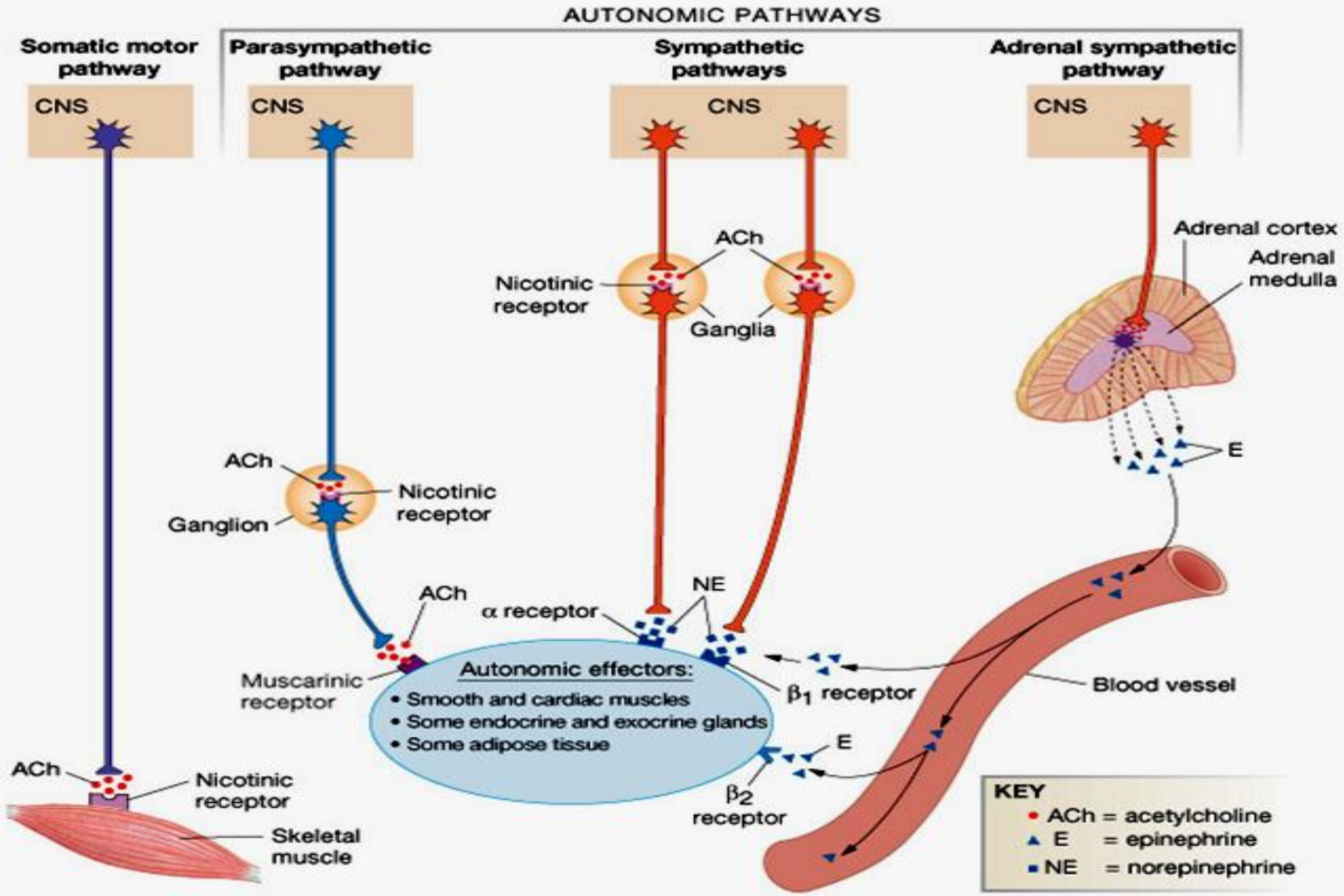
A schematic of the autonomic nervous system (ANS), which controls visceral functions largely outside our awareness


Somatic Motor Neuron
Somatic motor neuron
ACh
ACh: contraction of skeletal muscle (excitatory transmitters)
Spinal cord
(Myelinated)
Effector
Autonomic Motor Neuron
Autonomic motor neurons
ACh or NE
ACh
Preganglionic neuron (most are myelinated)
Postganglionic neuron (unmyelinated)
Spinal cord
Autonomic ganglion
Effectors
ACh or NE: contraction of smooth or cardiac muscle, stimulation or inhibition of glandular secretion (excitatory neuro-transmitter)

PERIPHERAL EFFERENT NERVES



Differences between parts of PNS



Divisions of ANS

1. Sympathetic division
2. Parasympathetic division

- Almost, all visceral organs are innervated by both divisions but they cause opposite effect.

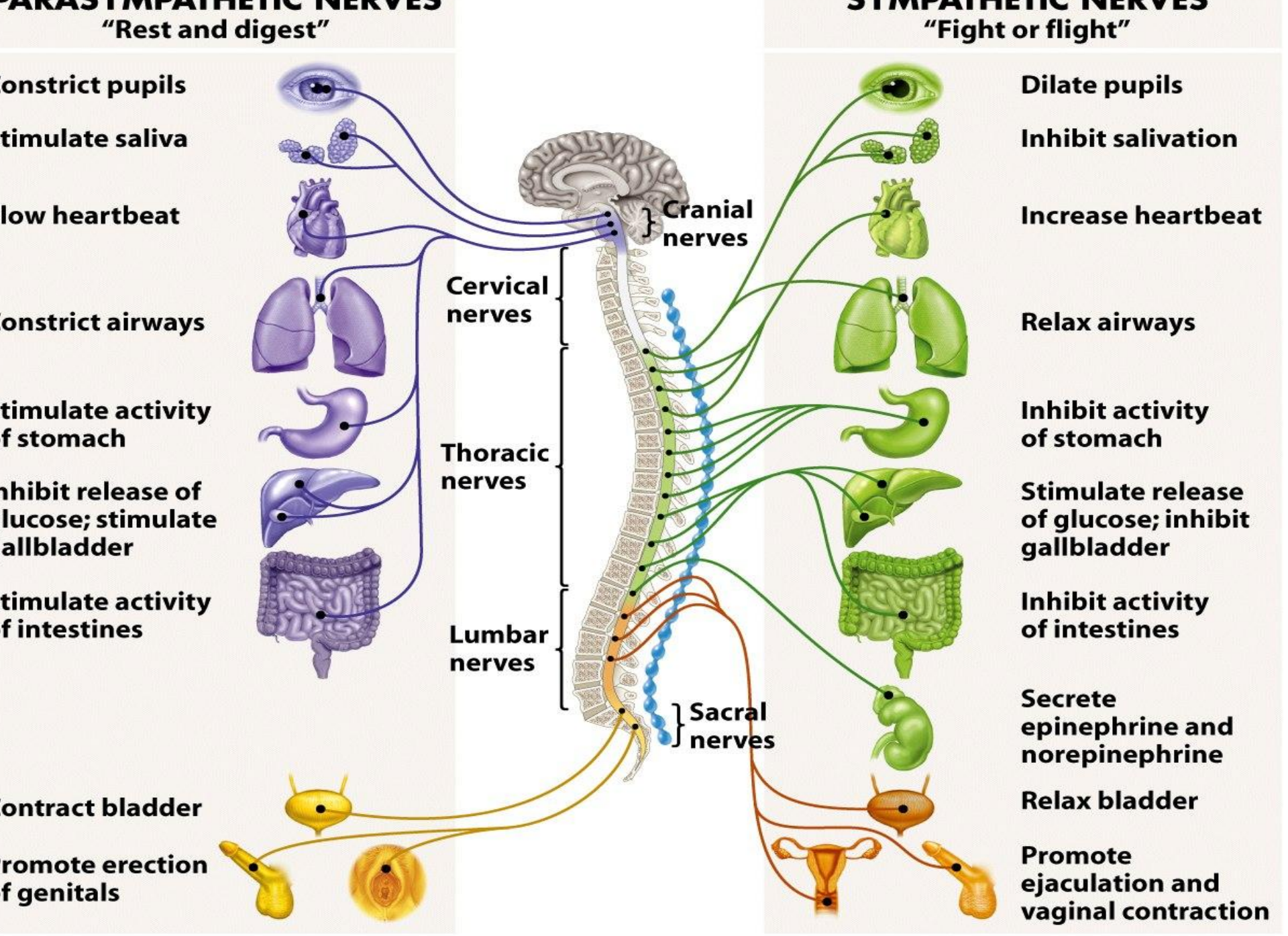
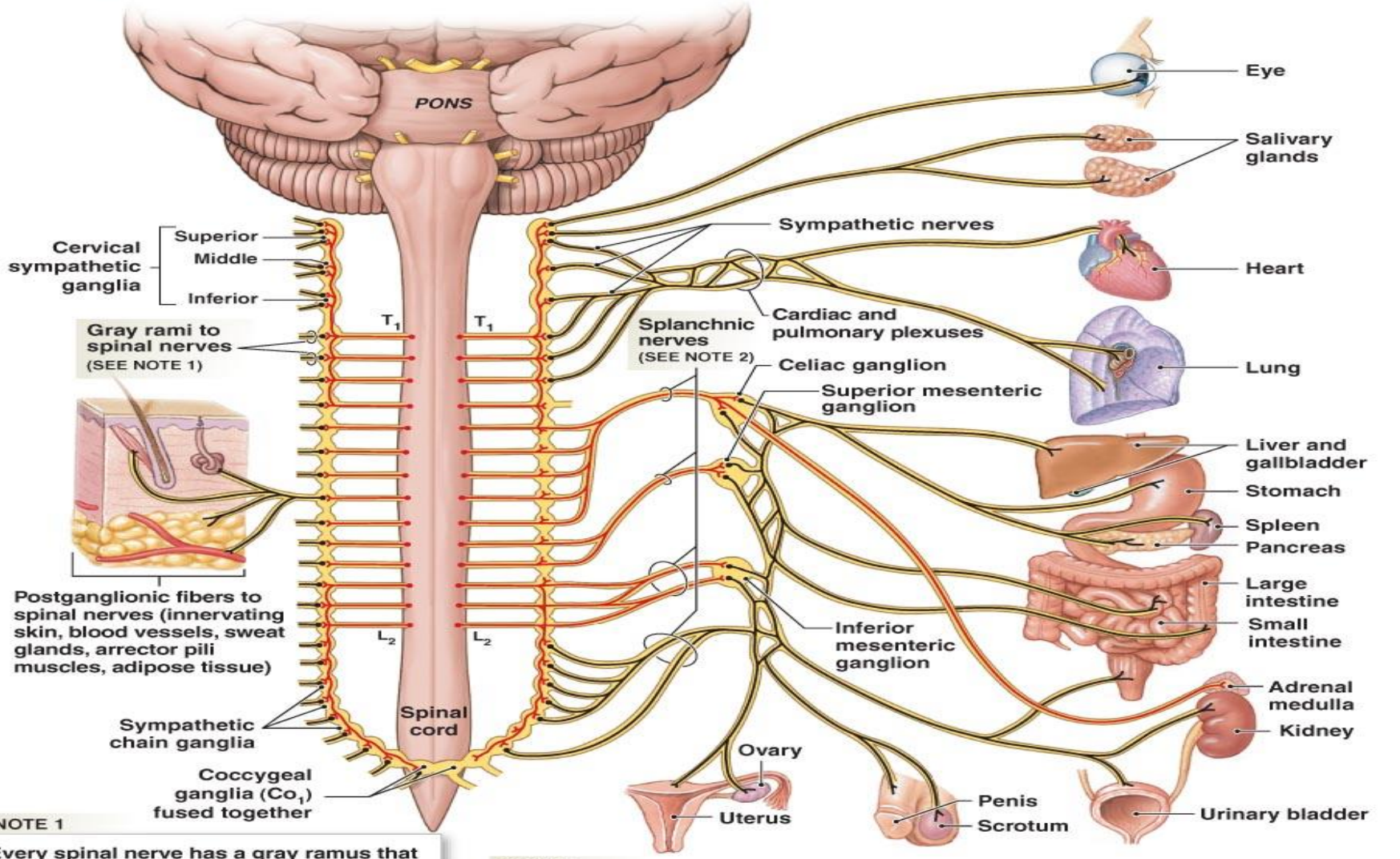


Figure 45-20 Biological Science, 2/e

Neurotransmitters in the ANS

- ANS preganglionic axons release **Ach** (**cholinergic fibers**).
- All parasympathatic postganglionic axons release **Ach**.
- Sympathetic postganglionic axons **norepinephrine** (**adrenergic fibers**).
- Sympathetic nervous system has an excitatory effect while parasympathetic nervous system has an inhibitory

The innervation of the sympathetic division: at left, the distribution of nerves to the skin, skeletal muscles, and tissues of the body wall; at right, the distribution of nerves to visceral organs



NOTE 1

Every spinal nerve has a gray ramus that carries sympathetic postganglionic fibers for distribution in the body wall and limbs. In the head and neck, postganglionic sympathetic fibers leaving the superior cervical sympathetic ganglia supply the regions innervated by cranial nerves III, VII, IX, and X.

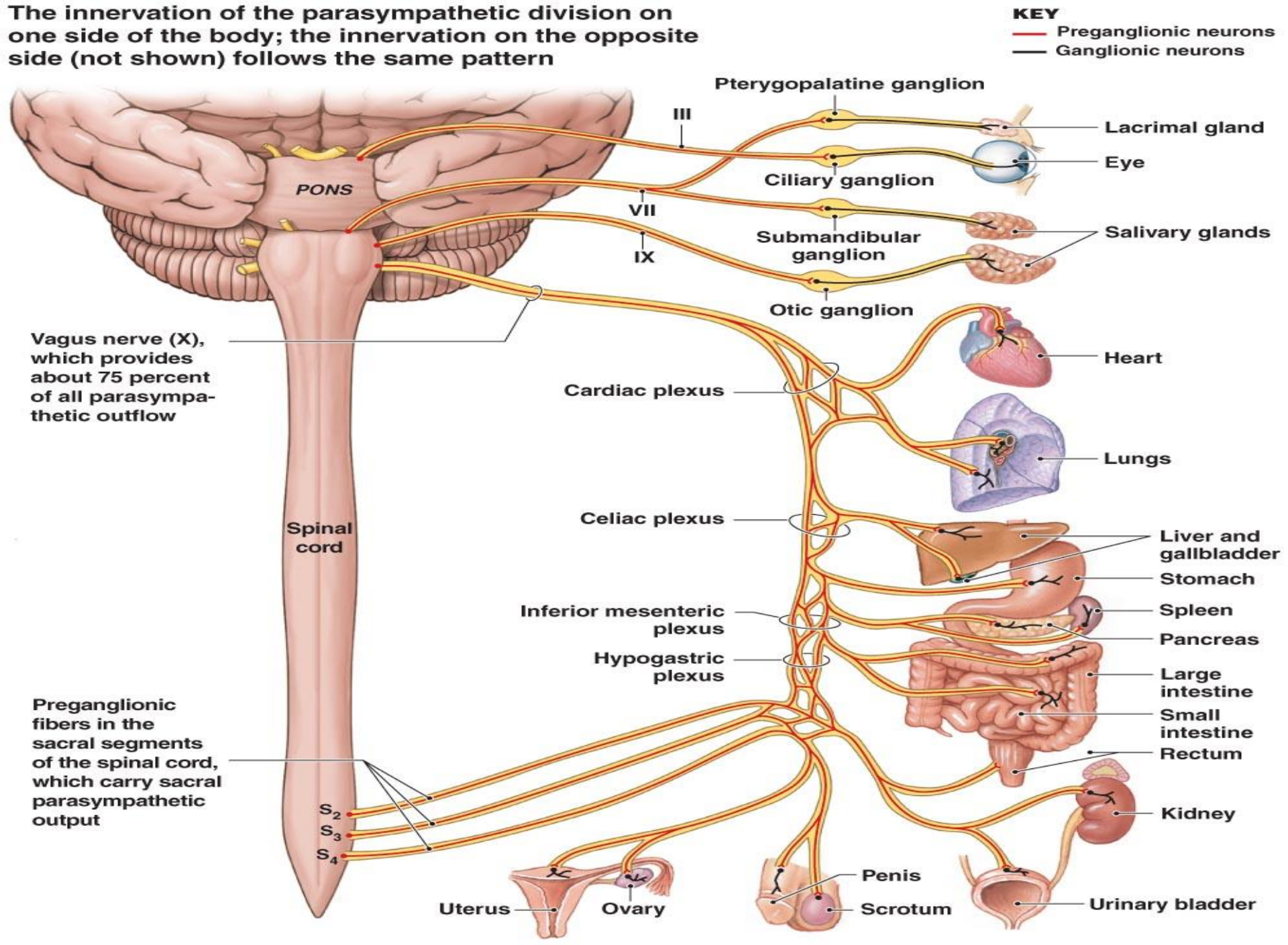
NOTE 2

Preganglionic fibers on their way to the collateral ganglia form the **splanchnic** (SPLANK-nik) **nerves**. Postganglionic fibers innervating structures in the thoracic cavity, such as the heart and lungs, form bundles known as **sympathetic nerves**.

KEY

Preganglionic neurons

Ganglionic neurons



Role of sympathetic system

- Mobilizes the body during activity; is the “fight or flight” system.

- Promotes adjustments during exercise or when threatened:

1. Blood flow is shunted to the skeletal muscles and heart.
2. Bronchioles dilate.
3. Liver releases glucose.

Role of parasympathetic division

- It promotes maintenance activities and conserve body energy.
- Its activity is illustrated in a person who relaxes or at rest, and after meal;

1. Blood pressure, heart rate, and respiratory rates are low.
2. GIT activity is high.
3. Pupils are constricted and lenses are accommondated for close vision.

ORGAN	EFFECT OF SYMPATHETIC STIMULATION	EFFECT OF PARASYMPATHETIC STIMULATION
leart	Increased rate, increased force of contraction (of whole heart)	Decreased rate, decreased force of contraction (of atria only)
lood Vessels	Constriction	Dilation of vessels supplying the penis and clitoris only
ungs	Dilation of bronchioles (airways) Inhibition (?) of mucus secretion	Constriction of bronchioles Stimulation of mucus secretion
igestive Tract	Decreased motility (movement) Contraction of sphincters (to prevent forward movement of contents) Inhibition (?) of digestive secretions	Increased motility Relaxation of sphincters (to permit forward movement of contents) Stimulation of digestive secretions
rinary Bladder	Relaxation	Contraction (emptying)
ye	Dilation of pupil Adjustment of eye for far vision	Constriction of pupil Adjustment of eye for near vision
iver (glycogen stores)	Glycogenolysis (glucose released)	None
dipose Cells (fat stores)	Lipolysis (fatty acids released)	None