

# **The 9<sup>th</sup> lecture**

**In**

# **Anatomy and Physiology**

**For the**

# **1<sup>st</sup> Class**

**By**

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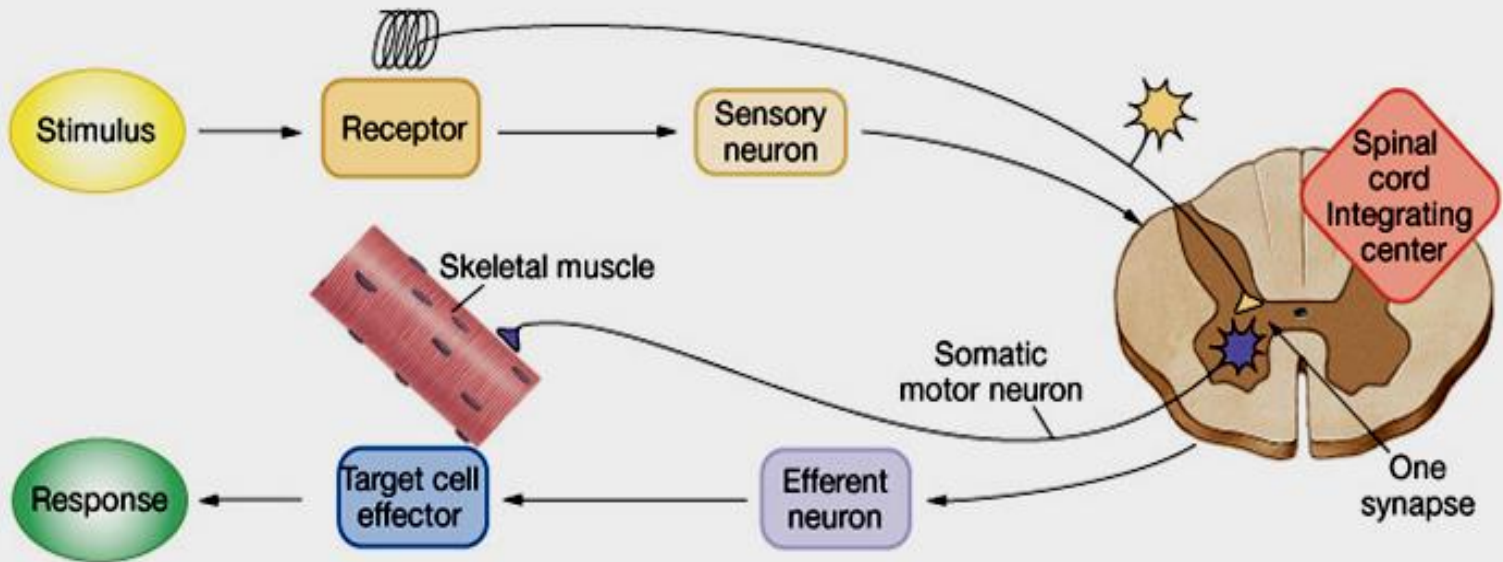
# Nervous System (Part III)

## The Peripheral Nervous System (PNS)

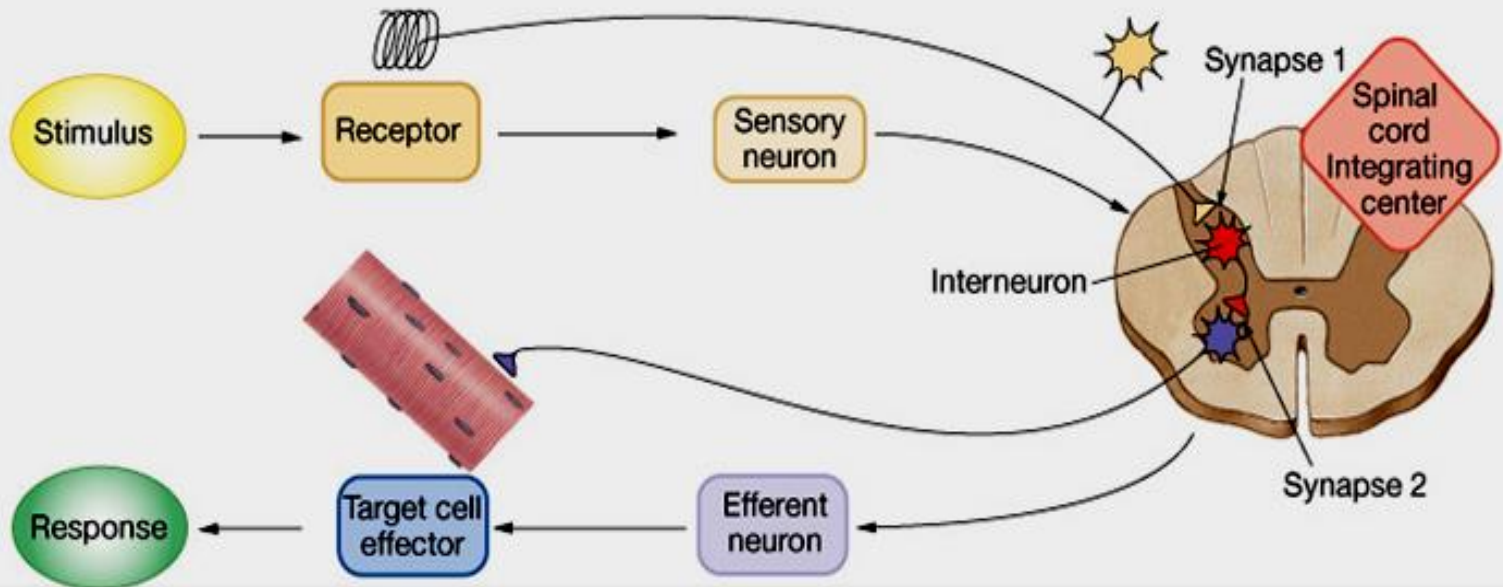
# Peripheral Nervous System (PNS)

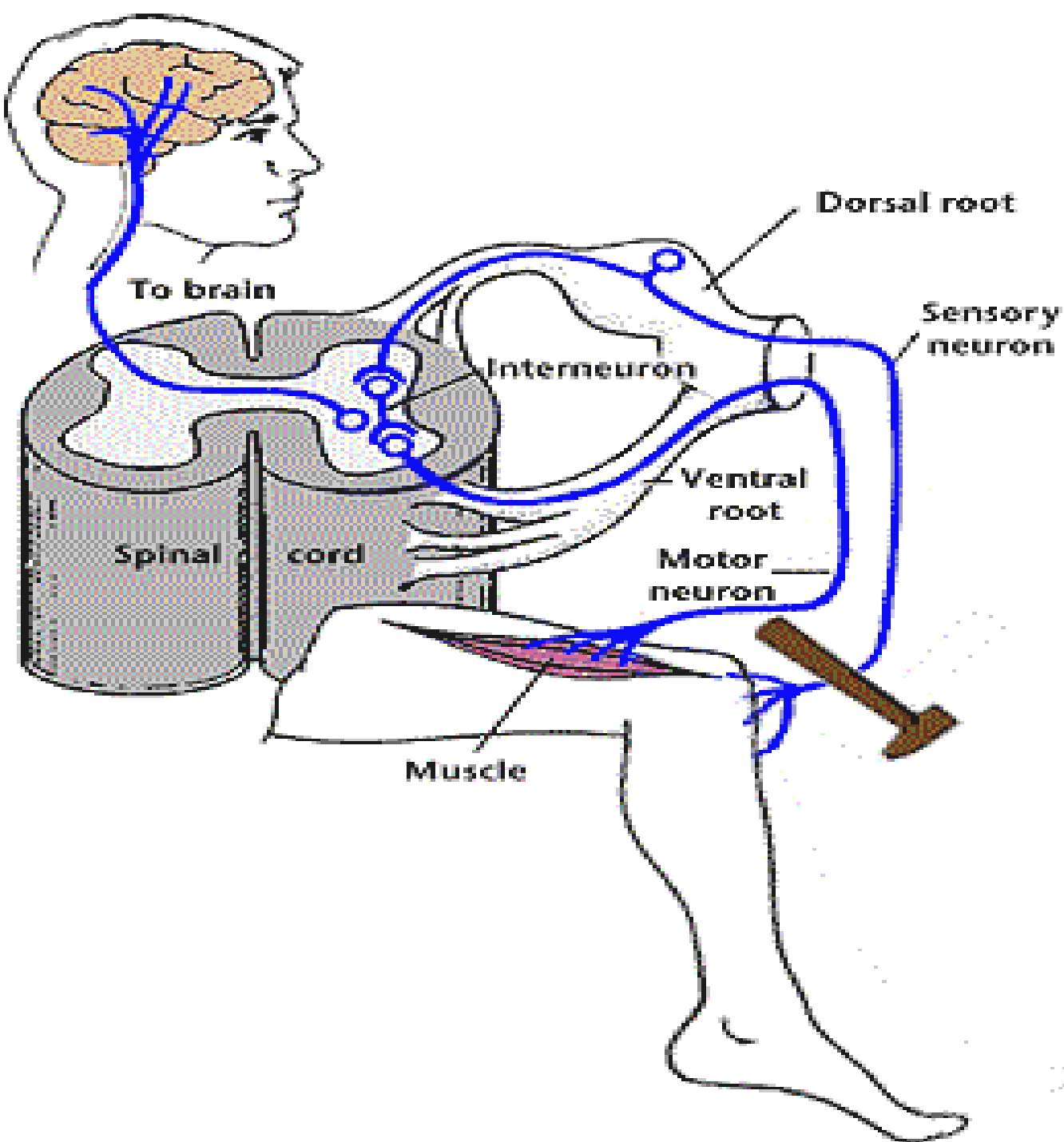
- All neuronal structures outside the central nervous system (the brain and the spinal cord) is called PNS.
- The main function of the PNS is to connect the CNS to the limbs and organs, by receiving data (such as sight or sounds) and sending it to the CNS for processing. The CNS in response to this data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

(a) A monosynaptic reflex has a single synapse between the afferent and efferent neurons.



(b) Polysynaptic reflexes have two or more synapses.





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

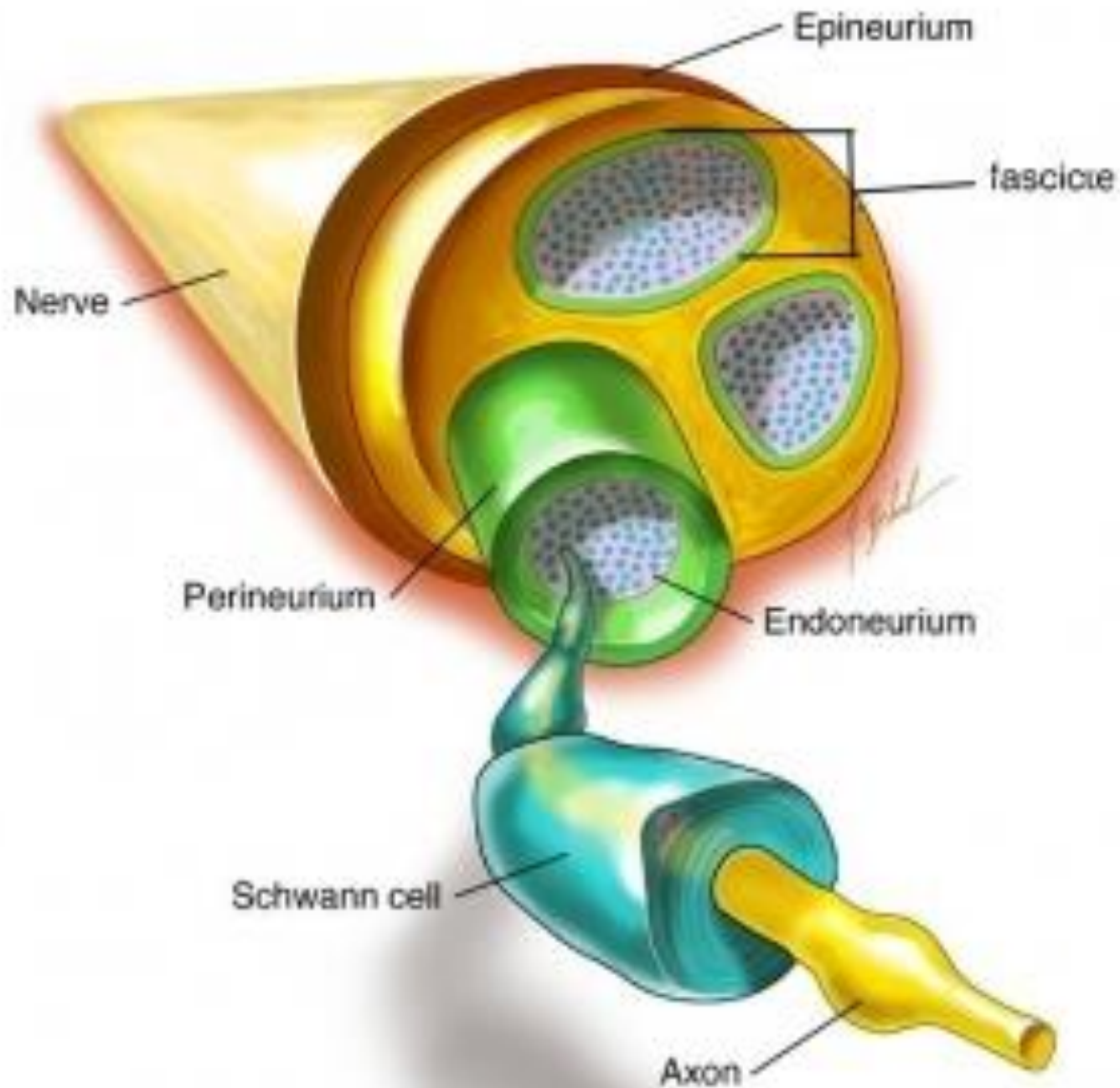
- These are specialized receptors. Their function is to respond to **stimuli** (changes in their environment).
- Examples on sensory receptors are;
  1. **Mechanoreceptors** – respond to *touch, pressure, itch* ....ect.
  2. **Thermoreceptors** – sensitive to *changes into temperature*.
  3. **Photoreceptors** – respond to *light*.
  4. **chemoreceptors** – respond to *changes in blood chemistry, smell*.



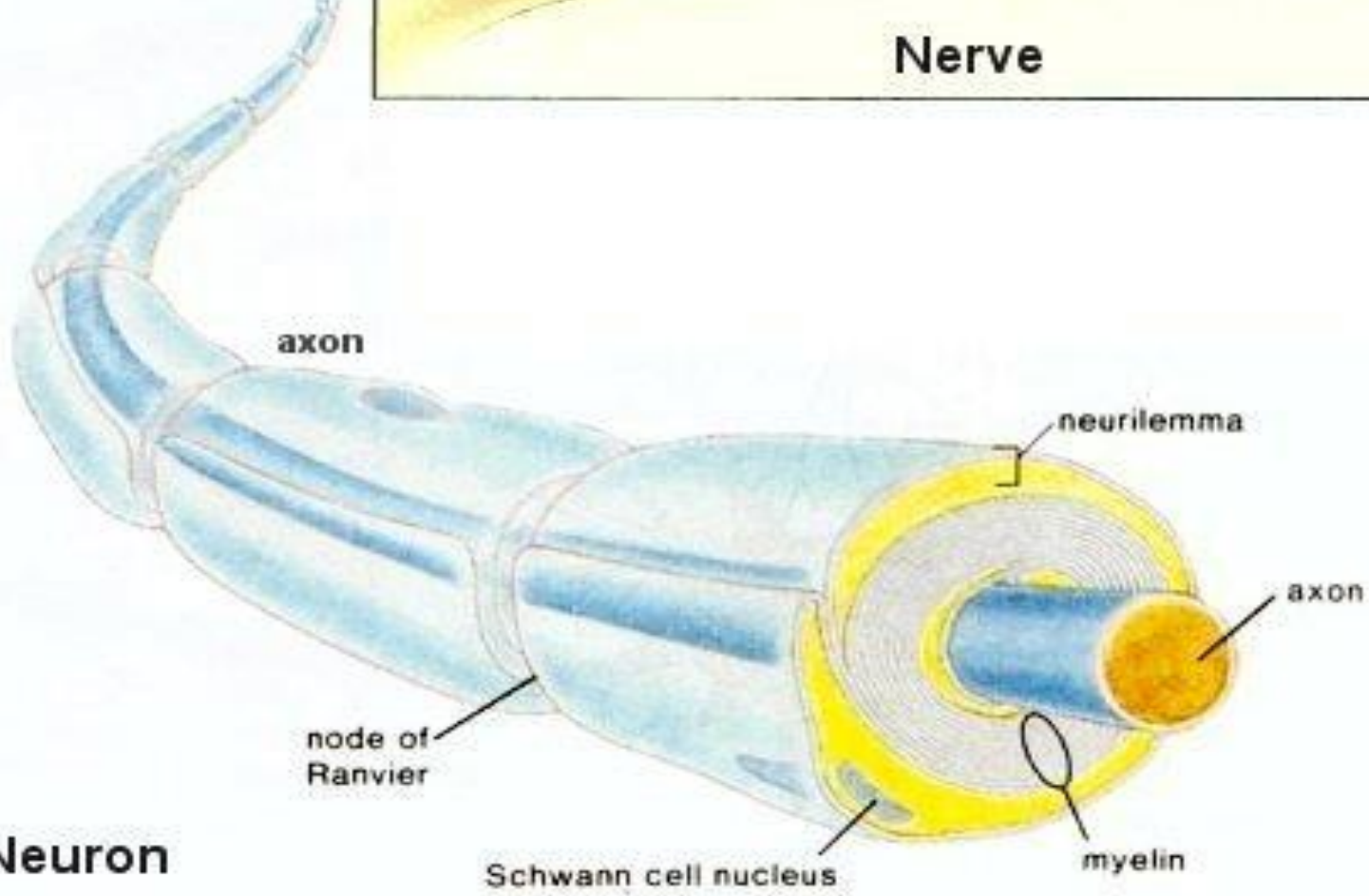
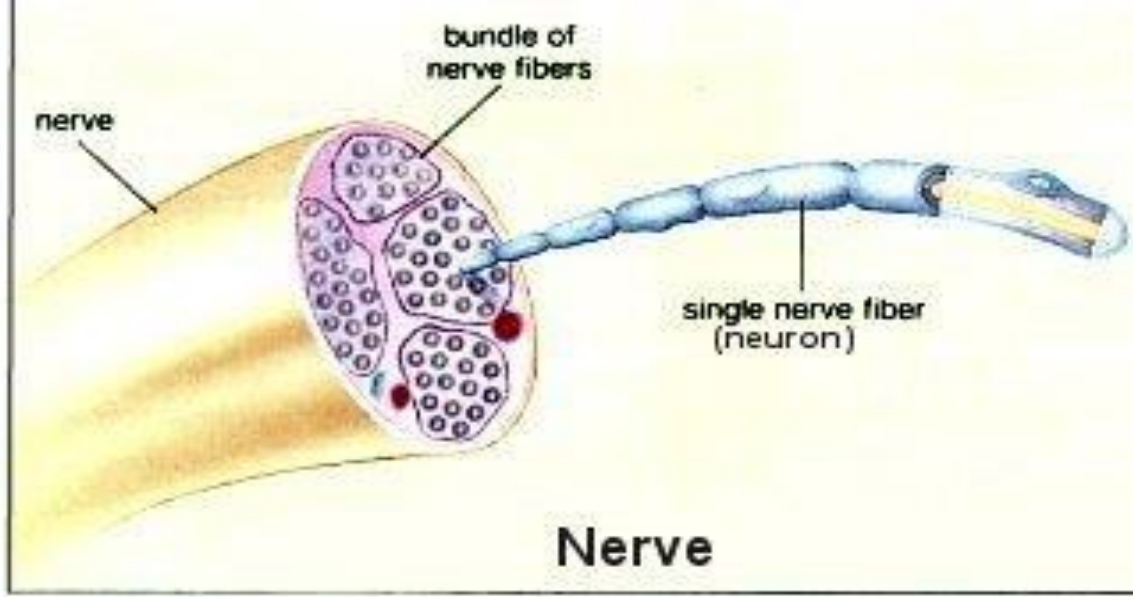
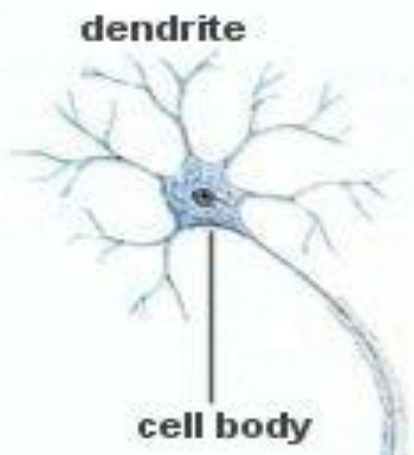
# Nerve

- 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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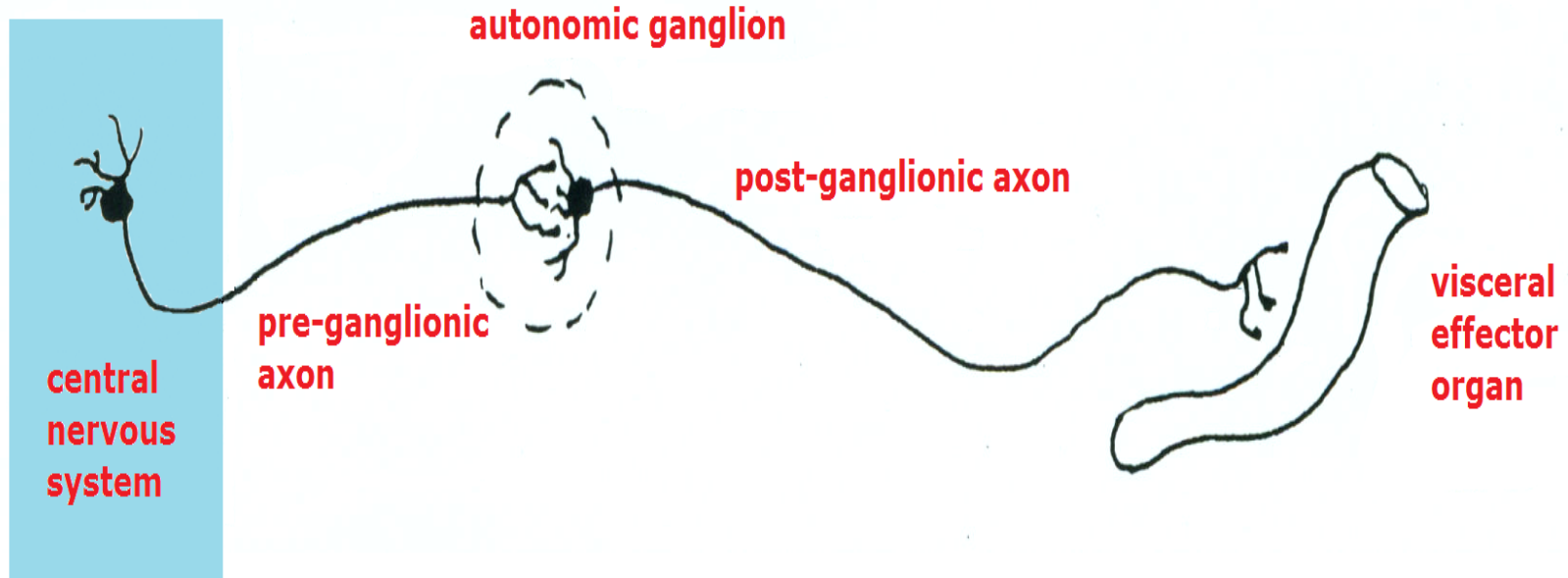
Nerve  
fiber



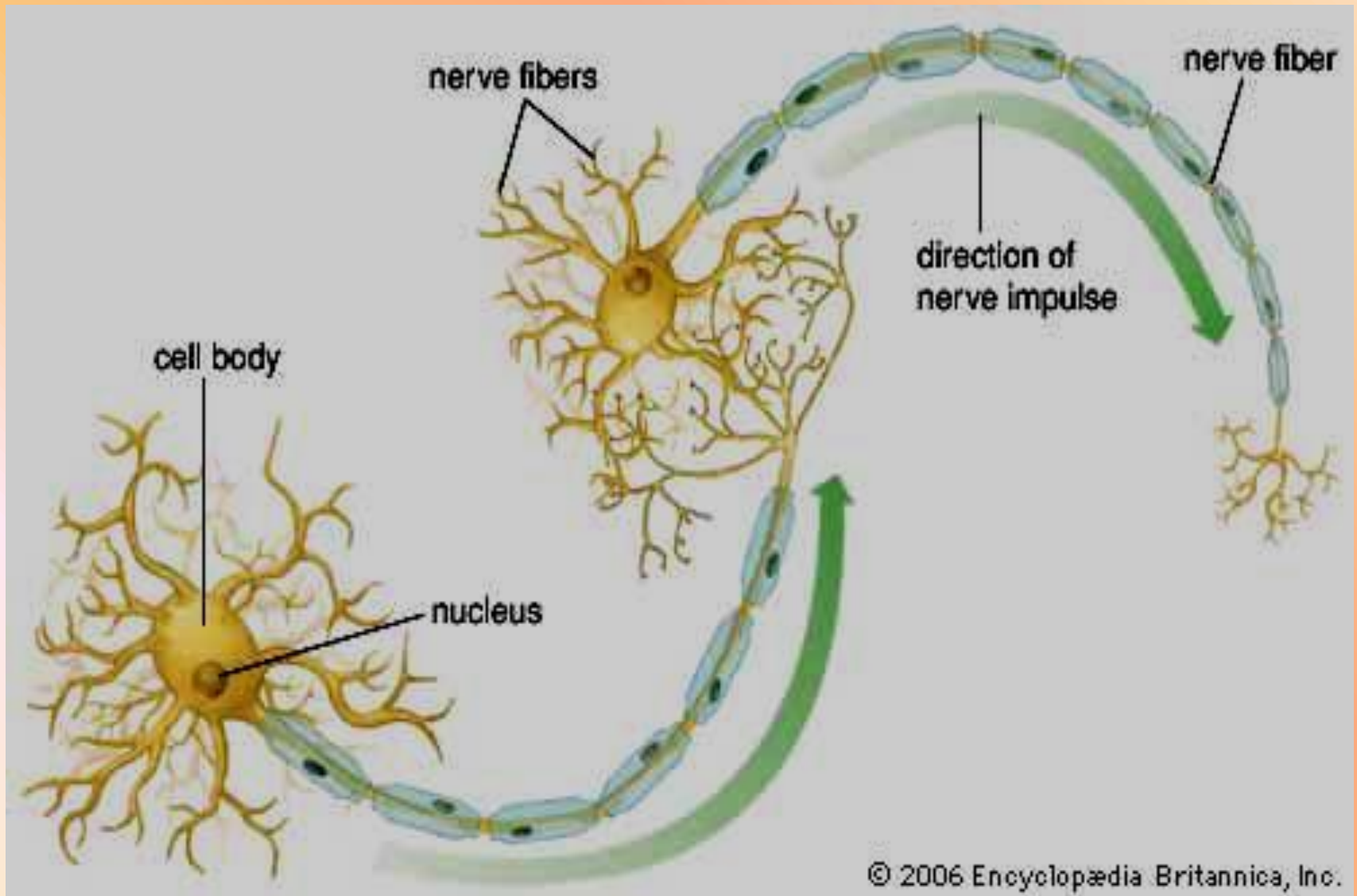
Nerve  
fiber

# Ganglia

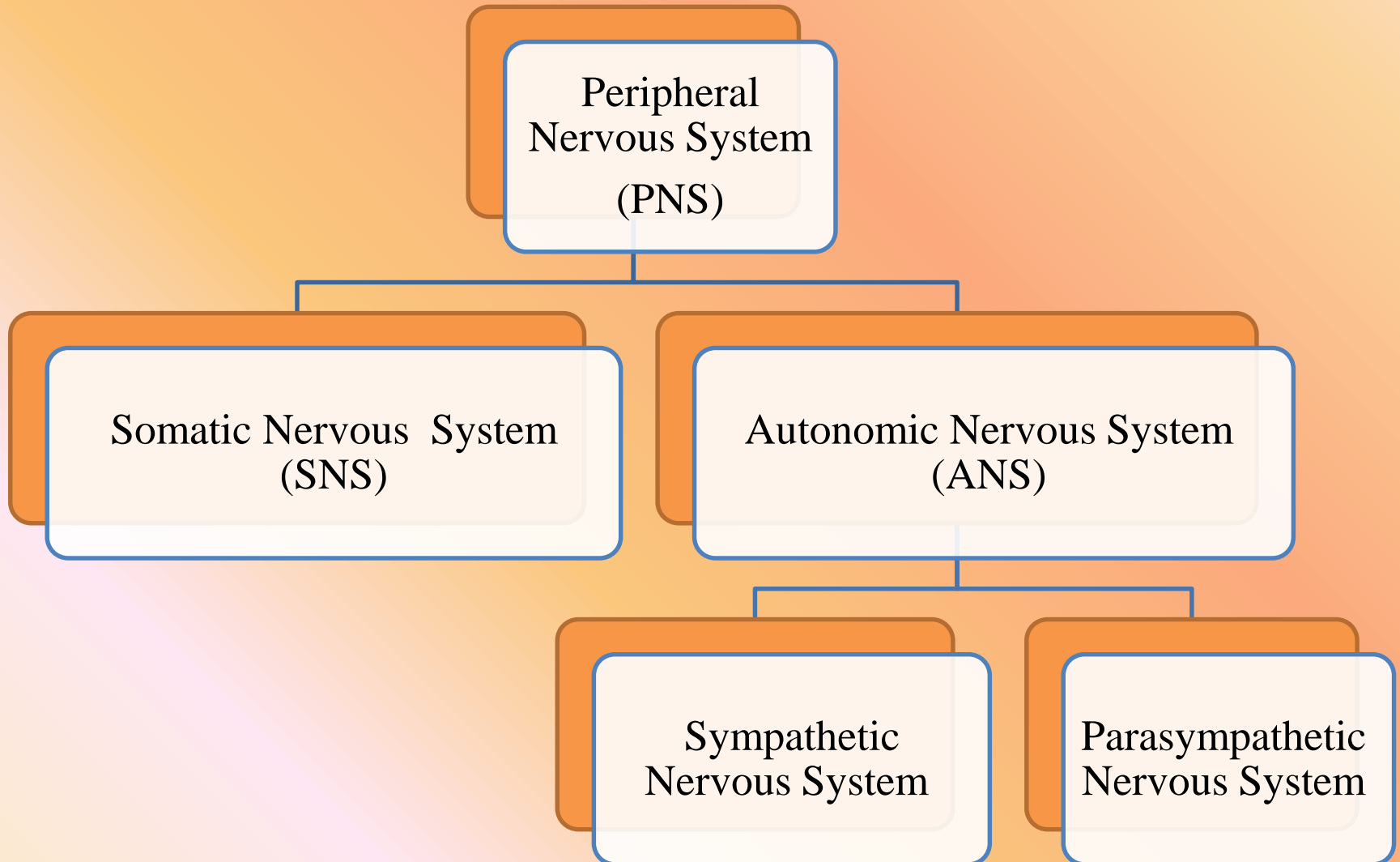
- Synapse between nerve cells outside the CNS is called ganglion



# Synapse between two neurons



# Parts of PNS



# 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 voluntary 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

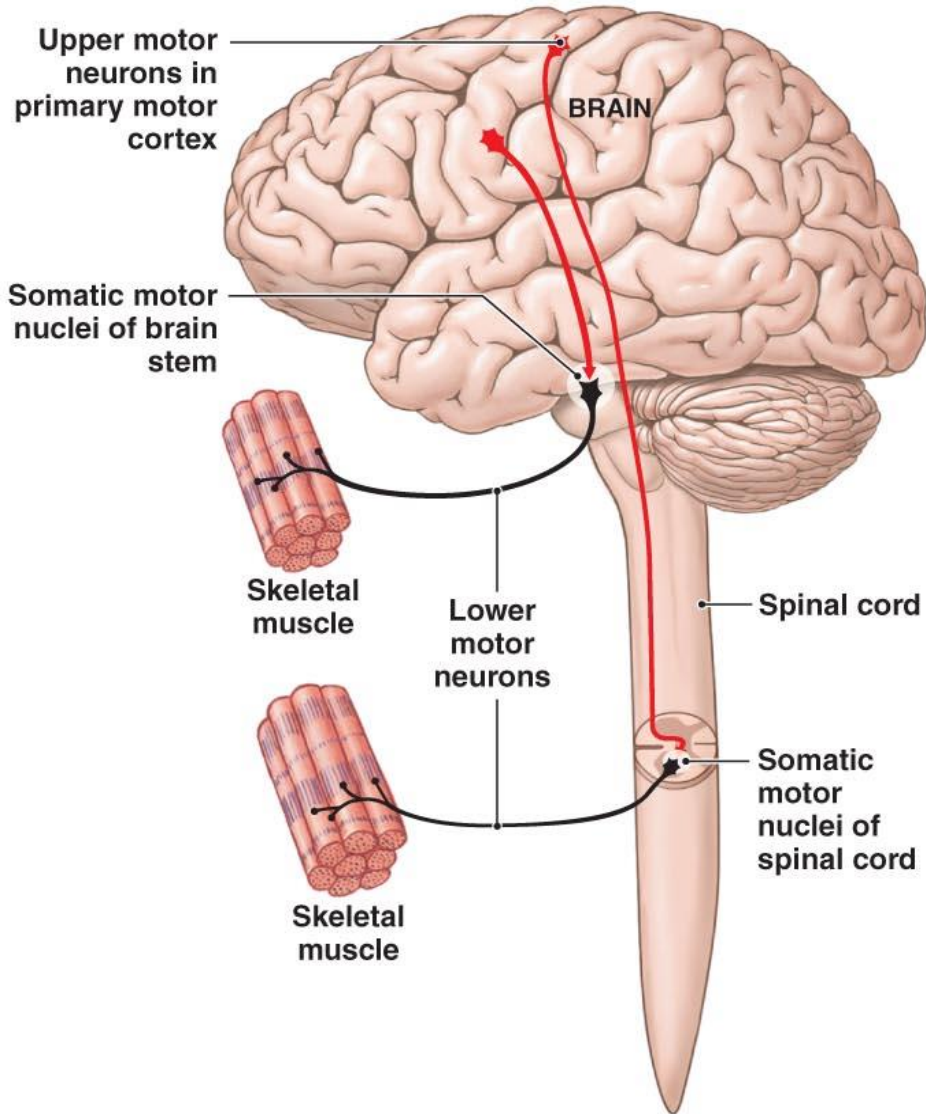


# Autonomic Nervous System (ANS)

- 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**.

# Somatic nervous system

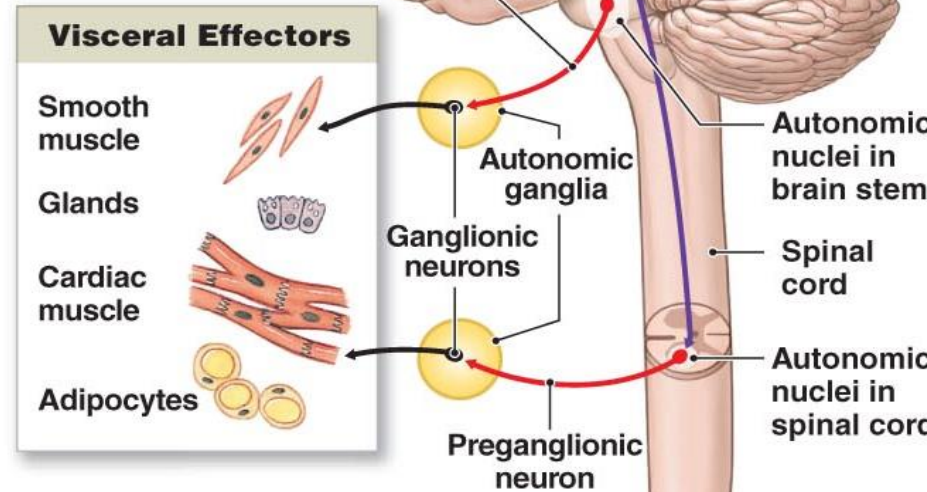
A schematic of the somatic nervous system (SNS), which provides conscious and sub-conscious control over skeletal muscles



# Parasympathetic system

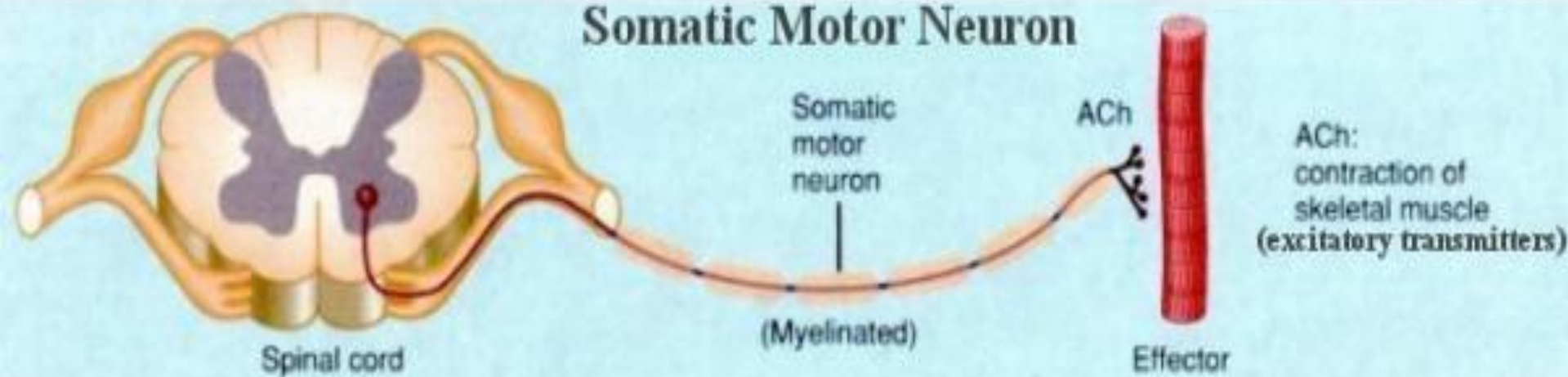
Visceral motor nuclei in hypothalamus

Preganglionic neuron

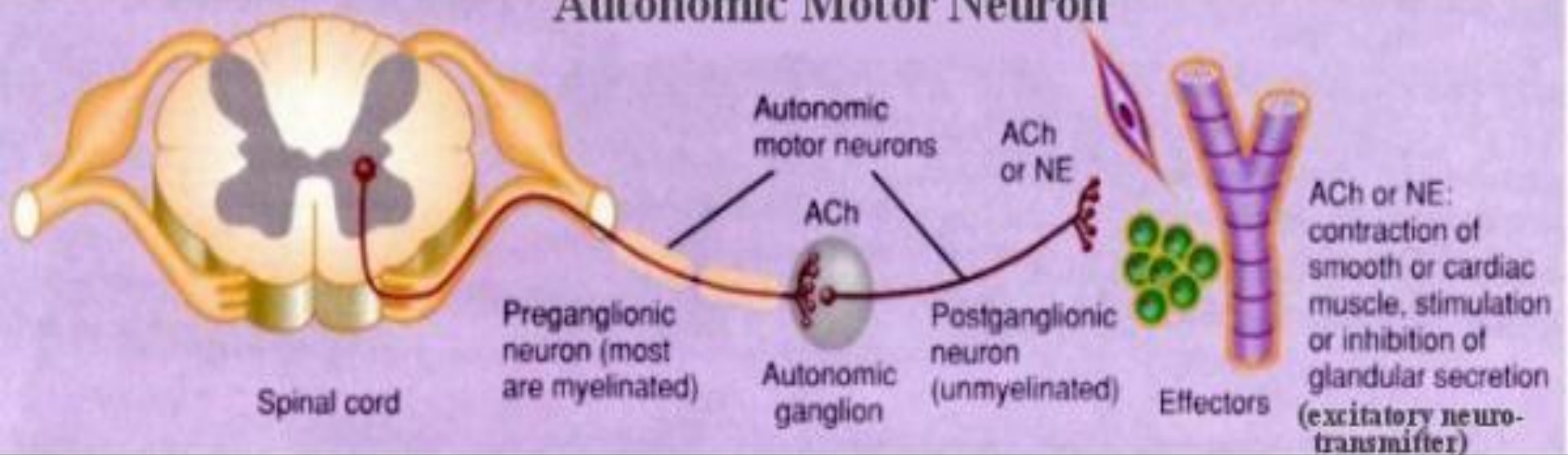


A schematic of the autonomic nervous system (ANS), which controls visceral functions largely outside our awareness

## Somatic Motor Neuron

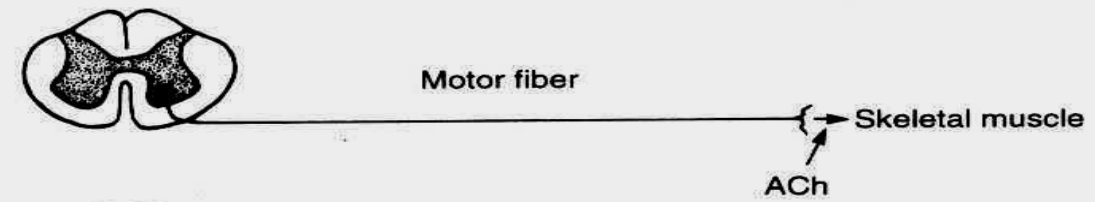


## Autonomic Motor Neuron



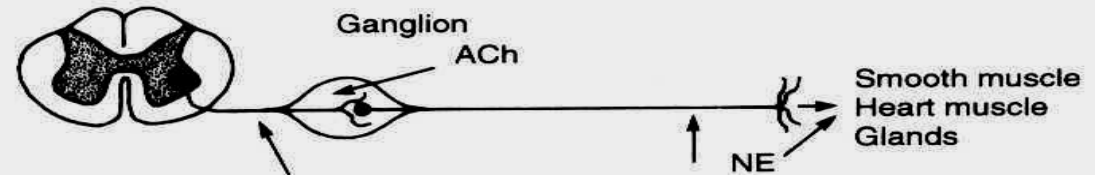
# PERIPHERAL EFFERENT NERVES

SOMATIC

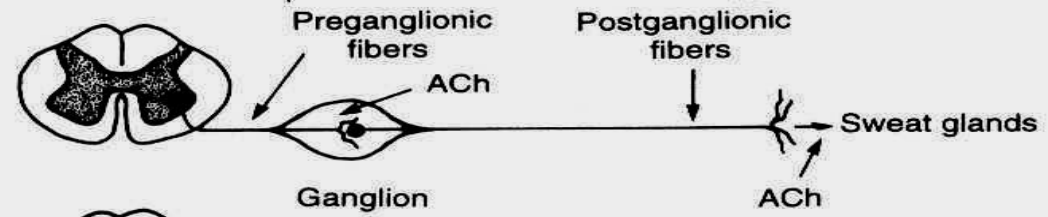


AUTONOMIC

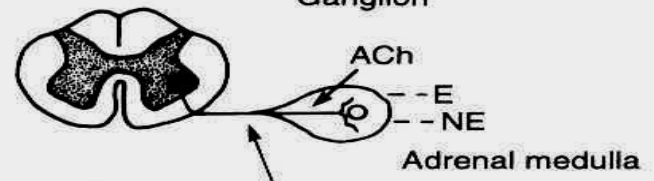
Sympathetic



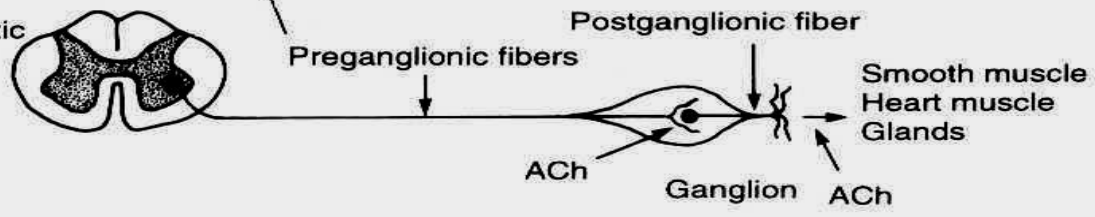
Sympathetic



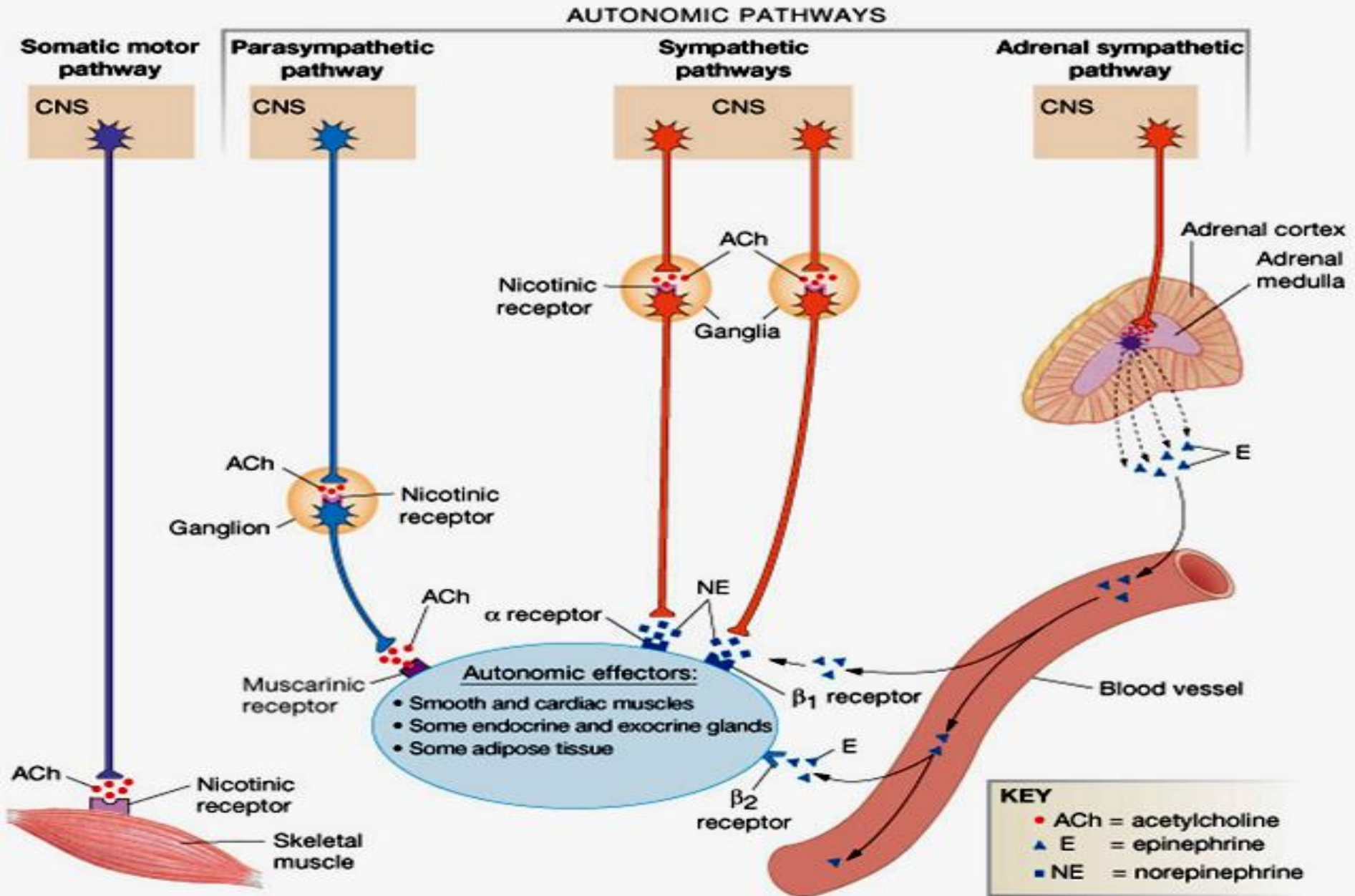
Sympathetic



Parasympathetic



# 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.

# ANS Anatomy

- The origin of **sympathetic fibers** is **thorocolumbar** region of the spinal cord while **parasympathetic fibers** are originated from brain and sacral spinal cord (**craniosacral**).
- The length of *pre-ganglionic sympathetic fibers* are **short**, but *post-ganglionic sympathetic fibers* are **long**.
- In contrast *pre-ganglionic parasympathetic fibers* are **long** and post ganglionic parasympathetic fibers are **short**.
- The **ganglia** in sympathetic system are located close to the to the spinal cord, but in parasympathetic system the ganglia located near the viscera (organ).

# PARASYMPATHETIC NERVES

"Rest and digest"

# SYMPATHETIC NERVES

"Fight or flight"

Constrict pupils

Stimulate saliva

Slow heartbeat

Constrict airways

Stimulate activity of stomach

Inhibit release of glucose; stimulate gallbladder

Stimulate activity of intestines

Contract bladder

Promote erection of genitals

Dilate pupils

Inhibit salivation

Increase heartbeat

Relax airways

Inhibit activity of stomach

Stimulate release of glucose; inhibit gallbladder

Inhibit activity of intestines

Secrete epinephrine and norepinephrine

Relax bladder

Promote ejaculation and vaginal contraction

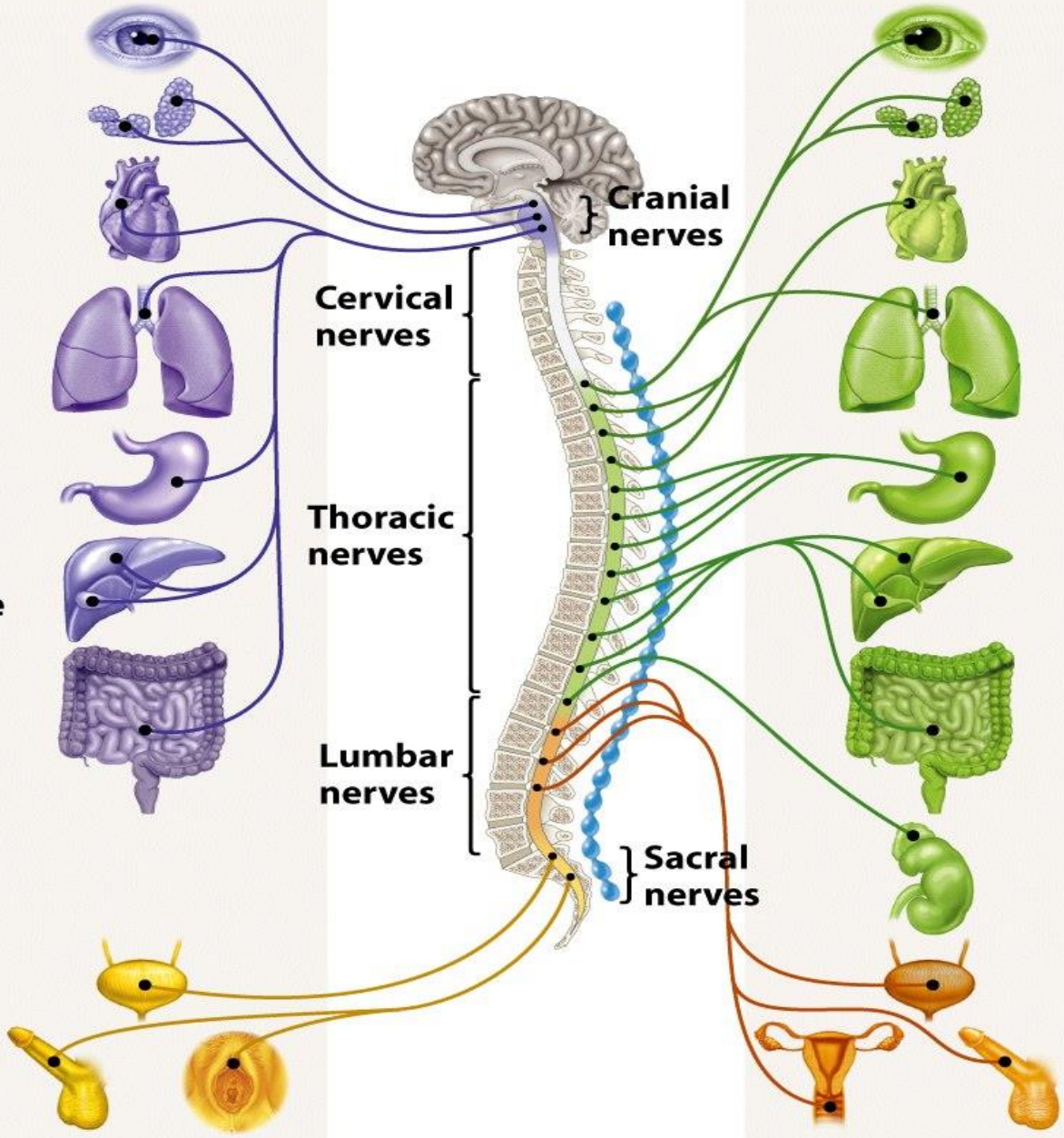


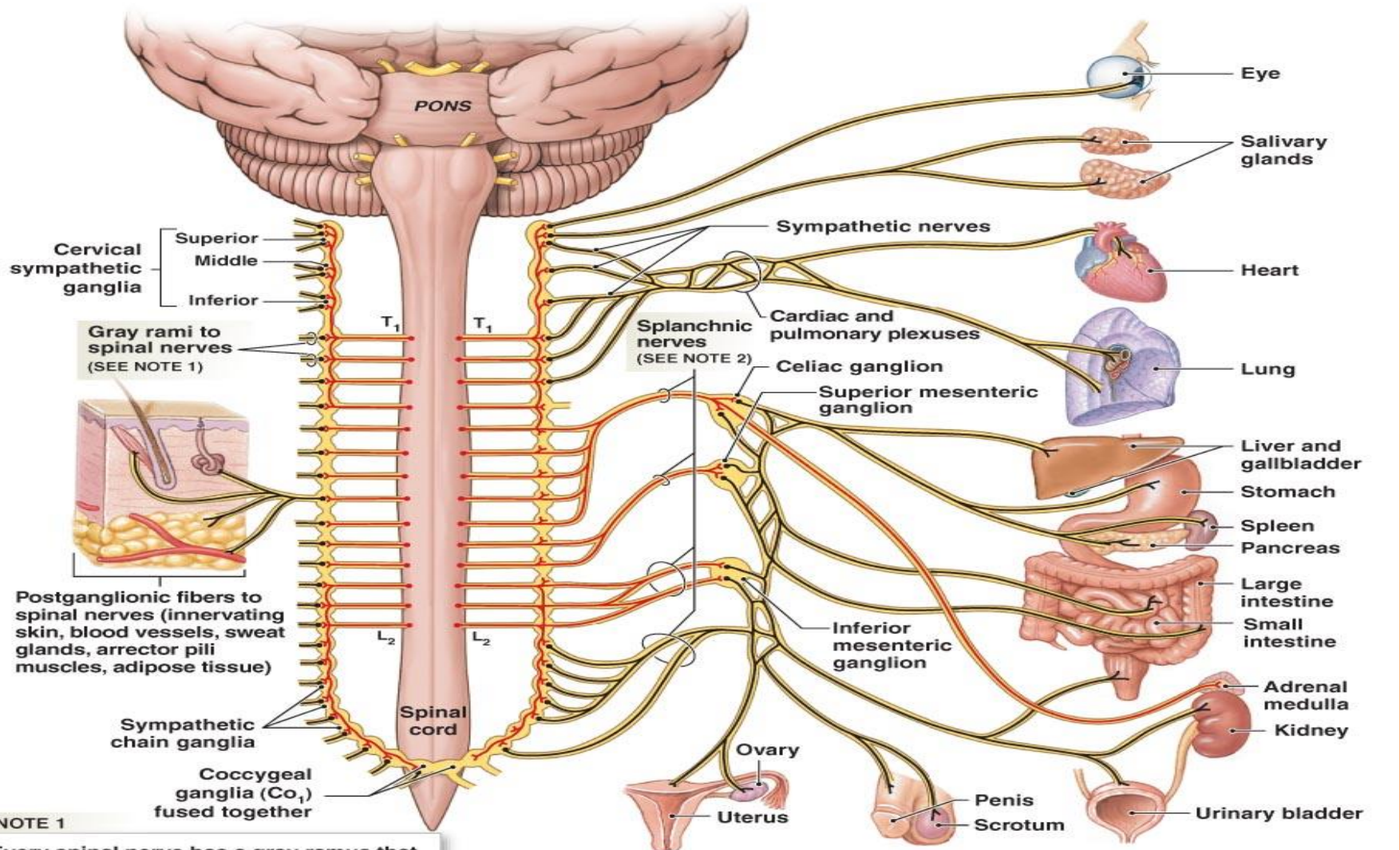
Figure 45-20 Biological Science, 2/e



# Neurotransmitters in the ANS

- ANS preganglionic axons release **Ach (cholinergic fibers)**.
- All parasympathetic 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**

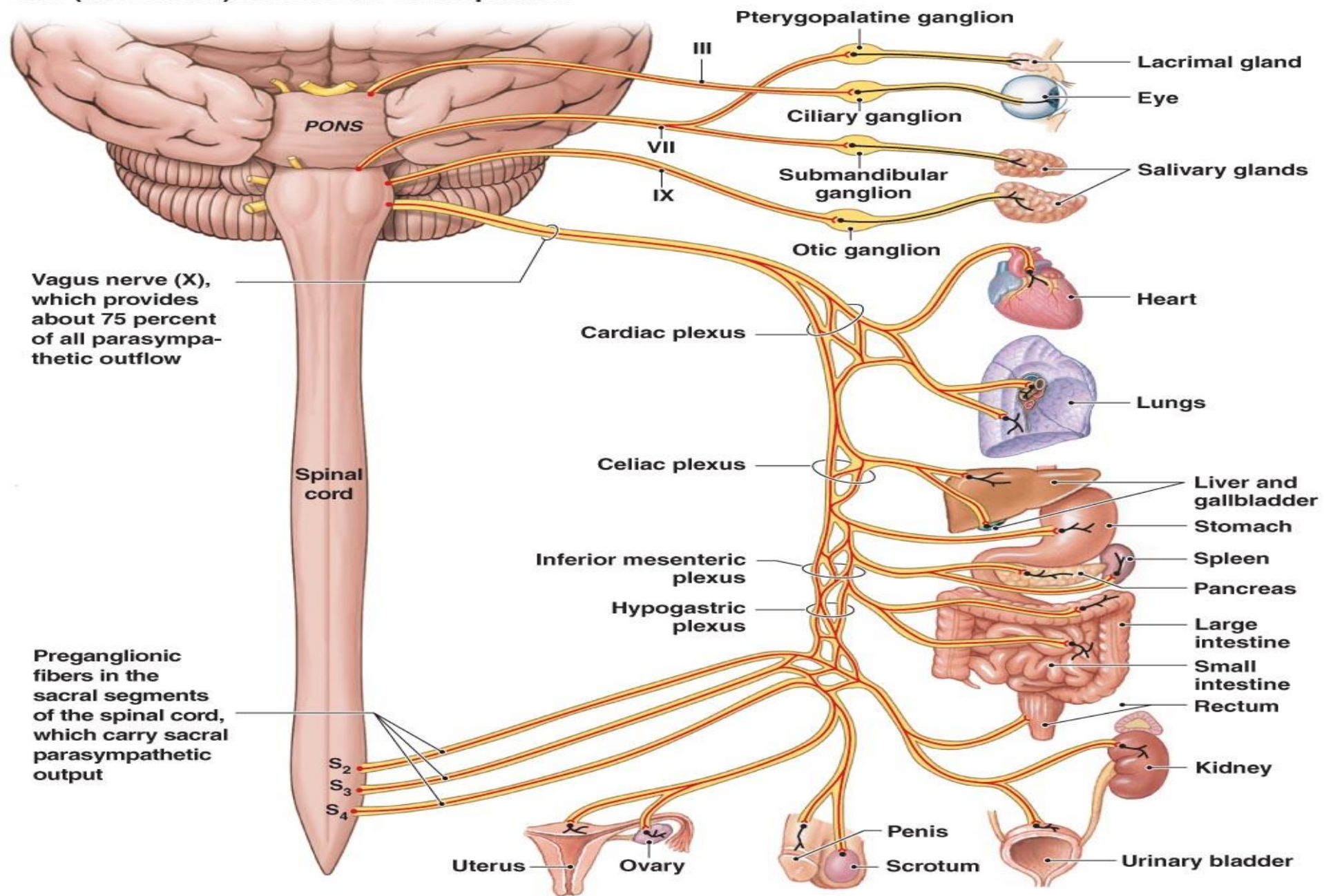
Preganglionic fibers on their way to the collateral ganglia form the **splanchnic (SPLANK-nik) nerves**. Postganglionic fibers innervating structures in the thoracic cavity, such as the heart and lungs, form bundles known as **sympathetic nerves**.

**KEY**

- Preganglionic neurons
- Ganglionic neurons

The innervation of the parasympathetic division on one side of the body; the innervation on the opposite side (not shown) follows the same pattern

**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 accommodated for close vision.

ORGAN	EFFECT OF SYMPATHETIC STIMULATION	EFFECT OF PARASYMPATHETIC STIMULATION
<b>Heart</b>	Increased rate, increased force of contraction (of whole heart)	Decreased rate, decreased force of contraction (of atria only)
<b>Blood Vessels</b>	Constriction	Dilation of vessels supplying the penis and clitoris only
<b>Lungs</b>	Dilation of bronchioles (airways) Inhibition (?) of mucus secretion	Constriction of bronchioles Stimulation of mucus secretion
<b>Digestive Tract</b>	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
<b>Urinary Bladder</b>	Relaxation	Contraction (emptying)
<b>Eye</b>	Dilation of pupil Adjustment of eye for far vision	Constriction of pupil Adjustment of eye for near vision
<b>Liver (glycogen stores)</b>	Glycogenolysis (glucose released)	None
<b>Adipose Cells (fat stores)</b>	Lipolysis (fatty acids released)	None