Animal production 1
(Physiology)

The Nervous System

Lec.5

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The Nervous System

There are two systems used for communication in your body:

1. *The nervous system controls and coordinates functions throughout the body and responds to internal and external stimuli with the use of nerves (Ex : pain , temperature , ….).*

1. *The endocrine system performs a similar function with the use of hormones.*

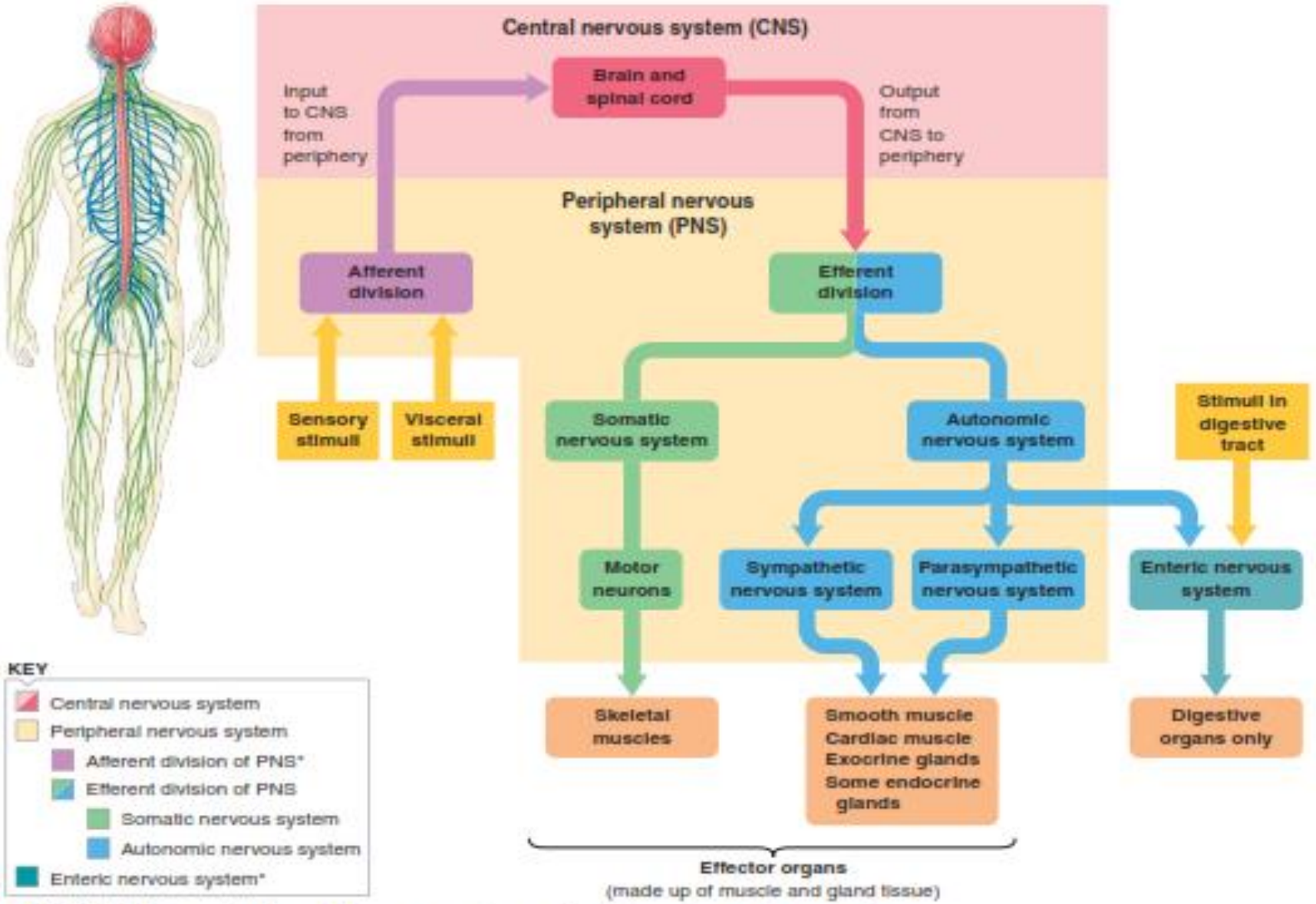
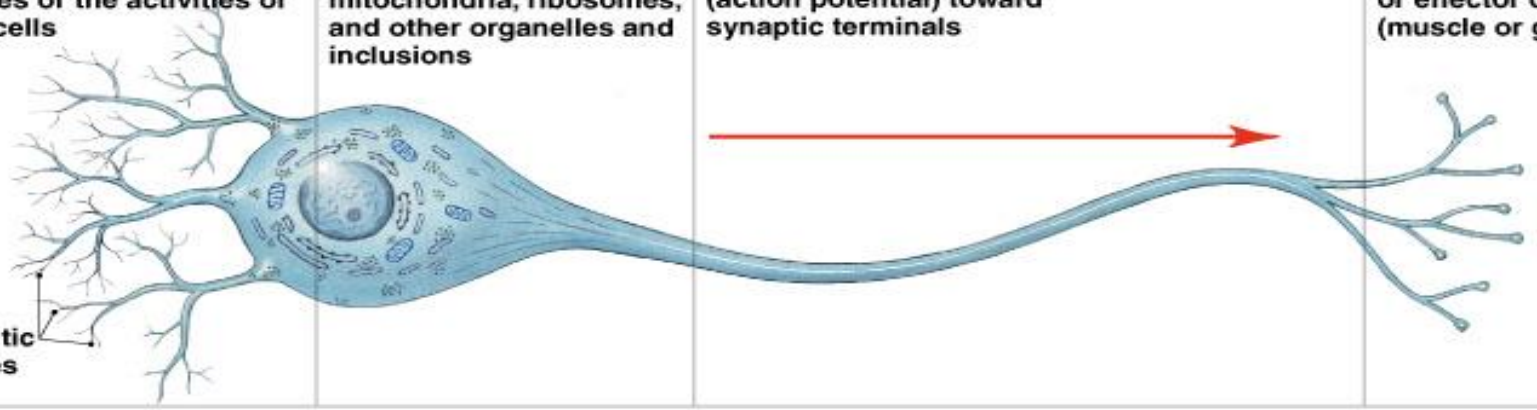


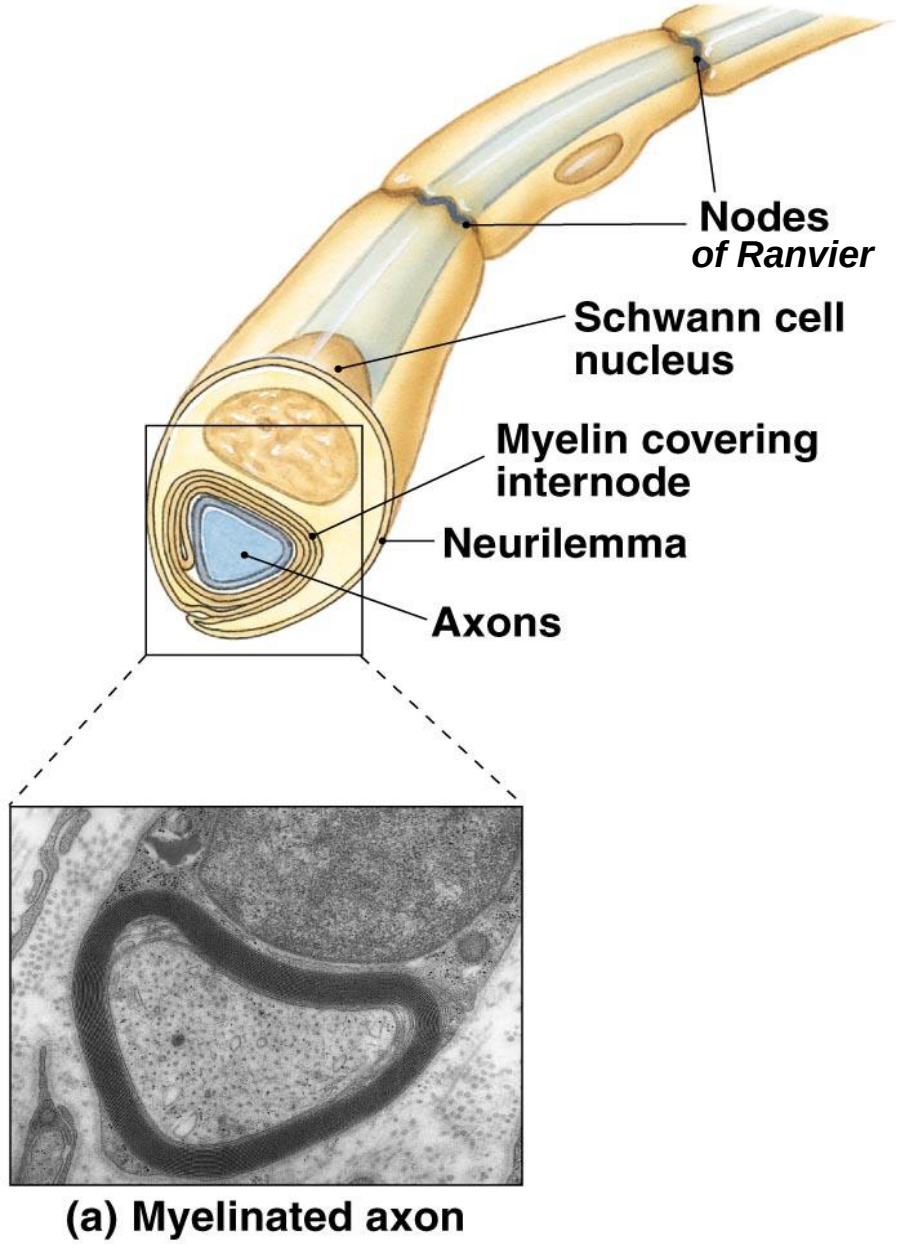
FIGURE 5-1 Organization of the nervous system. *The afferent division of the PNS and enteric nervous system are not shown in the human figure. Afferent fibers travel within the same nerves as efferent fibers but in the opposite direction. The enteric nervous system lies entirely within the wall of the digestive tract.

❖ Neuron structure*

Dendrites	Cell body	Axon	Synaptic terminals
Stimulated by environmental changes or the activities of other cells	Contains the nucleus and mitochondria, ribosomes, and other organelles and inclusions	Conducts nerve impulse (action potential) toward synaptic terminals	Affect another neuron or effector organ (muscle or gland)



Human Anatomy, 5e
by Frederic H. Martini/Michael J. Timmons/Robert B. Tallitsch



(a) Myelinated axon

- **Most** ***axons of the nervous system are surrounded by a myelin sheath (myelinated axons).***
- ✓ **The presence of myelin speeds up the transmission of action potentials along the axon.**
- ✓ ***Regions of the nervous system containing groupings of myelinated axons make up the* "white matter".**
- ✓ **"gray matter"** ***is mainly comprised of groups of neuron cell bodies, dendrites & synapses (connections between neurons).***

❖ Nerves:

Neurons *bundle together to form nerves. Some nerves may be only a few neurons, and others may be hundreds or thousands.*

- *The* **myelin sheath** *may insulate axons by surrounding it.*
- *There may be some gaps in the myelin sheath called* **nodes.**
- *Impulses jump from one node to the next, increasing the speed impulses travel.*

❖ *The speed, with which action potential travels down the axon depends on two factors:*

1- Whether the fiber is myelinated and ,

2- The diameter of the fiber.

- **Myelinated fibers** *conduct impulses about* **50 times** *faster than* **unmyelinated fibers** *of comparable size.*
- *When fiber diameter* **increases**, *the resistance to local current* **decreases**. *Thus, the larger the diameter of the nerve fiber, the faster it can propagate action potentials.*

❖ Classification of neurons:

Functional classification ***based on: type of information & direction of information transmission.***

1-Sensory (afferent) neurons –

- ***transmit sensory information from receptors of PNS towards the CNS.***
- ***most sensory neurons are unipolar, a few are bipolar.***

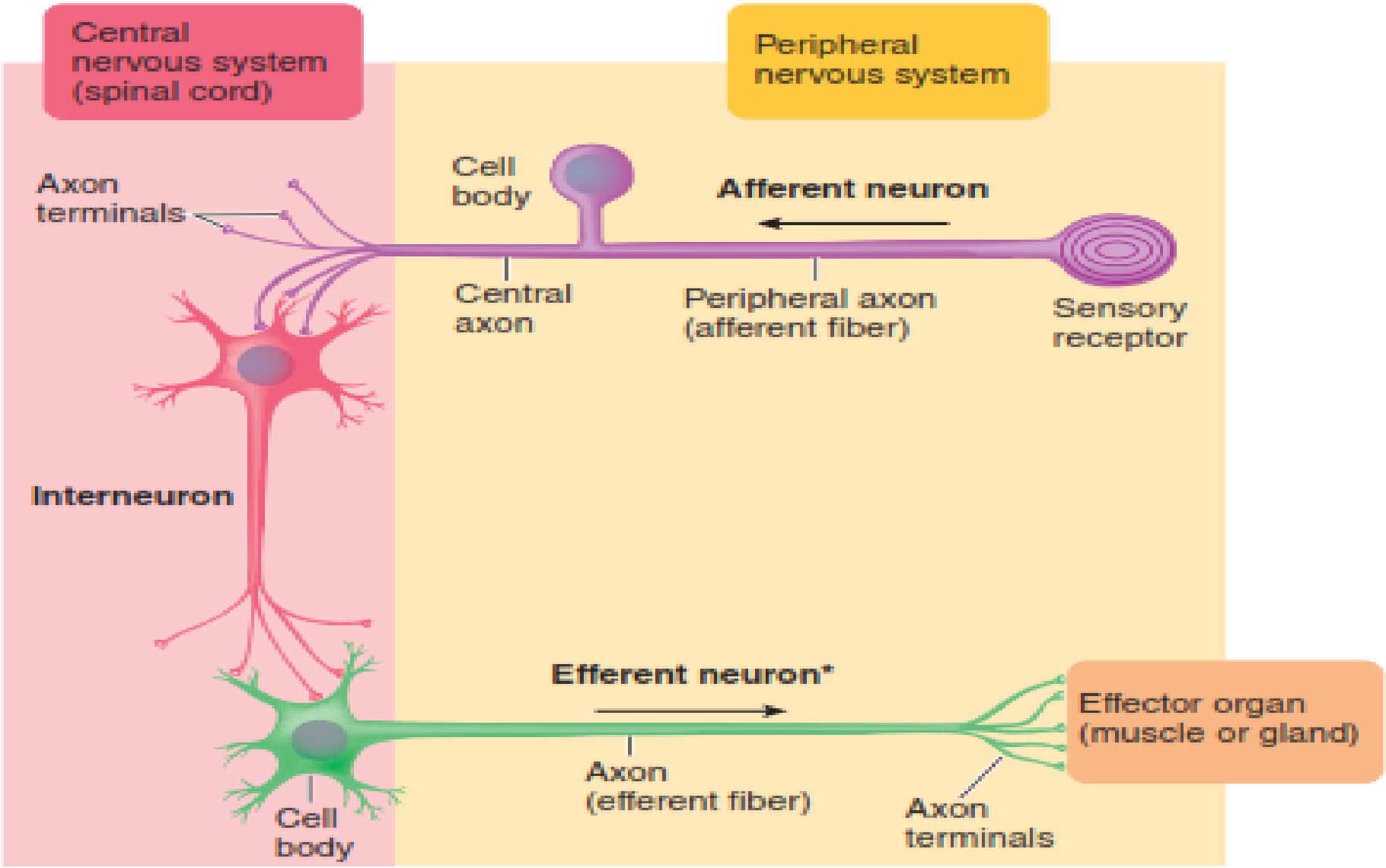
2-Motor (efferent) neurons –

- ***transmit motor information from the CNS to effectors (muscles /glands /adipose tissue) in the periphery of the body → all are multipolar.***

3-Association (interneurons) –

- ***transmit information between neurons within the CNS; analyze inputs, coordinate outputs → are the most common type of neuron (99% of all neuron) , all → are multipolar.***

✓ ***The structural link between the PNS and CNS occurs in the gray matter of the CNS. The grey matter can be viewed as the "computers" of the CNS and the white matter as the "wires" that connect the computers to each other.***



- **FIGURE 5-2 Structure and location of the three functional classes of neurons.** *Efferent autonomic nerve pathways consist of a two-neuron chain between the CNS and the effector organ.

Sense organs:

- ***Sensory receptors** are concentrated in the* **sense organs** →→

Eyes- Ears – Nose –Mouth - Skin

****The five general categories of* sensory receptors *are*:**

1-Pain receptors,

2-Thermo receptors,

3-Mechanoreceptors,

4-Chemoreceptors,and

5-Photoreceptors.

- **The 5 senses**: →→

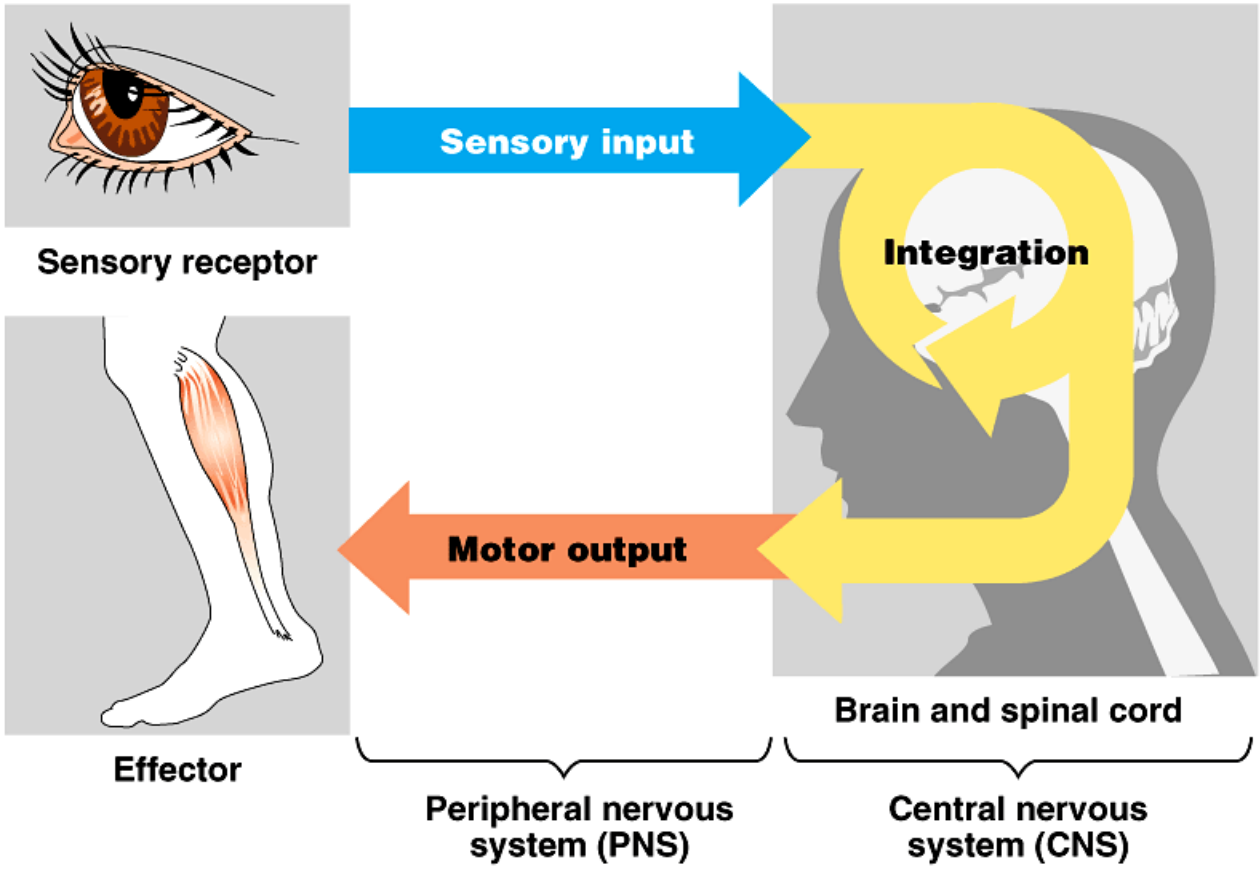
1-See,

2-Hear,

3-Smell,

4–Taste, and

5-Touch.



Resting Nerve:

Nerve impulses are electrical. The electric potential is created as the result of a sodium - potassium pump . It uses ATP to pump sodium ions (Na^+) out and potassium ions (K^+) in = active transport.

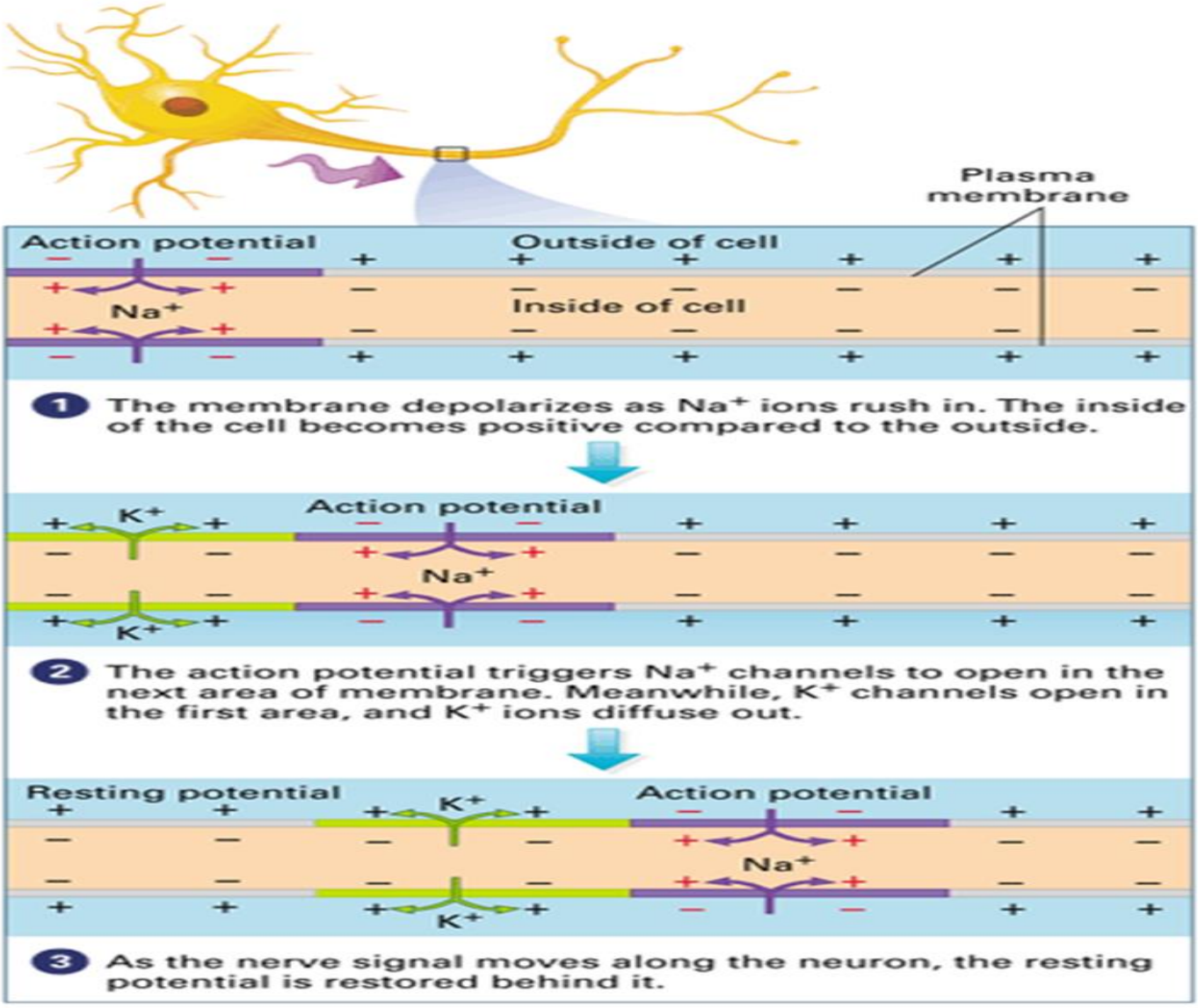
- ✓ ***This results in a negative charge inside the cell membrane and positive charge outside = resting potential.***

Nerve Impulse:*

An impulse begins when a neuron is stimulated by another neuron or by the environment.

- ✓ ***An impulse causes positively charged sodium ions (Na^+) to flow in temporarily reversing the charge of the cell membrane = action potential.***
- ✓ ***As the impulse passes, positively charged potassium ions (K^+) flow out and the charges restore to the normal resting potential.***

Nerve Impulse:*

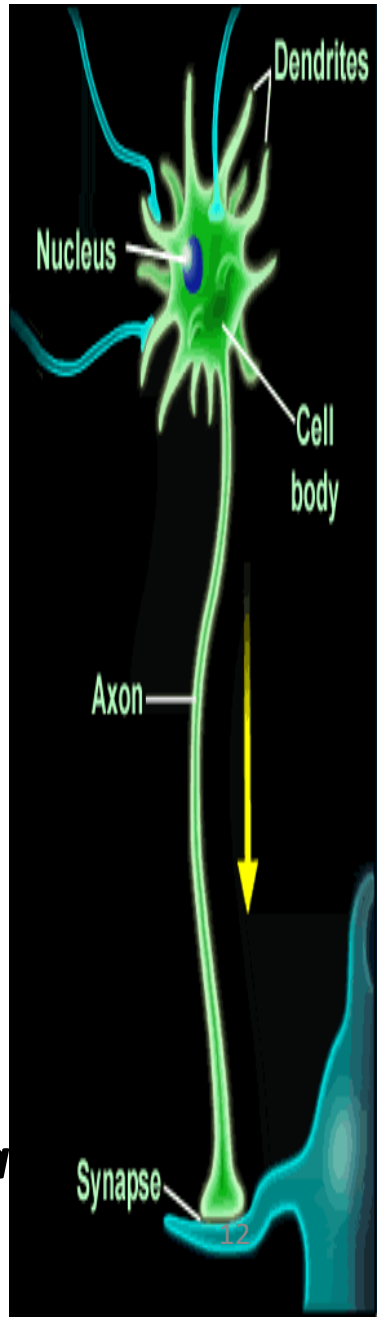


❖ Conduction across synapses:*

What happens once an action potential reaches the end of an axon?

- ***When the action potential reaches the axon terminals, they release a chemical messenger that alters the activity of the cells on which the neuron terminates.***
- ***A neuron may terminate at one of three structures: a muscle, a gland, or another neuron.***
- ***Therefore, depending on where a neuron terminates, can cause a muscle cell to contract, a gland cell to secrete, another neuron to transmit an electrical message along a nerve pathway, or some other function.***
- ***For now we will concentrate on the junction between two neuron → a synapse.***

Typically, a neuron-to-neuron synapse involves a junction between an axon terminal of one neuron, known as the presynaptic neuron, and the dendrites or cell body of a second neuron, known as the postsynaptic neuron.

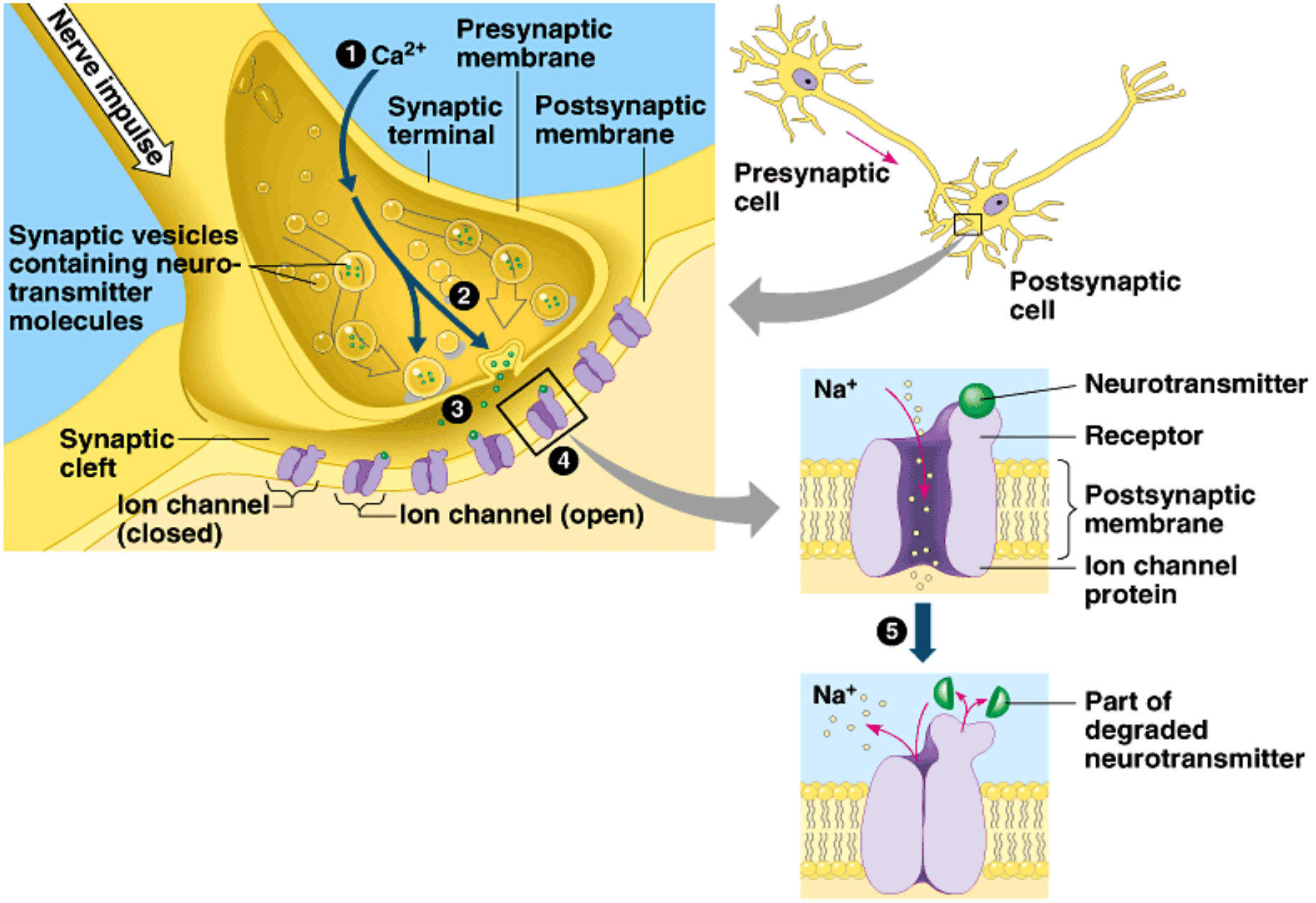


❖ Synapses:*

Less frequently, axon-to-axon and dendrite-to-dendrite connection occur. Most neuronal cell bodies and associated dendrites receive thousands of synaptic inputs, which are axon terminals from many other neurons. **It has been estimated that some neurons within the central nervous system receive as many as 100,000 synaptic inputs.**

❖ **The synapse** ***is a small gap that separates the axon terminal from the dendrites of the next neuron or another cell. The terminals contain tiny sacs or vesicles filled with*** **neurotransmitters** →→ ***(chemicals used by a neuron to transmit an impulse across a synapse), which stimulate the next neuron. There are dozens of different*** **neurotransmitters (NT)** ***in the neurons of the body.*** **NTs** ***can be either*** **excitatory** ***or*** **inhibitory**. ***Each neuron generally synthesizes and releases a single type of neurotransmitter.*** →→

❖ A chemical synapse:



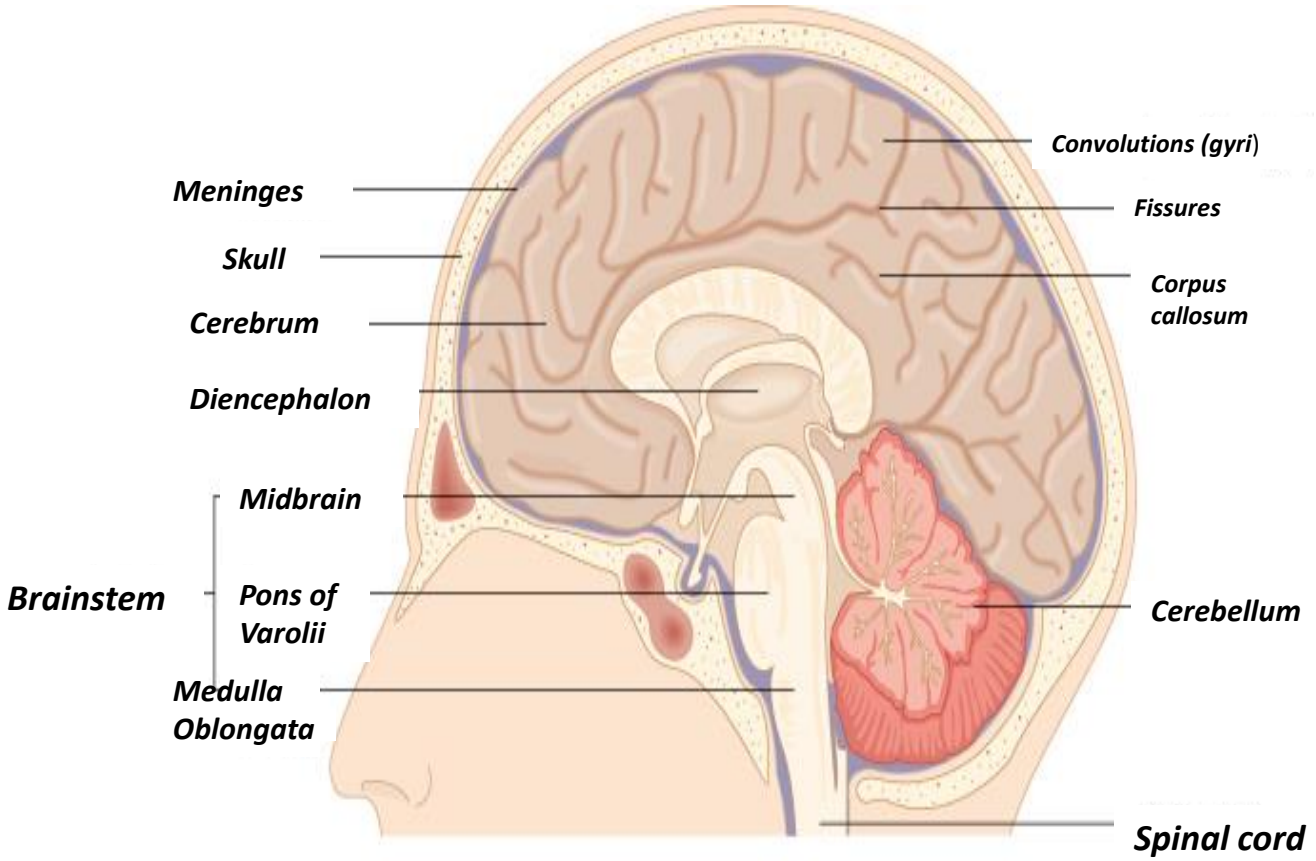
→ Key to Previous Diagram….

1. *Impulse from action potential* opens ion channels for Ca^{++}
2. *The increased Ca^{++} concentration in the axon terminal initiates the* release of the neurotransmitter (NT).
3. neurotransmitter *is released from its vesicle and crosses the "gap" or synaptic cleft and* attaches to a protein receptor on the dendrite.
4. *Interaction of* neurotransmitter *and* protein receptor *open post-synaptic membrane* ion channel for Na^{+}.
5. *After transmission the* neurotransmitter *is,* either *degraded by an enzyme,* or *, taken back into the pre-synaptic membrane by a transporter .*

Central Nervous System

- ***Consists of the brain and spinal cord.***
- ***The control center of the body responsible for controlling, receiving, and interpreting all stimuli.***
- ***Sends nerve impulses to instruct (order) muscles and glands to take or respond to certain actions.***
- ***Both voluntary and involuntary movements are controlled.***

Brain



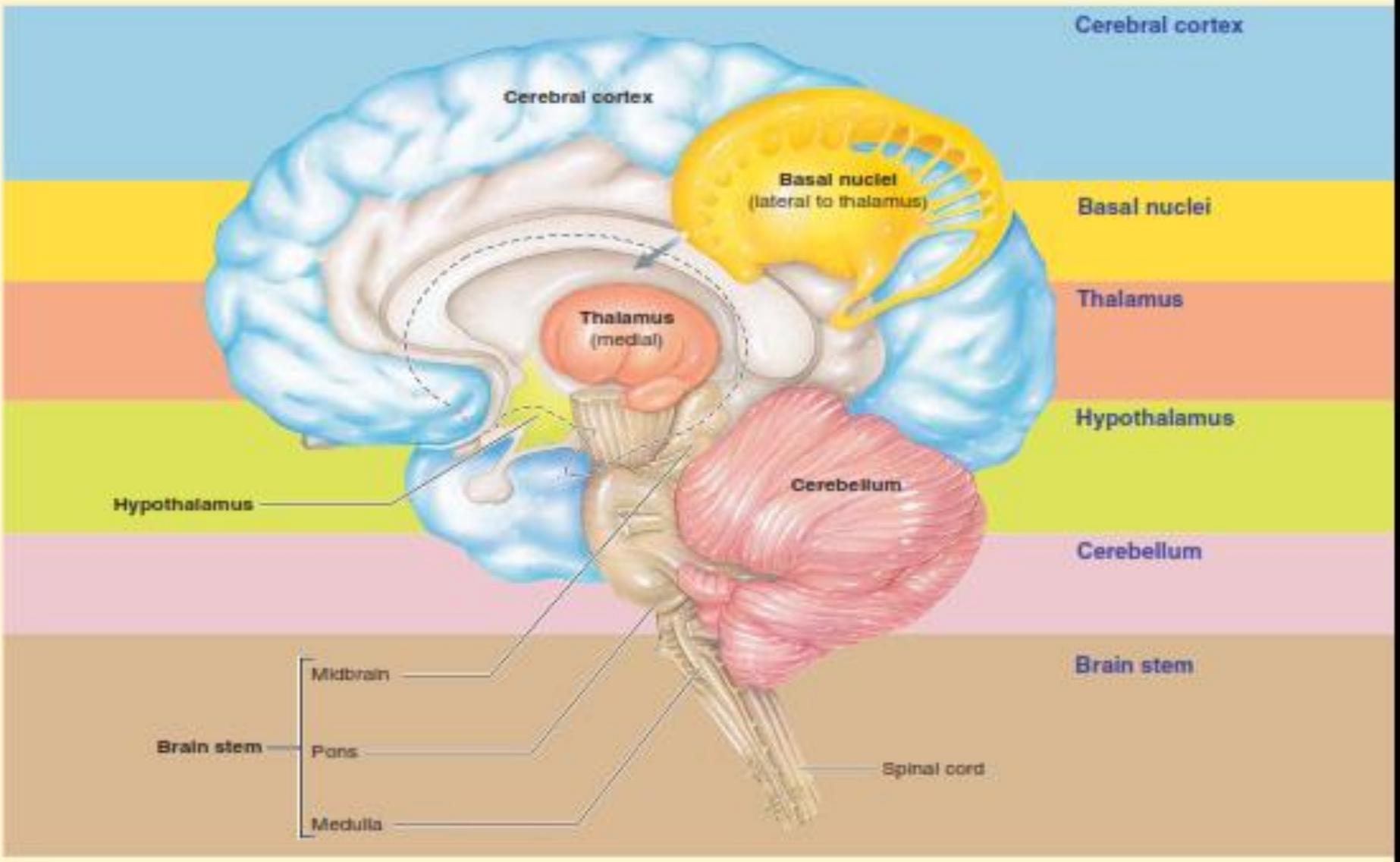
Brain

- Weighs about 3 pounds in adults.
- 75% water.
- Contains over 100 billion neurons.
- Controls bodily functions and interactions with the outside world.

Divisions of the Brain:

1-Cerebrum 2-Diencephalon 3-Cerebellum 4- Brain stem

TABLE 5-2 Overview of Structures and Functions of the Major Components of the Brain



1- Cerebrum : *Is most highly developed in human, where it constitutes about 80 % of the total brain weight. The cerebrum is composed of a thin outer shell of grey matter, the Cerebral cortex, covering a thick central core of white matter, Basal nuclei.*

- ***Responsible for:***

  1- Thought,

  2- decision making,

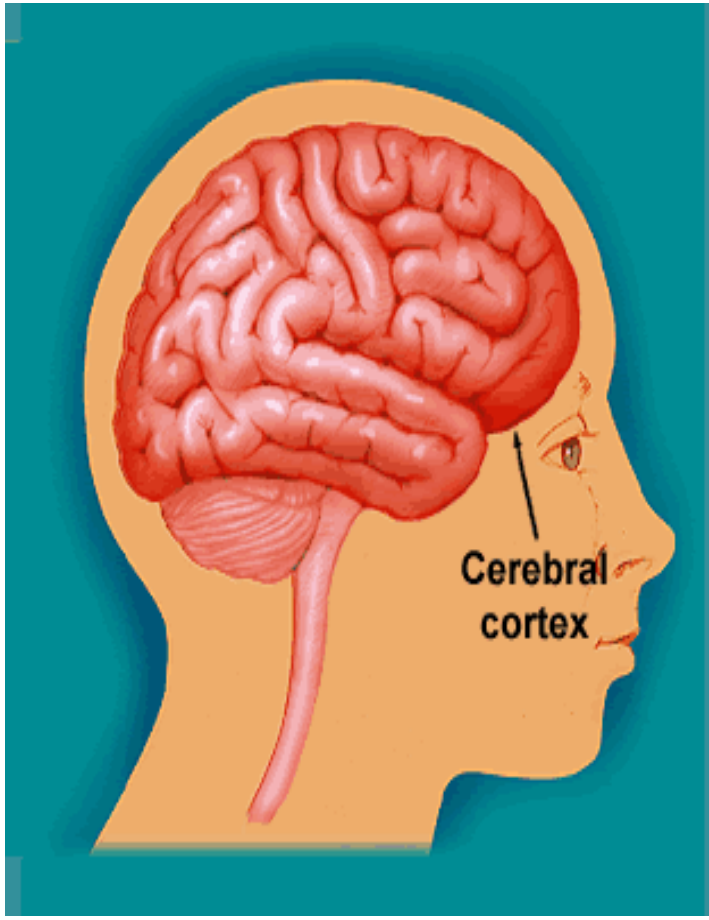
  3- Creativity,

  4- Language,

  5- Senses,

  6- Memory and,

  7- Voluntary control of movement.



2- Diencephalon:

The deep portion of the brain containing:

*A –Thalamus**

Major functions: ***- Relay station for all synaptic input,***
- Crude awareness of sensation, and
- Role in motor control.

*B –Hypothalamus**

Major functions:

1- Regulation of many homeostatic functions, such as temperature control, thirst, urine output, and food intake.

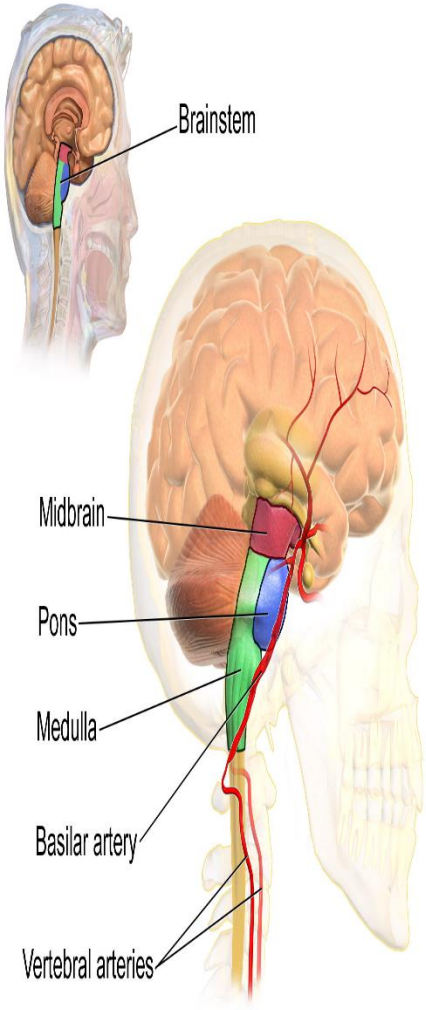
2- Important link between nervous and endocrine systems.

3- Extensive involvement with emotion and basic behavioral patterns.

3- Cerebellum:

- ***Maintenance of balance.***
- ***Enhancement of muscle tone (strength).***
- ***Coordination and planning of skilled voluntary muscle activity.***

4- Brain stem:



Made up of the midbrain; pons and the medulla oblongata . It is a critical connecting link between the remainder of the brain and the spinal cord.

Midbrain:

- **Involved with visual reflexes**

Pons of Varolii:

- ***Located between the midbrain and the medulla oblongata:→***
  a- It helps relay message from the cortex and the cerebellum,
  b- It also plays a key role in sleep and dreaming.

Medulla Oblongata:

- ***Contains centers that regulate:→*** **heart and lung functioning, swallowing, coughing, vomiting and sneezing.**

Spinal Cord:

The spinal cord extends through the vertebral canal and is connected to the spinal nerves . Links communication between the brain and the rest of the body.

- ***31 pairs of spinal nerves branch out from the spinal cord connecting brain to body.***

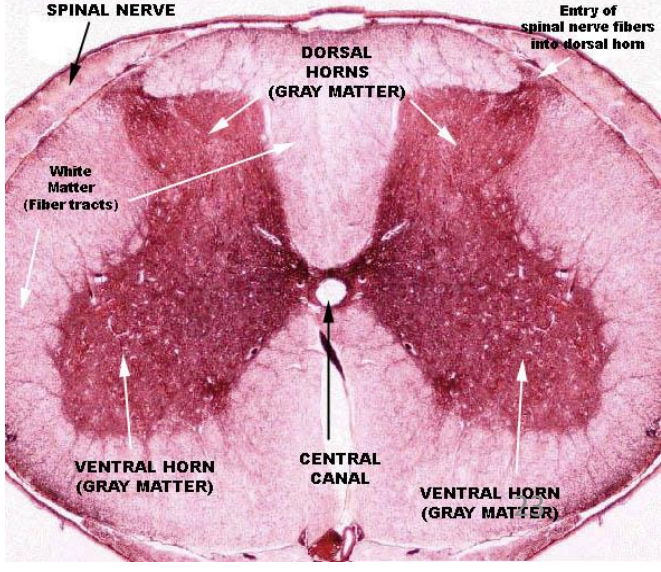
The spinal nerves are named according to region of the vertebral column from which they go out:

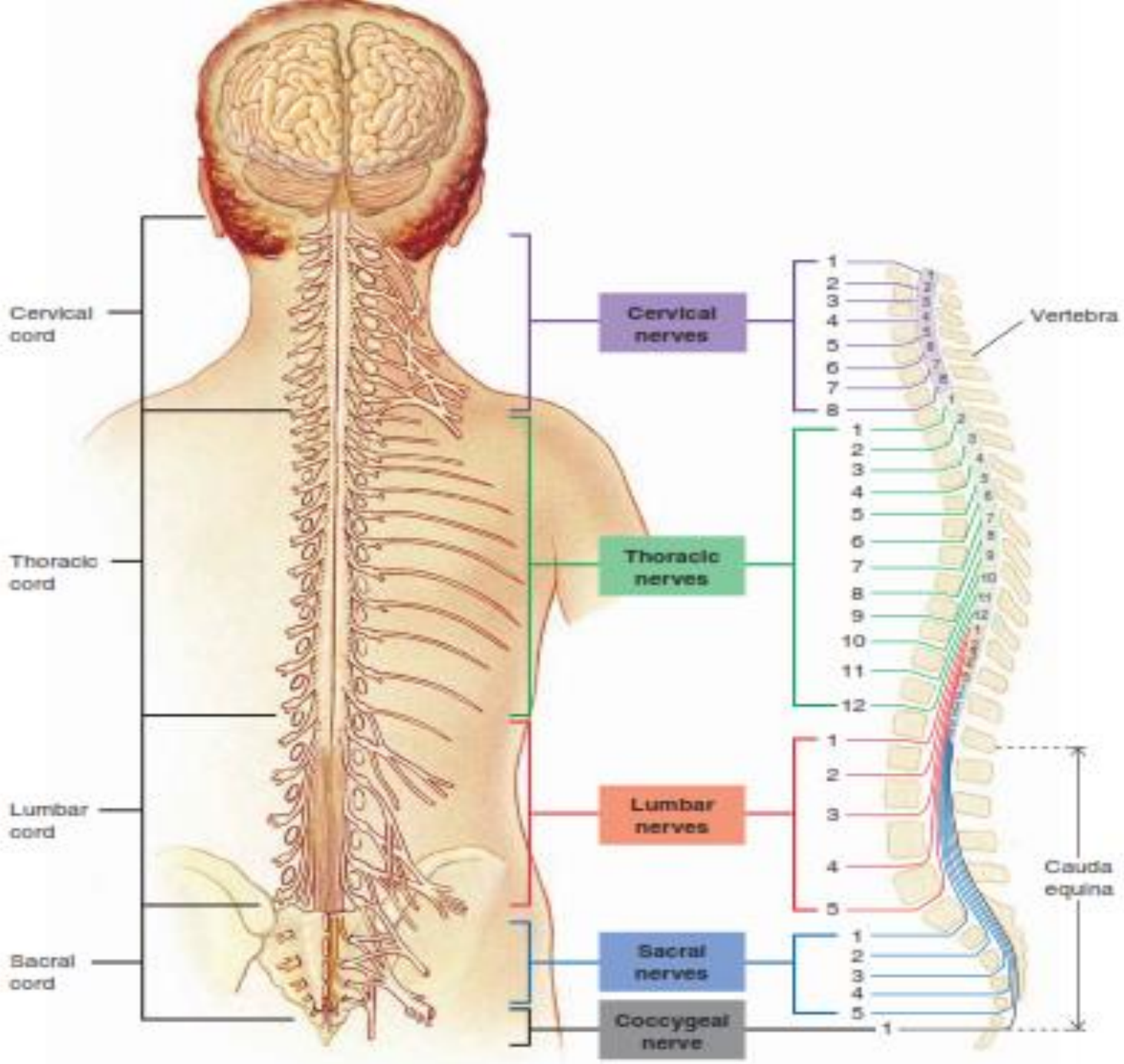
- ✓ ***There are 8 pairs of* cervical nerves, *12* thoracic nerves, *5* lumber (abdominal) nerves, *5* sacral (pelvic) nerves , *and one* coccygeal (tail bone) nerves.**

In contrast to the gray matter in the brain , the gray matter in the spinal cord forms a butterfly-shaped region on the inside and is surrounded by the outer white matter.

- ✓ ***Spinal nerves connect with each side of the spinal cord by a dorsal root and a ventral root:***
  - → ***Afferent fibers carrying incoming signals enter the spinal cord through the dorsal root;***
  - → ***Efferent fibers carrying outgoing signals leave through the ventral root.***

Spinal cord cross section→




Cervical cord
Thoracic cord
Lumbar cord
Sacral cord
Cervical nerves
Thoracic nerves
Lumbar nerves
Sacral nerves
Coccygeal nerve
Vertebra
Cauda equina
(a) Posterior view of spinal cord
(b) Lateral view of spinal cord

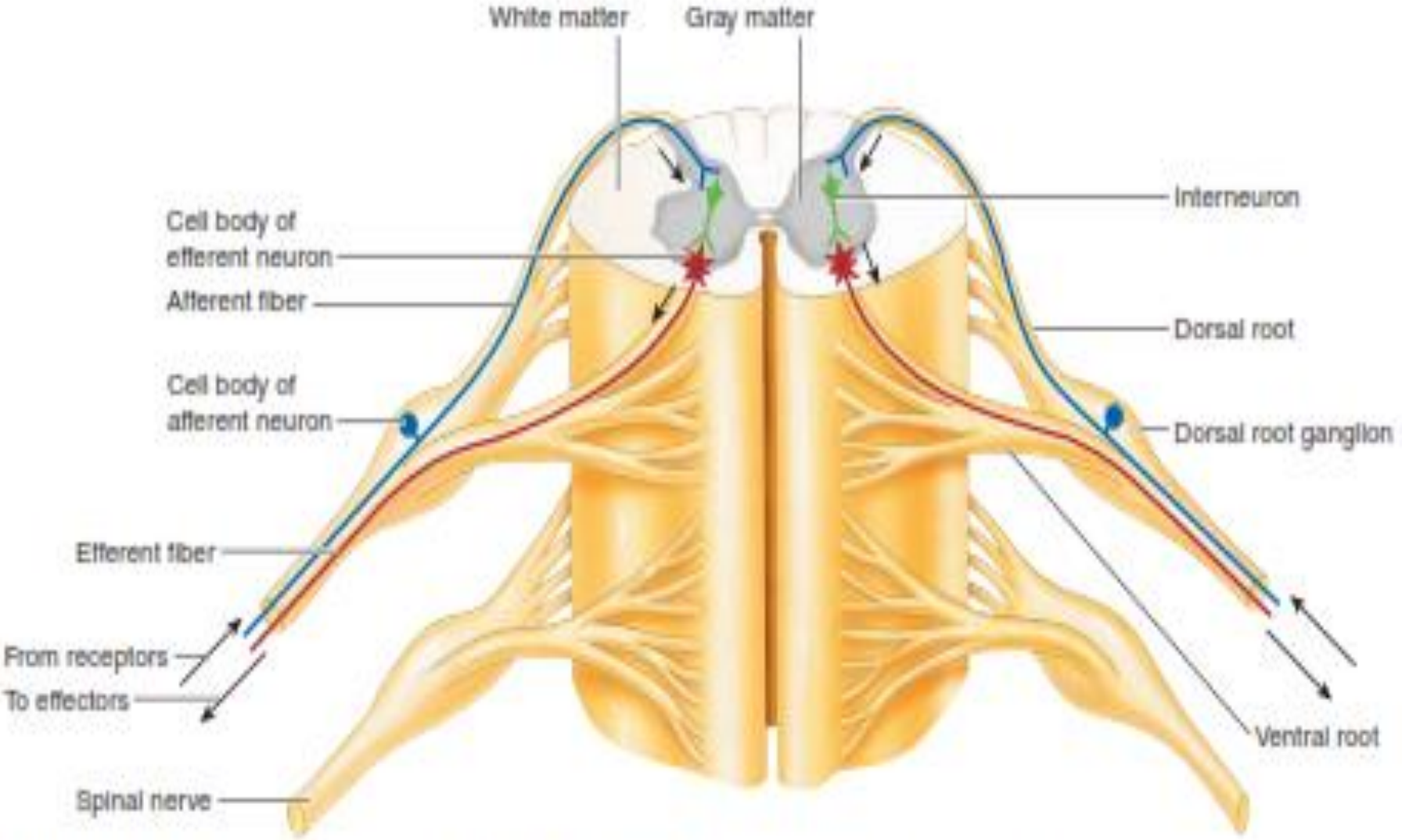


FIGURE 5-26 Spinal cord in cross section. The afferent fibers enter through the dorsal root, and the efferent fibers exit through the ventral root. Afferent and efferent fibers are enclosed together within a spinal nerve.

Peripheral Nervous System:*

Consists of 12 pairs of cranial nerves and 31 pairs of spinal nerves.

- ***Somatic Nervous System:***

Responsible for receiving and processing sensory input from the skin, muscles, tendons, joints, eyes, tongue, nose and ears as well as excite the voluntary contraction of skeletal muscles.

- ***Autonomic Nervous System (ANS):***

Carries impulses from the central nervous system to glands, various smooth muscles, cardiac muscle and various membranes. Stimulates organs, glands, and senses.

✓ ***Sympathetic Division of ANS:***

Operates when the body is under stress to activate responses necessary to react to dangerous situations.

✓ ***Parasympathetic Division of ANS:***

Operates to keep the body in homeostasis or balance under normal conditions.

Questions

First question:

1- Describe the structure of neuron.

2- Compare the composition of white and gray matter.

3- List the functional classification of neurons.

Second question: Mention the followings:

1- Nerves.

2- Nerve impulse.

3- Sense organs.

4- Synapses.

5- Spinal cord.

6- Functions of thalamus.

7- Functions of hypothalamus.

8- Peripheral Nervous System.

Best Wishes

- ***And***

- ***GOOD LUCK***