
بسم الله الرحمن الرحيم
السلام عليكم ورحمة الله وبركاته

بسم الله الرحمن الرحيم

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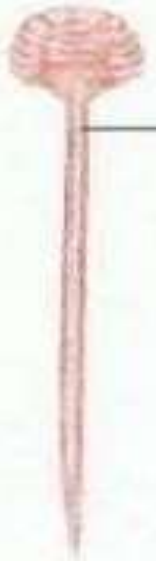
PhD ANATOMY, HISTOLOGY AND EMBRYOLOGY


Nervous
System

Nervous System



Central Nervous System (CNS)

Peripheral Nervous System (PNS)

Somatic Nervous System *(voluntary)*

Relays information to and from skin and skeletal muscles.

Autonomic Nervous System *(involuntary)*

Relays information to internal organs.

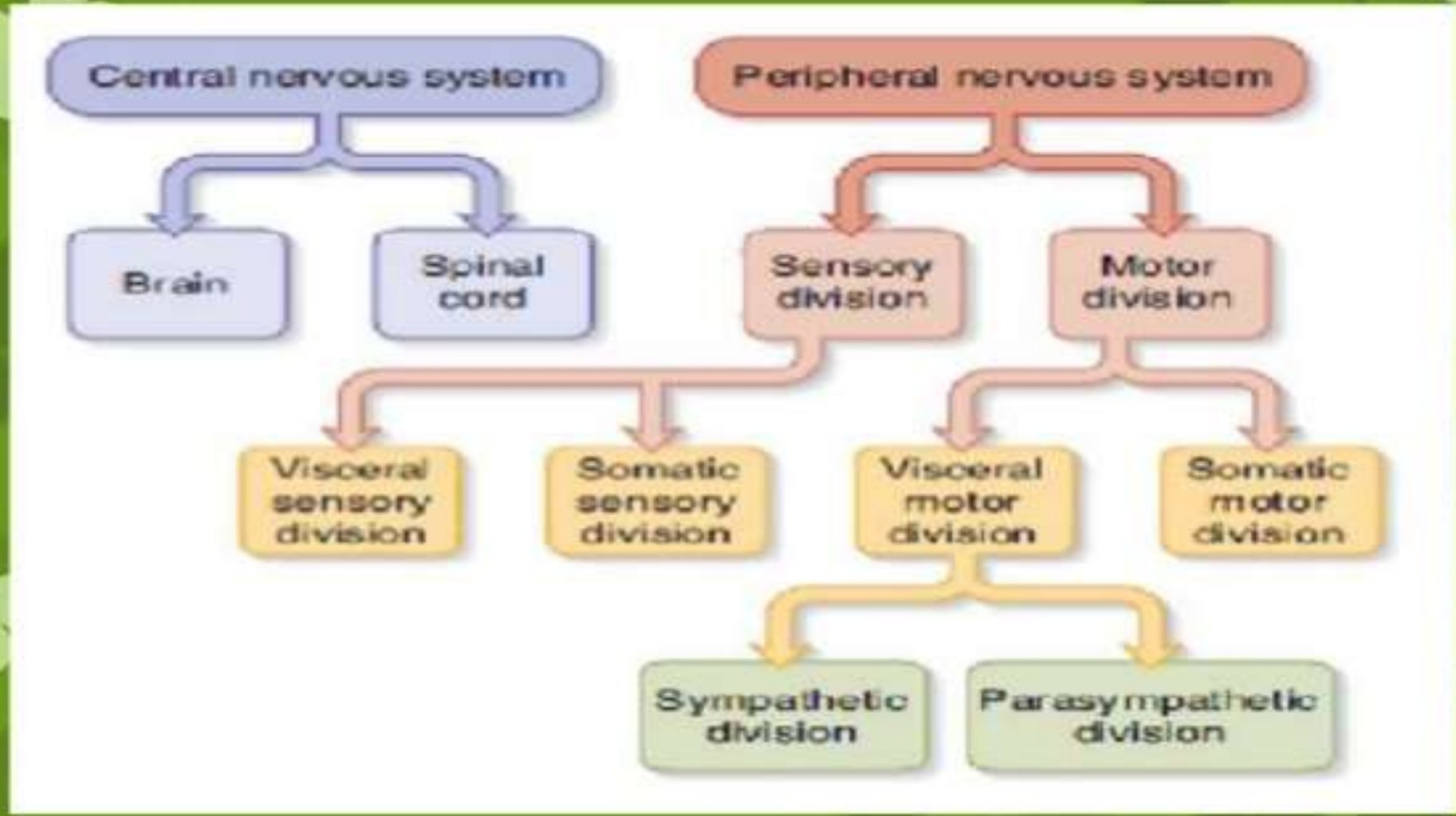
Sympathetic Nervous System

Controls organs in times of stress.

Parasympathetic Nervous System

Controls organs when body is at rest.

SUBDIVISION OF THE NERVOUS SYSTEM



Nervous System and Senses

The nervous system consists of two types of cells. Nerve cells are called **neurons**.

Various support cells are associated with the neurons, most typically, **Schwann cells**.

The parts of a neuron include the **dendrite** which receives the impulse (from another nerve cell or from a sensory organ), the **cell body** (numbers of which side-by-side form **gray matter**) where the **nucleus** is found, and the **axon** which carries the impulse away from the cell.

Wrapped around the axon are the **Schwann cells**, and the spaces/junctions between Schwann cells are called **nodes of Ranvier**.

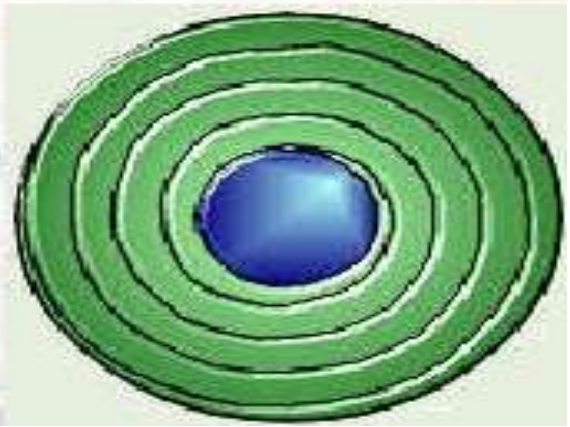
Collectively, the Schwann cells make up the **myelin sheath** (numbers of which side-by-side form white matter).

Schwann cells wrap around the axon (like the camp food, "pigs in a blanket").

Having an intact myelin sheath and nodes of Ranvier are critical to proper travel of the nerve impulse.

Diseases which destroy the myelin sheath (demyelinating disorders) can cause paralysis or other problems.

Schwann cells are analogous to the insulation on electrical wires, and just as electrical wires short out if there's a problem with the insulation, so also, neurons cannot function properly without intact myelin sheaths.



The nervous system has three basic functions:

1. **Sensory neurons** receive information from the sensory receptors.

2. **Interneurons** transfer and interpret impulses.

3. **Motor neurons** send appropriate impulses/ instructions to the muscles and glands.

Nervous System Function

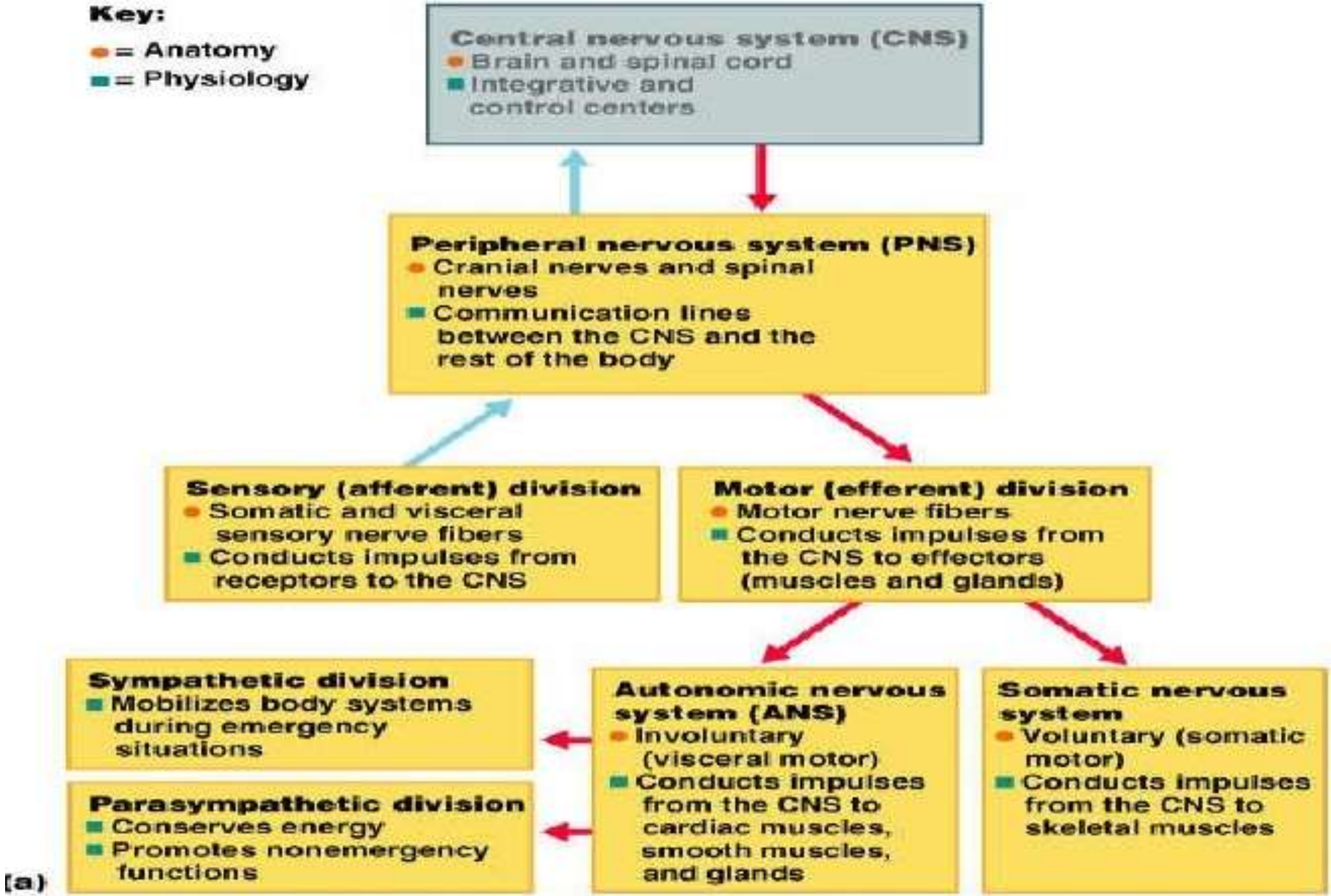
Somatic NS	Vs	Autonomic NS	
voluntary muscles and reflexes		visceral/smooth and cardiac muscle	
		Sympathetic NS	**Parasympathetic NS**
		increases energy expenditure prepares for action	decreases energy expenditure gains stored energy
		These have the opposite effects on the same organs	

Peripheral NS (PNS)	Vs	Central NS (CNS)
sensory and motor neurons		interneurons: brain and spine
		covered with three membranes, the **meninges** inflammation of these is called **meningitis** brain has gray matter on outside and white in center spine has white matter on outside and gray in center

PERIPHERAL DIVISIONS

Two Functional Subdivisions of the PNS

- Sensory division
  - "afferent division"
  - Nerve fibers conveying impulses to the CNS
    - *Somatic afferent fibers* convey impulses from the skin, muscles, and joints
    - *Visceral afferent fibers* convey impulses from visceral organs
- Motor division
  - , "efferent division"
  - Nerve fibers conveying impulses from the CNS


Key:
= Anatomy
= Physiology
Central nervous system (CNS)
Brain and spinal cord
Integrative and control centers
Peripheral nervous system (PNS)
Cranial nerves and spinal nerves
Communication lines between the CNS and the rest of the body
Sensory (afferent) division
Somatic and visceral sensory nerve fibers
Conducts impulses from receptors to the CNS
Motor (efferent) division
Motor nerve fibers
Conducts impulses from the CNS to effectors (muscles and glands)
Sympathetic division
Mobilizes body systems during emergency situations
Parasympathetic division
Conserves energy
Promotes nonemergency functions
Autonomic nervous system (ANS)
Involuntary (visceral motor)
Conducts impulses from the CNS to cardiac muscles, smooth muscles, and glands
Somatic nervous system
Voluntary (somatic motor)
Conducts impulses from the CNS to skeletal muscles
(a)

General Functions of the Nervous System_

Sensory receptors at the ends of peripheral nerves gather information and convert it into nerve impulses.

When sensory impulses are integrated in the brain as perceptions, this is the integrative function of the nervous system.

Conscious or subconscious decisions follow, leading to motor functions via effectors.

The nervous system sorts and interprets incoming information before directing a response.

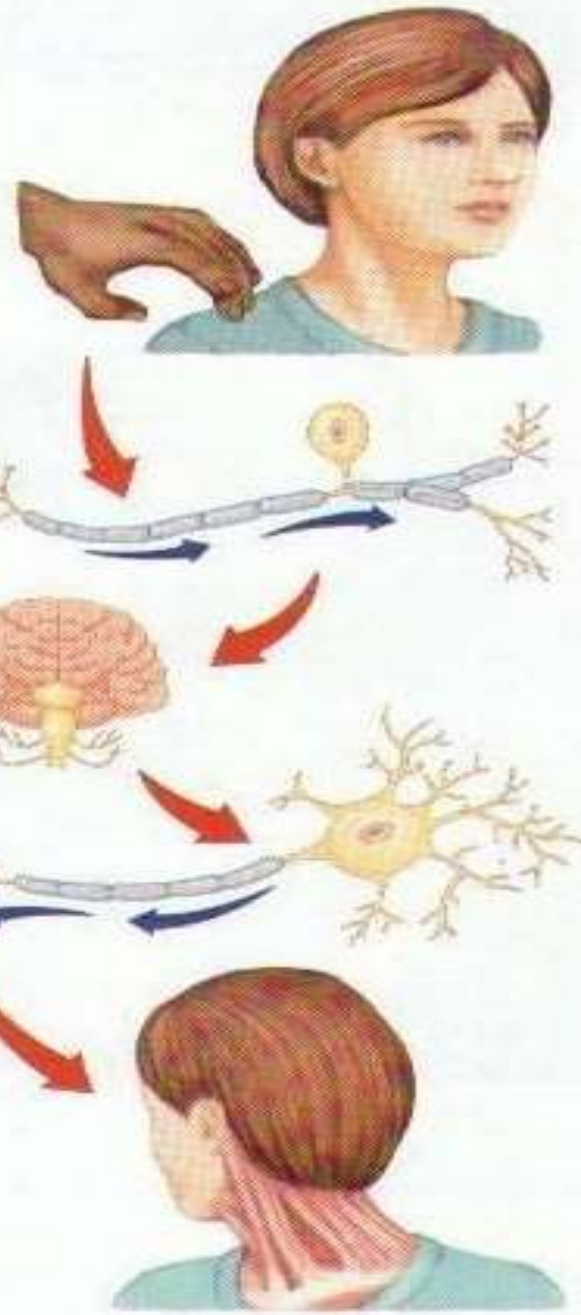
A Receptors in the skin sense a tap or other stimulus.

B Sensory neurons transmit the touch message.

C The message is interpreted. A response is sent to the motor neurons.

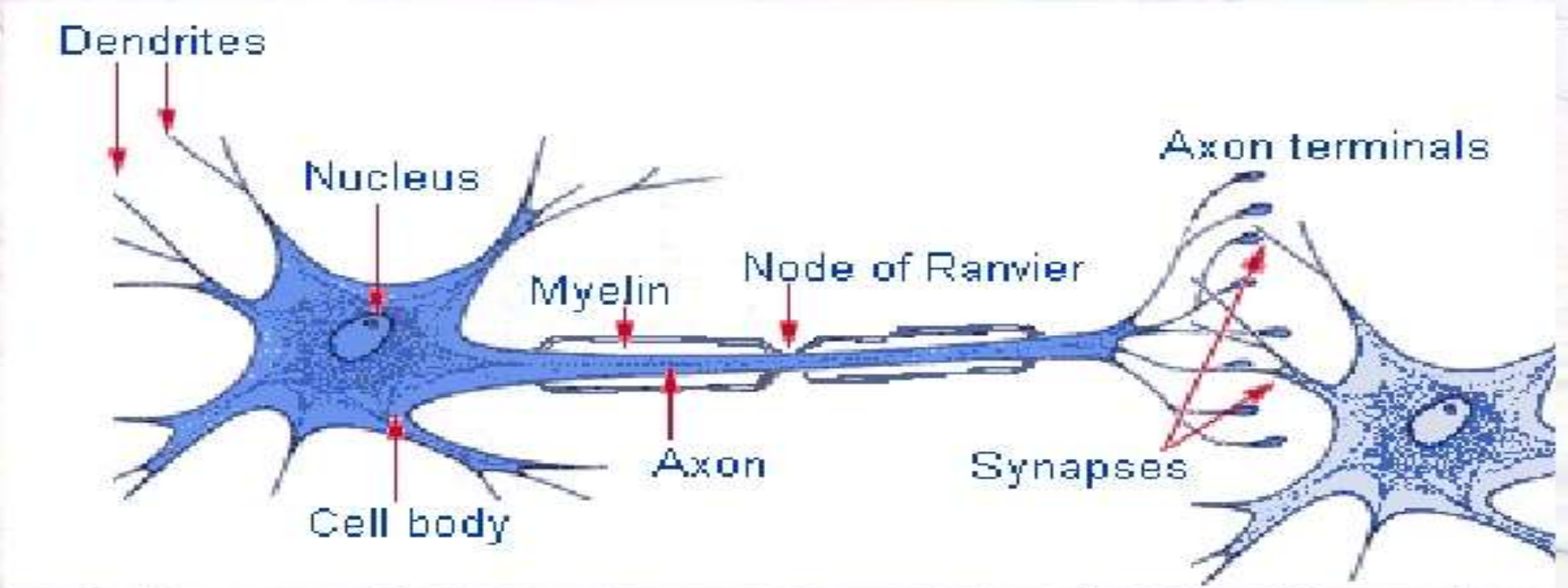
D Motor neurons transmit a response message to the shoulder muscles.

E The neck muscles are activated, causing the head to turn.



Neuron Structure_

A neuron has a cell body with mitochondria, lysosomes, a Golgi apparatus, Nissl bodies containing rough endoplasmic reticulum, and neurofibrils.



Nerve fibers include a solitary axon and numerous dendrites.

Branching dendrites carry impulses from other neurons (or from receptors) toward the cell body.

The axon transmits the impulse away from the axonal hillock of the cell body and may give off side branches.

Larger axons are enclosed by sheaths of myelin provided by Schwann cells and are myelinated fibers.

The outer layer of myelin is surrounded by a neurilemma (neurilemmal sheath) made up of the cytoplasm and nuclei of the Schwann cell.

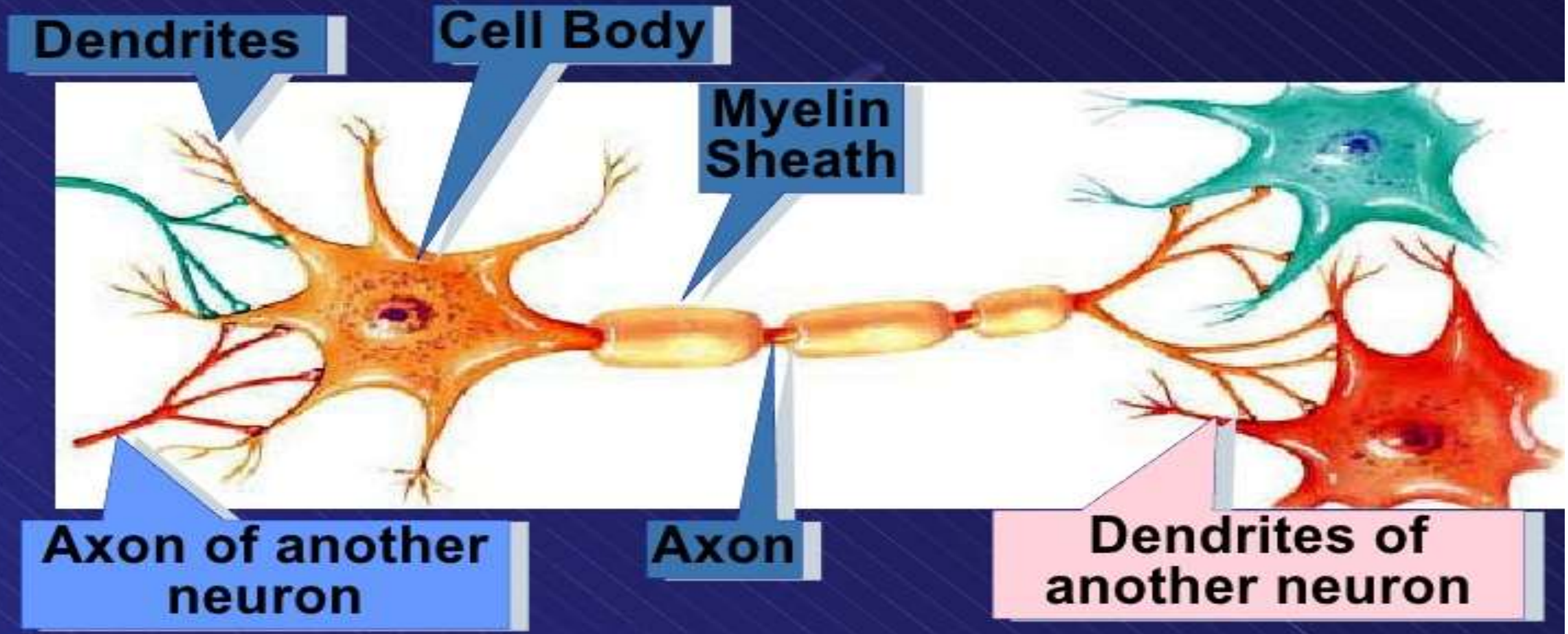
Narrow gaps in the myelin sheath between Schwann cells are called nodes of Ranvier.

The smallest axons lack a myelin sheath and are unmyelinated fibers.

White matter in the CNS is due to myelin sheaths in this area.

Unmyelinated nerve tissue in the CNS appears gray.

Neurons


Dendrites
Cell Body
Myelin Sheath
Axon of another neuron
Axon
Dendrites of another neuron

Types of Neurons & Neuroglial Cells

Neurons can be grouped in two ways: on the basis of structural differences (bipolar, unipolar, and multipolar neurons), and by functional differences (sensory neurons, interneurons, and motor neurons).

Classification of Neurons:

Bipolar neurons are found in the eyes, nose, and ears, and have a single axon and a single dendrite extending from opposite sides of the cell body.

Unipolar neurons are found in ganglia outside the CNS and have an axon and a dendrite arising from a single short fiber extending from the cell body.

Multipolar neurons have many nerve fibers arising from their cell bodies and are commonly found in the brain and spinal cord.

Sensory neurons (afferent neurons) conduct impulses from peripheral receptors to the CNS and are usually unipolar, although some are bipolar neurons.

Interneurons are multipolar neurons lying within the CNS that form links between other neurons.

Motor neurons are multipolar neurons that conduct impulses from the CNS to effectors.

Classification of Neuroglial Cells

Neuroglial cells fill spaces, support neurons, provide structural frameworks, produce myelin, and carry on phagocytosis.

Schwann cells are the meylin-roducing neuroglia of the peripheral nervous system; other types are components of the central nervous system.

Microglial cells are small cells that phagocytize bacterial cells and cellular debris.

Oligodendrocytes form myelin in the brain and spinal cord.

Astrocytes are near blood vessels and support structures, aid in metabolism, and respond to brain injury by filling in spaces.

Ependyma cover the inside of ventricles and form choroid plexuses within the ventricles.

Nerve Impulse

A nerve impulse is conducted as action potential is reached at the trigger zone and spreads by a local current flowing down the fiber, and adjacent areas of the membrane reach action potential.

Impulse Conduction

Unmyelinated fibers conduct impulses over their entire membrane surface.

Myelinated fibers conduct impulses from node of Ranvier to node of Ranvier, a phenomenon called saltatory conduction.

Saltatory conduction is many times faster than conduction on unmyelinated neurons.

All-or-None Response

If a nerve fiber responds at all to a stimulus, it responds completely by conducting an impulse (all-or-none response).

Greater intensity of stimulation triggers more impulses per second, not stronger impulses.

The Synapse

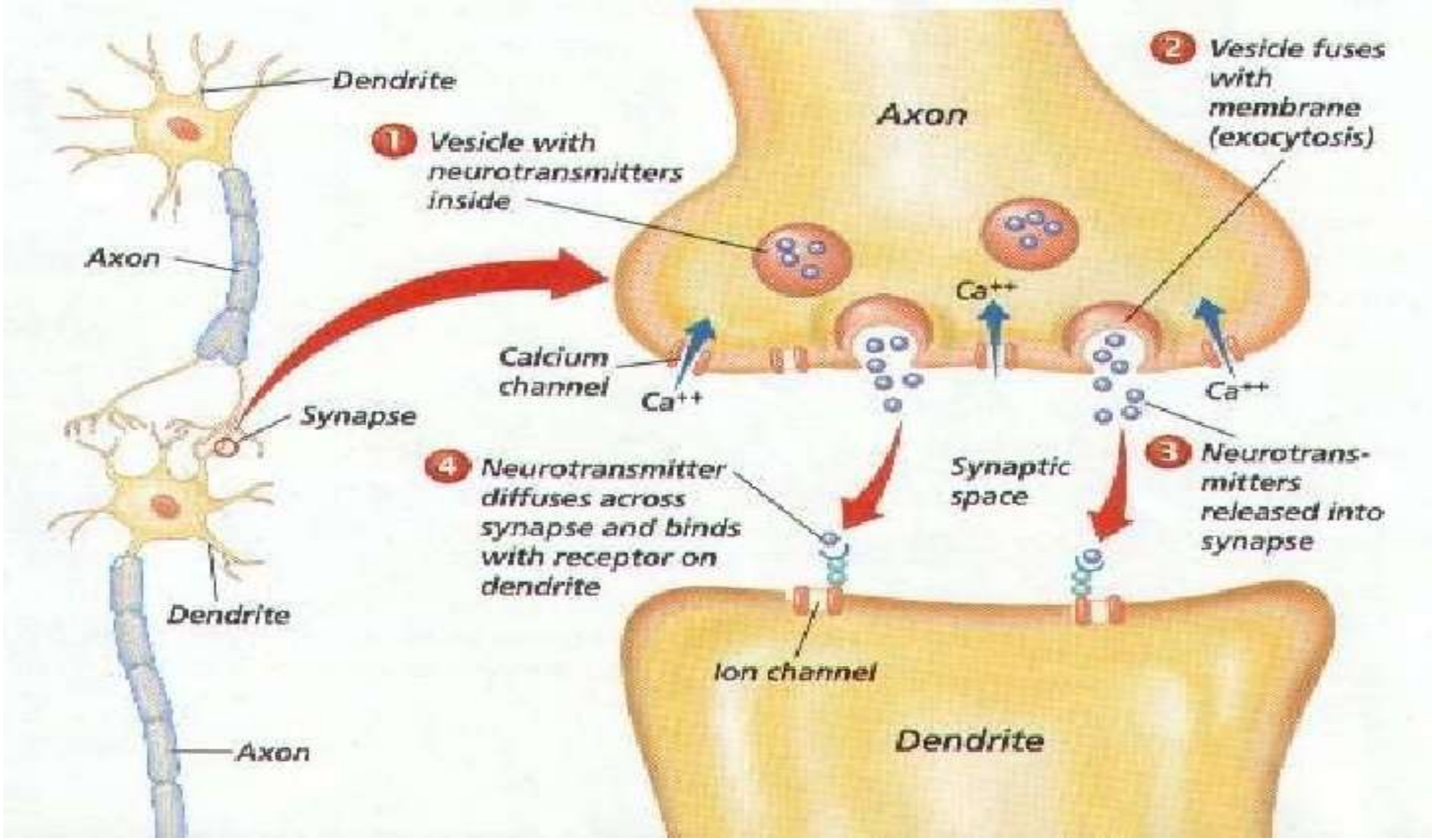
The junction between two communicating neurons is called a synapse; there exists a synaptic cleft between them across which the impulse must be conveyed.

Synaptic Transmission

The process by which the impulse in the presynaptic neuron is transmitted across the synaptic cleft to the postsynaptic neuron is called synaptic transmission.

When an impulse reaches the synaptic knobs of an axon, synaptic vesicles release neurotransmitter into the synaptic cleft.

The neurotransmitter reacts with specific receptors on the postsynaptic membrane.


Dendrite
Axon
Synapse
Dendrite
Axon
1 Vesicle with neurotransmitters inside
Axon
2 Vesicle fuses with membrane (exocytosis)
Ca++
Calcium channel
Ca++
Ca++
3 Neurotrans-mitters released into synapse
Synaptic space
4 Neurotransmitter diffuses across synapse and binds with receptor on dendrite
Ion channel
Dendrite

Convergence

A single neuron within a pool may receive impulses from two or more fibers (convergence), which makes it possible for the neuron to summate impulses from different sources.

Divergence

Impulses leaving a neuron in a pool may be passed into several output fibers (divergence), a pattern that serves to amplify an impulse.

Types of Nerves

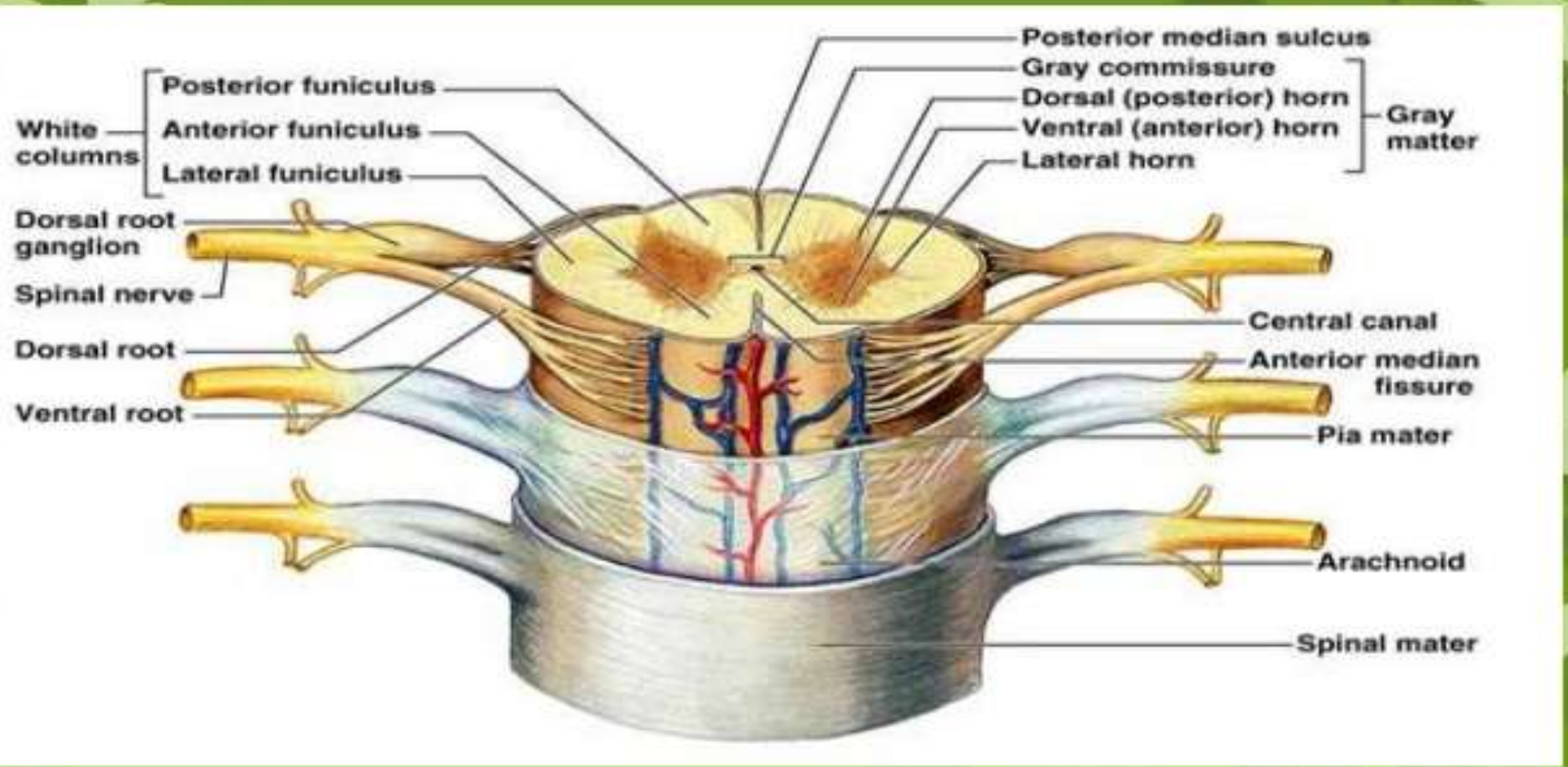
A nerve is a bundle of nerve fibers held together by layers of connective tissue.

Nerves can be sensory, motor, or mixed, carrying both sensory and motor fibers.

CROSS-SECTIONAL ANATOMY

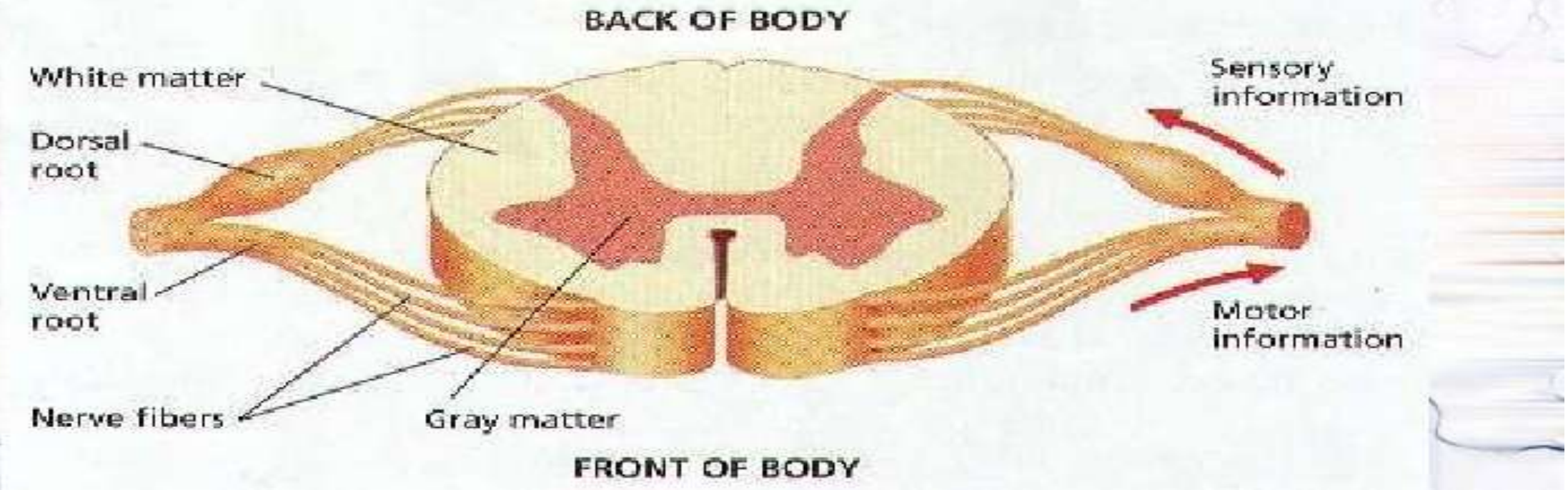
- The spinal cord consists of two kinds of nervous tissue called **gray** and **white matter**.
- **Gray matter** has a relatively dull color because it contains little myelin.
- It has butterfly- or H-shaped in cross sections
- It contains the **somas, dendrites**, and proximal parts of the **axons** of neurons.
- It is the site of **synaptic contact** between neurons (information processing)

GRAY AND WHITE MATTER



Spinal Cord

The spinal cord begins at the base of the brain and extends as a slender cord to the level of the intervertebral disk between the first and second lumbar vertebrae.



Structure of the Spinal Cord

The spinal cord consists of 31segments, each of which gives rise to a pair of spinal nerves.

A cervical enlargement gives rise to nerves leading to the upper limbs, and a lumbar enlargement gives rise to those innervating the lower limbs.

Two deep longitudinal grooves (anterior median fissure and posterior median sulcus) divide the cord into right and left halves.

White matter, made up of bundles of myelinated nerve fibers (nerve tracts), surrounds a butterfly-shaped core of gray matter housing interneurons.

A central canal contains cerebrospinal fluid.

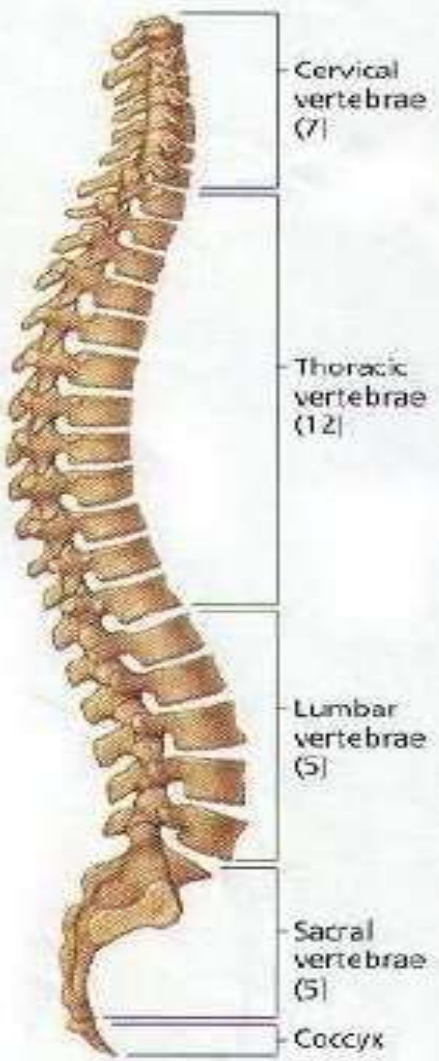
Functions of the Spinal Cord

The spinal cord has two major functions: to transmit impulses to and from the brain, and to house spinal reflexes.

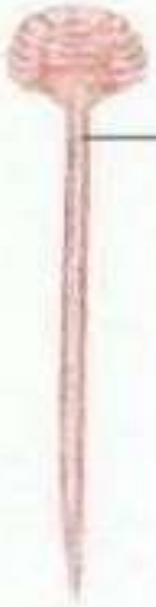
Tracts carrying sensory information to the brain are called ascending tracts; descending tracts carry motor information from the brain.

The names that identify nerve tracts identify the origin and termination of the fibers in the tract.

Many spinal reflexes also pass through the spinal cord.



Nervous System



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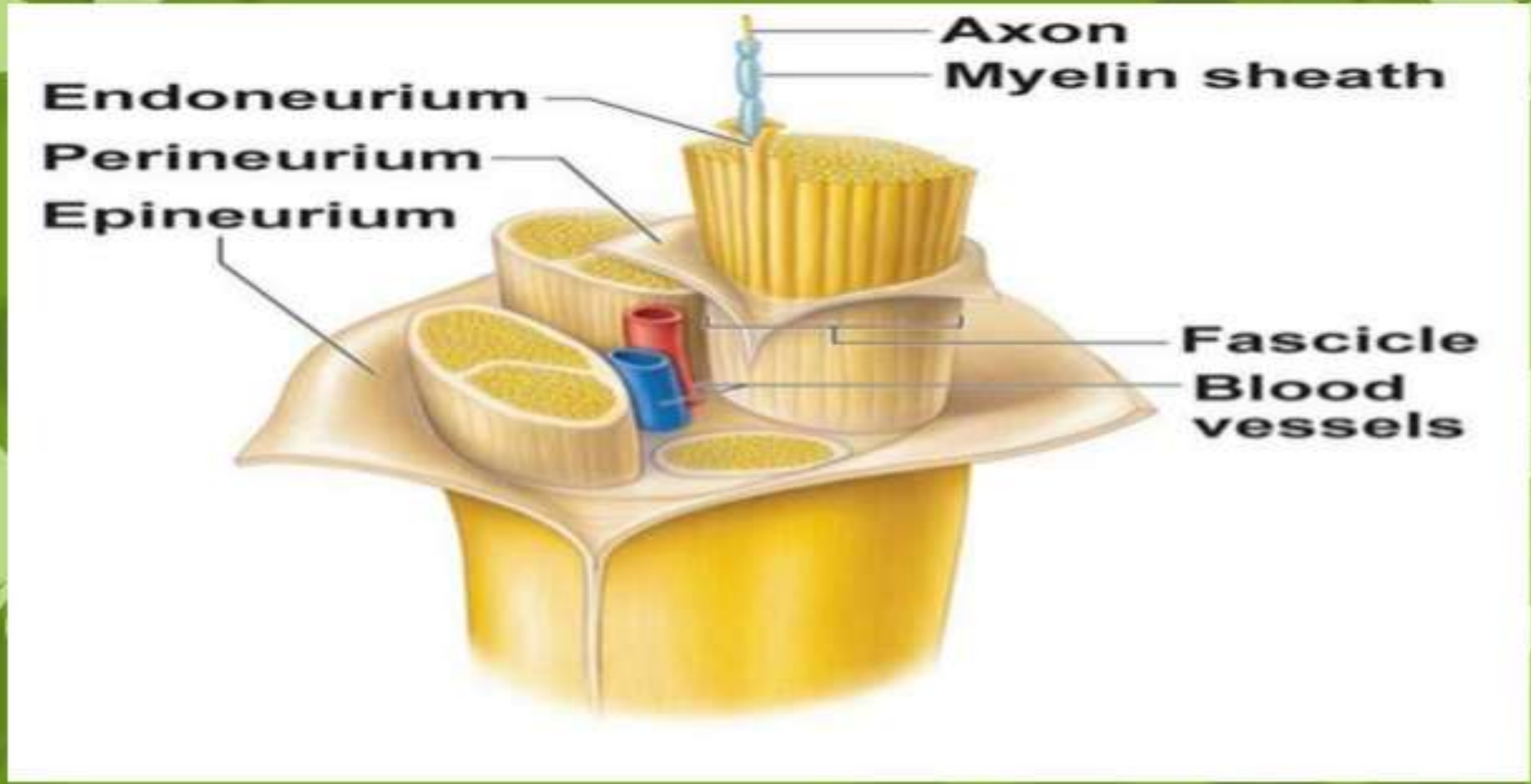
GENERAL ANATOMY OF NERVES AND GANGLIA

- A **nerve** is a **cordlike** organ composed of numerous nerve fibers **(axons)** bound together by connective tissue.
- Nerve fibers of the peripheral nervous system are ensheathed in **Schwann cells**, which form a **neurilemma** and often a myelin sheath around the axon. Nerves has:
- **endoneurium, perineurium and epineurium**

ANATOMY OF A NERVE



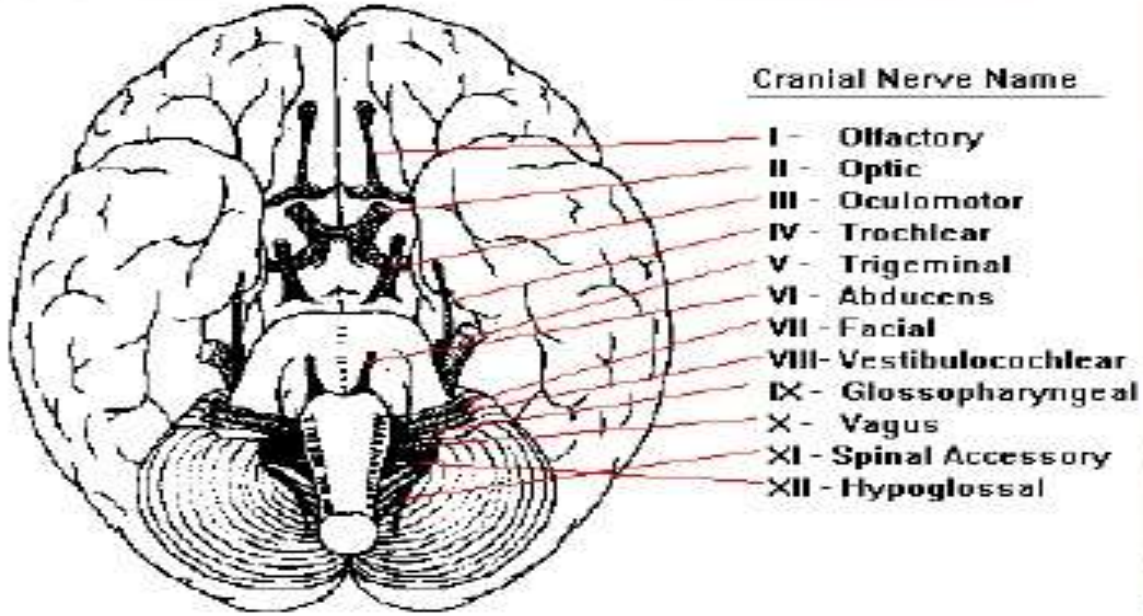
Peripheral Nervous System

1. The peripheral nervous system (PNS) consists of the cranial and spinal nerves that arise from the central nervous system and travel to the remainder of the body.
2. The PNS is made up of the somatic nervous system that oversees voluntary activities, and the autonomic nervous system that controls involuntary activities.

Cranial Nerves

12 pairs of cranial nerves arise from the underside of the brain, most of which are mixed nerves.

The 12 pairs are designated by number and name and include the olfactory, optic, oculomotor, trochlear, trigenimal, abducens, facial, vestibulocochlear, glossopharyngeal, vagus, accessory, and hypoglossal nerves.



FUNCTIONS OF CRANIAL NERVES

Number	Name	Function
I	Olfactory	Sense of smell
II	Optic	Vision
III	Oculomotor	Motor control of some eye muscles and eyelid
IV	Trochlear	Motor control of some eye muscles
V	Trigeminal	Chewing muscles and some facial sensation
VI	Abducent	Motor control of some eye muscles
VII	Facial	Motor control of facial muscles, salivation. Taste and cutaneous sensations.
VIII	Acoustic	Equilibration, static sense and hearing
IX	Glossopharyngeal	Salivation, sensations of skin, taste and viscera
X	Vagus	Motor control of the heart and viscera, sensation from the thorax, pharynx and abdominal viscera
XI	Accessory	Motor impulses to the pharynx and shoulder
XII	Hypoglossal	Motor control of the tongue, some skeletal muscles, some viscera, sensation from skin and viscera

Spinal Nerves

1. 31 pairs of mixed nerves make up the spinal nerves.
2. Spinal nerves are grouped according to the level from which they arise and are numbered in sequence, beginning with those in the cervical region.
3. Each spinal nerve arises from two roots: a dorsal, or sensory, root, and a ventral, or motor, root.
4. The main branches of some spinal nerves form plexuses.
5. Cervical Plexuses – Lie on either side of the neck and supply muscles and skin of the neck.
6. Brachial Plexuses – Arise from lower cervical and upper thoracic nerves and lead to the upper limbs.
7. Lumbrosacral Plexuses – Arise from the lower spinal cord and lead to the lower abdomen, external genitalia, buttocks, and legs.

SPINAL NERVES

- There are 31 pairs of spinal nerves: 8 cervical (**C1–C8**), 12 thoracic (**T1–T12**), 5 lumbar (**L1–L5**), 5 sacral (**S1–S5**), and 1 coccygeal (**Co**).

- The first cervical nerve emerges between the skull and atlas

- The others emerge through intervertebral foramina, including the anterior and posterior foramina of the sacrum and the sacral hiatus.

AUTONOMIC NERVOUS SYSTEM (ANS)

- ANS is motor nervous system that controls glands, cardiac muscle, and smooth muscle
- The primary target organs of the ANS are the viscera of the thoracic and abdominal cavities
- Its job is to regulate such fundamental states and life processes as **heart rate, blood pressure, body temperature, respiratory airflow, pupillary diameter, digestion, energy metabolism, defecation, and urination.**

Autonomic Nervous System

The autonomic nervous system has the task of maintaining homeostasis of visceral activities without conscious effort.

General Characteristics

The autonomic nervous system includes two divisions: the sympathetic and parasympathetic divisions, which exert opposing effects on target organs.

The parasympathetic division operates under normal conditions.

The sympathetic division operates under conditions of stress or emergency.

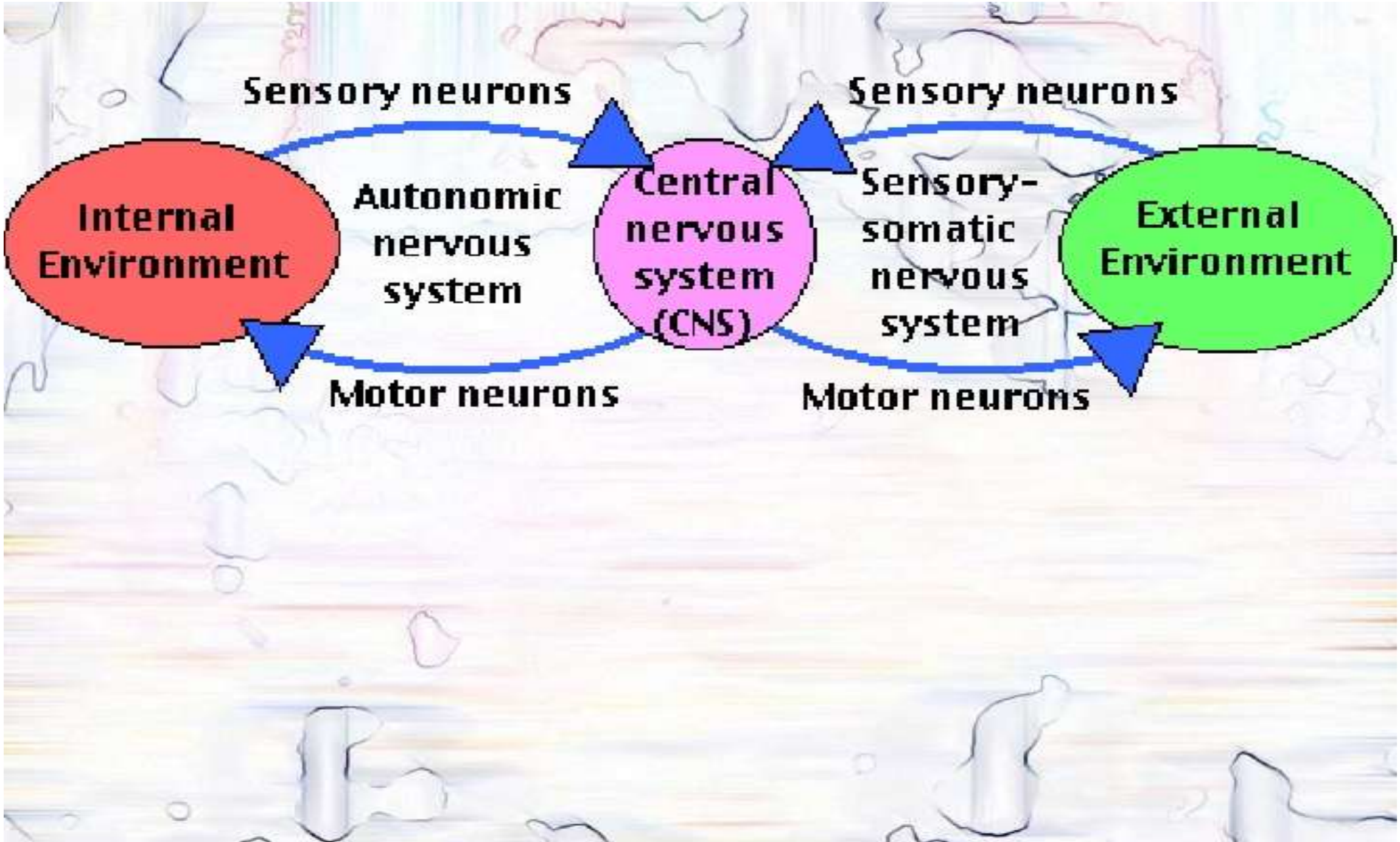
Autonomic Nerve Fibers

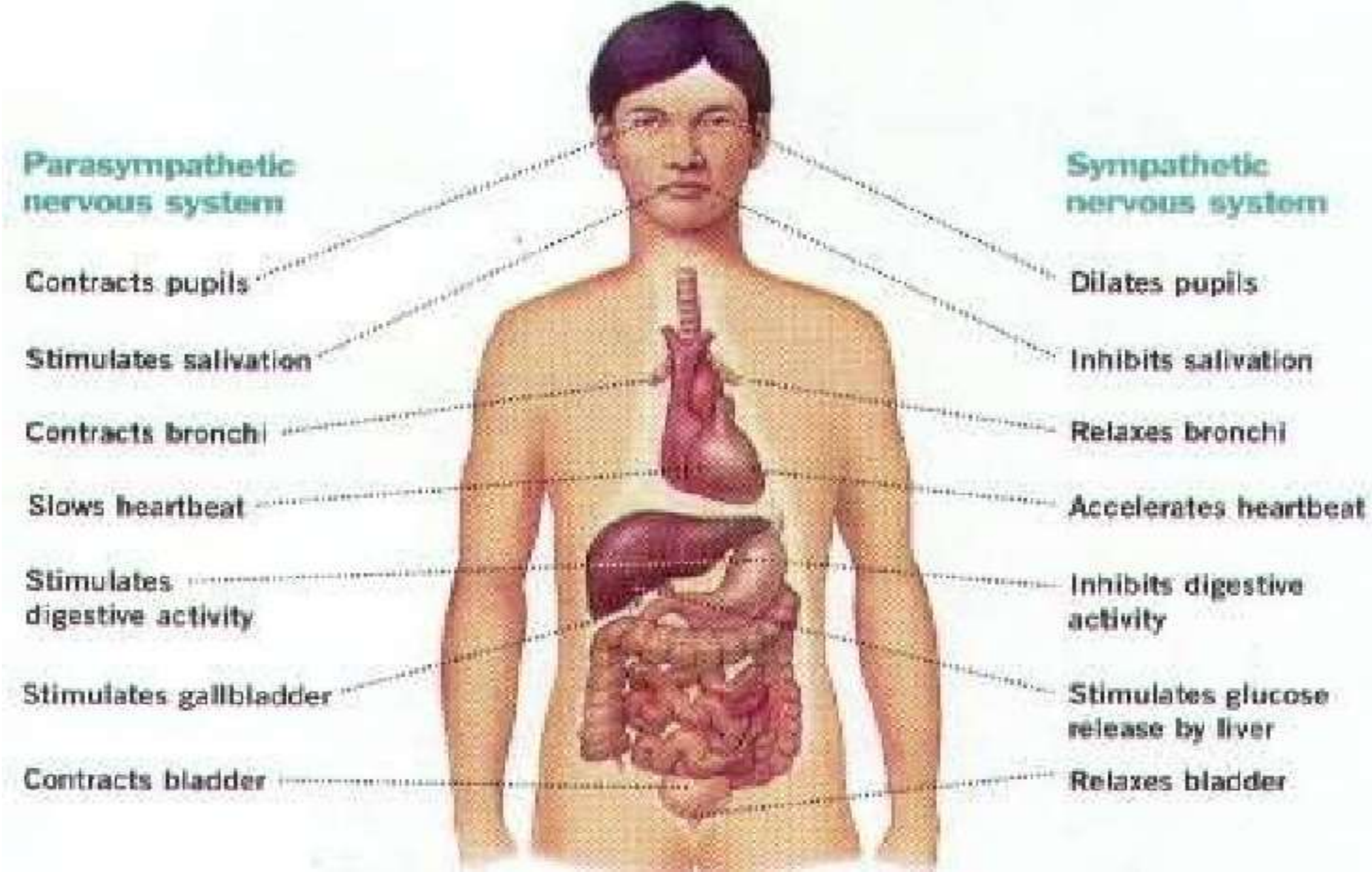
In the autonomic motor system, motor pathways include two fibers: a preganglionic fiber that leaves the CNS, and a postganglionic fiber that innervates the effector.

Sympathetic Division

Fibers in the sympathetic division arise from the thoracic and lumbar regions of the spinal cord, and synapse in paravertebral ganglia close to the vertebral column.

Postganglionic axons lead to an effector organ.


Sensory neurons
Sensory neurons
Internal Environment
Autonomic nervous system
Central nervous system (CNS)
Sensory-somatic nervous system
External Environment
Motor neurons
Motor neurons


Parasympathetic nervous system
Contracts pupils
Stimulates salivation
Contracts bronchi
Slows heartbeat
Stimulates digestive activity
Stimulates gallbladder
Contracts bladder
Sympathetic nervous system
Dilates pupils
Inhibits salivation
Relaxes bronchi
Accelerates heartbeat
Inhibits digestive activity
Stimulates glucose release by liver
Relaxes bladder

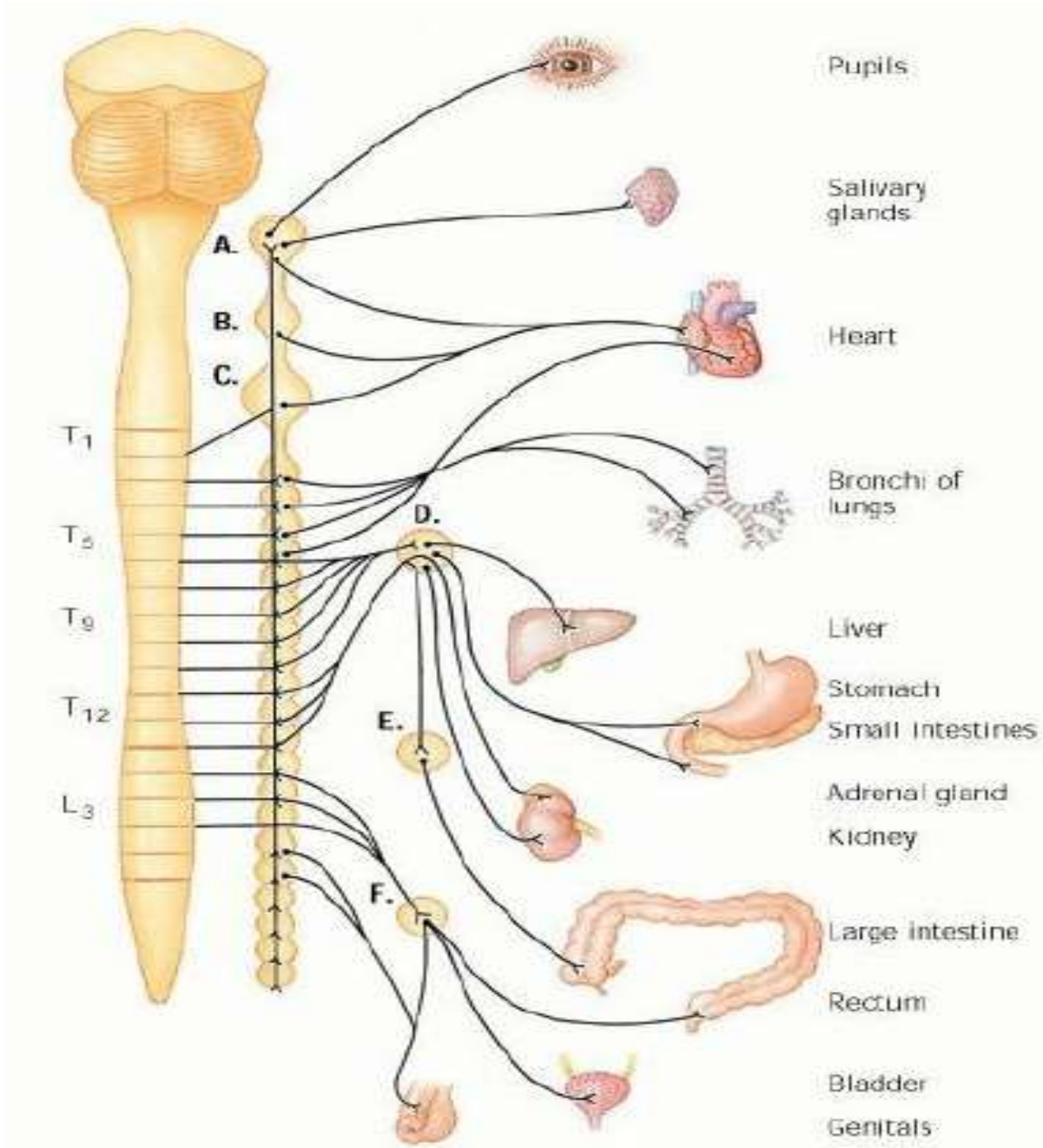
Parasympathetic Division – Fibers in the parasympathetic division arise from the brainstem and sacral region of the spinal cord, and synapse in ganglia close to the effector organ.

Autonomic Neurotransmitters

1. Preganglionic fibers (PF) of both sympathetic and parasympathetic divisions release acetylcholine. Parasympathetic PF are cholinergic fibers and release acetylcholine.

2. Sympathetic postganglionic fibers are adrenergic and release norepinephrine.

3. The effects of these two divisions, based on the effects of releasing different neurotransmitters to the effector, are generally antagonistic.



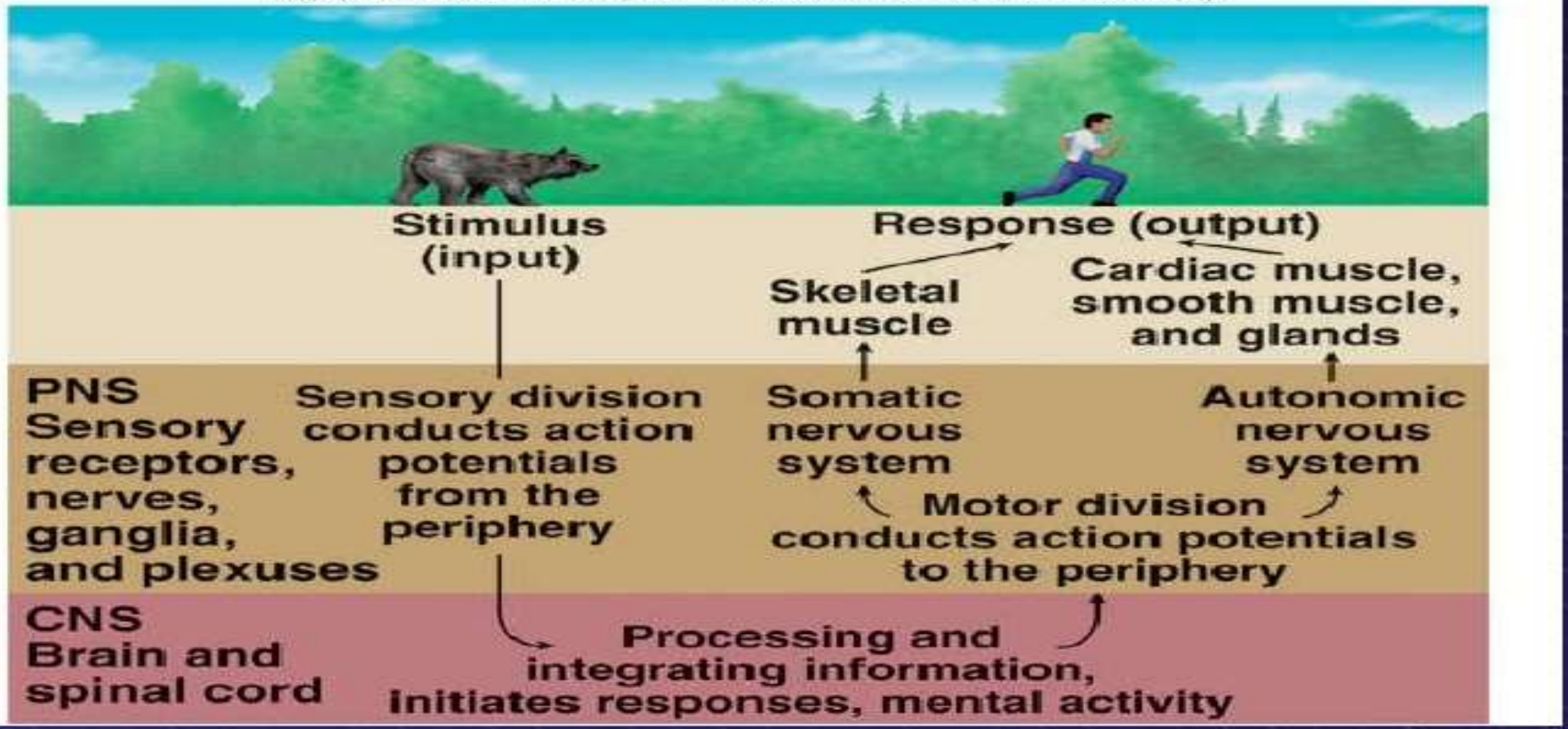
The sympathetic system. Preganglionic fibers, solid line; post ganglionic fibers, broken lines.

6. Control of Autonomic Activity

a. The autonomic nervous system is largely controlled by reflex centers in the brain and spinal cord.

b. The limbic system and cerebral cortex alter the reactions of the autonomic nervous system through emotional influence.

Nervous System Organization




Thank You