BP 201T. HUMAN ANATOMY AND PHYSIOLOGY-II (Theory)

UNIT-ONE(PART-2)

Prepared by,

Dr.REMYA RADHAKRISHNAN

ASSISTANT PROFESSOR

RAMA UNIVERSITY, KANPUR

UNIT-1 PART 2
5 HOURS
Central nervous system: Meninges, ventricles of brain and cerebrospinal fluid.structure and functions of brain (cerebrum, brain stem, cerebellum), spinal cord (gross structure,
functions of afferent and efferent nerve tracts,reflex activity)

CENTRAL NERVOUS SYSTEM

The parts of central nervous system includes:

- ✓ Brain
- ✓ Brain stem – medulla, pons, midbrain
- ✓ Diencephalon – thalamus & hypothalamus
- ✓ Cerebellum
- ✓ Cerebrum
- ✓ Spine
- ✓ Spinal Cord

MENINGES

Meninges are the three coverings around the brain & spine and help cushion, protect, and nourish the brain and spinal cord.

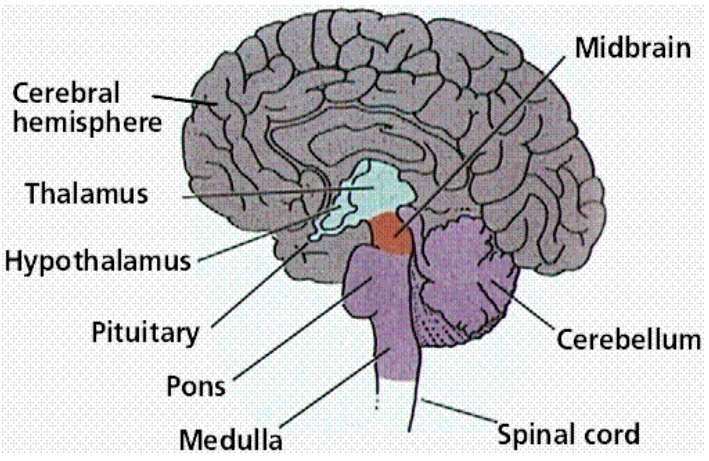
DURA MATER is the most outer layer, very tough

ARACHNOID MATER is the middle layer and adheres to the dura mater and has weblike attachments to the innermost layer, the pia mater

PIA MATER is very thin, transparent, but tough, and covers the entire brain,following it into all its crevices (sulci) and spinal cord

cerebrospinal fluid, which buffers, nourishes, and detoxifies the brain and spinal cord, flowsthrough the subarachnoid space, between the arachnoid mater and the pia mater

REGIONS OF THE BRAIN



Cerebellum – coordination of movement and aspects of motor learning

Cerebrum – conscious activity including perception, emotion, thought, and planning

Thalamus – Brain's switchboard – filters and then relays information to various brain regions

Medulla – vital reflexes as heart beat and respiration

Brainstem – medulla, pons, and midbrain (involuntary responses) and relays information from spine to upper brain

Hypothalamus– involved in regulating activities internal organs, monitoring information from the

autonomic nervous system, controlling the pituitary gland and its hormones, and regulating sleep and appetite

CEREBRUM

It is the largest portion of the brain, encompasses about two-thirds of the brain mass .

It consists of two hemispheres divided by a fissure – corpus callosum

It includes the cerebral cortex, the medullary body, and basal ganglia

cerebral cortex is the layer of the brain often referred to as gray matter because it has cell bodies and synapses but no myelin.

The cortex (thin layer of tissue) is gray because nerves in this area lack the insulation or white fatty myelin sheath that makes most other parts of the brain appear to be white.

The cortex covers the outer portion (1.5mm to 5mm) of the cerebrum andcerebellum

The cortex consists of folded bulges called gyri that create deep furrows or fissures called sulci.The folds in the brain add to its surface area which increases the amount of gray matter and the quantity of information that can be processed

Medullary body – is the white matter of the cerebrum and consists of myelinated axons

Commissural fibers – conduct impulses between the hemispheres and form corpus callosum

Projection fibers – conduct impulse in and out of the cerebral hemispheres

Association fibers – conduct impulses within the hemispheres

Basal ganglia – masses of gray matter in each hemisphere which are involved in the control of voluntary muscle movement

FUNCTIONS OF CEREBELLUM:

- Helps to coordinate voluntary muscles:but does not send impulses directly to muscles
- Acts with cerebrum to coordinate different groups of muscles smooths and coordinates complex sequences of muscular activity needed for body movements
- Controls skeletal muscles to maintain balance receives input from proprioceptors in muscles, tendons and joints and equilibrium receptors and eyes
- Learning and storing motor skills eg. playing musical instrument, riding a bike, typing, etc
- Cerebellum also has roles in awareness, emotion and judging the passage of time
- Diseases of cerebellum produce Ataxia

eg. tremors

speech problems difficulty with equilibrium (not paralysis).

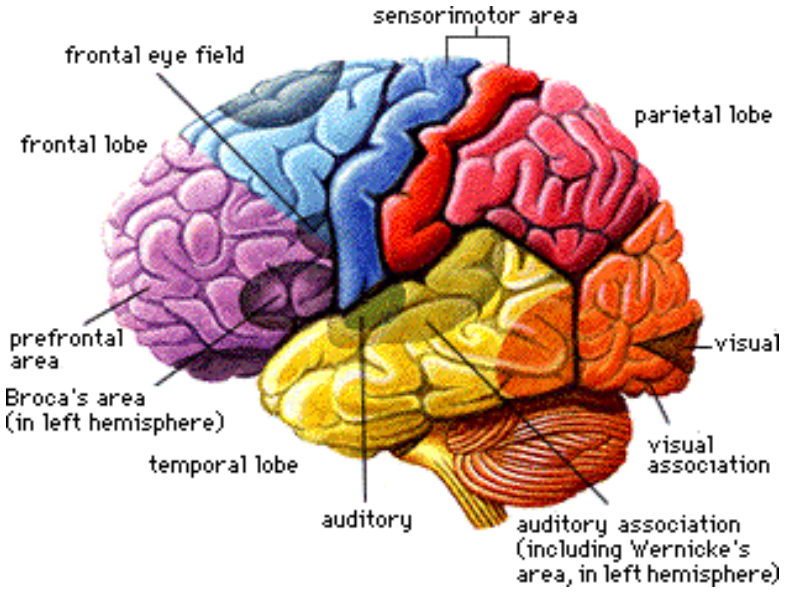
LOBES OF THE CEREBRUM

FRONTAL – motor area involved in movement and in planning & coordinating behavior

PARIETAL – sensory processing, attention, and language

TEMPORAL – auditory perception, speech, and complex visual perceptions

OCCIPITAL – visual center – plays a role in processing visual information



SPECIAL REGIONS OF BRAIN

Broca's area – located in the frontal lobe – important in the production of speech

Wernicke's area – comprehension of language and the production of meaningful speech

Limbic System – a group of brain structures (amygdale, hippocampus, septum, basal ganglia, and others) that help regulate the expression of emotions and emotional memory

VENTRICLES OF THE BRAIN

ventricles are fluid filled cavities inside brain:

1 and 2nd- inside cerebral hemispheres (lateral ventricles)

3rd – small slit at the base of the brain inside diencephalon (thalamus)

4th – diamond shaped extension of central spinal canal in brain stem

capillary beds in pia mater of meninges extend into the 4 ventricles of the brain where they form

choroid plexi.

It is surrounded by astrocytes (blood brain barrier)

Each choroid plexus secretes CSF into ventricles produces ~500ml of CSF/day.

BRAIN STEM

The brain stem is about the size of a thumb in diameter and approximately 3 inches long.

Structures. Its structures are the **midbrain**, **pons**, and the **medulla oblongata**.

Midbrain. The midbrain extends from the mammillary bodies to the pons inferiorly; it is composed of two

bulging fiber tracts, the **cerebral peduncles**, which convey descending and ascending impulses.

Corpora quadrigemina. Dorsally located are four rounded protrusions called the corpora quadrigemina

because they remind some anatomist of two pairs of twins; these bulging nuclei are reflex

centers involved in vision and hearing.

Pons. The pons is a rounded structure that protrudes just below the midbrain, and this area of the brain stem is

mostly fiber tracts; however, it does have important nuclei involved in the control of breathing.

Medulla oblongata. The medulla oblongata is the most inferior part of the brain stem; it contains nuclei that

regulate vital visceral activities; it contains centers that control heart rate, blood pressure, breathing, swallowing,and vomiting among others.

Reticular formation. Extending the entire length of the brain stem is a diffuse mass of gray matter, the reticular formation; the neurons of the reticular formation are involved in motor control of the visceral organs; a special group of reticular formation neurons, the **reticular activating system (RAS)**, plays a role in consciousness and the awake/sleep cycles.

CEREBROSPINAL FLUID

Cerebrospinal fluid (CSF) is a watery "broth" similar in its makeup to blood plasma, from which it forms.

Contents. The CSF contains less protein and more vitamin C, and glucose.

Choroid plexus. CSF is continually formed from blood by the choroid plexuses; choroid plexuses are clusters of capillaries hanging from the "roof" in each of the brain's ventricles.

Function. The CSF in and around the brain and cord forms a watery cushion that protects the fragile nervous tissue from blows and other trauma.

Normal volume. CSF forms and drains at a constant rate so that its normal pressure and volume (150 ml-about half a cup) are maintained.

Lumbar tap. The CSF sample for testing is obtained by a procedure called lumbar or **spinal tap**;because the withdrawal of fluid for testing decreases CSF fluid pressure,

the patient must remain in a horizontal position (lying down) for 6 to 12 hours after the procedure to prevent an agonizingly painful “spinal headache”.

THE BLOOD-BRAIN BARRIER

No other body organ is so absolutely dependent on a constant internal environment as is the brain, and so the blood-brain barrier is there to protect it.

Function. The neurons are kept separated from blood borne substances by the so-called blood-brain barrier, composed of the least permeable capillaries in the whole body.

Substances allowed. Of water-soluble substances, only water, glucose, and essential amino acids pass easily through the walls of these capillaries.

Prohibited substances. Metabolic wastes, such as toxins, urea, proteins, and most drugs are prevented from entering the brain tissue.

Fat-soluble substances. The blood-brain barrier is virtually useless against fats, respiratory gases, and other fat-soluble molecules that diffuse easily through all plasma membranes.

SPINAL CORD

The cylindrical spinal cord is a glistening white continuation of the brain stem.

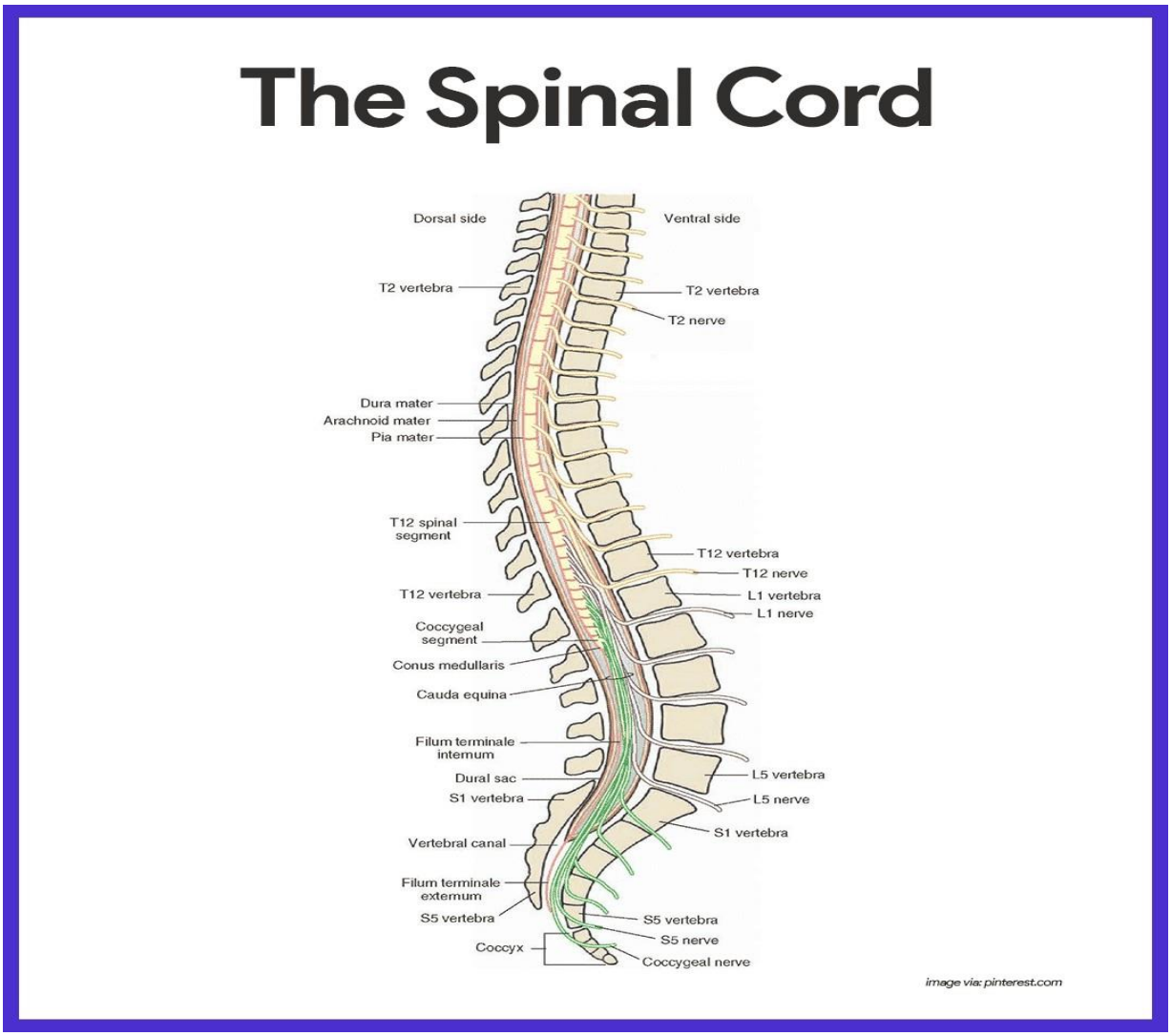
Length. The spinal cord is approximately **17 inches (42 cm)** long.

Major function. The spinal cord provides a two-way conduction pathway to and from the brain, and it is a major reflex center (spinal reflexes are completed at this level).

Location. Enclosed within the vertebral column, the spinal cord extends from the foramen magnum of the skull to the first or second lumbar vertebra, where it ends just below the ribs.

Meninges. Like the brain, the spinal cord is cushioned and protected by the meninges; meningeal coverings do not end at the second lumbar vertebra but instead extend well beyond the end of the spinal cord in the vertebral canal.

Spinal nerves. In humans, **31 pairs** of spinal nerves arise from the cord and exit from the vertebral column to serve the body area close by.



Cauda equina. The collection of spinal nerves at the inferior end of the vertebral canal is called cauda equina because it looks so much like a horse's tail.

Gray Matter of the Spinal Cord and Spinal Roots

The gray matter of the spinal cord looks like a butterfly or a letter H in cross section.

Projections. The two posterior projections are the **dorsal**, or **posterior**, **horns**; the two anterior projections are the **ventral**, or **anterior**, **horns**.

Central canal. The gray matter surrounds the central canal of the cord, which contains CSF.

Dorsal root ganglion. The cell bodies of sensory neurons, whose fibers enter the cord by the **dorsal root**, are found in an enlarged area called dorsal root ganglion; if the dorsal root or its ganglion is damaged, sensation from the body area served will be lost.

Dorsal horns. The dorsal horns contain interneurons.

Ventral horns. The ventral horns of gray matter contain cell bodies of motor neurons of the somatic nervous system, which send their axons out the ventral root of the cord.

Spinal nerves. The dorsal and ventral roots fuse to form the spinal nerves.

White Matter of the Spinal Cord

White matter of the spinal cord is composed of myelinated fiber tracts- some running to higher centers, some traveling from the brain to the cord, and some conducting impulses from one side of the spinal cord to the other.

Regions. Because of the irregular shape of the gray matter, the white matter on each side of the cord is divided into three regions- the **dorsal, lateral**, and **ventra**l columns; each of the columns contains a number of fiber tracts made up of axon with the same destination and function.

Sensory tracts. Tracts conducting sensory impulses to the brain are sensory, or **afferent**, tracts.

Motor tracts. Those carrying impulses from the brain to skeletal muscles are motor, or **efferent**, tracts.

CRANIAL NERVES

The 12 pairs of cranial nerves primarily serve the head and the neck.

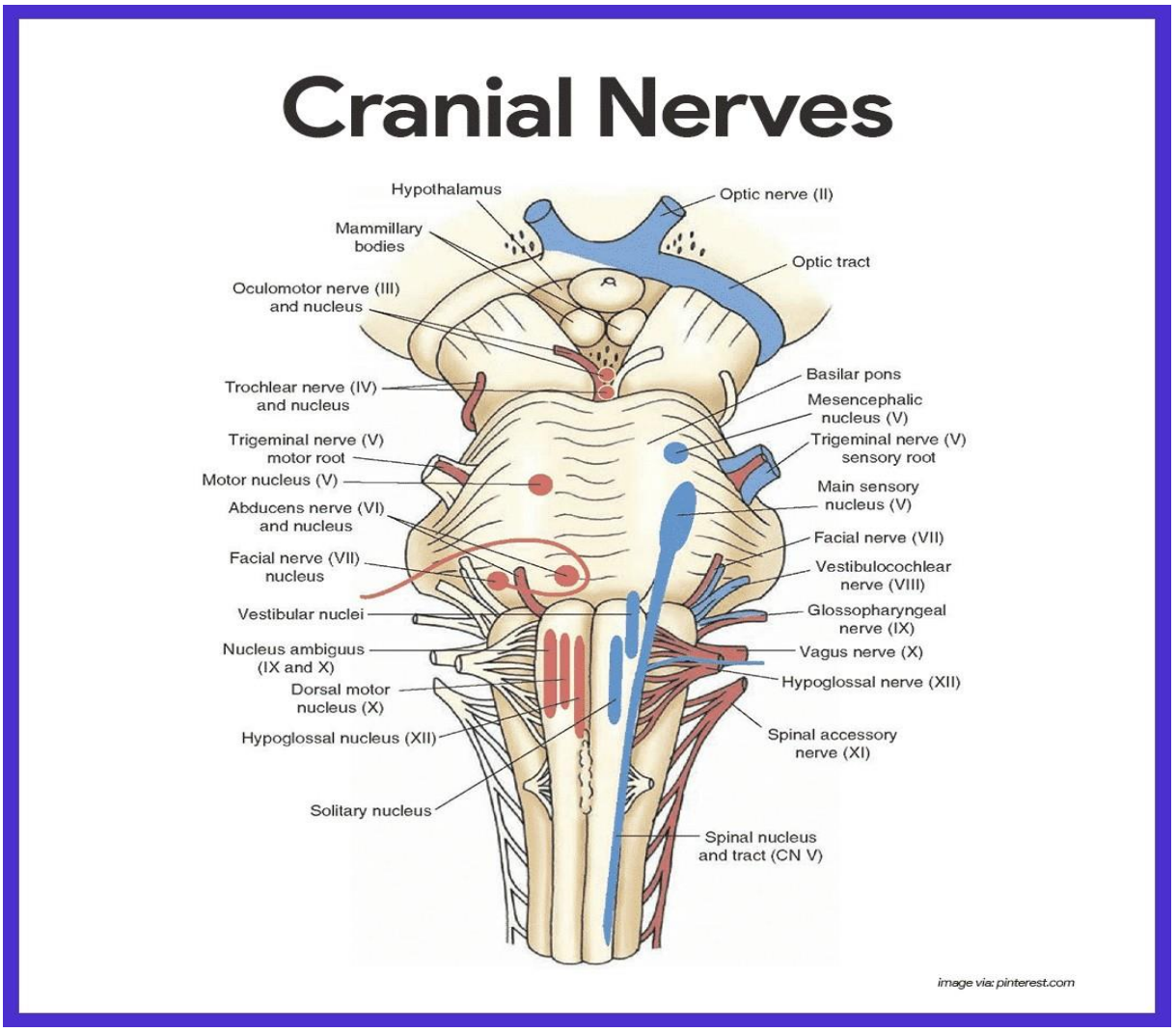
They include:

Olfactory. Fibers arise from the olfactory receptors in the nasal mucosa and synapse with the olfactory bulbs; its function is purely sensory, and it carries impulses for the sense of smell.

Optic. Fibers arise from the retina of the eye and form the optic nerve; its function is purely sensory, and carries impulses for vision.

Oculomotor. Fibers run from the midbrain to the eye; it supplies motor fibers to four of the six muscles (superior, inferior, and medial rectus, and inferior oblique) that direct the eyeball; to the eyelid; and to the internal eye muscles controlling lens shape and pupil size.

Trochlear. Fibers run from the midbrain to the eye; it supplies motor fibers for one external eye muscle (superior oblique).



Trigeminal. Fibers emerge from the pons and form three divisions that run to the face; it conducts sensory impulses from the skin of the face and mucosa of the nose and mouth; also contains motor fibers that activate the chewing muscles.

Abducens. Fibers leave the pons and run to the eye; it supplies motor fibers to the lateral rectus muscle, which rolls the eye laterally.

Facial. Fibers leave the pons and run to the face; it activates the muscles of facial expression and the lacrimal and salivary glands; carries sensory impulses from the taste buds of the anterior tongue.

Vestibulocochlear. fibers run from the equilibrium and hearing receptors of the inner ear to the brain stem; its function is purely sensory; vestibular branch transmits impulses for the sense of balance, and cochlear branch transmits impulses for the sense of hearing.

Glossopharyngeal. Fibers emerge from the medulla and run to the throat; it supplies motor fibers to the pharynx (throat) that promote swallowing and saliva production; it carries sensory impulses from the taste buds of the posterior tongue and from pressure receptors of the carotid artery.

Vagus. Fibers emerge from the medulla and descend into the thorax and abdominal cavity; the fibers carry sensory impulses from and motor impulses to the pharynx, larynx, and the abdominal and thoracic viscera; most motor fibers are parasympathetic fibers that promote digestive activity and help regulate heart activity.

Accessory. Fiber arise from the medulla and superior spinal cord and travel to muscles of the neck and back; mostly motor fiber that activate the sternocleidomastoid and trapezius muscles.

Hypoglossal. Fibers run from the medulla to the tongue; motor fibers control tongue movements;; sensory fibers carry impulses from the tongue.

SPINAL NERVES AND NERVE PLEXUSES

The 31 pairs of human spinal nerves are formed by the combination of the ventral and dorsal roots of the spinal cord.

Rami. Almost immediately after being formed, each spinal nerve divides into dorsal and ventral rami, making each spinal nerve only about 1/2 inch long; the rami contains both sensory and motor fibers.

Dorsal rami. The smaller dorsal rami serve the skin and muscles of the posterior body trunk.

Ventral rami. The ventral rami of spinal nerves T1 through T12 form the intercostal nerves, which supply the muscles between the ribs and the skin and muscles of the anterior and lateral trunk.

Cervical plexus. The cervical plexus originates from the C1-C5, and **phrenic nerve** is an important nerve; it serves the diaphragm, and skin and muscles of the shoulder and neck.

Brachial plexus. The **axillary nerve** serve the deltoid muscles and skin of the shoulder, muscles, and skin of superior thorax; the r**adial nerve** serves the triceps and extensor muscles of the forearm, and the skin of the posterior upper limb; the **median**

nerve serves the flexor muscles and skin of the forearm and some muscles of the hand; the **musculocutaneous nerve** serves the flexor muscles of arm and the skin of the lateral forearm; and the **ulnar nerve** serves some flexor muscles of forearm; wrist and many hand muscles, and the skin of the hand.

Lumbar plexus. The **femoral nerve** serves the lower abdomen, anterior and medial thigh muscles, and the skin of the anteromedial leg and thigh; the **obturator nerve** serves the adductor muscles of the medial thigh and small hip muscles, and the skin of the medial thigh and hip joint.

Sacral plexus. The **sciatic nerve** (largest nerve in the body) serves the lower trunk and posterior surface of the thigh, and it splits into the common fibular and tibial nerves; the **common fibular nerve** serves the lateral aspect of the leg and foot, while the **tibial nerve** serves the posterior aspect of leg and foot; the **superior and inferior gluteal nerves** serve the gluteal muscles of the hip.

AUTONOMIC NERVOUS SYSTEM

The autonomic nervous system (ANS) is the motor subdivision of the PNS that controls body activities automatically.

Composition. It is composed of a specialized group of neurons that regulate cardiac muscle, smooth muscles, and glands.

Function. At every moment, signals flood from the visceral organs into the CNS, and the automatic nerves make adjustments as necessary to best support body activities.

Divisions. The ANS has two arms: the sympathetic division and the parasympathetic division.

ANATOMY OF THE PARASYMPATHETIC DIVISION

The parasympathetic division allows us to “unwind” and conserve energy.

Preganglionic neurons. The preganglionic neurons of the parasympathetic division are located in brain nuclei of several cranial nerves- III, VII, IX, and X (the vagus being the most important of these) and in the S2 through S4 levels of the spinal cord.

Craniosacral division. The parasympathetic division is also called the craniosacral division; the neurons of the cranial region send their axons out in cranial nerves to serve the head and neck organs.

Pelvic splanchnic nerves. In the sacral region, the preganglionic axons leave the spinal cord and form the pelvic splanchnic nerves, also called the pelvic nerves, which travel to the pelvic cavity.

ANATOMY OF THE SYMPATHETIC DIVISION

The sympathetic division mobilizes the body during extreme situations, and is also called the thoracolumbar division because its preganglionic neurons are in the gray matter of the spinal cord from T1 through L2.

Ramus communicans. The preganglionic axons leave the cord in the ventral root, enter the spinal nerve, and then pass through a ramus communicans, or small communicating branch, to enter a sympathetic chain ganglion.

Sympathetic chain. The sympathetic trunk, or chain, lies along the vertebral column on each side.

Splanchnic nerves. After it reaches the ganglion, the axon may synapse with the second neuron in the sympathetic chain at the same or a different level, or the axon may through the ganglion without synapsing and form part of the splanchnic nerves.

Collateral ganglion. The splanchnic nerves travel to the viscera to synapse with the ganglionic neuron, found in a collateral ganglion anterior to the vertebral column.

REFERENCE

1. 1. Principles of Anatomy and Physiology by Tortora Grabowski. Palmetto, GA, U.S.A.;fifteenth edition;pg no: 403-440
2. Ross and Wilson Anatomy And Physiology In Health And Illness;12TH EDITION;Pg no: 143-190
3. https://www.weber.edu/wsuimages/mollysmith/3510Presentations/Nerve.PPT