

THE URINARY SYSTEM & NERVOUS SYSTEM LECTURE 6

**1ST YEAR-BIOLOGY SUBJECT –
LABORATORY SCIENCE
DEPARTMENTS**

**ALZAHRAA UNIVERSITY – COLLEGE
OF PHARMACY**

Dr .Esraa Ali Almustafa

M.B.Ch.B , F.I.C.M.S /PATH

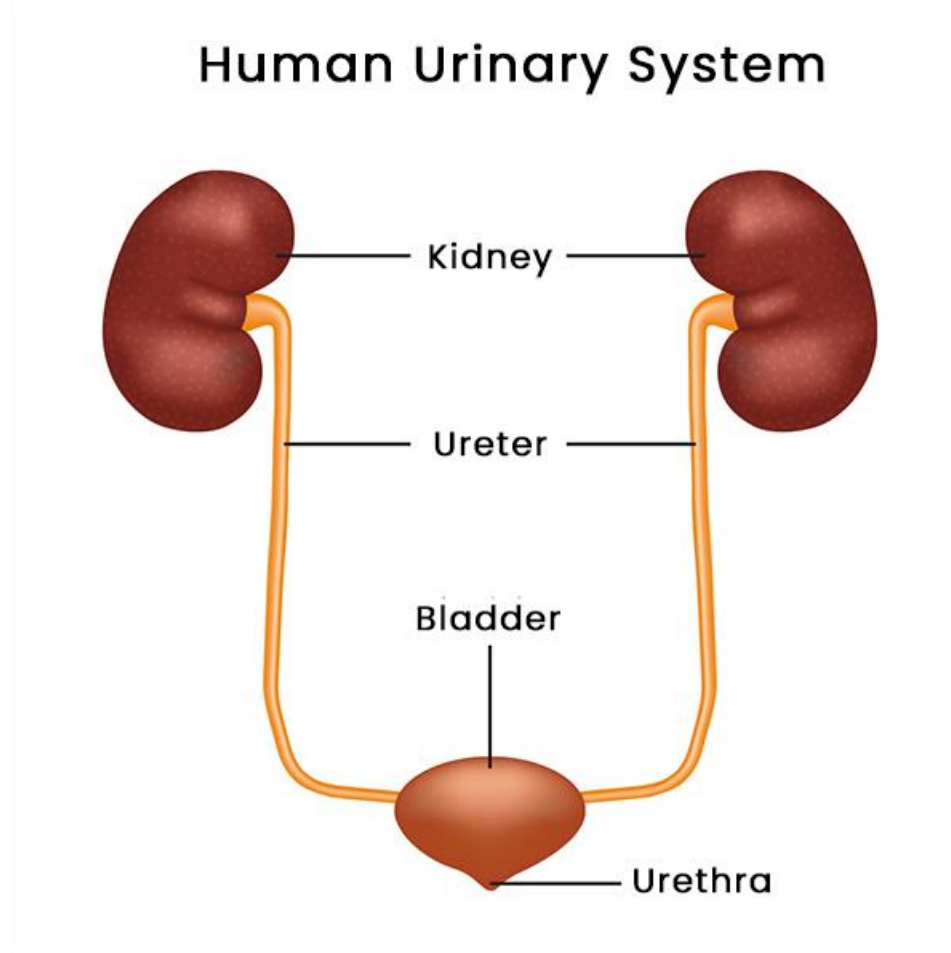
Learning outcomes

- At the end of the lecture you should be able to
 1. Summarize the function of the urinary system
 2. Identify the organs of the urinary system and state their function
 3. Identify the structure of the nephron and state the function of each
 4. Summarize the three processes involved in the formation of urine
 5. Distinguish between central & peripheral nervous system

Urinary system

- **introduction:**
- The urinary system, also known as the renal system, plays a crucial role in maintaining homeostasis by regulating the composition, volume, and pH of blood, as well as eliminating waste products from the body.
- It consists of the kidneys, ureters, bladder, and urethra.

Urinary system

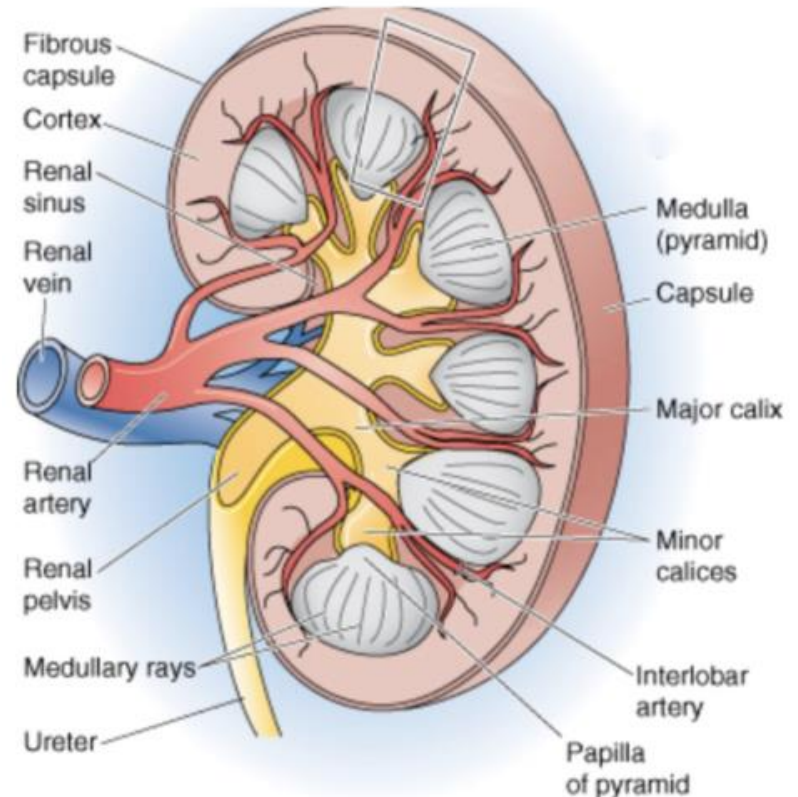


Kidneys:

- - **Location:** The kidneys are two bean-shaped organs located retroperitoneally, on either side of the vertebral column, around the level of the T12 to L3 vertebrae.
- - **Structure:**
 - - **Cortex:** The outer region containing renal corpuscles and convoluted tubules.
 - - **Medulla:** The inner region consisting of renal pyramids and collecting ducts.
 - - **Renal Pelvis:** A funnel-shaped structure that collects urine from the major calyces and drains it into the ureters.

Nephrons

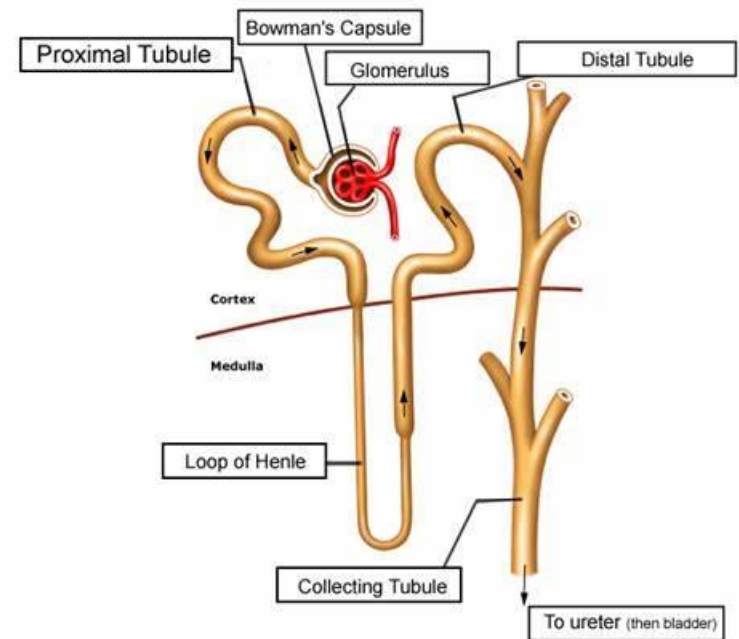
- - **Nephrons:** The functional units of the kidneys, each kidney contains about 1 million nephrons, responsible for filtering blood and forming urine.
- **The nephron can be divided**
- **into two main parts:**
 - 1. Renal Corpuscle
 - 2. Renal Tubule



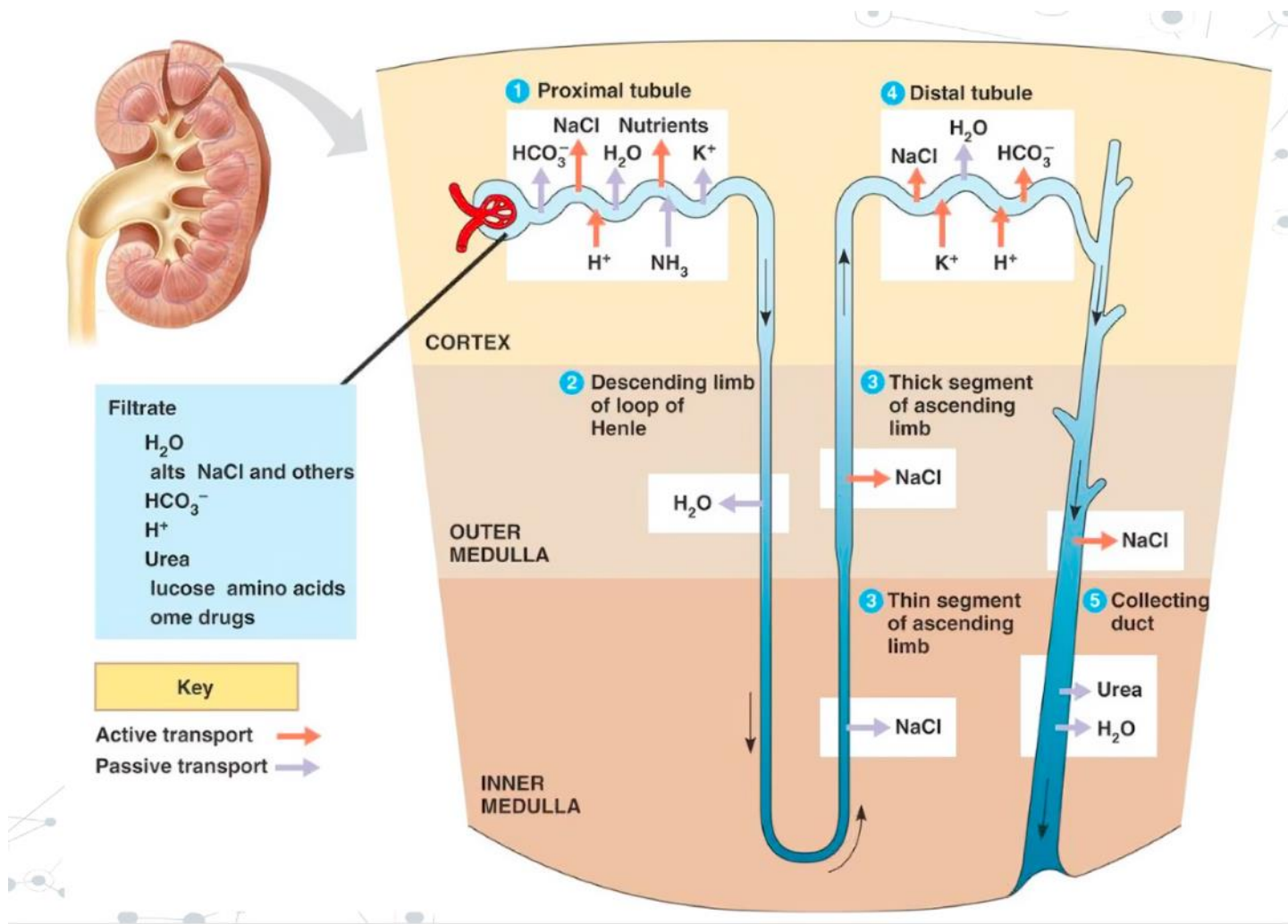
Renal Corpuscle:

The renal corpuscle is the site where blood is filtered. It consists of two main structures:

- **Glomerulus:** A tuft of capillaries that are responsible for the filtration of blood.
- **Bowman's Capsule:** A cup-shaped structure that surrounds the glomerulus and collects the filtered fluid (called filtrate or glomerular filtrate).



RENAL TUBULES



Renal Tubule:

The renal tubule is where the filtrate undergoes **processing—reabsorption and secretion**—to form urine. It has three main sections:

- **Proximal Convoluted Tubule (PCT):**
- The first part of the renal tubule
- Here, a large amount of filtrate is reabsorbed back into the bloodstream. This includes :glucose , amino acids, and electrolytes
-

• Loop of Henle:

- The loop of Henle plays a crucial role in **creating a concentration gradient in the kidney medulla. It consists of a descending limb and an ascending limb:**
- **Descending Limb:** Permeable to water but not solutes. As the filtrate moves down, water is reabsorbed into the surrounding tissue due to the osmotic gradient in the medulla.
- **Ascending Limb:** Impermeable to water but actively transports sodium, chloride, and potassium ions out of the filtrate, which helps in creating the osmotic gradient necessary for water reabsorption in the collecting duct.

•

• Distal Convoluted Tubule (DCT):

- This part is responsible for fine-tuning the composition of the filtrate.
The DCT reabsorbs:
 - Sodium and chloride ions under hormonal control (especially aldosterone).
 - • Secretes potassium and hydrogen ions into the filtrate to help regulate electrolyte and acid-base balance.
 - •
- **Collecting Duct:**
 - The final segment of the nephron, where the filtrate (now called urine) is collected.
 - The collecting ducts merge to form larger ducts, which empty into the renal pelvis.
 - The reabsorption of water and sodium is fine-tuned here, primarily under the influence of ADH (which increases water reabsorption) and aldosterone (which increases sodium reabsorption).

Ureters:

- - **Structure:** Two muscular tubes (approximately 25-30 cm long) that transport urine from the kidneys to the bladder.
- - **Function:** Peristaltic contractions propel urine toward the bladder.

- **c. Urinary Bladder:**

- - **Structure:** A hollow, muscular organ that stores urine. It can hold approximately 400-600 mL of urine.
-
- - Layers:
- - **Mucosa:** The inner lining that is stretchable and contains transitional epithelium.
- - **Muscularis:** The middle layer (detrusor muscle) that contracts to expel urine.
- - **Adventitia:** The outer connective tissue layer.

d. Urethra:

- - **Structure:** A tube that carries urine from the bladder to the outside of the body.
- - **Length:** Approximately 4 cm long in females and 20 cm long in males.
- - **Sphincters:**
 - - Internal Urethral Sphincter: Involuntary muscle that prevents leakage from the bladder.
 - - External Urethral Sphincter: Voluntary muscle that allows for conscious control of urination.

Function of the Urinary System

a. **Filtration:**

- - The kidneys filter blood to remove waste products eg urea & creatinine

• **b. Reabsorption:**

- - Essential substances such as water, glucose, amino acids, and electrolytes are reabsorbed back into the bloodstream from the renal tubules.

• **c. Secretion:**

- - The kidneys secrete additional waste products and excess ions into the renal tubules for elimination, **contributing to the regulation of blood pH and electrolyte balance.**

d. Excretion:

- - The final product, urine, is composed of water, urea, creatinine, uric acid, and various electrolytes. This urine is transported to the bladder for storage until elimination.

- **2 . Regulation of Homeostasis**

- **a. Fluid and Electrolyte Balance:**

- - The urinary system **regulates the volume and composition of body fluids** by adjusting the excretion of water and electrolytes (sodium, potassium, calcium).

- **b. Acid-Base Balance:**

- - The kidneys help maintain blood pH by excreting hydrogen ions and reabsorbing bicarbonate

- **c. Blood Pressure Regulation:**

- - The kidneys produce the enzyme renin, which activates the renin-angiotensin-aldosterone system (RAAS) to regulate blood pressure by controlling fluid balance and vascular resistance.

- **d. Erythropoiesis:**

- - The kidneys secrete erythropoietin, a hormone that stimulates the production of red blood cells in response to low oxygen levels in the blood.

- **E- Activation of vitamin D**

Urine Formation Process

a. Glomerular Filtration:

- - Blood enters the glomerulus under high pressure, forcing water and solutes through the filtration membrane into Bowman's capsule, forming the filtrate.

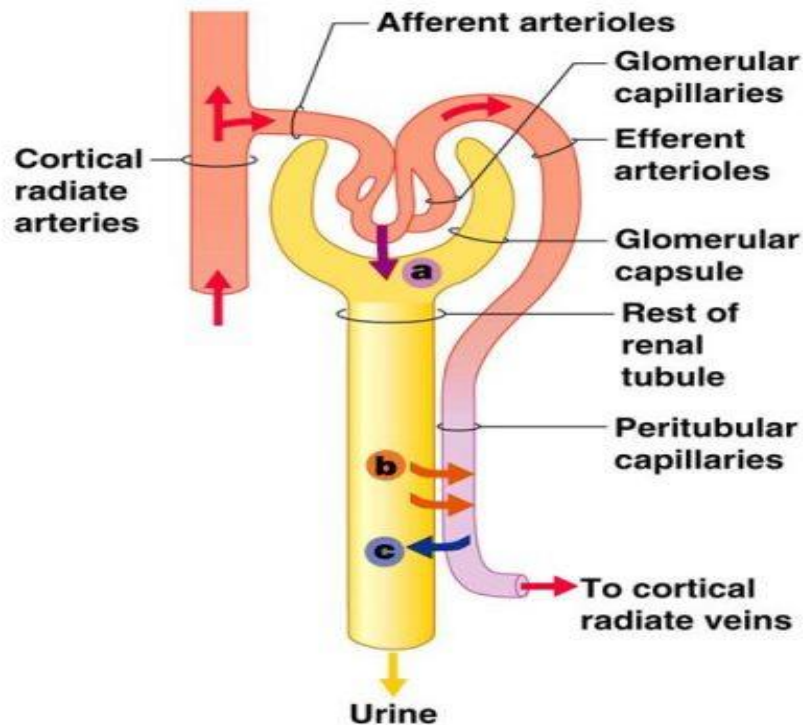
• b. Tubular Reabsorption:

- - As the filtrate moves through the proximal convoluted tubule, loop of Henle, distal convoluted tubule, and collecting duct, approximately 99% of water and essential substances are reabsorbed.

- c. Tubular Secretion: Additional wastes and excess ions are secreted into the tubules from the peritubular capillaries, further refining the urine composition.

Urine Formation Process

Urine Formation



KEY:

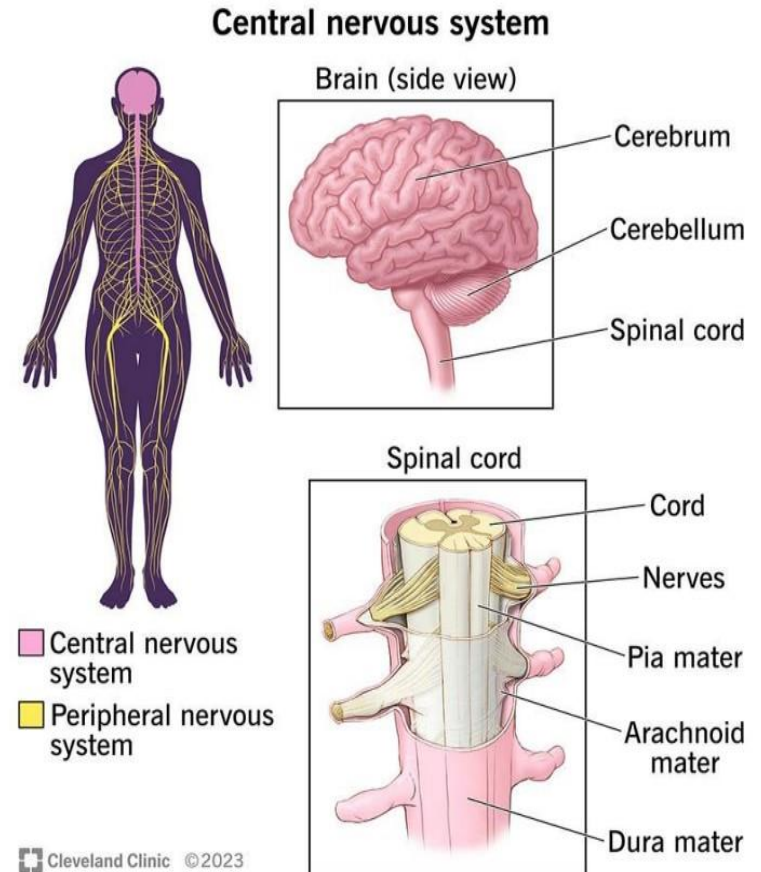
a **Glomerular Filtration:** Water and solutes smaller than proteins are forced through the capillary walls and pores of the glomerular capsule into the renal tubule.

b **Tubular Reabsorption:** Water, glucose, amino acids, and needed ions are transported out of the filtrate into the tubule cells and then enter the capillary blood.

c **Tubular Secretion:** H^+ , K^+ , creatinine, and drugs are removed from the peritubular blood and secreted by the tubule cells into the filtrate.

The Nervous System

- The nervous system is the **control and communication system** of the body.
- It allows organisms to detect changes in their environment, process this information, and produce appropriate responses.



Divisions of the Nervous System

- The nervous system is broadly divided into two main parts:
- **1. Central Nervous System (CNS)**
- The CNS consists of the **brain** and **spinal cord**.
- **It processes information and determines the body's response.**
- **2. Peripheral Nervous System (PNS)**
- The PNS consists of **nerves** that branch out from the CNS to the rest of the body.
- **It is further divided into:**
 - **Somatic Nervous System (SNS):** Controls voluntary movements (e.g., skeletal muscles).
 - **Autonomic Nervous System (ANS):** Controls involuntary functions (e.g., heart rate, digestion).

Nervous tissue consists of two major types of cell

- 1- **neurons** are The Functional Unit of the Nervous System
- **responsible** for conduction, propagation, and reception of nervous impulses. Have Processes called axons or dendrites extend from these cell
- 2- **glial cells (neuroglia)**:- supportive cells associated with neurons. No axons or dendrites. These cells are involved in nutrition, support, insulate & protection of neuron

note

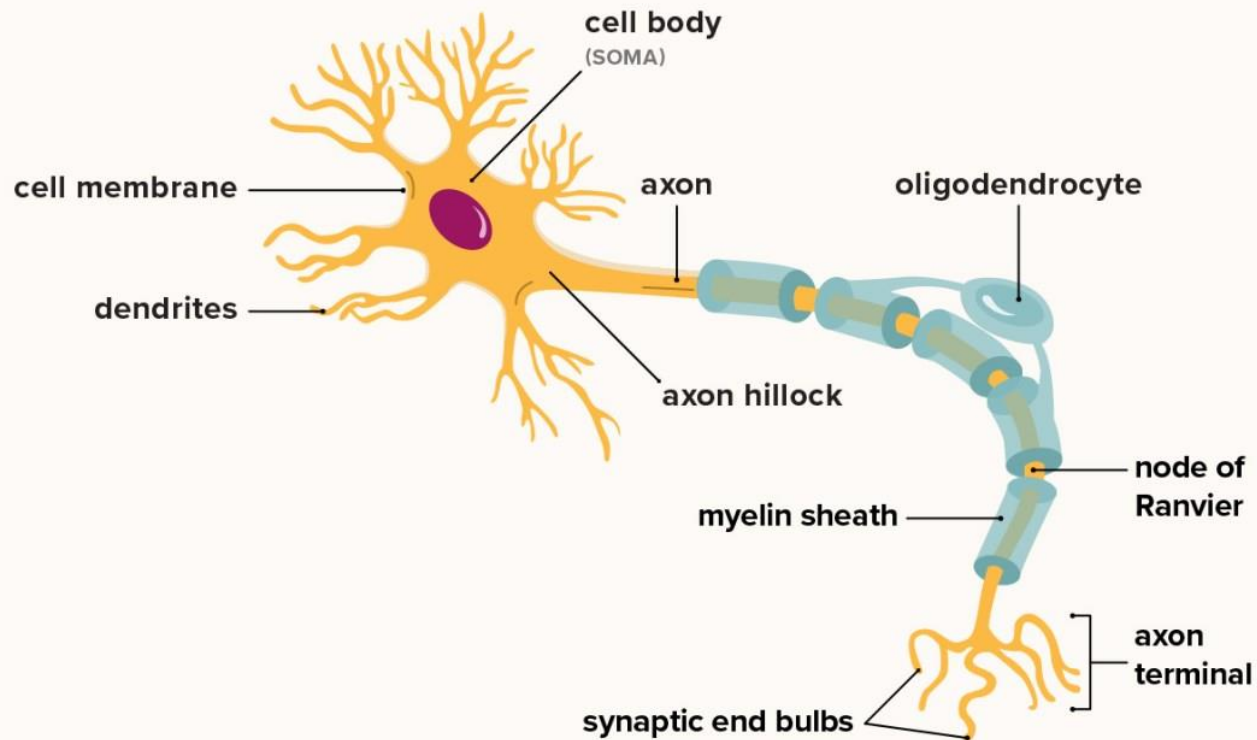
- Neurons or nerve cells are not mitotically active (they can't divide to replace neurons that are damaged because of disease or acute damage to CNS , SO any damage to neuron is permanent)

Neurons

- Neurons are highly specialized cells that **transmit electrical and chemical signals**.
- **Structure of a Neuron**
- **Cell Body (Soma)**: Contains the nucleus and organelles.
- **Dendrites**: Short, branched extensions that receive signals from other neurons.
- **Axon**: A long fiber that transmits impulses away from the cell body.
- **Myelin Sheath**: A fatty layer that insulates the axon, speeding up nerve impulses.
- **Synaptic Terminals**: The ends of the axon through which communicate with other cells.

Structure of a Neuron

Structure of a neuron



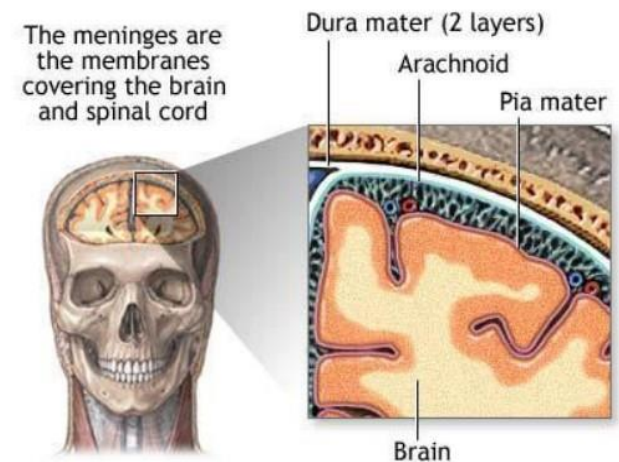
Neurons can be classified based on their function:

- **1. Motor neurons** :- efferent, axon extends out of CNS to an effector organ/tissue
- **2. Sensory neurons** :- afferent, dendrite/axon extends from peripheral sensory structure
- **3. Interneurons** :- form connections between neurons

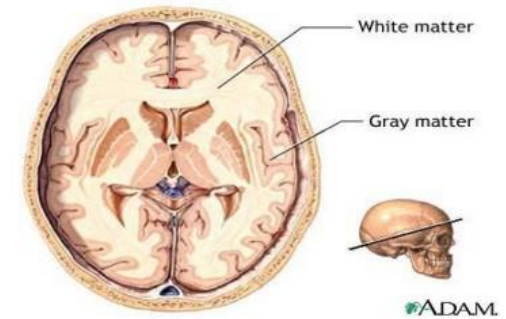
Central Nervous System (Brain and Spinal Cord)

- The brain lies within the cranial cavity of the skull and the spinal cord occupies the vertebral canal within the vertebral column.
- **the brain and spinal cord are protected and nourished by 3 membranes called meninges that are located between the bone and soft tissue of the nervous system.**

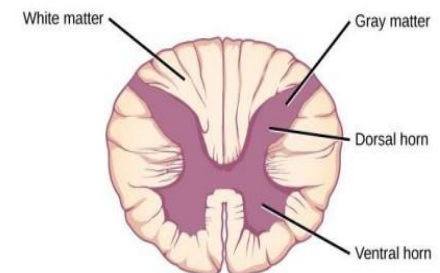
The Meninges: - protective connective tissue sheaths surrounding the brain and spinal cord. Contain 3 layers dura mater, arachnoid, pia mater



- The CNS has a characteristic tissue arrangement called grey matter and white matter .
- Grey matter contains the cell bodies (soma) of neurons and the supporting cells (neuroglia) as well as unmyelinated dendrites and axons.
- White matter does not contain any cell bodies, but mostly contains myelinated nerve fibres .



- While The central region of the spinal
- cord is grey matter, and the surrounding region is white matter



Peripheral Nervous Systems

- **It consists of peripheral neurons & ganglia**
- **Peripheral Nerves:** are composed of bundles of nerve fibers - (mostly the axons) held together by Connective Tissue and include
 - spinal nerves connected to the spinal cord
 - cranial nerves connected with the brain
- **Ganglia** are typically ovoid structures containing nerve cell bodies and glial cells supported by Connective Tissues . They serve as stations to transmit nerve impulses, one nerve enters and another exists from each ganglion

Thank you
Any questions ?