Aakash + BYJU'S NOTES

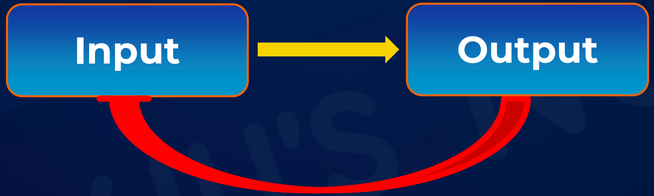
Excretory Products and their Elimination

Key Takeaway

1. Homeostasis
2. Elimination of Waste Products
3. Modes of Excretion
4. Evolution of Excretory Structures
5. Human Excretory System
6. Kidneys
7. Nephrons
8. Ureters, Urinary bladder & Urethra

Homeostasis

- **Homeostasis** is the ability to maintain a relatively internal stable state. This state persists despite the external environmental changes.
    - It is a self-regulating process by which **biological** systems tend to maintain stability.
- **A negative feedback loop** is a reaction that causes a decrease in the function. The product of a reaction leads to a decrease in the overall reaction.
    - These negative feedback loops are responsible for the stabilisation of a system and the maintenance of a stable state.



- These negative feedback loops aid in maintaining homeostasis in living organisms.

- Examples:
    - Blood glucose levels are regulated with the help of two hormones, **insulin and glucagon**.
    - The excretory system helps in maintaining the level of urea in the body.

Elimination of Waste Products

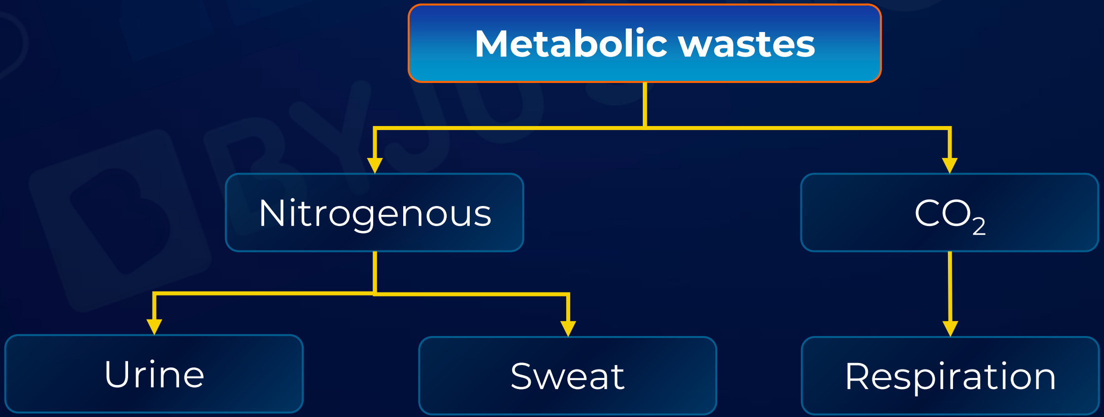
Excretion

- Elimination of nitrogenous wastes
- Produced by metabolic activities

Egestion

- Elimination of waste and undigested food
- Faeces expelled through anus

- Excretion and egestion are ways in which the body maintains balance.

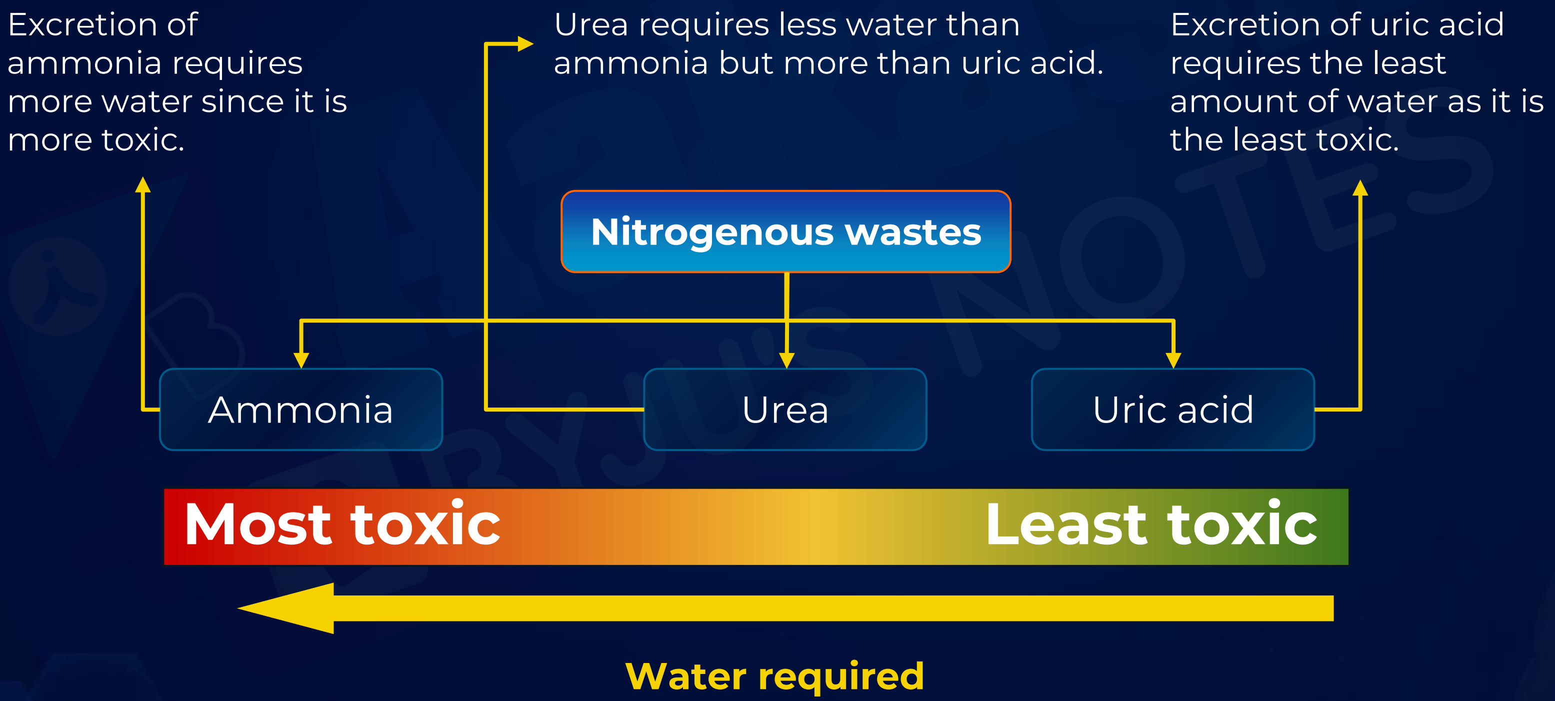


Metabolic wastes

- Nitrogenous
  - Urine
  - Sweat
- CO_2
  - Respiration

Elimination of Waste Products

- Nitrogenous wastes are of three types:



Nitrogenous wastes

Ammonia

Excretion of ammonia requires more water since it is more toxic.

Urea

Urea requires less water than ammonia but more than uric acid.

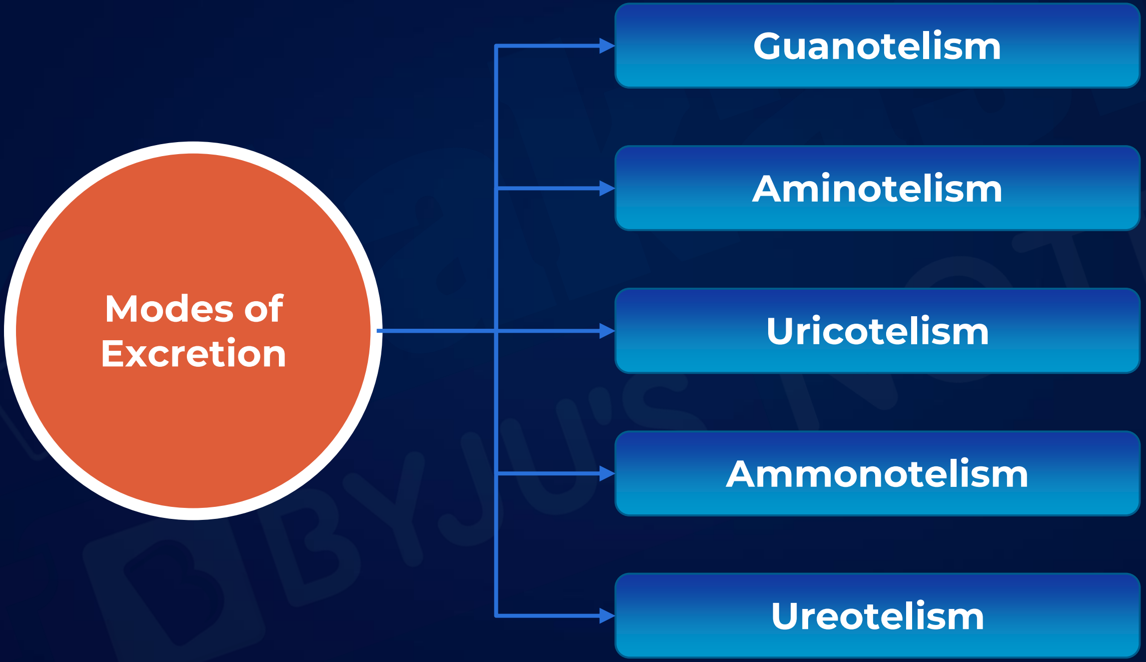
Uric acid

Excretion of uric acid requires the least amount of water as it is the least toxic.

Most toxic **Least toxic**

Water required

Modes of Excretion



Modes of Excretion

- Guanotelism
- Aminotelism
- Uricotelism
- Ammonotelism
- Ureotelism

Modes of Excretion

Guanotelism

- It is the process of eliminating **guanine** from the body.
- Guanine is insoluble in water.
- Examples: Spider and scorpion.

Aminotelism

- It is the process of eliminating **amino acids** from the body.
- Examples: *Unio, Asterias* etc.

Uricotelism

- It is the process of eliminating nitrogenous waste like **uric acid** from the body.
- It is the least toxic form of nitrogenous waste.
- Uric acid is insoluble in water.
- It is passed in the form of pellet/**precipitate**.
- Uric acid is formed due to nucleic acid’s metabolism (from purines).
- Examples: Reptiles, birds, land snails, terrestrial insects.

Modes of Excretion

Ammonotelism

- It is the process of elimination of nitrogenous waste, like **ammonia**.
- Ammonia is readily soluble in water.
- Ammonia is toxic and hence requires more water for excretion.
- It is only seen in **aquatic animals**.
- In marine fishes, ammonia is eliminated through gills.
- Examples: *Ascaris*, protozoa, bony fishes, sponges, coelenterates etc.

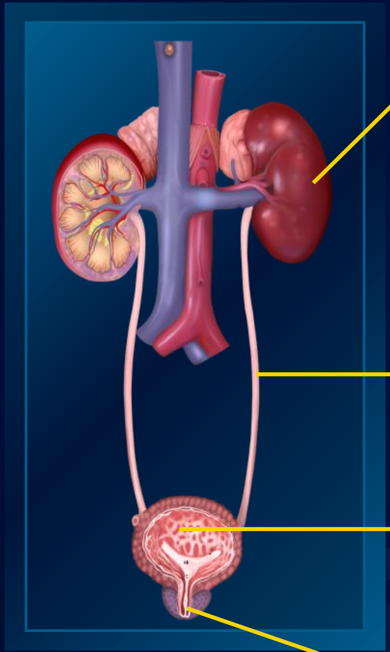
Ureotelism

- Ureotelism is the process of elimination of **urea** from the body of an organism.
- Urea is neither too toxic nor the least toxic like uric acid.
- Terrestrial animals adapt to conserve water. They produce less toxic forms of nitrogenous wastes.
    - The water available for terrestrial animals like humans is less.
    - They convert ammonia into urea.
    - Urea is 10,000 times less toxic than ammonia.
- Examples: Marine fishes, terrestrial amphibians and mammals.

Evolution of Excretory Structures

1. **Protonephridia (Flame Cells):** Seen in platyhelminthes, rotifers, some annelids and cephalochordates
2. **Nephridia:** Seen in earthworms and other annelids
3. **Malpighian tubules:** In cockroaches
4. **Green glands/ Antennal glands:** In prawns
5. **Kidneys:** In humans

Human Excretory System



Human excretory system

Kidney

- Reddish-brown, bean-shaped structures which exist in pair
- Weighs 120–170 g, approximately; 10–12 cm in length, 5–7 cm in width and 2–3 cm in thickness.
- Located near the inner dorsal wall of the abdominal cavity, between the levels of last thoracic and the third lumbar vertebrae (parts of the backbone).
- **Filter out the body waste** and send waste in the form of urine to the ureter.

Ureter

- They are long, thin tubes made of smooth muscles.
- They **carry urine** from the kidney to urinary bladder.

Urinary bladder

- It is a hollow muscular organ that is elastic in nature.
- It **collects** and **stores the urine** until the urine has to be eliminated out of the body.

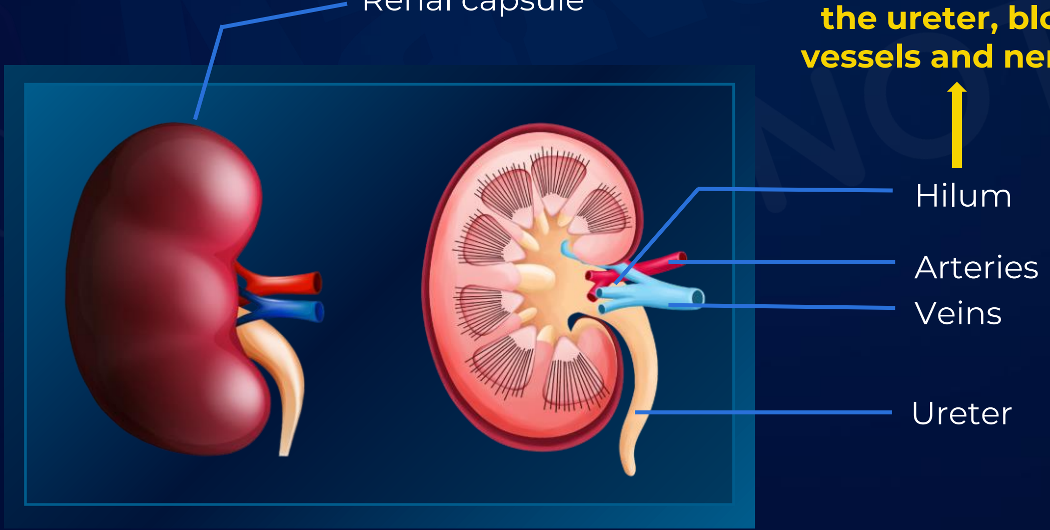
Urethra

- It is a thin, hollow tube present at the end of the urinary bladder.
- It **passes urine out** of the urinary bladder.

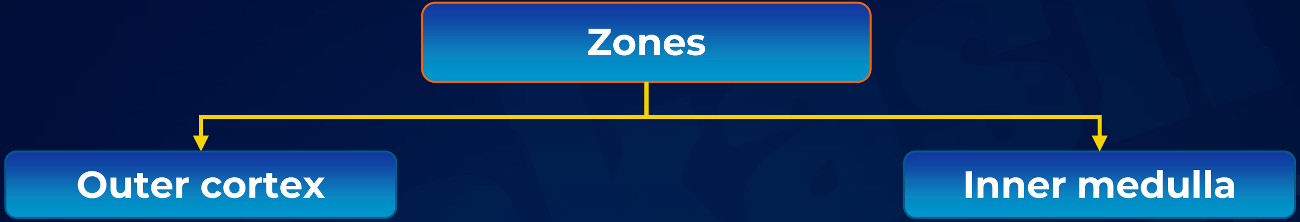
Kidneys

The outer layer of a kidney is a tough capsule known as the renal capsule.

The entry point of the ureter, blood vessels and nerves.



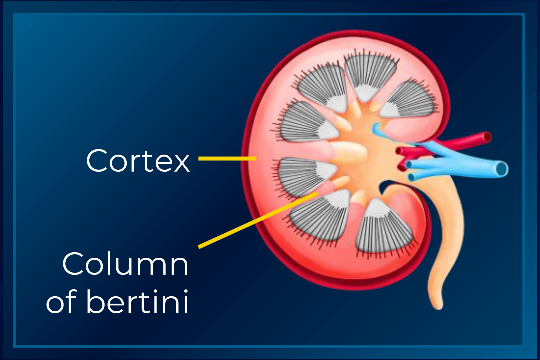
Kidneys



Zones

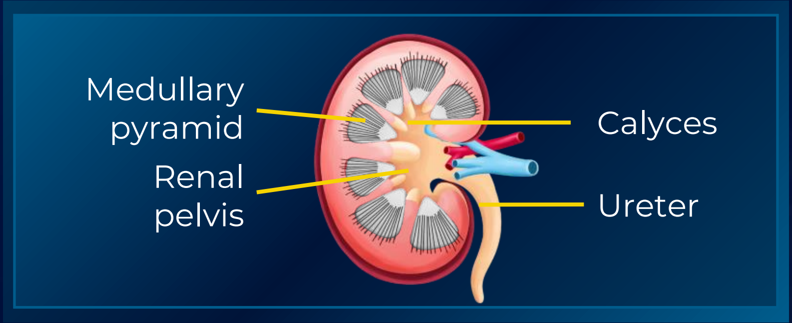
Outer cortex

- The cortex is the zone that occupies the peripheral zone of the kidneys.
- It extends in between the medullary pyramids as renal columns known as **columns of Bertini**.



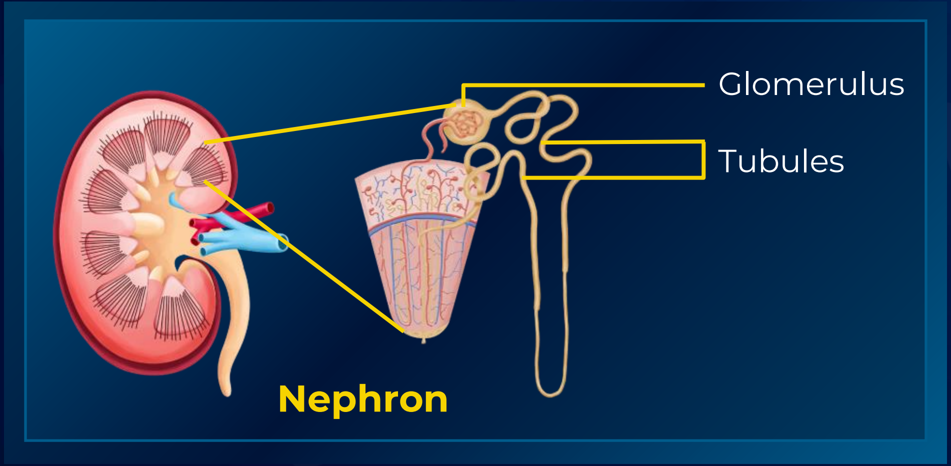
Inner medulla

- The medulla is the inner portion of the kidneys that is divided into a few conical masses and known as **medullary pyramids** that project into the **calyces**.
- The calyces open into a funnel-shaped region known as the renal pelvis.
- The renal pelvis opens into the ureter.



Nephrons

- The structural and functional units of kidneys are the **nephrons**.
- **Each kidney** has nearly **one million** complex tubular structures known as nephrons.



Parts of the nephron

- **Renal tubules**
- **Glomerulus**

Nephrons

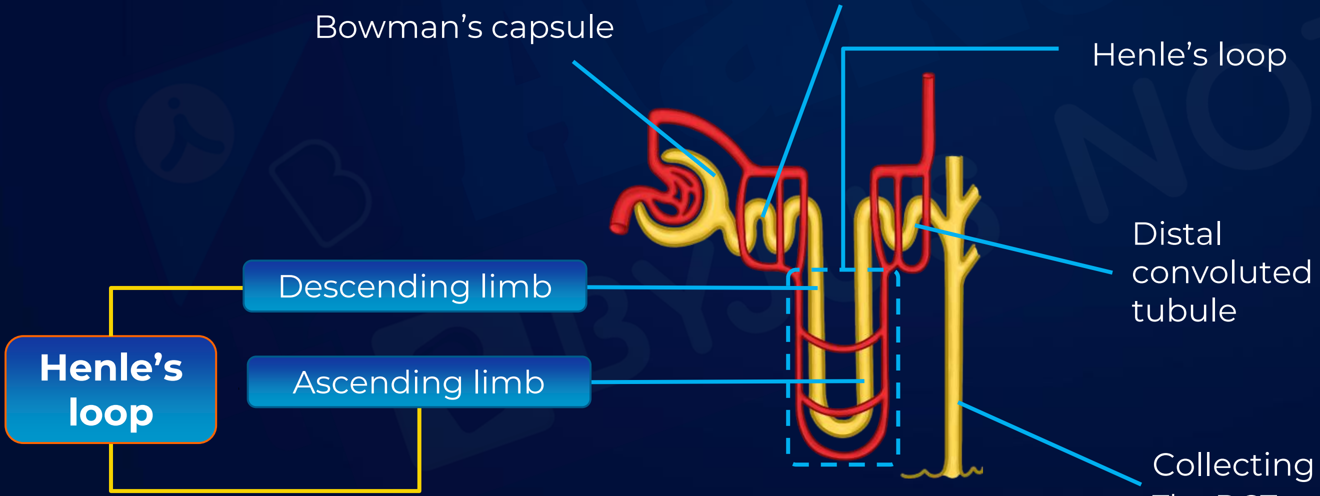
Renal tubules

The renal tubule begins with a double-walled, cup-like structure known as **Bowman's capsule**.

The tubule continues further to form a highly coiled network known as the **proximal convoluted tubule (PCT)**.

The hairpin-shaped **Henle's loop** is the next part of the tubule.

The ascending limb continues as another highly coiled, tubular region known as the **distal convoluted tubule (DCT)**.

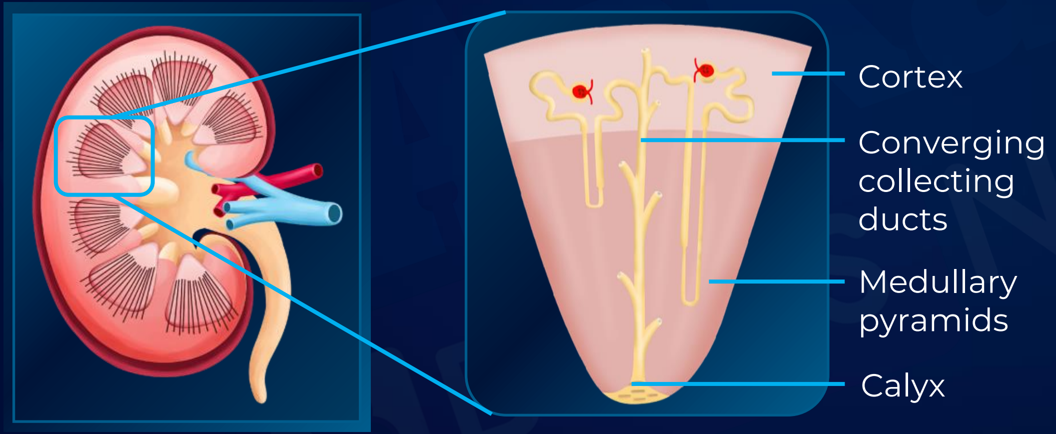


The DCTs of many nephrons open into a straight tube known as the **collecting duct**.

Nephrons

Renal tubules

Collecting duct



Many collecting ducts converge and open into the renal pelvis through medullary pyramids in the calyces.

- The **collecting duct is not a part of the nephron**.
- The DCT carries the urine to the collecting duct.
- Many nephrons open into one collecting duct.
- Many collecting ducts converge into the medulla part of the kidney.
- Collecting ducts enter medulla and form **ducts of Bellini**.

Nephrons

Glomerulus

Glomerulus is a tuft of capillaries formed by the afferent arteriole..

The Glomerulus

Malpighian body/ Renal corpuscle

Glomerulus

Bowman's capsule

Efferent arteriole Blood from the glomerulus is carried away by the efferent arteriole.

Henle's loop

Afferent arteriole

A fine branch of renal artery

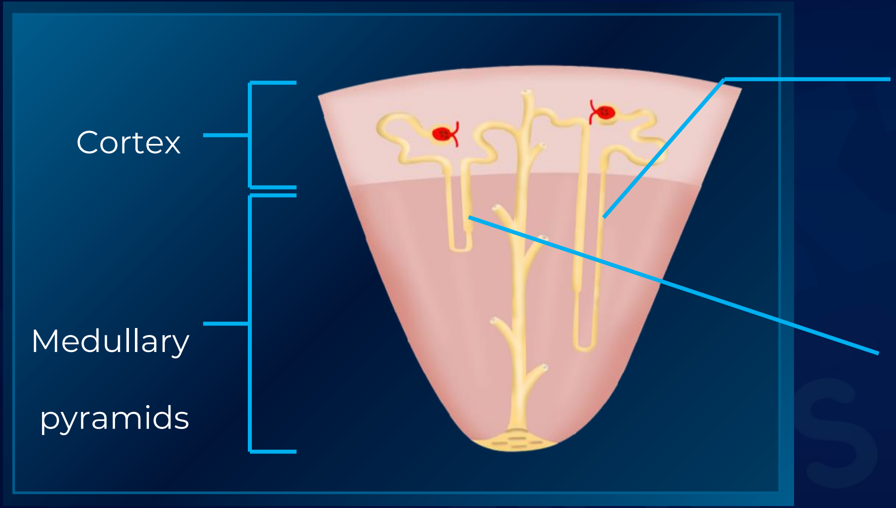
Peritubular capillaries

The efferent arteriole, emerging from the glomerulus, forms a fine capillary network around the renal tubule known as the **peritubular capillaries**.

Vasa rectum

A minute vessel of peritubular capillaries network runs parallel to the Henle's loop, forming a **U-shaped** vasa rectum. Vasa recta are **absent or highly reduced in cortical nephrons.**

Types of Nephrons



Juxtamedullary nephrons

- Henle’s loop is long
- Extends deep into the medulla
- Vasa rectum seen here

Cortical nephrons

- Henle’s loop is short
- Extends very little into the medulla
- Peritubular capillaries seen here
- Vasa recta is absent or highly reduced

Ureters, Urinary Bladder & Urethra

Ureters

- The ureters receive the urine from the renal pelvis and **pass it on to the urinary bladder**.

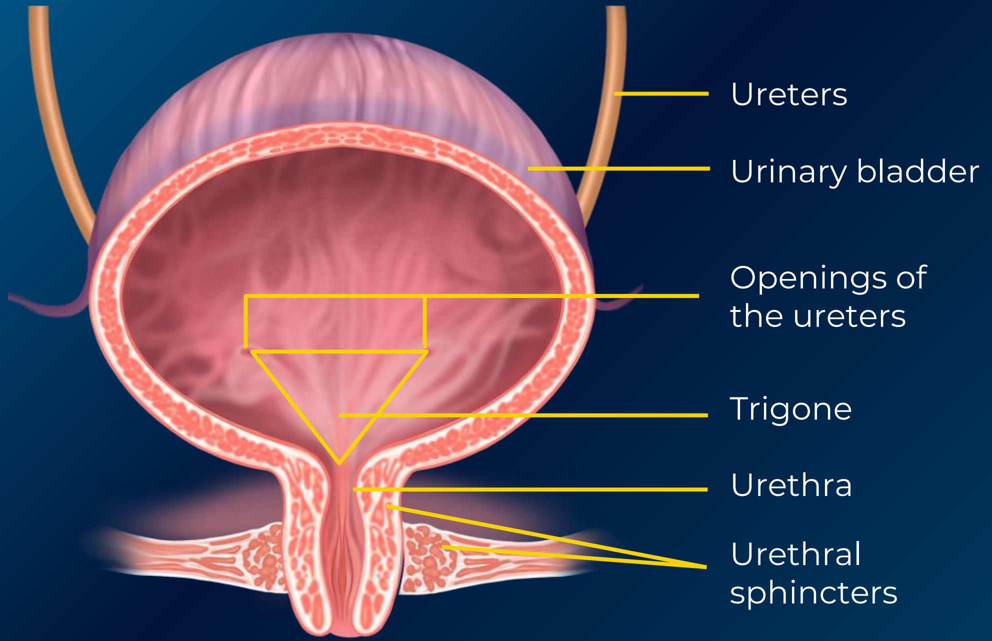
Urinary bladder

- The urinary bladder receives urine from the ureters through small openings.
- Its main function is to **store** and **expel urine**.
- The bladder is lined by a layer of epithelial tissue known as the **transitional epithelium**.
- This epithelium has the ability to expand and allow the **storage of large amounts of urine**.
- The urinary bladder opens into the urethra.

Urethra

- The urethra is a duct that drains the urine out of the bladder.
- The openings of the ureters and the urethra in the bladder form a triangular region known as the **trigone**.
- The passage of the urine from the bladder to the urethra and its removal from the urethra is guarded by the **urethral sphincters**.

Ureters, Urinary Bladder & Urethra



Urine Formation

- **Urine is the liquid by-product** secreted by kidneys. Its main purpose is to **remove wastes** like **urea**, **uric acid** and **excess water** from blood.
- The process of filtration occurs in kidneys with the help of filtration units known as **nephrons**.
- Urine formation takes place in different parts of the nephron, which involves **three main processes.**

Urine formation : **Ultrafiltration** → **Reabsorption** → **Secretion**

Urine Formation

Ultrafiltration

- Filtration of blood takes place in the glomerulus, which is known as **glomerular filtration**.
- Blood from the glomerulus is carried away by the **efferent arteriole**.
- The **efferent arteriole** is **narrower than afferent arterioles**.
- The blood pressure in the glomerular capillaries becomes very high, leading to continuous **ultrafiltration** (**filtration under pressure**) through semi-permeable glomerular capillaries.

  The amount of the filtrate formed by the kidneys per minute is called **glomerular filtration rate (GFR).**

  GFR in a healthy individual is approximately **125 ml/min,** i.e., **180 litres per day.**
- The glomerular capillary blood pressure causes the filtration of blood through **3 layers**, i.e.,
  - Endothelium of glomerular blood vessel
  - Bowman’s capsule epithelium
  - Basement membrane

Urine Formation

- The epithelial cells of Bowman's capsule known as **podocytes** are arranged in an intricate manner so as to leave some minute spaces known as **filtration slits** or **slit pores**.
- Blood is filtered finely through these membranes.
- Almost all the constituents of the plasma (except the proteins) pass into the lumen of Bowman's capsule.
- The fine filtration of blood through the three-layered membrane is known as **ultrafiltration**.

Glomerular filtration rate

- The amount of filtrate formed by the kidneys per minute is known as **glomerular filtration rate (GFR)**.

GFR in a healthy individual is approximately 125 ml/minute, i.e., 180 litres per day!

Urine Formation

Reabsorption

- This is the second step in the formation of urine from filtrate.
- The **urine released is 1.5 litres** as compared to the volume of the filtrate formed per day, which is 180 litres.
- 99% of the filtrate is reabsorbed by the renal tubules. This process is known as **reabsorption**.
- The tubular epithelial cells in different segments of the nephron perform reabsorption either by active or passive mechanisms.

Actively transported substances

- Glucose
- Amino acids
- Na^+

Passively transported substances

- Nitrogenous wastes
- Water (initial segments of nephron)

Urine Formation

Secretion

- The tubular cells **secrete substances like H^+, K^+**, and ammonia into the filtrate. This step is known as **tubular secretion.**
- It helps in the **maintenance of the ionic and acid-base balance** of the body fluids.

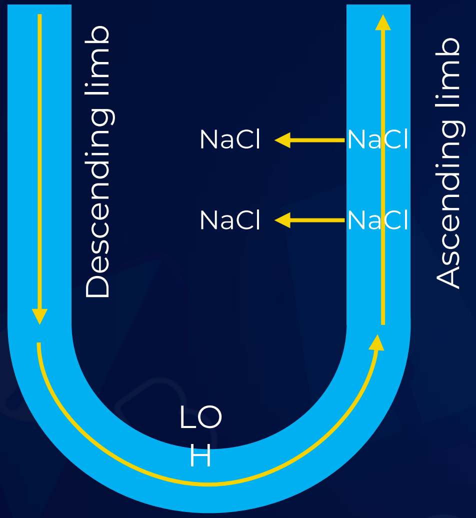
Proximal convoluted tubule

- Lined by a simple, **cuboidal brush-border epithelium**
  - Increases the surface area for reabsorption
- Nearly all of the **essential nutrients and 70-80 percent of electrolytes and water** are **reabsorbed** here.
- Helps in **maintaining the pH and the ionic balance of the body fluids**.
  - Achieved by selective secretion of hydrogen and ammonia ions into the filtrate.

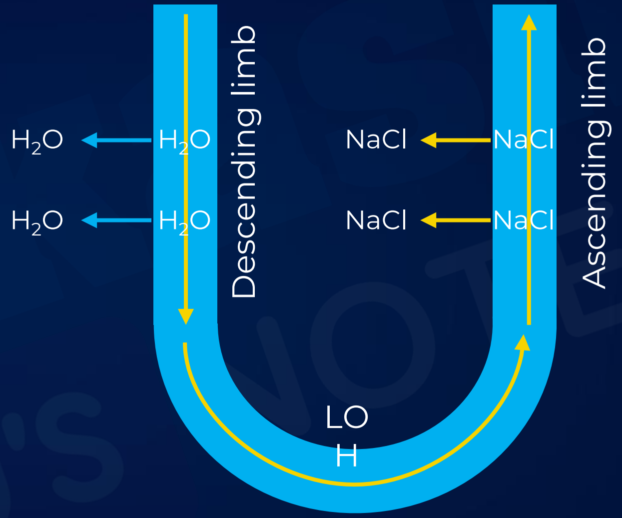
Loop of Henle

- Major reabsorption takes place in the descending and ascending loops.
- **Ascending limb is impermeable** for water due to the lack of aquaporins but allows the transport of electrolytes actively or passively.
- **Descending limb, loop of Henle, is permeable to water** but almost impermeable to electrolytes due to the lack of transporters.
- It plays a significant **role in the maintenance of high osmolarity of medullary interstitial fluid**.

Urine Formation



As NaCl moves out of the ascending loop, the osmolarity in the medulla increases.



This, in turn, allows water to be **reabsorbed from the descending loop through aquaporins** to reduce the osmolarity in the medulla. This concentrates the filtrate as it moves down.

- Therefore, as the concentrated filtrate passes upward, it gets diluted due to the passage of electrolytes to the medullary fluid.

Urine Formation

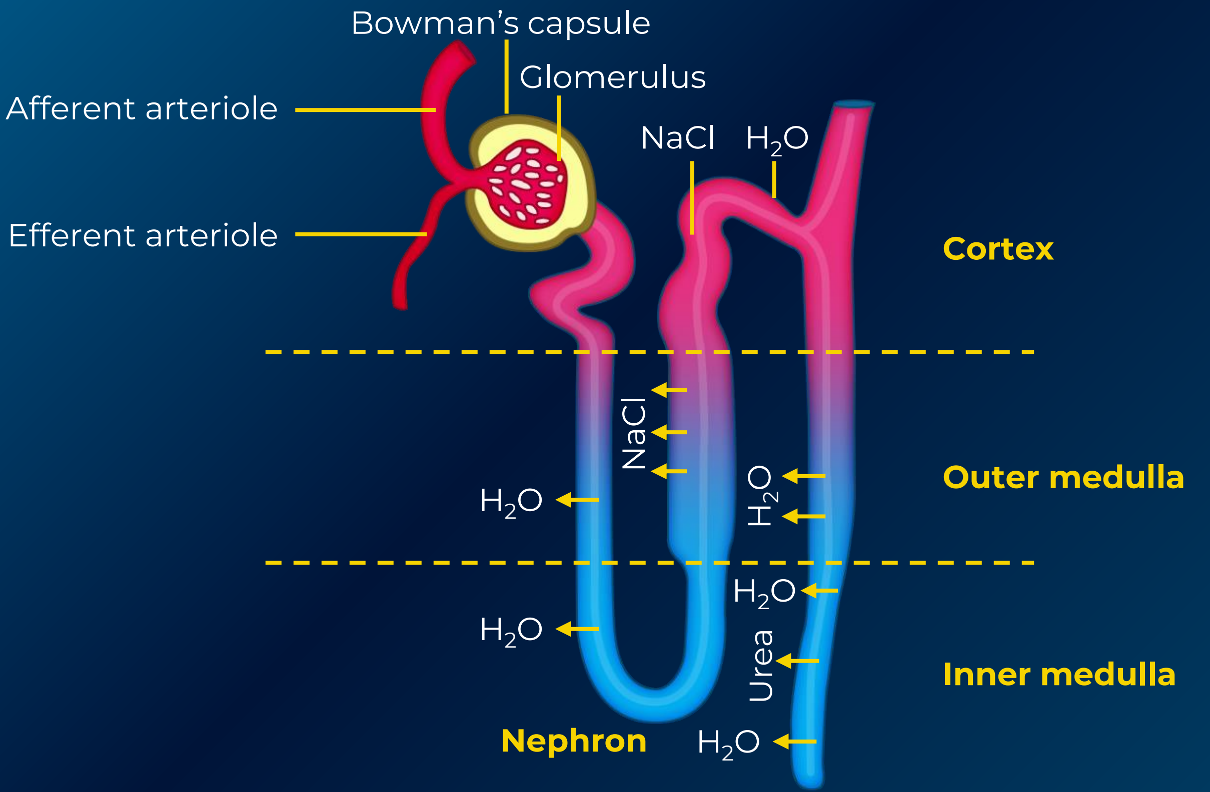
In Distal Convoluted Tubule

- Conditional reabsorption of Na^+ and water takes place in this segment.
- It is capable of reabsorption of HCO^{3-} (bicarbonate ions).
- It performs selective secretion of hydrogen-potassium ions and NH^{3+} to **maintain the pH and the sodium-potassium balance in the blood**.

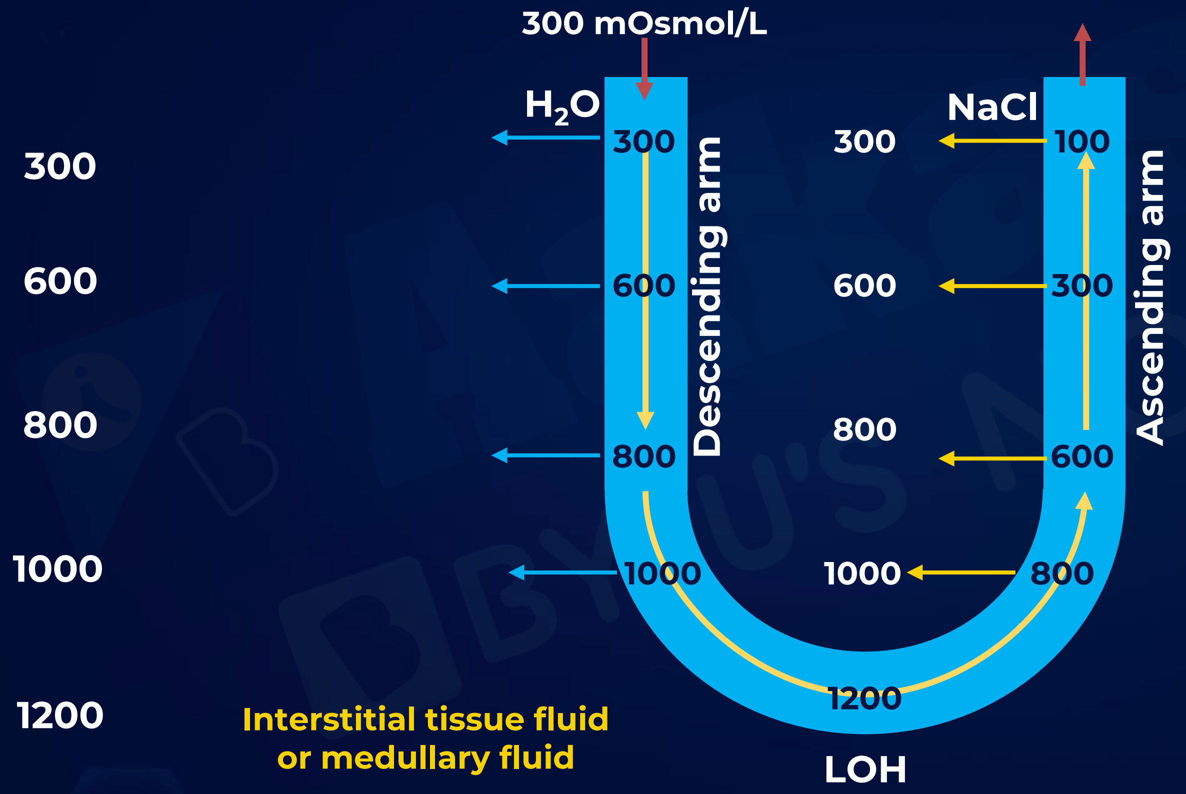
In Collecting duct

- This long duct **extends** from the cortex of the kidney to the inner parts of the **medulla**.
- Large amounts of water could be reabsorbed from this region to produce concentrated urine.
- This segment allows the passage of **small amounts of urea into the medullary interstitium** to keep up the osmolarity.
- It also plays a role in the maintenance of pH and ionic balance of blood by the selective secretion of H^+ and K^+ ions.

Urine Formation



Concentration of Urine



Concentration of Urine

- Kidneys of higher vertebrates (such as mammals, human beings, birds, etc.) have the ability to absorb more and more water from the tubular filtrate (in the Loop of Henle region) to make the urine more concentrated.
- This can be achieved by a special mechanism known as the **countercurrent mechanism.**
- It is also known as the urine **concentration mechanism.**

- **Osmolarity:** total number of solute particles per litre
- **Filtrate enters descending limb of LOH at 300 mOsmol/L.**
- The ascending limb pumps out salt into tissue fluid; osmolarity decreases inside ascending limb and increases in medullary fluid
- Increased osmolarity inside descending limb than interstitium: Water moves from descending loop to the interstitium till equilibrium.
- Concentration gradient formed inside LOH: 300-1200 mOsmol/L.

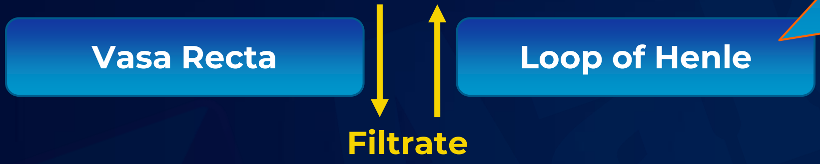
Concentration of Urine

Process in vasa recta

- The efferent arteriole that exits the Bowman's capsule forms a U-shaped capillary network around the Henle's loop. This is the **vasa recta**.
- The blood in the vasa recta flows in the opposite direction of the flow of blood in the LOH.
- Blood entering **descending vasa recta: 300 mOsmol/L.**
- The capillary walls are permeable to both water and solute.
- When the 300 mOsmol/L blood moves downwards into the 600 mOsmol/L region of medullary fluid:
    - some water moves outside the vasa recta
    - some solute from the medullary fluid moves into the capillary due to higher osmolarity outside.
    - This continues until equilibrium is reached between blood and medullary fluid.
- This process continues as the **blood moves downward upto 1200 mOsmol/L.**

Countercurrent Mechanism

Filtrate flowing in the opposite direction through the Henle's loop and Vasa recta forms a counter current.



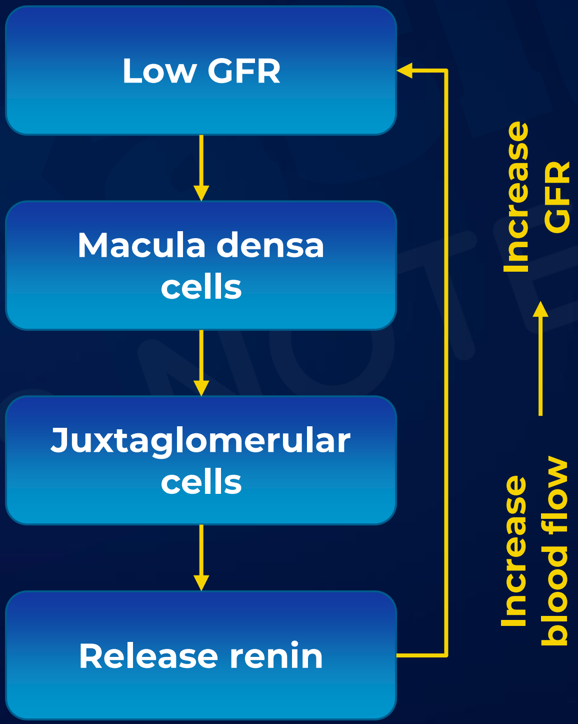
Descending limb is permeable to water, and the ascending limb is permeable to electrolytes

The proximity between Henle's loop and the vasa recta as well as the countercurrent in them **help in maintaining an increasing osmolarity** towards the inner medullary interstitium.

- **Blood entering ascending vasa recta: 1200 mOsmol/L.**
- The capillary walls are permeable to both water and solute.
- When the 1200 mOsmol/L blood moves upwards into the 1000 mOsmol/L region of medullary fluid, some water moves inside the vasa recta and some solute from the capillary moves into the medullary fluid due to lower osmolarity outside. This continues until equilibrium is reached between blood and medullary fluid.
- This process continues as the blood moves upward upto 300 mOsmol/L and finally 300 mOsmol/L blood comes out of ascending vasa recta.

Juxtaglomerular Apparatus (JGA)

- JGA is **a special, sensitive region** formed by cellular modifications in a part of the nephron, where the **distal convoluted tubule crosses the afferent arteriole**.
- **DCT cells in the region are modified** to form cells known as the **macula densa cells**.
- The cells of the **afferent arteriole** that brings blood to Bowman's capsule are also modified to form **juxtaglomerular cells**.
- **A fall in GFR can activate the JG cells to release renin**, which can stimulate the glomerular blood flow and thereby bring the GFR back to normal.



Low GFR

Macula densa cells

Juxtaglomerular cells

Release renin

Increase blood flow

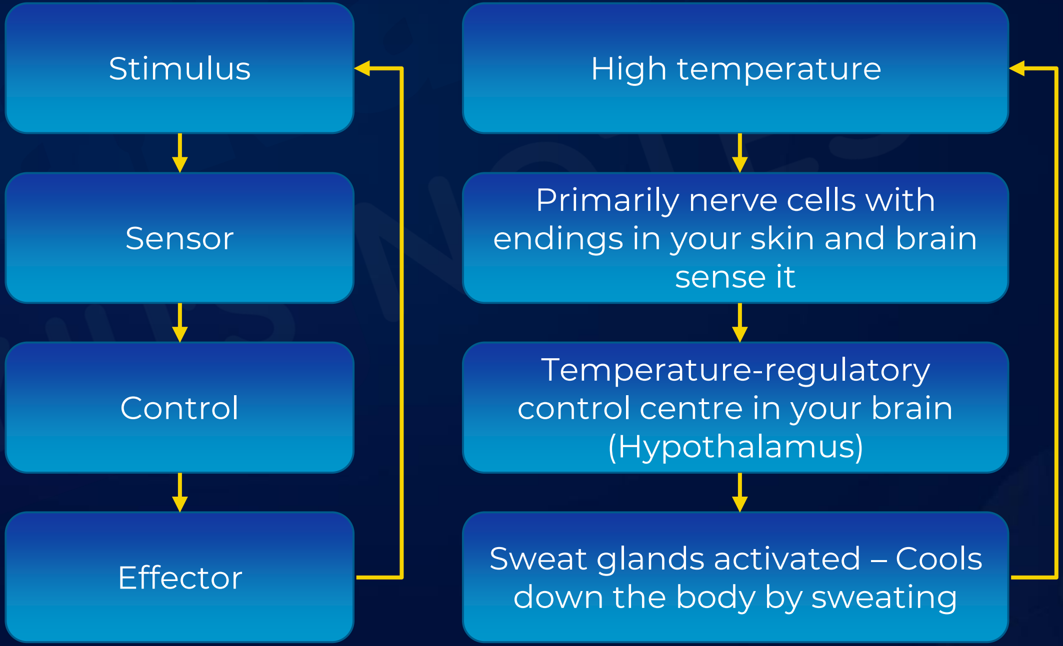
Increase GFR

Thus, **JGA** maintains a stable GFR in the nephron. Helps in **maintaining homeostasis and stable blood pressure.**

Osmoregulation and Homeostasis

- **Osmoregulation** is the process by which an organism regulates the water and salt balance in the body to maintain homeostasis.

- All homeostatic mechanisms use negative feedback to maintain balance.
- **Example:** Sweat glands release sweat, which ultimately reduces the body temperature.



Stimulus

Sensor

Control

Effector

High temperature

Primarily nerve cells with endings in your skin and brain sense it

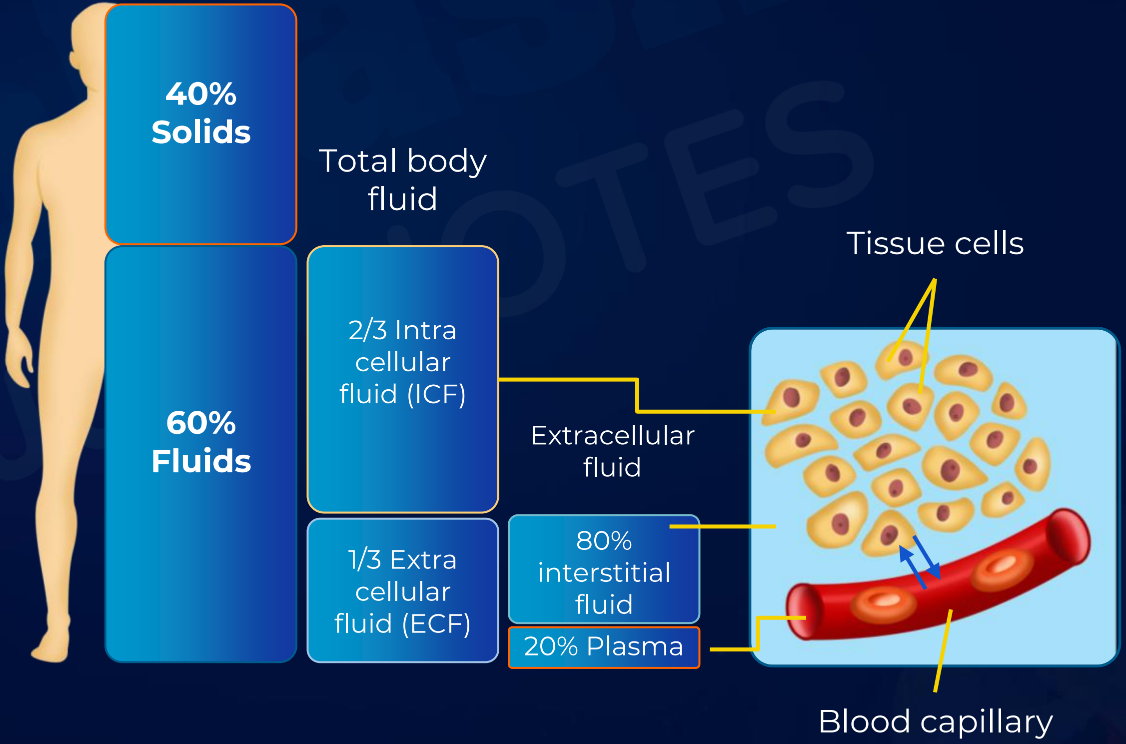
Temperature-regulatory control centre in your brain (Hypothalamus)

Sweat glands activated – Cools down the body by sweating

Osmoregulation and Homeostasis

- 60% of our body is made up of water.
- Body fluids are lost due to:
  - Sweating
  - Urination
  - Breathing
- So, **homeostasis** is lost as water level is decreased and this is the stimulus for the body to initiate homeostasis or negative feedback.
- **A decrease in body fluids is the stimulus.**

Total body mass (male)



Regulation of Kidney

Osmoreceptors

- A decrease in body fluids is the stimulus and this triggers the osmoreceptors or the sensory receptors.
- These are **sensory receptors** that sense changes in the following:
    - Blood volume
    - Body fluid volume
    - Ionic concentration
- They are found in the hypothalamus.
    - Hypothalamus is a small region in the brain, above the pituitary.

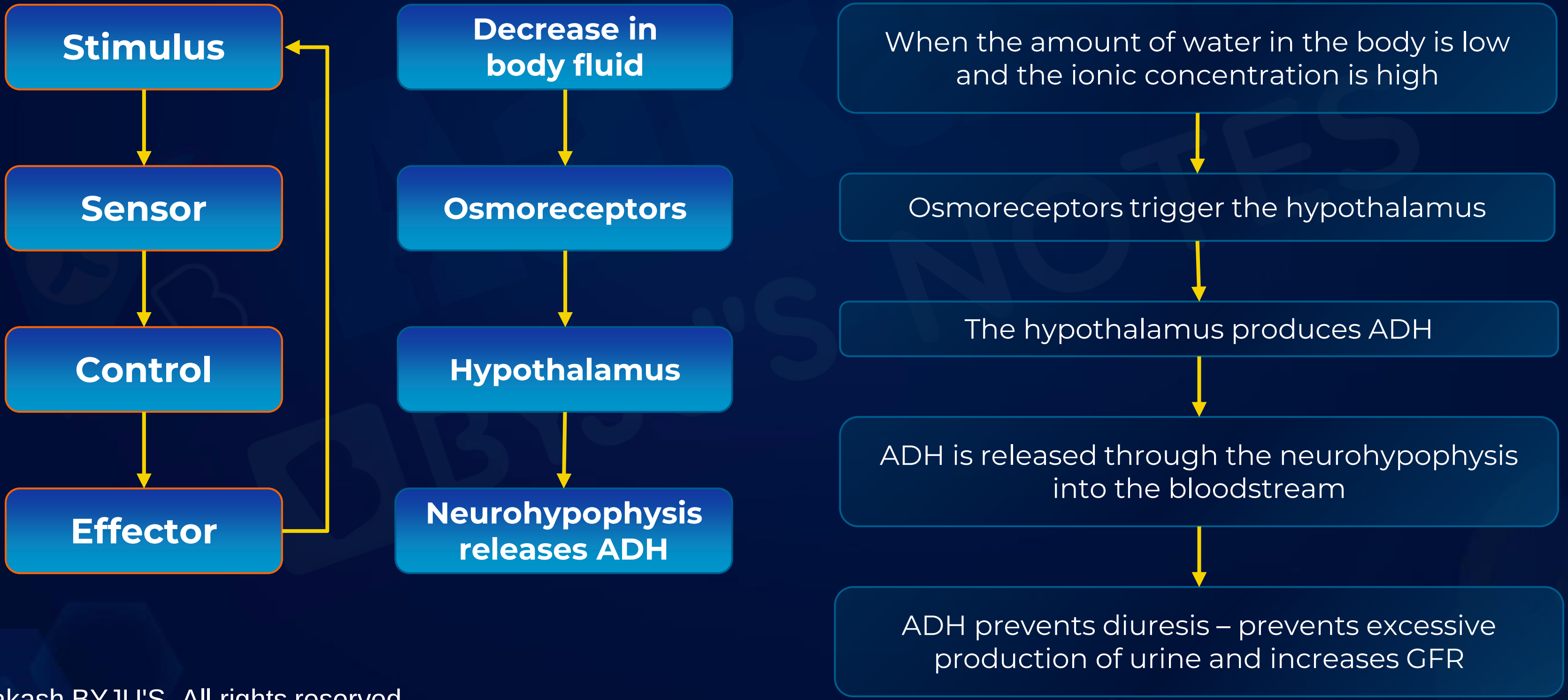
Hormonal regulation

Antidiuretic hormone (ADH)

- It is also known as **vasopressin**.
- Anti means opposing and diuresis means increased excretion of water.
- Diuretic is a substance **that decreases the excretion of water**.
- So, antidiuretic hormone reduces the production of urine by conserving body water and reducing the loss of water in urine.
- **Functions:**
    - Prevents diuresis by preventing excessive production of urine.
    - It **increases the GFR.**

Regulation of Kidney

1. Mechanism of action of ADH: To prevent diuresis



Stimulus

Sensor

Control

Effector

Decrease in body fluid

Osmoreceptors

Hypothalamus

Neurohypophysis releases ADH

When the amount of water in the body is low and the ionic concentration is high

Osmoreceptors trigger the hypothalamus

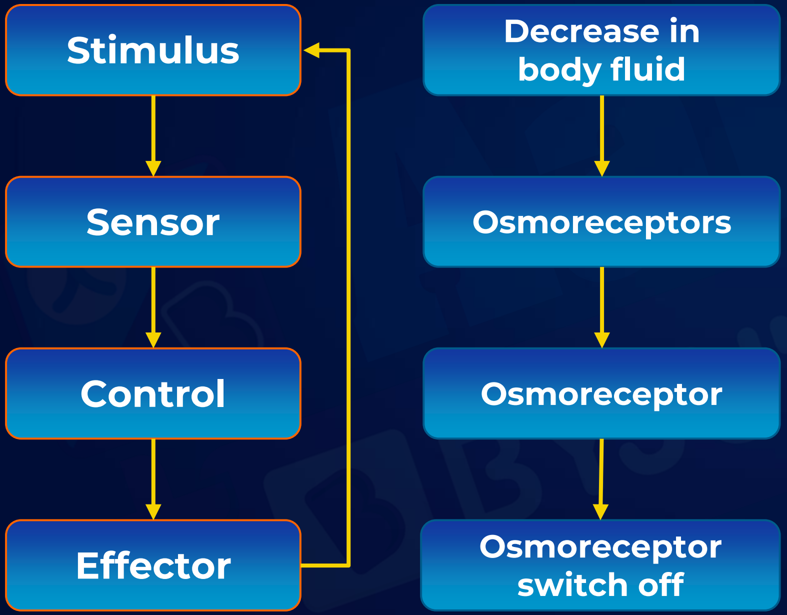
The hypothalamus produces ADH

ADH is released through the neurohypophysis into the bloodstream

ADH prevents diuresis – prevents excessive production of urine and increases GFR

Regulation of Kidney

When body gains excess water



Stimulus

Sensor

Control

Effector

Decrease in body fluid

Osmoreceptors

Osmoreceptor

Osmoreceptor switch off

When the amount of water in the body is high: ADH is low or absent, and there is no reabsorption of water in the collecting duct. Hence, large volume of urine is excreted out.

When the amount of water in the body is low: ADH directs the reabsorption of water from the collecting duct which leads to excretion of small amount of water in the urine.
So, the colour of urine depends on the amount of water in it.

Suppression of ADH production leads to low water reabsorption in CT.

Regulation of Kidney

2. Mechanism of action of ADH: To increase GFR

Decrease in blood volume leads to low blood pressure, which activates the osmoreceptors.

Osmoreceptors that are activated send signals to the hypothalamus.

The hypothalamus in response to this releases ADH from neurohypophysis.

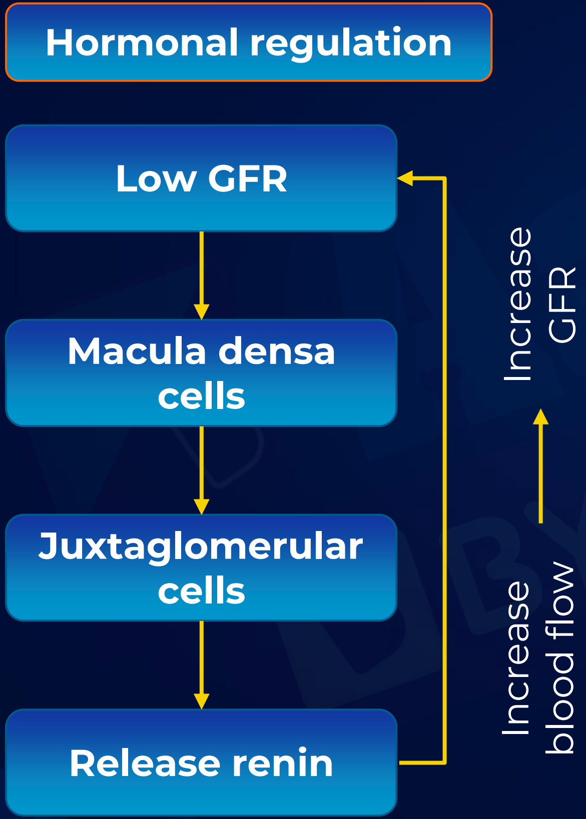
The ADH released brings about reabsorption of water at the level of collecting duct and DCT.

ADH also can bring about constriction of blood vessels.

This constriction results in the increase in BP.

The increase in BP results in the increase in GFR.

Regulation of Kidney



Hormonal regulation

Low GFR

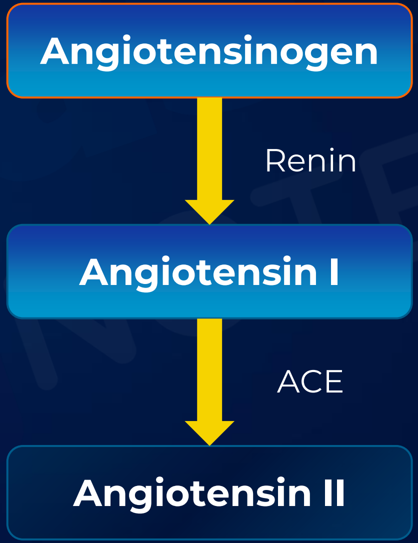
Macula densa cells

Juxtaglomerular cells

Release renin

Increase blood flow

Increase GFR



Mechanism of action of RAAS system

Angiotensinogen

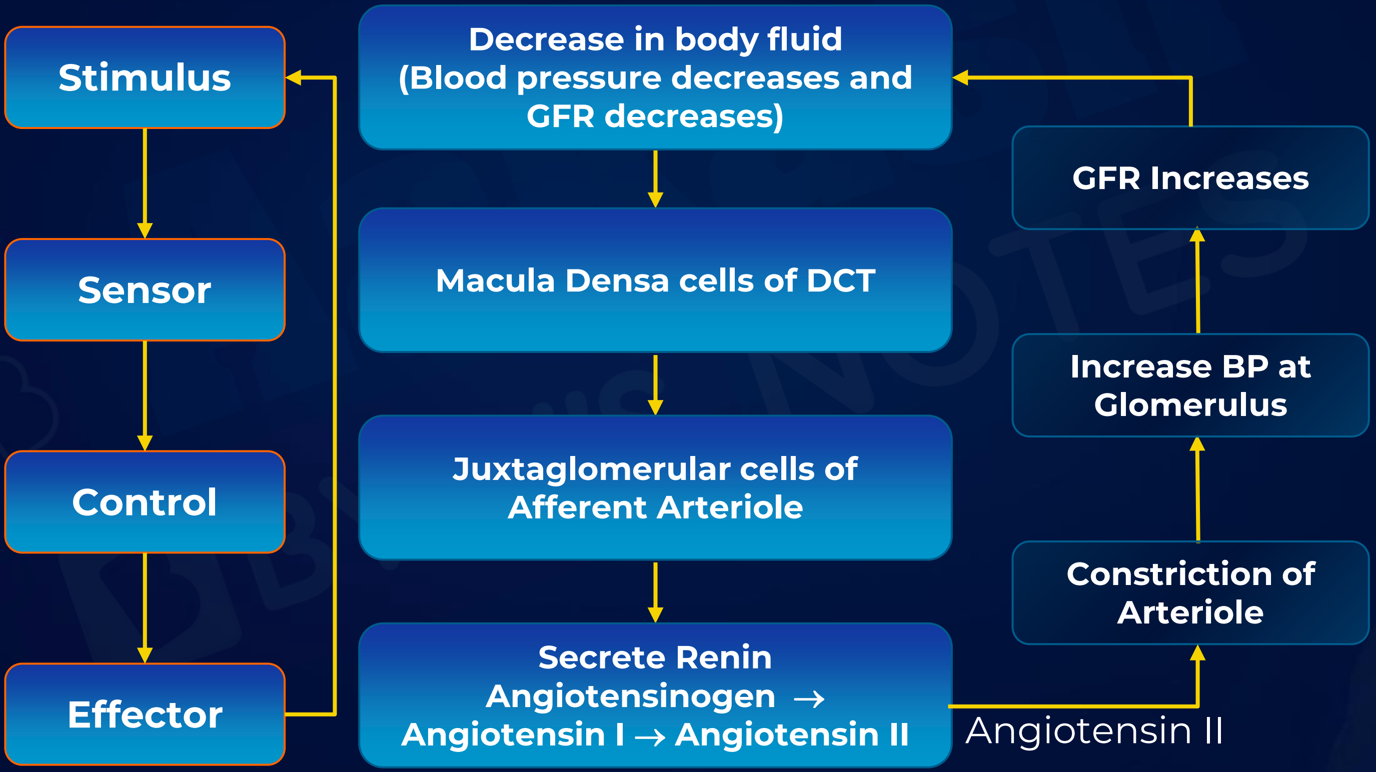
Renin

Angiotensin I

ACE

Angiotensin II

Regulation of Kidney



Stimulus

Sensor

Control

Effector

Decrease in body fluid (Blood pressure decreases and GFR decreases)

Macula Densa cells of DCT

Juxtaglomerular cells of Afferent Arteriole

Secrete Renin Angiotensinogen → Angiotensin I → Angiotensin II

Angiotensin II

Constriction of Arteriole

Increase BP at Glomerulus

GFR Increases

Regulation of Kidney

Renin-angiotensin-aldosterone-system

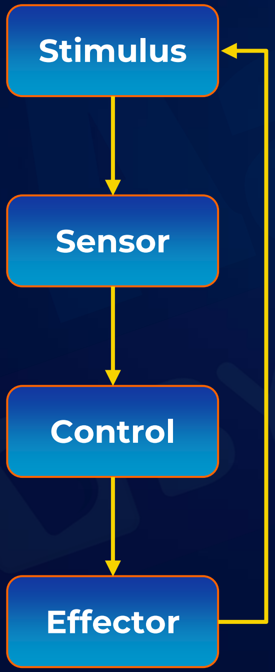
- It mainly comprises three hormones: renin, angiotensin II, and aldosterone.

	Synthesis	**Action**	**Action on sodium and water**
Renin-angiotensin system	Release of **renin** by juxtaglomerular cells	Angiotensin II increases BP by vasoconstriction of the arterioles. It also stimulates aldosterone production.	Retention of sodium and water
Aldosterone	Secreted by **adrenal cortex**	Regulates the the renal tubules	Retention of sodium and water

Regulation of Kidney

Atrial natriuretic factor (ANF)

- It is secreted by **cardiac atria**.
- It lowers the blood pressure by **vasodilation**.

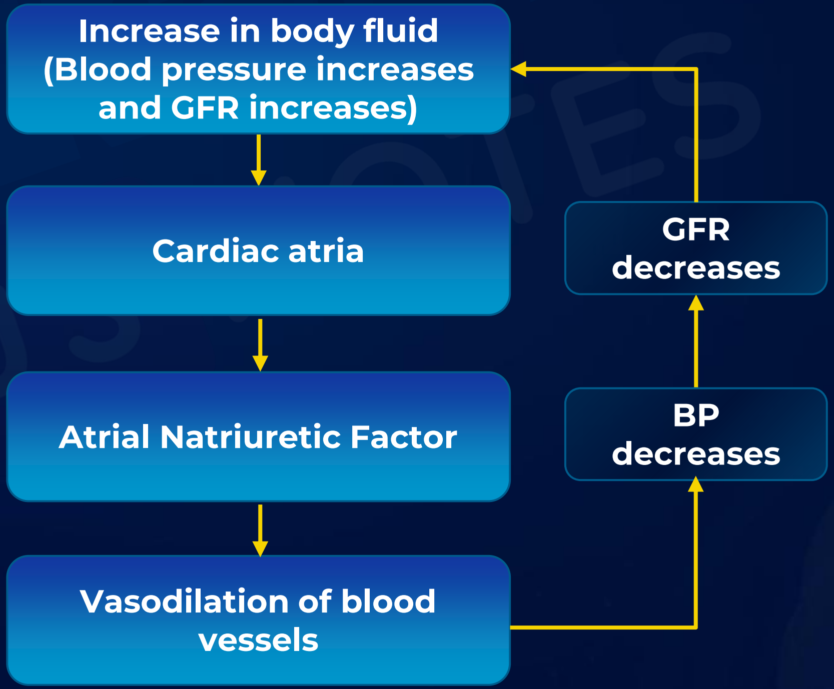


Stimulus

Sensor

Control

Effector



Increase in body fluid (Blood pressure increases and GFR increases)

Cardiac atria

Atrial Natriuretic Factor

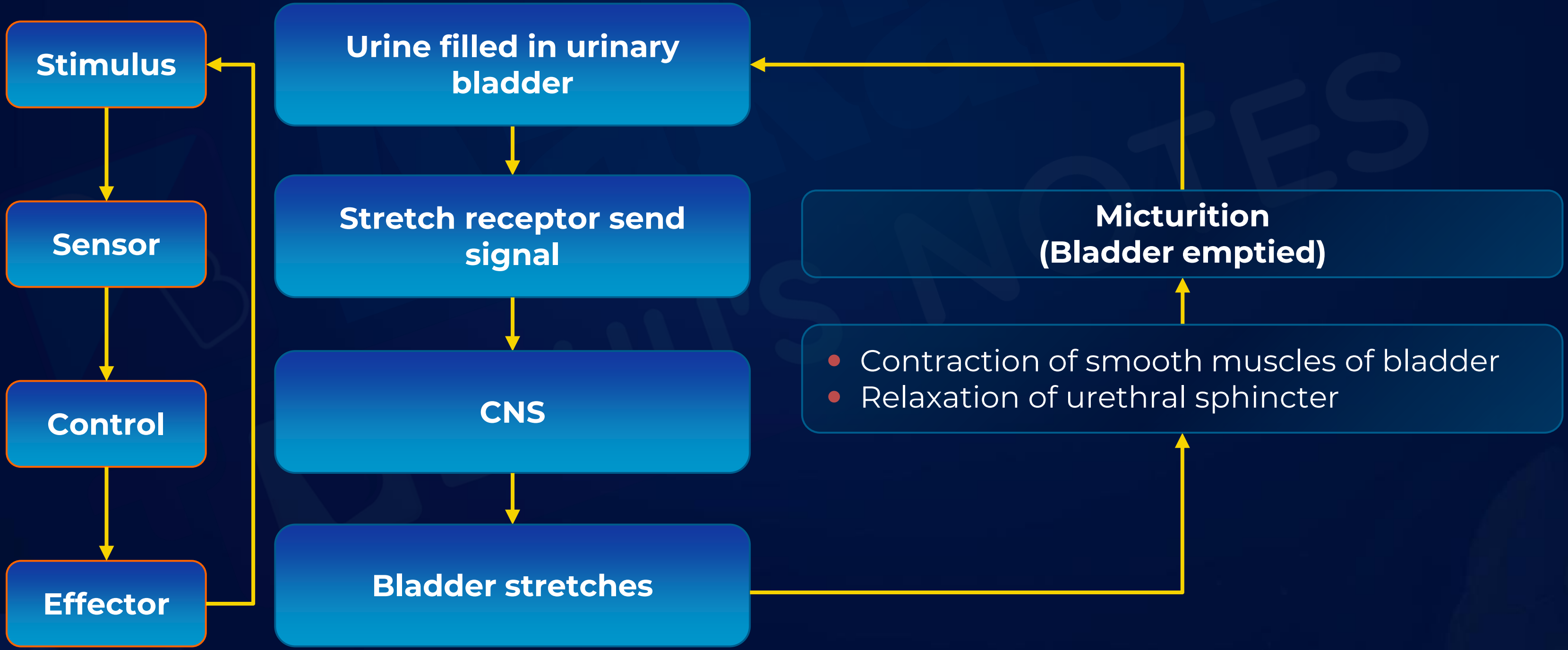
Vasodilation of blood vessels

BP decreases

GFR decreases

Micturition

- It is the process of the release of urine.
- The neural mechanism causing it is known as the **micturition reflex**.



Stimulus

Sensor

Control

Effector

Urine filled in urinary bladder

Stretch receptor send signal

CNS

Bladder stretches

- Contraction of smooth muscles of bladder
- Relaxation of urethral sphincter

Micturition (Bladder emptied)

Urine: Physical and Chemical Properties

- An adult human excretes, on an average, **1-1.5 litres** of **urine** per day.
- On an average, **25-30 gm** of **urea** is excreted per day.
- The urine formed is a **light yellow-coloured watery fluid.**
- It is slightly acidic (**pH = 6.0**) and has a characteristic odour.

Accessory Excretory Organs

Accessory excretory organs

Lungs

- **It removes carbon dioxide 200ml/min** (18 litres/day).
- Significant quantities of **water is released** everyday.

Skin

Sweat glands

- Function of sweat is to facilitate a **cooling effect** on the surface of body.
- **Excrete** watery fluid containing **NaCl**, small amounts of **urea**, and **lactic acid**.

Sebaceous glands

- Excrete substances like sterols, hydrocarbons, and waxes through **sebum**.
- Secretions provide a **protective oily covering** for the skin.

Liver

- **Secretes bile-containing substances** like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins, and drugs.
- Most of these substances ultimately **pass out** along with digestive wastes.

Disorders of Excretory System

Kidney/Renal failure

- The condition where the kidneys stop working is known as **kidney/renal failure**.
- The kidney loses its ability to perform excretion that can be gradual or sudden.

Types of kidney failure

Acute renal failure

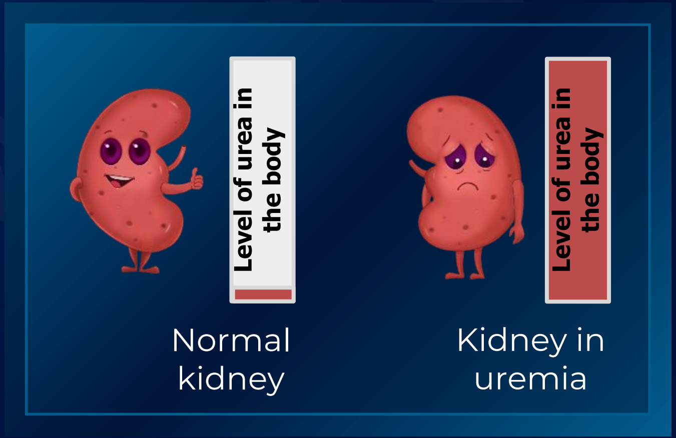
- Rapid fall in glomerular filtration rate (GFR)
- Rise in urea and creatinine levels

Chronic renal failure

- Gradual decrease in GFR

Uremia

- The **accumulation of urea** in the blood due to the malfunctioning of kidneys is known as uremia.
    - It is highly toxic to the body.

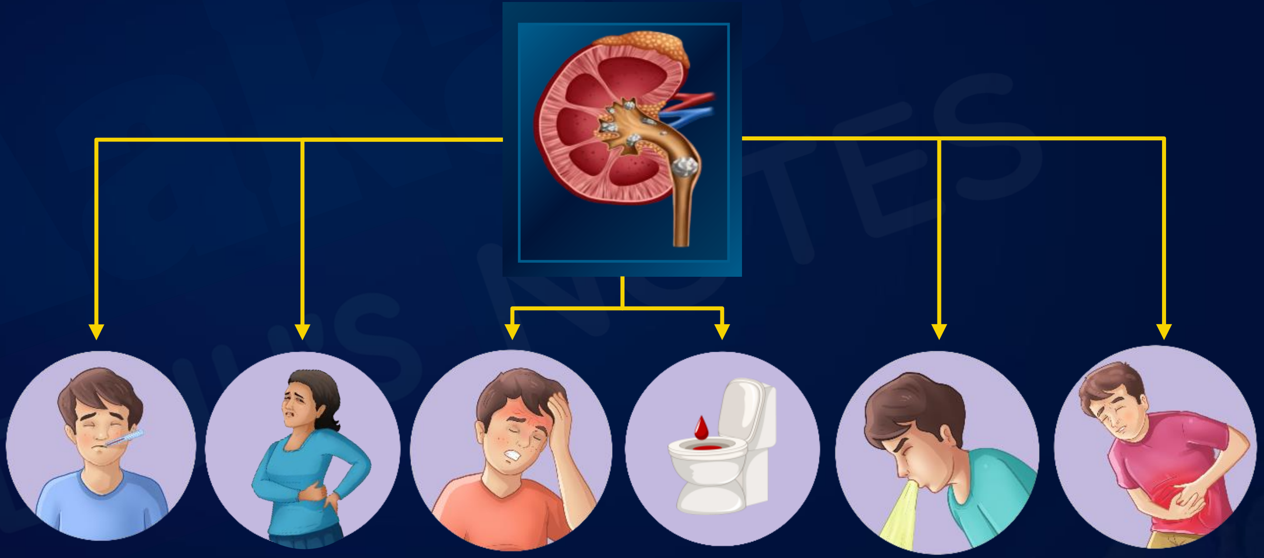


Disorders of Excretory System

Renal calculi/Kidney stones

- They are the **deposits of an insoluble mass of crystallised salts** (oxalates) in the kidney.
- They are also known as **kidney stones**.

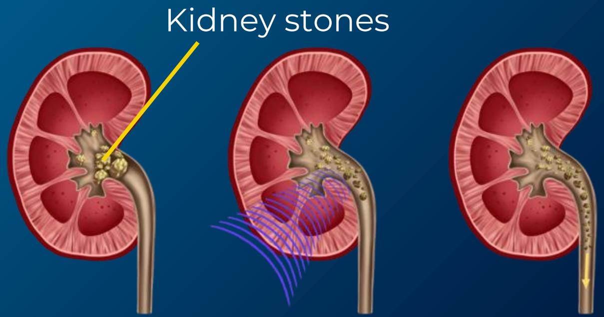
Symptoms of renal calculi



- Fever
- Backache
- Dizziness
- Blood in the urine
- Vomiting
- Stomach pain

Disorders of Excretory System

Treatment of renal calculi



- Large stones need to be removed by surgery.
- Ultrasound shock waves crush stones.
- Smaller pieces pass out of body in urine.

Medicine

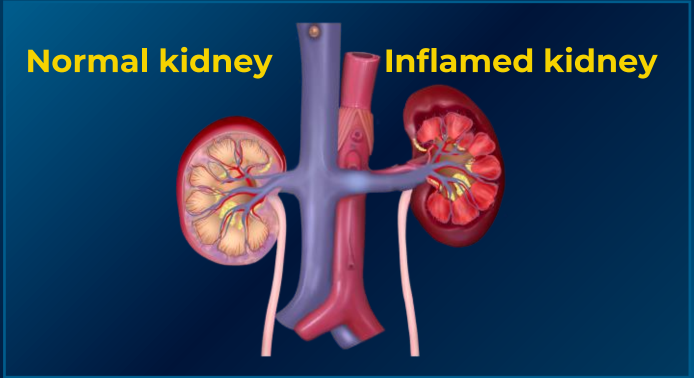
Surgery

Drink enough water

Disorders of Excretory System

Glomerulonephritis

- It is the **inflammation** of glomerulus.



Ketonuria

- It is the **presence of ketone bodies** in urine.

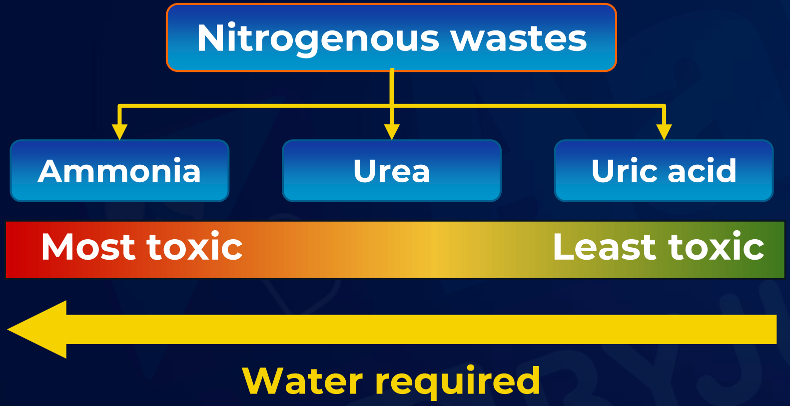
Glycosuria

- It is the **excess of glucose** in urine.

Haemodialysis

- It is the process of **filtering nitrogenous wastes** from blood by draining the blood from a convenient artery and passing it through the dialysis unit.
- The filtered blood is then pumped into the body.
- The dialysing unit consists of the following:
    - **Artificial kidney or Dialyser:** It is the filter that removes the wastes.
    - **Dialysing fluid or Dialysate:** It is the fluid in the dialyser.

Summary



Nitrogenous wastes

Ammonia

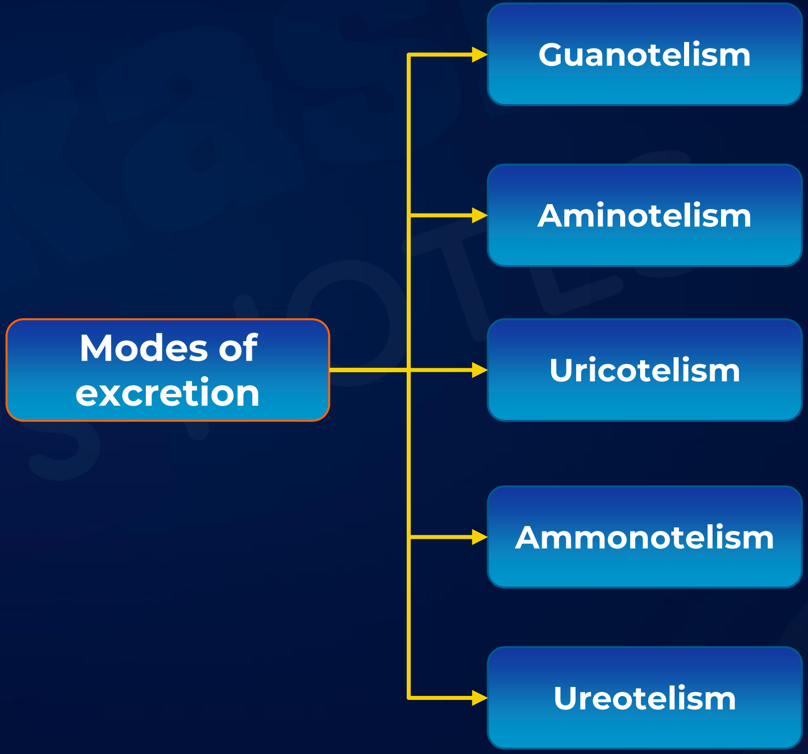
Urea

Uric acid

Most toxic

Least toxic

Water required



Modes of excretion

Guanotelism

Aminotelism

Uricotelism

Ammonotelism

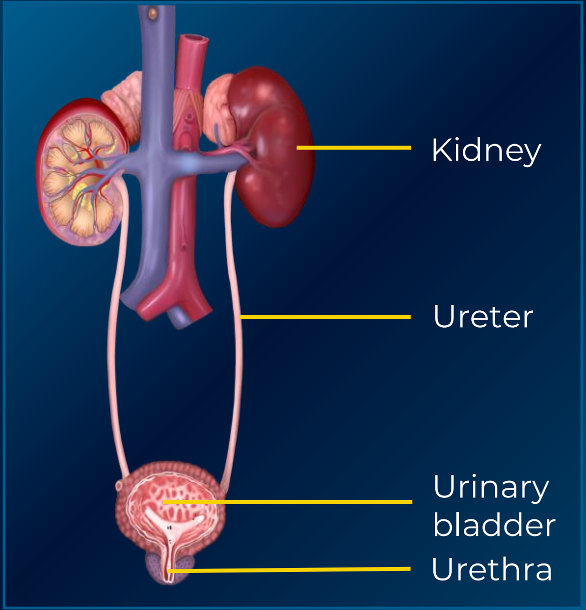
Ureotelism

Summary

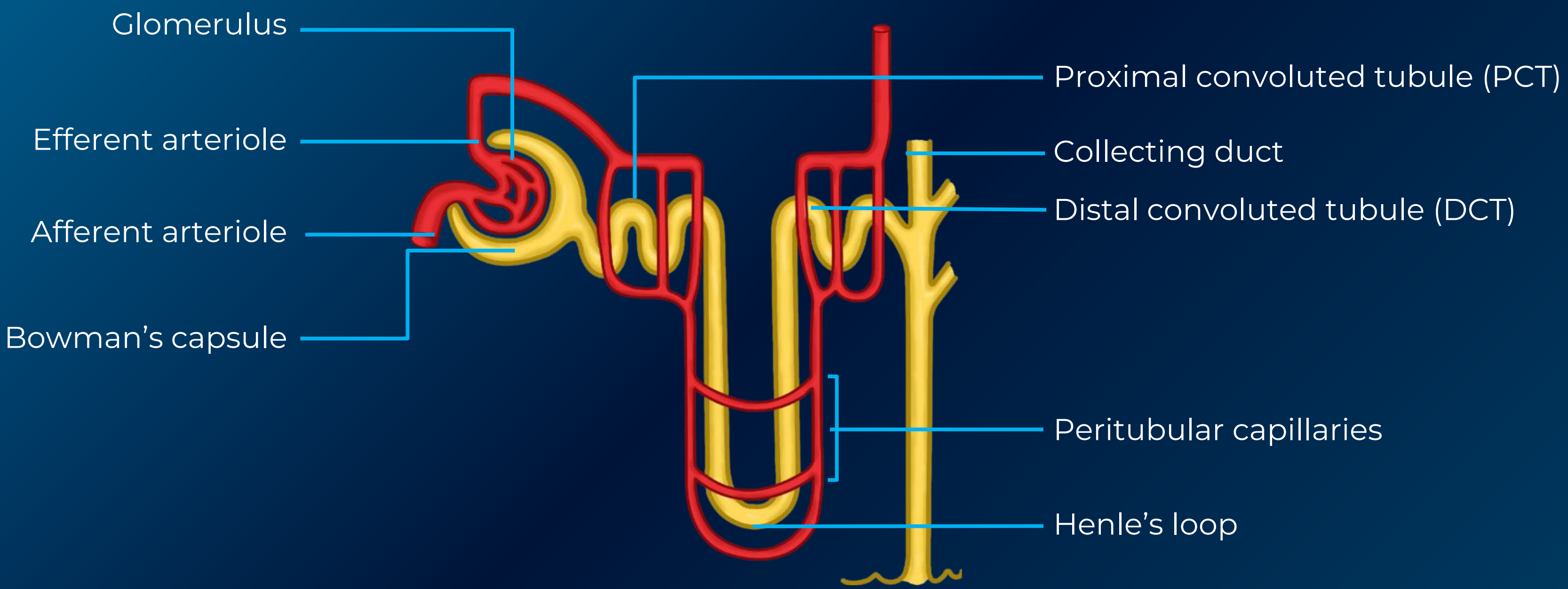
Evolution of excretory structures

- Protonephridia (Flame Cells): Platyhelminthes
- Nephridia: Earthworms
- Malpighian tubules: Cockroaches
- Green glands/ Antennal glands: Prawns
- Kidneys: Humans

Human excretory system



Summary: Nephron



Summary: Urine Formation

Ultrafiltration

- Blood filtered through **semi permeable** glomerular capillaries under **very high pressure**.
- Glomerular filtrate: plasma except **proteins**.
- Glomerular filtration rate: **125 ml/min (180 litres/day)**.

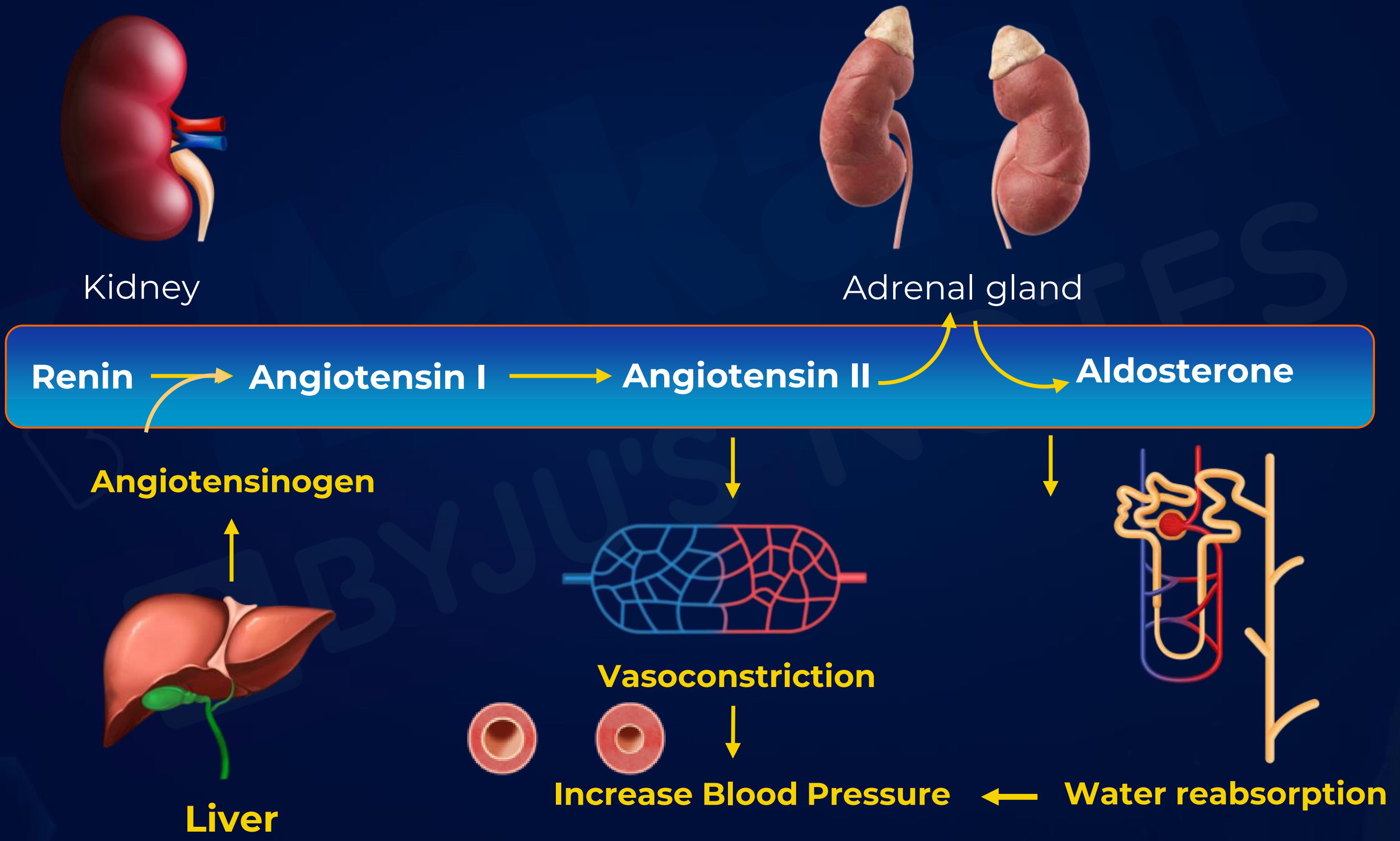
Reabsorption

- Reabsorbed from the filtrate by the **tubular epithelial cells**.
- **Active:** glucose, amino acids, Na^+
- **Passive:** nitrogenous wastes, water
- PCT: 70-80% of water and electrolytes, essential nutrients
- LOH: water (desc. limb), electrolytes (asc. limb)
- DCT: Na^+, water, HCO_3^-
- CT: Urea

Secretion

- Secreted into the filtrate by the **tubular epithelial cells** of various parts of nephron.
- PCT: H^+, K^+, NH_3
- LOH: no secretion
- DCT: H^+, K^+, NH_3
- CT: H^+, K^+

Summary: Mechanism of Action of RAAS System



Kidney

Adrenal gland

Renin → Angiotensin I → Angiotensin II → Aldosterone

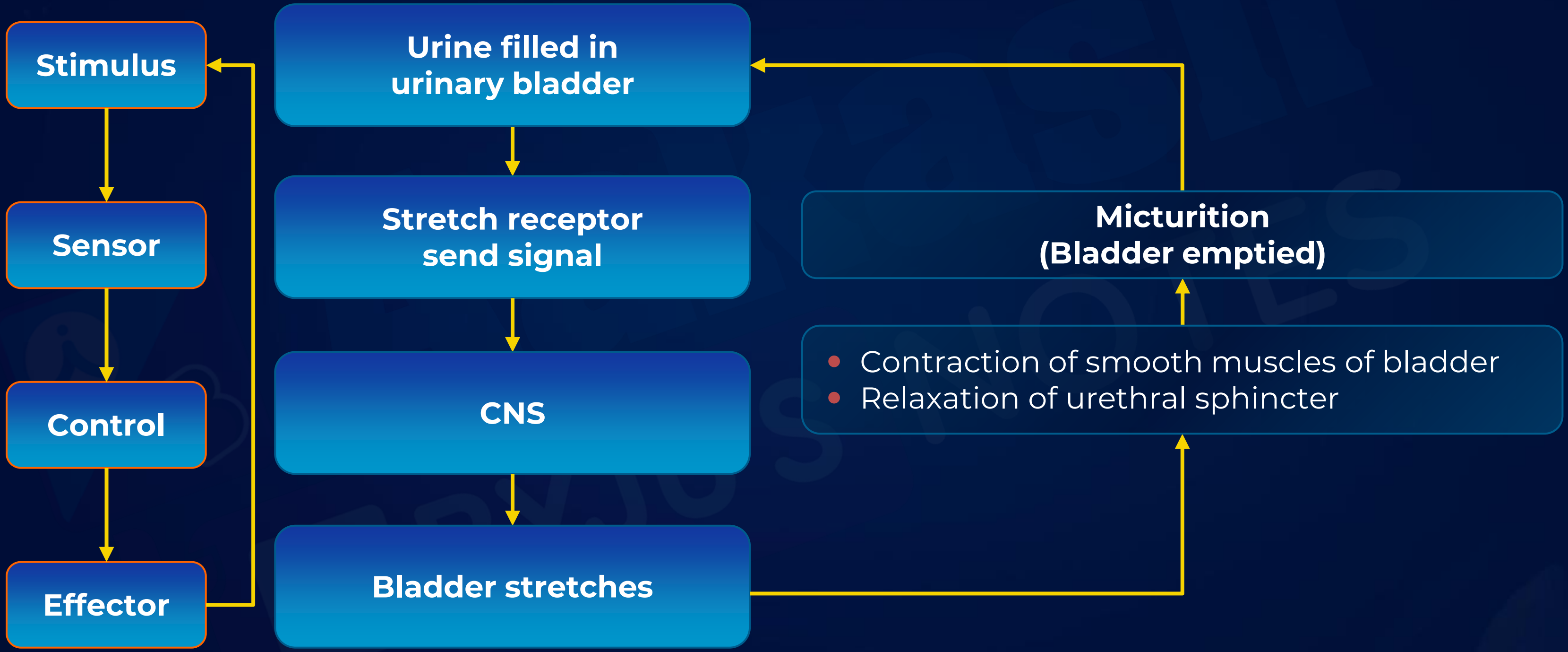
Angiotensinogen

Liver

Vasoconstriction

Increase Blood Pressure ← Water reabsorption

Summary: Micturition



Stimulus

Sensor

Control

Effector

Urine filled in urinary bladder

Stretch receptor send signal

CNS

Bladder stretches

Micturition (Bladder emptied)

- Contraction of smooth muscles of bladder
- Relaxation of urethral sphincter

Summary

- **Accessory excretory organs**
  - **Lungs**
    - CO_2 and water vapour
  - **Skin**
    - Sweat and sebum
  - **Liver**
    - Bile salts

Summary

Types of kidney failure

Acute renal failure

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Chronic renal failure

- Gradual decrease in GFR.

Urinary disorders

- Uremia
- Renal failure
- Kidney stones
- Ketonuria
- Glomerulonephritis
- Glycosuria