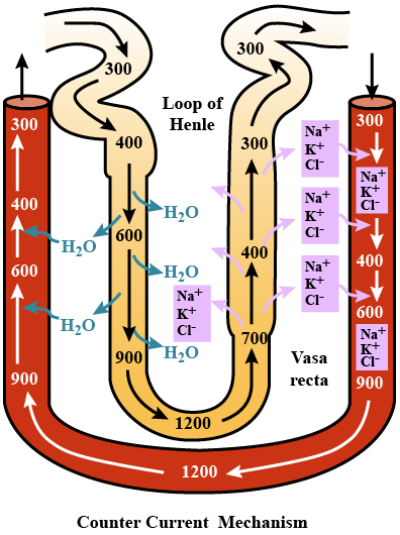
- **Function of Tubules-** Lined by simple cuboidal brush border epithelium to increase surface area.

<table>
<tr><th rowspan="2">Proximal Convoluted Tubule</th><th colspan="2">Henle's Loop</th><th rowspan="2">Distal Convoluted Tubule</th></tr>
<tr><th>Ascending Limb</th><th>Descending</th></tr>
<tr><td rowspan="2">• Present in Cortex region.
• 70-80 percent of nutrients, electrolytes and water are reabsorbed.
• Glucose, Amino Acids, Na^+, K^+ are absorbed actively.
• Buffer HCO_3^-, Cl^-, Some amount of urea is reabsorbed.
• Maintain pH and ionic balance through selective secretion of H^+ and NH_3 into the filtrate.
• Uric Acid, Creatinine, Antibodies, drugs, pigments & diuretics are secreted actively.</td><td>• Minimum reabsorption.
• Maintains high osmolarity of medullary interstitial fluid.
• Impermeable to water through entire length.
• Narrow part is permeable to inorganic ions (Na^+, K^+, Cl^-)& Urea but in broad part Active reabsorption of electrolytes (Na^+) take place.</td><td>• Narrow part is permeable to water but impermeable to electrolytes.
• Broad Part is impermeable to ions, urea & water.</td><td rowspan="2">• Present in Cortex region.
• Conditional reabsorption of Na+ and water.
• Capable of reabsorption of HCO3 – and H^+
• Selective secretion of H^+, NH_3, and K^+ is actively.
• Maintains the pH and sodium-potassium balance.</td></tr>
<tr><td colspan="2">• U shaped tubule extends to Medulla.
• As the concentrated filtrate passes upward, it gets diluted due to the passage of electrolytes to the medullary fluid.</td></tr>
</table>

Collecting Duct: It extends from the cortex of the kidney to the inner parts of the medulla in each approx 6 nephron drains.

- Reabsorb water to produce a concentrated urine.
- Maintains osmolarity by allowing the passage of small amounts of urea into the medullary interstitium.
- Selectively secrets H+ and K+ ions and maintains pH and ionic balance of the body.

Mechanism of Concentration of Filtrate



Counter Current Mechanism

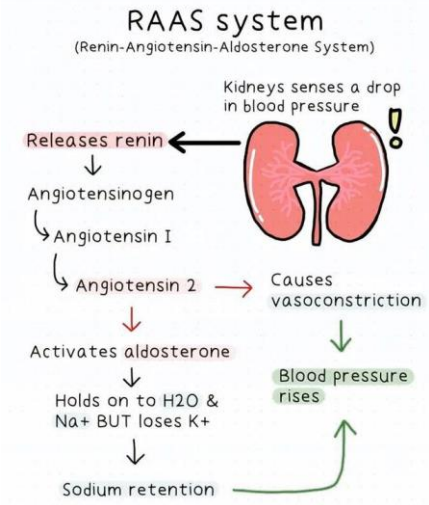
- Mammals produce concentrated urine through Henle's loop and vasa recta.
- Filtrate flows in opposite directions in Henle's loop than blood flows in vasa recta forming a counter current, aiding reabsorption, secretion and maintains concentration gradient in medullary interstitium.
- Maintains an increasing osmolarity from cortex (300 mOsmolL–1) to inner medulla (1200 mOsmolL–1).
- Gradient caused by NaCl and urea; NaCl transported by ascending limb of Henle's loop and exchanged with vasa recta.
- Urea enters ascending limb, transported back to interstitium by collecting tubule.
- Interstitial gradient aids easy water passage from collecting tubule, concentrating urine.
- Human kidneys can produce urine nearly four times more concentrated than the initial filtrate.

Role of Kidney Function

Case I- Excessive fluid loss (As in case of Loose motion)

- Osmoreceptors present in **Hypothalamus & carotid artery** activated by changes in blood volume and ionic concentration activates hypothalamus to stimulates neurohypophysis (Posterior Pituitary) to release Antidiuretic Hormone (**ADH**) or vasopressin (vessel constrictor).
- ADH promotes water reabsorption in DCT & Collecting Duct, preventing diuresis.
- Increased body fluid volume suppresses osmoreceptors, reducing ADH release in feedback.

Case II- Renin-Angiotensin Aldosterone System (RAAS)



- Fall in Blood Pressure or GFR activates JG cells (present in afferent arteriole & DCT) to release Renin.
- Renin converts Angiotensinogen released by liver into blood is converted to Angiotensin I which further is converted to Angiotensin II with the help of Angiotensin Converting Enzyme (**ACE**) released from Lungs.
- Angiotensin II (powerful vasoconstrictor) directly increases glomerular blood pressure / GFR and increases Na^+ & water absorption from PCT.

- Angiotensin II also stimulates the adrenal cortex to release aldosterone which promotes Na+ & water reabsorption from DCT, further increasing blood pressure and GFR.

Case III- ANF mechanism acts as a regulatory check on the renin-angiotensin system.

- Increased blood flow to atria triggers release of Atrial Natriuretic Factor (ANF).
- ANF induces vasodilation (blood vessel expansion) results in decreased blood pressure.

Micturition: The process of expulsion of urine from the urinary bladder.

Micturition reflex-Till a voluntary signal is given by the CNS, the urine is stored in the urinary bladder.

- When urinary Bladder is filled the stretch receptors in urinary bladder sends signal to CNS (Medulla (ANS) & cerebrum (Somatic N S)).
- **Case I-**Under Favourable Condition ANS send signal to PNS this causes the contraction of smooth muscles of the bladder and a relaxation of the urethral inner(involuntary)-sphincter & outer sphincter (voluntary controlled by Cerebrum) causing urine release.
- **Case II-** Under Unfavourable/Emergency Condition- signals from ANS goes to Sympathetic NS which dilate Smooth muscles and cerebrum causes contraction of outer sphincter results in control or STOPs Micturition.

Urine Constitute: pH of Urine is 6 (slightly acidic), colour is pale yellow due to presence of Urochrome.

It constitute approximately 95% water, with the remaining 5% comprising urea, creatinine, electrolytes (sodium, potassium, chloride, bicarbonate), uric acid, ammonia, and trace elements.

On an average, 25-30 gm of urea is excreted out per day.

The presence of glucose (glycosuria) and ketone bodies (ketonuria) in urine is indicative of diabetes mellitus, signaling high blood sugar levels and increased fat metabolism.

ROLE OF OTHER ORGANS IN EXCRETION

- Lungs remove about 200mL/minute of CO_2 and significant water daily.
- Liver secretes bile with bilirubin, biliverdin, cholesterol, hormones, vitamins, & drugs which are pass out with digestive wastes.
- Skin's sweat glands eliminate NaCl, urea, and lactic acid, facilitating cooling and waste removal.
- Sebaceous glands in the skin release sebum containing sterols, hydrocarbons, and waxes for protective covering.

Disorders of the Excretory System

Towards the end of the chapter on excretory products and their elimination, we find out about the disorders of the excretory system. They are as follows:

- **Uremia** – accumulation of urea in blood due to malfunctioning of kidneys. This can lead to kidney failures. Remedy haemodialysis.
- **Renal failure** – The condition where the glomerular filtration stops and both the kidney's stop working is called Renal failure. In this case kidney transplant is the only option available.
- **Renal calculi** – Stones or insoluble salts are formed within the kidney,
- **Glomerulonephritis (Bright's Disease)** – Inflammation of glomeruli in the kidneys. It occurs due to the entry of RBCs or proteins.

Haemodialysis : (When both the kidneys of a person fail, they are advised for haemodialysis)

- Blood is drawn from the Radial Artery.
- It is mixed with heparin (an anticoagulant) and cooled to 0°C.
- The blood flows into the dialysis chamber, made of a cellophane tube (semipermeable), containing a dialysis solution isotonic to blood and hypotonic to nitrogenous waste.
- Nitrogenous waste, such as urea and soluble salts, diffuses from the blood to the dialysis solution, which is then replaced with a new one.
- After filtration, the blood is brought back to normal body temperature and returned to the body via the Radial Vein, after mixing it with Anti-heparin.