CHAPTER

7 Excretory Products and their Elimination

EXCRETORY WASTE

Metabolism — Excess ingestion

↓

Results in accumulation of

→ **Nitrogenous wastes**– NH_2, urea, uric acid

→ Other contents – CO_2, H_2O, ions (Na^+, K^+, Cl^-, PO_4^{3-}, SO_4^{2-})

Removed ↓

Partially/Completely

Common Nitrogenous Wastes

Nature of nitrogenous waste formed and their excretion vary among animals depending on the **habitat/availability of water**.

Common nitrogenous waste	Nature & Examples	Toxicity level and water required	Special Features
Ammonia (Ammonia converts into urea in liver)	**Ammonotelic** ❖ Aquatic insects ❖ Many bony fishes ❖ Aquatic amphibians	Maximum	❖ Diffusion through gills surface or body surface as ammoium NH_4^+ ions
Urea	**Ureotelic** ❖ Marine fishes ❖ Many terrestrial amphibians ❖ Mammals	Lesser	❖ **Kidneys** filter urea from blood
Uric acid	**Uricotelic** ❖ Land snails ❖ Insects ❖ Reptiles ❖ Birds	Least	❖ Pellet/Paste (Semi-solid) ❖ Minimum loss of water
❖ Kidneys do not play a significant role in removal of ammonia.			

Different Excretory Structures

❖ Excretory strcuture eliminate nitrogenous waste & maintain fluid and ionic balance

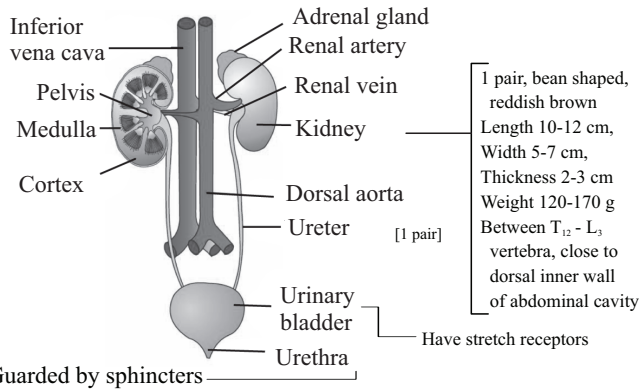
Structures	Examples
• Protonephridia/flame cells (osmoregulation)	• Platyhelminthes (*Planaria*) Rotifers Some annelids Cephalochordates (*Amphioxus*)
• Nephridia	• Annelids (Earthworms)
• Malpighian tubules	• Insects (Cockroaches)
• Antennal/Green glands	• Crustaceans (Prawn)

❖ Function of excretory structures:

❖ Eliminate nitrogenous wastes.

❖ Maintain ionic and acid-base balance of body fluids, i.e., osmoregulation.

HUMAN EXCRETORY SYSTEM



❖ Guarded by sphincters

MICTURITION

❖ Process of release of urine

❖ Mechanism -**Micturition reflex**

Urinary bladder (Store urine)

Activates

Stretch receptors — signals → CNS (voluntary signals)

Send motor messages

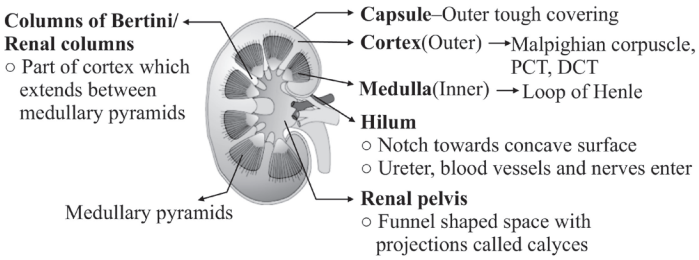
Urimary bladder

Smooth muscles of Bladder contract Urethral sphincters relax

Release

Urine

KIDNEY

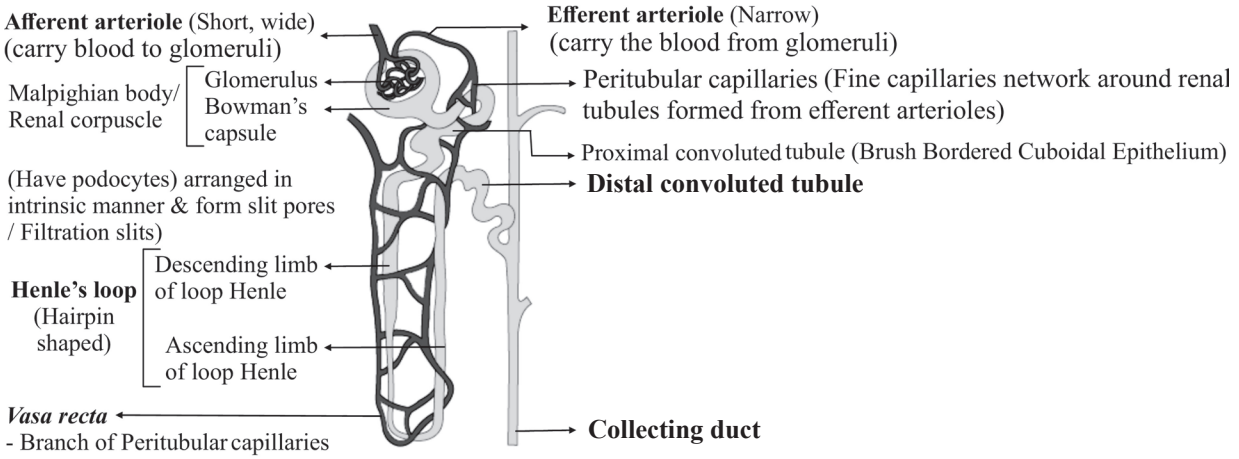


Medullary pyramids are conical masses that project into calyces.

NEPHRON

Functional unit of kidney Nearly **1 million** complex tubular structure

Each nephron has two parts—(i) Glomerulus (ii) Renal Tubules (Tuft of capillaries, line by simple squamous epithelium)



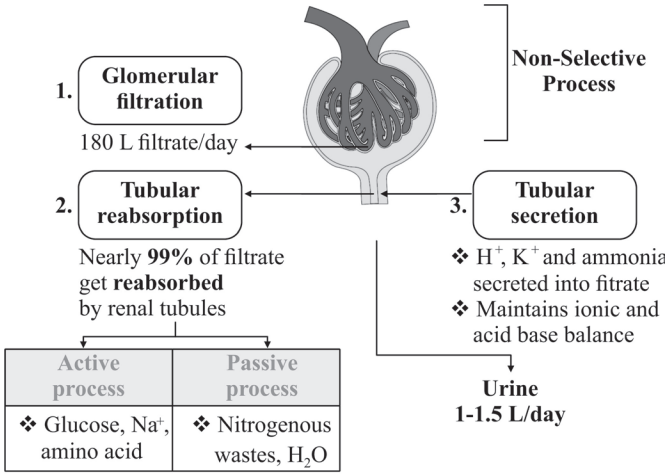
Types of Nephron
- Cortical → Loop of Henle short, *Vasa recta* absent
- Juxtamedullary → loop of Henle deep into medulla, *Vasa Recta* present

❖ Juxtaglomerular apparatus (JGA): Cellular modifications in DCT and afferent arteriole at the location of their contact.

❖ JGA is composed of JG Cells and Macula densa.

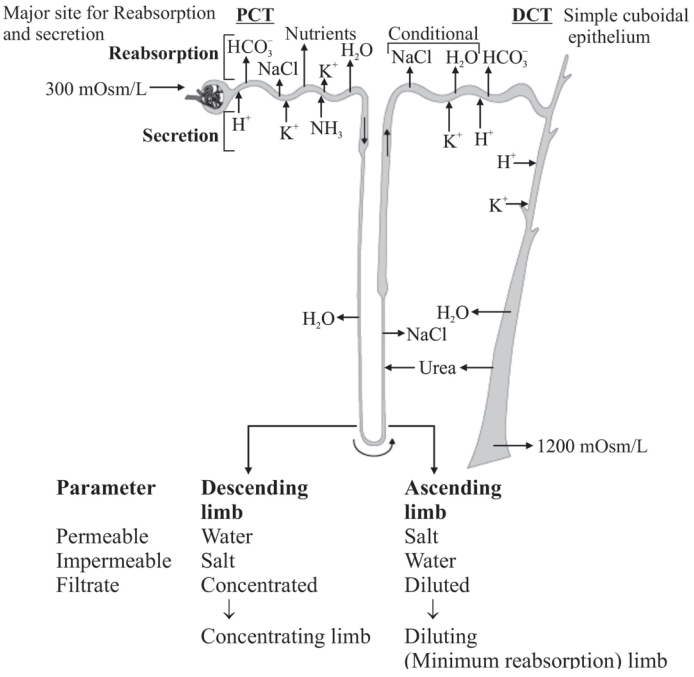
❖ DCT and collecting duct concentrate the filtrate about four times.

URINE FORMATION



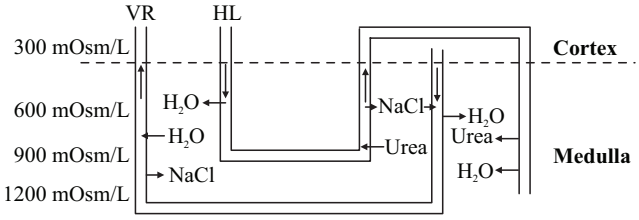
- ❖ Filtration is due to pressure in the glomerular capillaries.
- ❖ Glomerular filtration rate (GFR) = Filtration/min 125 ml/min

FUNCTIONS OF THE TUBULES



Parameter	Descending limb	Ascending limb
Permeable	Water	Salt
Impermeable	Salt	Water
Filtrate	Concentrated	Diluted
	↓	↓
	Concentrating limb	Diluting (Minimum reabsorption) limb

Operates between the two limbs of loop of Henle and *vasa recta*



The Filtrate gets concentrated as it moves down the descending loop of Hence and diluted as it move by ascending loop of Henle.

REGULATION OF KIDNEY FUNCTION		
Hypothalamus	**JGA/ Renin-Angiotensin Mechanism**	**Heart**
Works when GFR Low, Blood Volume Low ❖ osmoreceptors in hypothalamus activated. ❖ Release of ADH/ Vasopressin ↓ Prevent Diuresis	Low GFR/ Glomerular blood flow/Glomerular blood pressure Activate↓ JG cells to release renin Angiotensinogen (Liver) → Angiotensin I ACE - Angiotensionogen converting enzyme **Angiotensin II** **Activate** (Vasopressin) ❖ Adrenal cortex aldosterone ↓ Reabsorption of Na+ & water from distal part of Tubule ↓ Blood pressure and GRP increase	Increase blood flow to atria of heart ↓ Release of ANF (Atrial natriuretic factor) ↓Work Vasodilation ↓Result ❖ Blood pressure decrease ❖ GFR decrease ❖ Checks on Renin-Angiotensin Mechanism

Characteristics and Composition of Urine

- Colour - Light yellow
- pH = 6
- Odour - Characteristic
- Urea - 25-30 gm/day
- Glucosuria [Glucose in urine], Ketonuria [Ketone in urine] } Diabetes mellitus

Role of Other Organs in Excretion

Accessory structure	Basic work
Lungs	• Remove large amount of CO_2 • Approximately 200 mL/min • Remove significant quantity of water
Liver (Largest gland)	• Remove Bile-containing substances along with Digestive wastes.
Skin • Sweat gland	• Removes NaCl, urea and lactic acid • Facilitates cooling effect
• Sebaceous gland	• Removes steroles, hydrocarbons, waxes.
Salivary glands	• Small amount of nitrogenous wastes are eliminated through saliva

Disorders of Excretory System

Disorders	Symptoms or Treatment
Renal calculi	Stone or insoluble mass of crystalised salts (e.g., oxalates)
Glomerulonephritis	Inflammation of glomeruli of kidney
Renal/kidney failure	Malfunctioning of kidneys may lead to kidney failure. **Treatment** (i) Haemodialysis: Process to remove urea from blood • Boon for thousands of uremic patients all over the world. • Composition of dialysing fluid is same as plasma except the nitrogenous wastes.
	(ii) Kidney transplantation Ultimate method in correction of acute renal failure • Functional kidney is taken from donor • To minimise rejection, close relatives are preferred as donor • Modern clinical problems have increased success rate of such complicated techniques