

# Excretory System

The different metabolic end products that are harmful to the body system are constantly excreted from the body through different channels via kidney, skin, lungs & GI tract.

**Kidney-** It is situated in the post. Abdominal cavity & have a cortex & medulla. The functional unit is k/a nephron

Sl. No.	Species	No. of nephrons
1	Cow	$8.0 \times 10^6$
2	Pig	$2.5 \times 10^9$
3	Cat	$3.8 \times 10^6$

### **Supplies-**

- ✓ Afferent arterioles breaks up into a tuft of capillaries & supplies to glomerulus & then branches from the interlobular artery.
- ✓ After passing through Bowmans capsule, further reunites to form efferent arterioles & conducts blood away glomerulus

- ✓ Then distributed into another set of capillaries k/a peritubular arteriole passes along the loop of Henle
- ✓ It again reunites to form renal vein & drains venous blood to caudal vena cava
- ✓ Kidney is innervated by the sympathetic divisions
- ✓ Renal blood flow & glomerular filtration are controlled by reflex vasoconstriction through vasomotor centre in the midbrain & pons

**Process of urine filtration-** It takes three following steps

- ❖ Glomerular filtration
- ❖ Tubular selective reabsorption
- ❖ Tubular secretion

Filtration takes place in the glomerular network of capillaries to retain cellular components within vascular system. The size & net electric charge influences the rate of filtration.

## **Renin – Angiotensin – Aldosterone mechanism:**

- ✚ Renal blood flow & glomerular filtration rate are partly under the control of R-A-A mechanism
- ✚ During systemic hypotensive condition, renal arteriolar pressure goes down & stimulates juxtaglomerular cells
- ✚ Adjacent to the wall of afferent arterioles stimulate to secrete renin
- ✚ Renin triggers the transformation of a protein angiotensinogen produced in the liver to angiotensin-I, a decapeptide
- ✚ Angiotensin-I is further converted to angiotensin-II, an octapeptide by enzyme
- ✚ Angiotensin-II is a potent vasoconstrictor & also stimulates production of aldosterone, a mineralocorticoid from the adrenal cortex & vasopressin from the pituitary

- ✚ Aldosterone  $\uparrow^{es}$  Na & water reabsorption from the renal tubule
- ✚ Angiotensin-II also helps to secrete 2 vasodilative substances, prostaglandin E & I
- ✚ It keeps the renal afferent arteriole pressure near normal
- ✚ Through its feedback effect, it suppress further release of renin

### **Tubulo-glomerular feedback mechanism-**

- 📖 An  $\uparrow^{ed}$  rate of flow of fluids through the tubules  $\downarrow^{es}$  filtration rate of the glomerulus
- 📖 Aldosterone, vasopressin & catecholamine  $\uparrow$  water & insoluble reabsorption &  $\uparrow$  blood volume
- 📖 Insulin & high levels of dietary proteins causes sustained  $\uparrow$  in renal blood flow which in turn  $\uparrow^{es}$  glomerular filtration rate

- Natriuretic hormone from atrium is responsible for causing natriuresis & diuresis & thus reduces blood volume & glomerular filtration rate

## **Proximal convoluted tubule (PCT):**

### **Na reabsorption-**

- It happens through active transport & energy requirement is met by  $\text{Na}^+\text{K}^+\text{ATPase}$  pump located in the proximal tubular epithelium
- $\text{Na}^+$  is actively transported from the tubular epithelial cells to peritubular space & results as intracellular  $\text{Na}^+$  concentration is depleted &  $\text{K}^+$  channel & cell becomes –vely charged
- $\text{Na}^+$  transport is facilitated by  $\text{H}^+$  diffusion in opposite direction &  $\text{HCO}_3^-$  diffuses into the peritubular space or to the lumen in exchange of  $\text{Cl}^-$  diffusion into the cell

## Proteins & peptide transport:

- PCT also reabsorbs proteins with low molecular wt. as these are filtered out through glomerular filtrate
- Brush border epithelial cells have peptidases which breakdown peptide into amino acids & absorbed through microvilli
- Peptides & amino acids are directly absorbed by plasma membrane through  $\text{CO}_2$  transport with  $\text{H}^+$
- Endocytic vesicles transfer the protein to lysosome. Lysosome in turn release amino acid by proteolytic lysosomal enzyme.
- The amino acid released are ultimately absorbed into peritubular blood vessels.
- $\text{Cr}^{++}$  &  $\text{K}^+$  absorption in the PCT takes place through solvent drag action or passive diffusion due to electrical gradient
- The reabsorption of  $\text{HCO}_3^-$  also takes place by  $\text{Na}^+$  gradient .

**Water reabsorption:-** The PCT reabsorbs approximately 60-65 % of water in the filtrate from tubule to peritubular capillaries

**Counter current mechanism (Henle`s loop):**

- The length of the tubule from the cortex to medulla & the concentration of Na at different length of loop are deciding factor in this counter current system.
- The glomerular filtrate after reabsorption of some solutes isotonicly.
- As it passes down, the descending limb, appears a passive diffusion of Na into the tubule & becomes hypertonic.
- This hypertonic fluid & water was passed through the ascending limb from tubule to the surrounding tissue, delivered to the distal CT.
- The ADH decides the permeability to water of the DCT epithelium & hypotonic fluid attains isotonic/hypotonic state depending upon the situation.

➤ The fluid as it passes through the collecting tubule becomes more hypotonic & as a result of this hypertonic urine is formed & passes through the ureter.

**Uric acid formation:** These are formed from ammonia in the liver & kidney. In reptiles & birds, it is formed instead of urea being impermeable to water.

**Micturition:** The term used to indicate the process of emptying the urinary bladder.

### **Normal urine volume:**

Cattle	-	17 - 45 ml/kg/b.wt/day
Sheep/ Goat	-	10 - 40
Horse	-	3 - 18
Swine	-	5 - 30
Dog	-	20 - 100
Cat	-	10 - 20

# Some terminologies regarding urine:

- Polyurea -  $\uparrow^{\text{ed}}$  flow of urine
- Oligurea -  $\downarrow^{\text{ed}}$  flow of urine
- Anurea - absence of urine
- Stamguria - Slower & painful flow of urine
- Glucosurea - presence of glucose in urine
- Proteinurea - presence of protein in urine
- Natruria - Excess Na in the urine

**Urinary system:** The domestic animals have been shaped kidney except right equine kidney which looks like as heart shaped & Ox having lobulated kidney.

✓ The medial part of kidney, the hilus have the entrance of arteries & nerves & the ureter, veins & lymphatic vessels leave.

✓ The renal medulla contains radially arranged collecting tubules some loop of henle.

✓ The medulla is surrounded by the renal cortex, granular appearance because of proximal & distal convoluted tubules & other segments of loop of henle

**Blood & Nerve supply:** Two renal arterioles receive the cardiac output & enters the hilus into a number of relatively large branches, the interlobar arteries. Further they give rise to the afferent arterioles & each arterioles branches repeatedly to form a tufted capillary network called glomerulus. The capillaries of the glomerulus coalesce into an efferent arterioles which leaves each glomerulus.

Arcuate vein drain blood from cortex & medulla and enter the renal veins via interlobar veins.