

URINARY SYSTEM

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Components

1. **Kidneys**- produces urine
2. **Ureter**- transports urine towards the urinary bladder
3. **Urinary bladder**- stores urine temporarily prior to elimination
4. **Urethra**- conducts urine to the exterior

Functions of urinary system

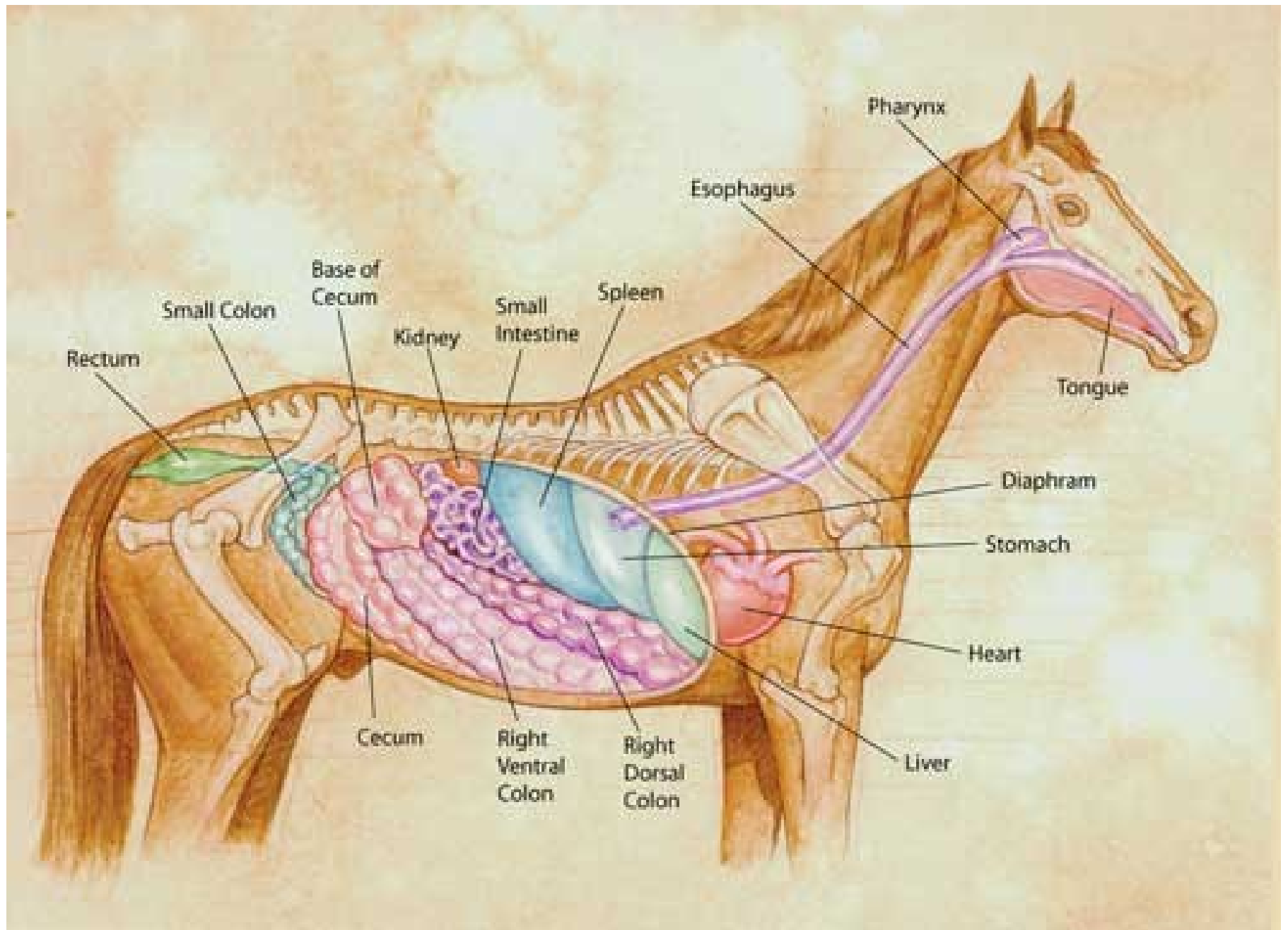
- i. Removal of **waste products** from blood and eliminating them as urine.
- ii. Maintenance of normal **osmotic pressure** in blood and tissues (regulates water + electrolytes)
- iii. **Acid base balance**
- iv. **Renin production**
- v. Secretion of **erythropoietin**
- vi. **Urine storage**

1. KIDNEY

Location

- **Retroperitoneal** in position, **beneath lumbar vertebrae** on either side of vertebral column
- Position- vary slightly with species (table)
- **Right kidney**- usually more cranial EXCEPT in **pig** where it is symmetrically placed (L1-4 for both)
- **Ruminants:**
 - Rumen has pushed left kidney backwards and to the right to lie caudal and ventral to right (in contact with left surface of spiral colon)
 - The left kidney has also become pendulous and almost entirely invested with peritoneum

- **Carnivores**- left kidney loosely attached to peritonium and vary in position (depending on degree of fullness)
- Kidneys- **held in position** by visceral pressure and by attachment to fascia of sublumbar muscles
- **Medial border**- of right kidney related to the caudal vena cava while that of the left is related to abdominal aorta (see human photo)
- Except in pig- **cranial pole** of the right kidney lies on renal notch of liver



External morphology

- Shape/ form vary with species;-
 - **Carnivores & small ruminants**: well rounded bean shaped kidneys
 - **Swine**: bean shaped but flattened dorsoventrally and with sharp poles
 - **Ox**: RT- lobated irregular oval;
LT- pyramidal in shape
 - **Horse**: RT-heart shaped
LT- bean shaped
- **Color**- varies from brownish red to dark bluish red (depending on amount of blood)
- **Borders, poles & surfaces**: each kidney has a convex lateral border & a concave medial border, a caudal & cranial poles; and dorsal and ventral surface

- **Medial border-** indented at middle by renal hilus, which leads into small cavity called renal sinus which contains renal pelvis
- **Passing via the hilus-** blood vessels, lymphatics, nerves & ureter enter kidney
- **Kidney-** covered by a **capsule** (renal capsule) which is easily removed in healthy animals; the capsule has prominent veins (capsular veins) in cats
- **Kidneys-** partly covered by **perirenal fat**, whose thickness varies with species and state of nutrition (more in pig & ruminants, less in carnivores and least in horse)

Internal morphology

- The kidney parenchyma is divided into: an external cortex & an internal medulla
 - i. **Cortex**- paler & forms a continuous zone below capsule; granular appearance (due to the presence of renal corpuscles)
 - ii. **Medulla**: darker inner zone show narrow spikes of tissue called **medullary rays** (radiates into cortex)
- Kidneys- comprise of radially arranged units called **lobes** (these are not readily apparent except in ox)

- Each lobe consists of a cap-like cortical tissue enclosing the base of pyramid-shaped medullary tissue called **renal pyramid**
- The apex of the renal pyramid is called **renal papillae** and this projects into renal sinus.
- Thus each lobe consists of a medullary pyramid capped at its base by part of the cortex, and a renal papillae which is directed towards the renal sinus
- Individual papillae are inserted into recesses of renal pelvis or ureter called **renal calices** (in papillated kidneys)
- Cortical tissue (wedge-shaped) extending into the medulla between adjacent pyramids are called **renal columns**

- **Renal lobes** are completely fused in carnivores, small ruminants & horse; partially fused in pig and distinctly separate in bovine
- **Kidney surfaces** of carnivores, small ruminants, horse & pig- the kidneys are smooth surfaced owing to complete fusion of cortical tissue of neighboring lobes
- **Bovine kidneys-** are superficially divided by fissures due to incomplete fusion of the cortical tissue
- The fusion of the lobes is not limited to the cortex but may also involve the medulla.
- Where the pyramids are not completely fused, individual papillae projects separately (or in groups) into the renal sinus in what are called **papillated kidneys** (e.g. ox and pig)
- Where the pyramids are completely fused, the apices of the pyramids form a ridge-like common papilla called **renal crest**

- Carnivores, small ruminants and horse- lobes are completely fused and a renal crest is present
- Pig- the lobes are partially fused and thus retains individual or aggregates of papillae that project into calices of the renal pelvis
- Bovine- lobes are separate and each papillae projects separately into a calix located at the end of a branch of the ureter (no renal pelvis)

Vascular supply

- **Renal artery** enter kidney via hilus
- Renal artery branch (within renal pelvis) to form **lobar arteries**
- Each lobar artery enters renal parenchyma and run along renal column as **interlobar arteries**
- At corticomedullary junction, interlobar artery branch to form **arcuate arteries**
- Arcuate arteries follow a course along the junction giving rise, at regular intervals, to **interlobular arteries**, which enter cortex

- Each interlobular artery gives rise to a short **afferent arteriole** which enter renal corpuscle, from which emerge single **efferent arterioles**
- The efferent arterioles give rise to a network of capillaries found surrounding nephronal tubules called **peritubular capillaries**

NB: Many of the interlobular arteries also give off branches (capillaries) that supply renal capsule

Venous drainage

- Peritubular capillaries drain into **interlobular veins** (or directly into arcuate veins)
- Capsular capillaries drain into **subcapsular veins** and then into **interlobular veins**
- Interlobular veins drain into **arcuate veins** and then into **interlobar veins** that run along renal columns to form, within renal pelvis, **lobar veins**
- The lobar veins drain into the **renal vein** which leave the kidney at the hilus to join the caudal vena cava
- Note: In some species, the kidney capsule is drained by **distinct capsular veins** directly into the renal vein.