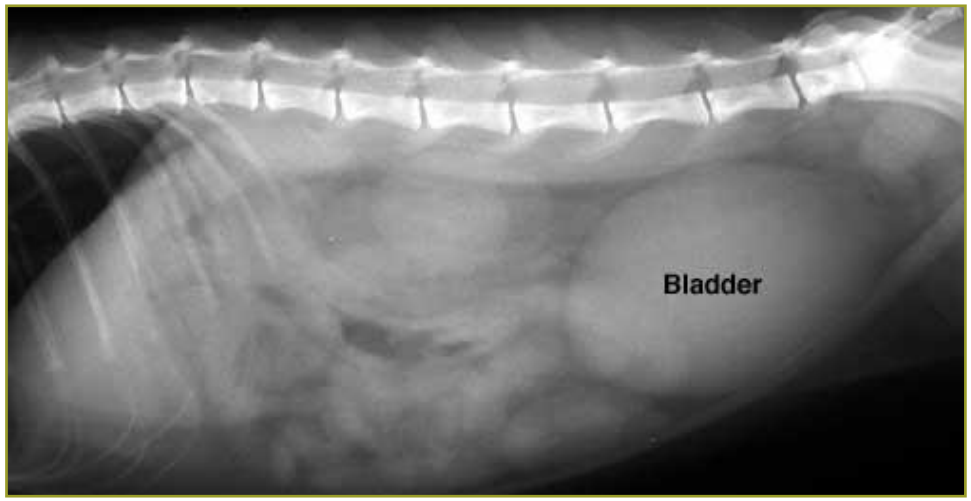
VET-114
Animal Anatomy and Physiology 2

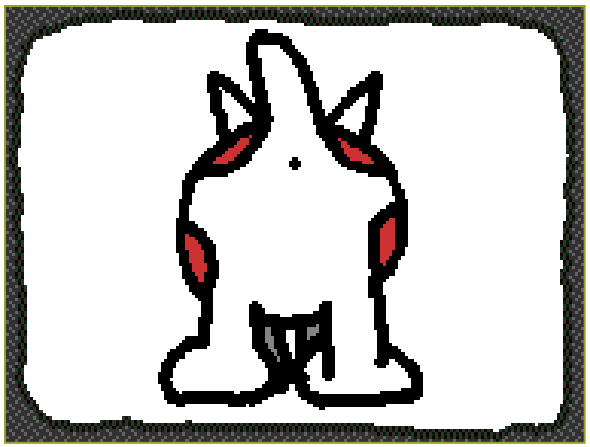
Webinar – Chapter 16

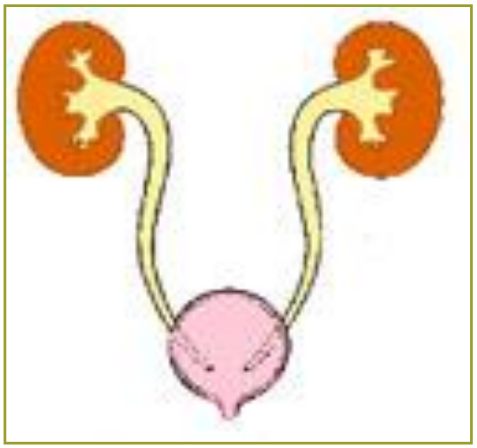
Trace a Urea Molecule through the Urinary System

The Urinary System

Chapter 16 – Pages 374-386



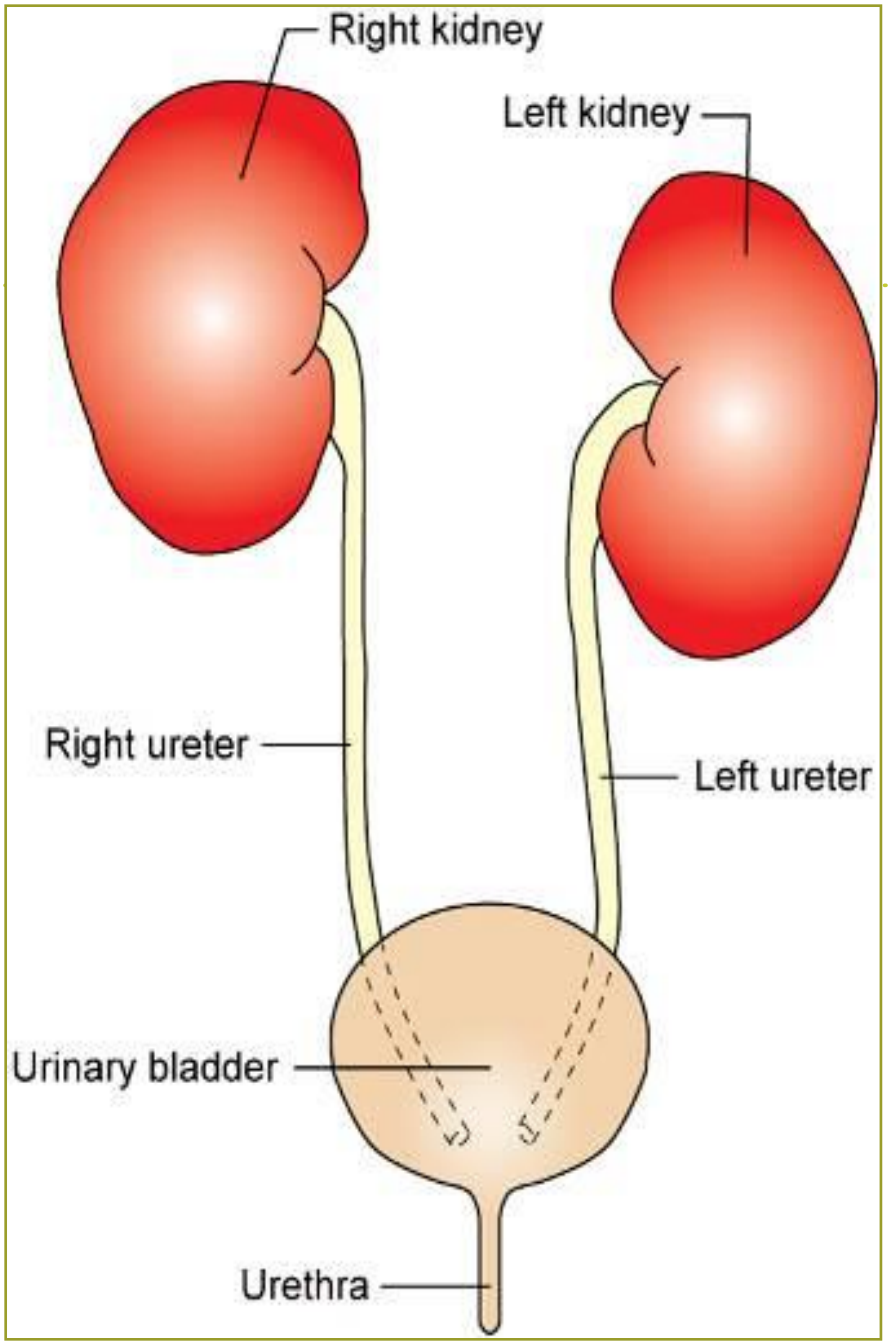


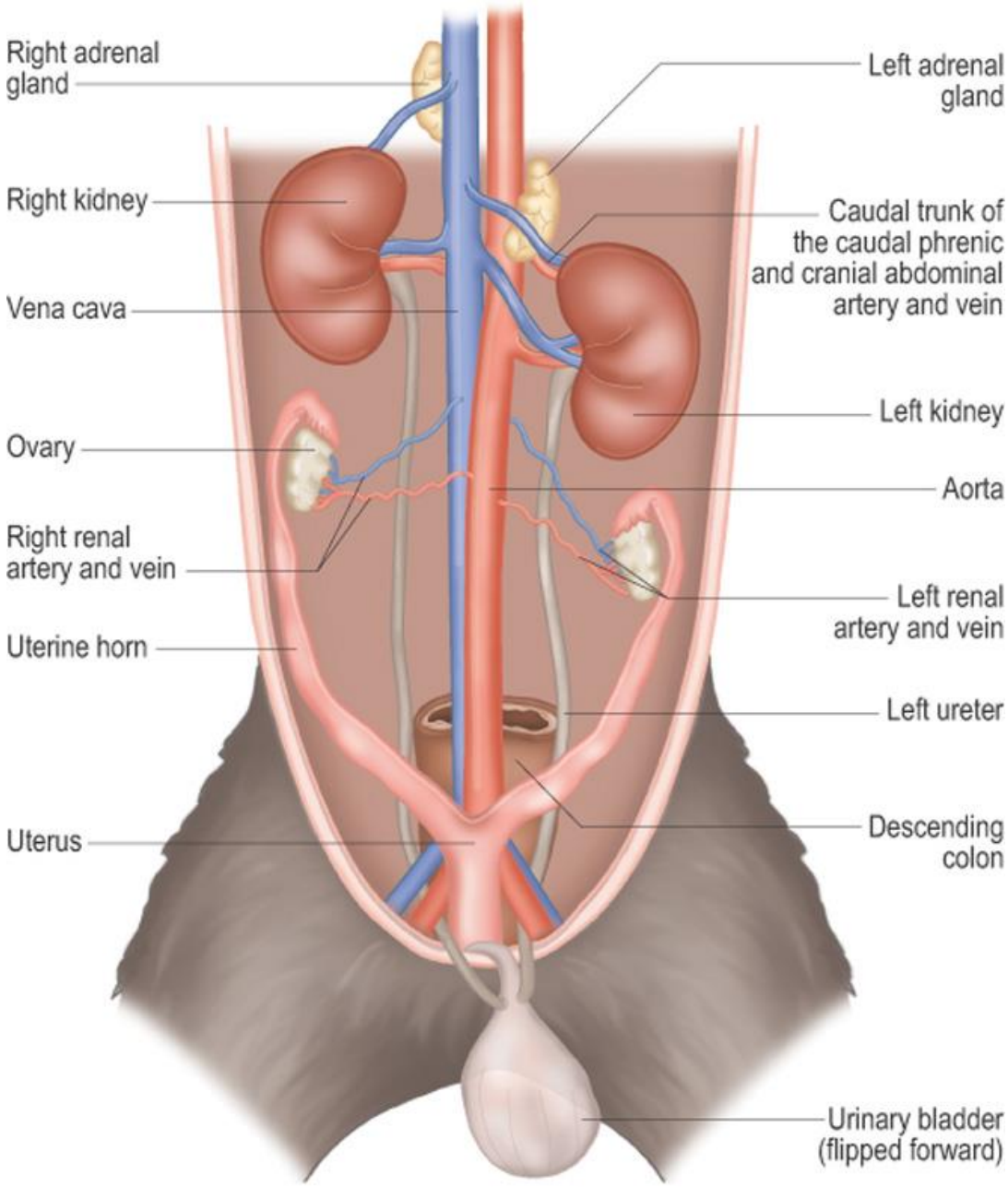


Urinary System Gross Anatomy

Figure 16-1, Page 375

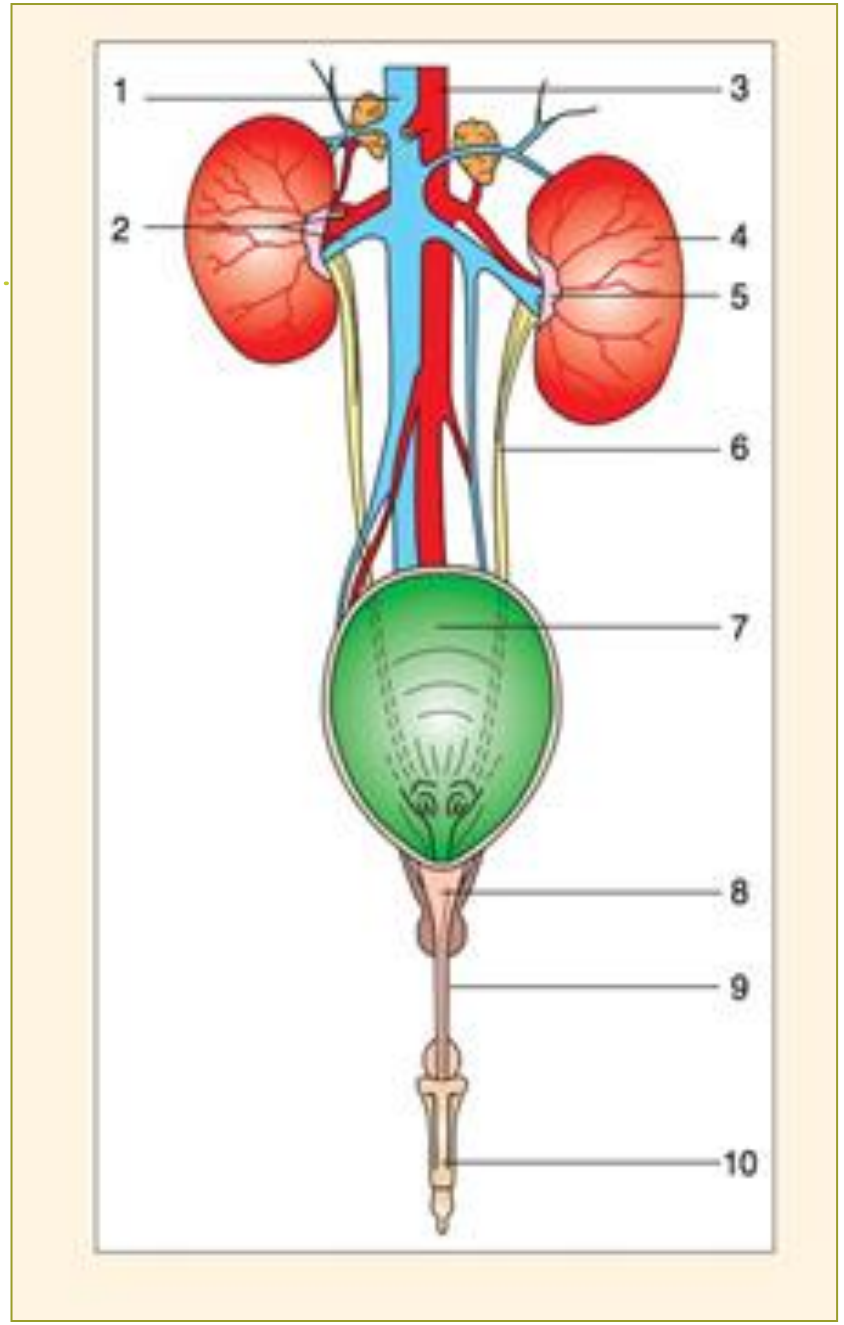
- Urology
- Kidneys
- Ureters
- Urinary bladder
- Urethra





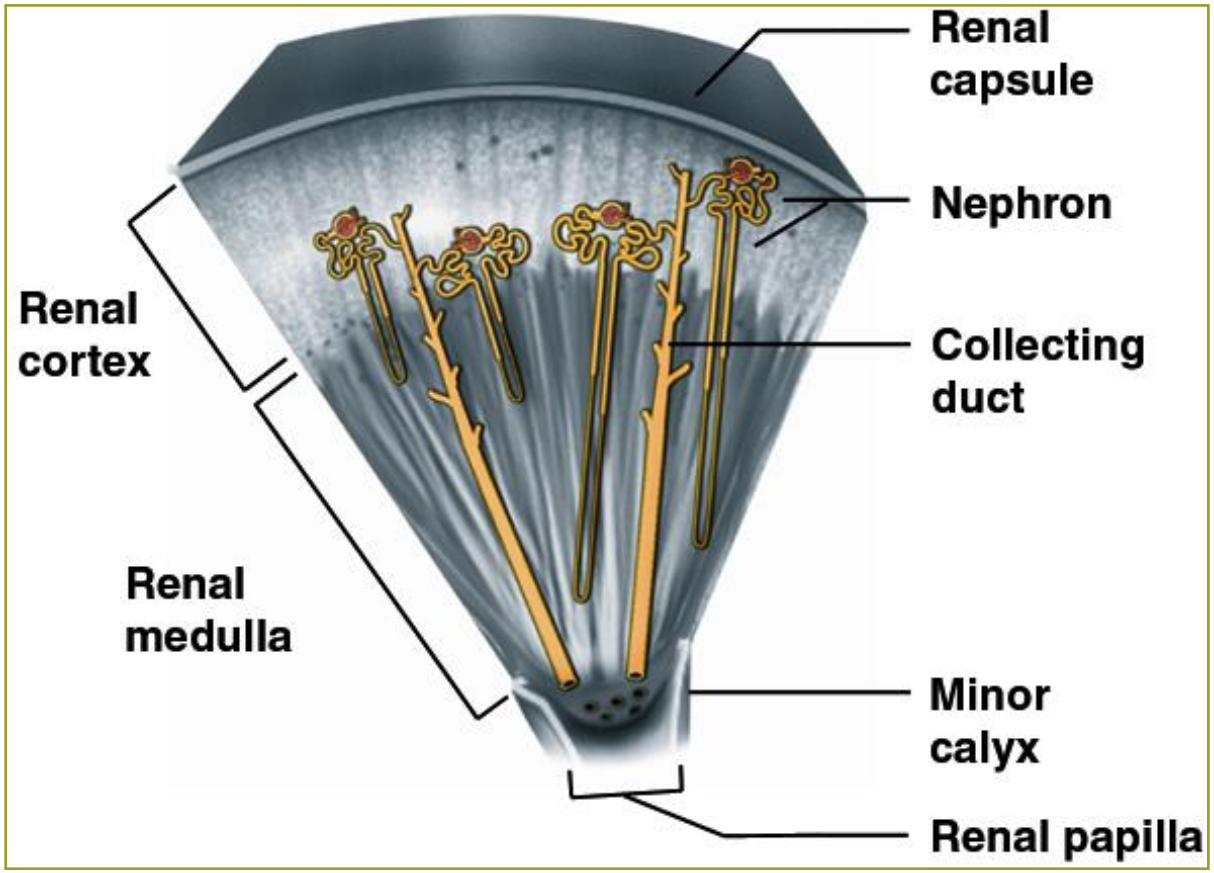
Identify the Structures of the Male Urinary System

Bassert Lab Manual – Page 404



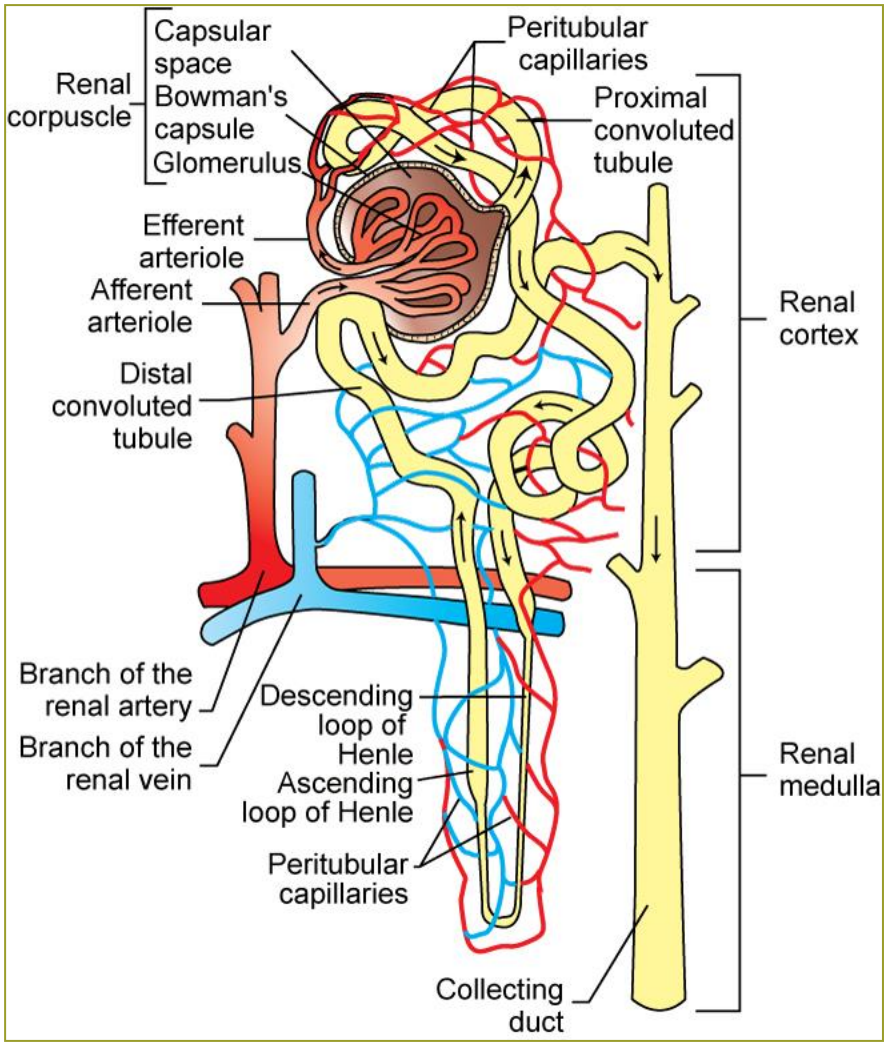
Microscopic Anatomy of Kidney

- Nephron
- 1 million nephrons per kidney



Microscopic Anatomy (Histology) of Kidneys

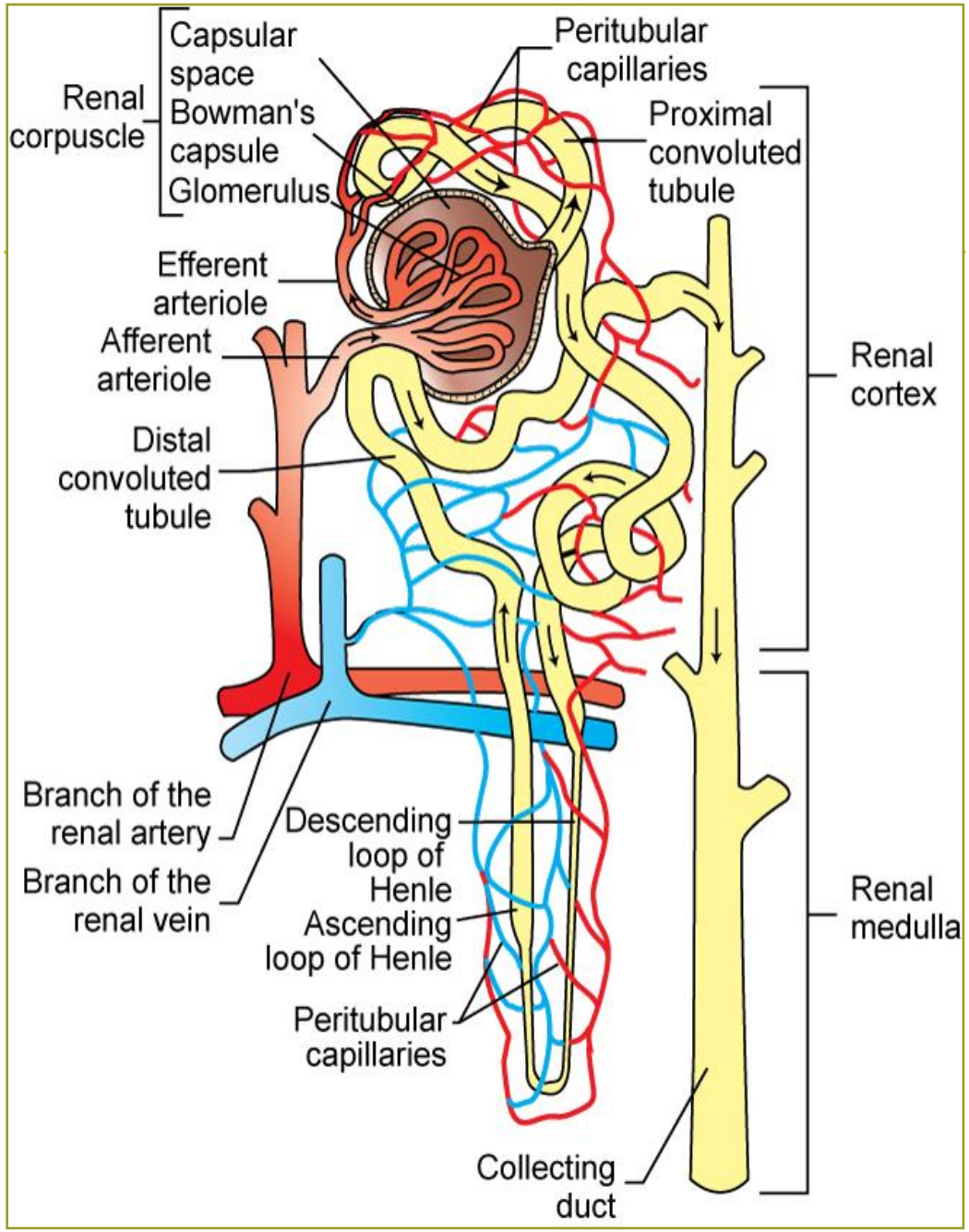
- Nephron: basic functional unit of kidneys
- Number of nephrons per kidney varies
- Each nephron consists of a renal corpuscle, proximal convoluted tubule, loop of Henle and distal convoluted tubule



Nephron Structure

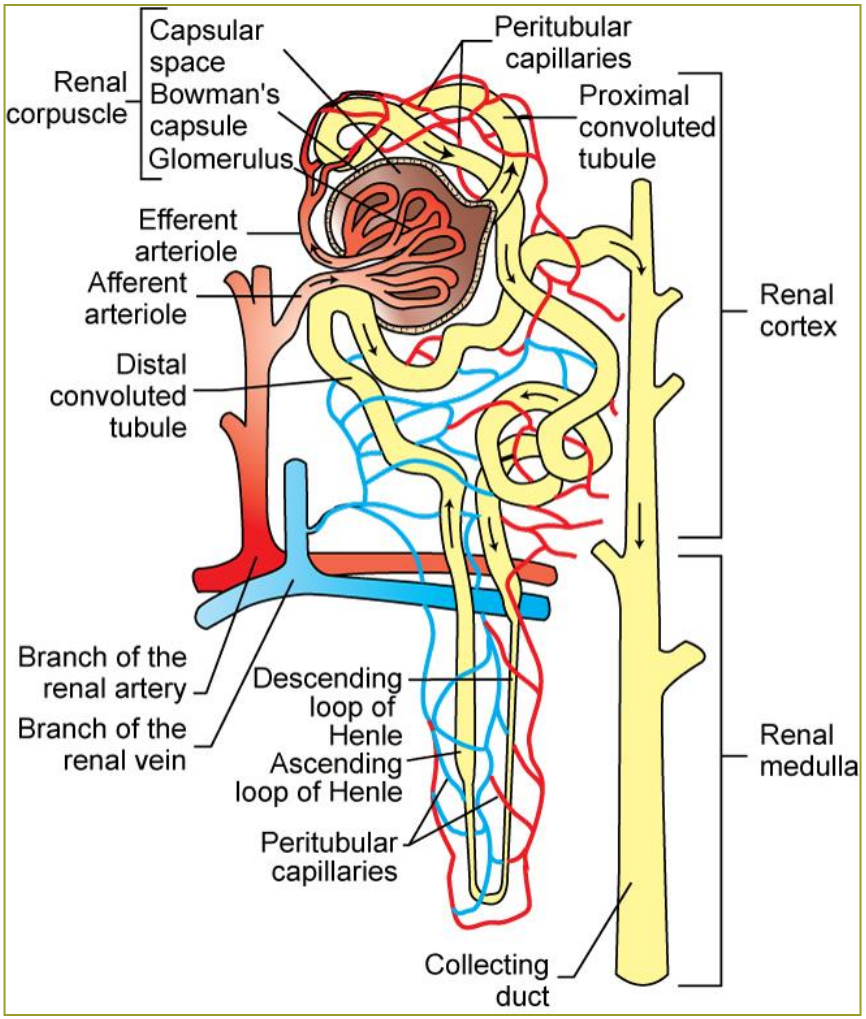
Figure 16-3, Page 377

- Glomerulus
- Bowman's capsule
- Glomerular filtrate
- Proximal convoluted tubule (PCT)
- Loop of Henle
- Distal convoluted tubule (DCT)
- Collecting ducts



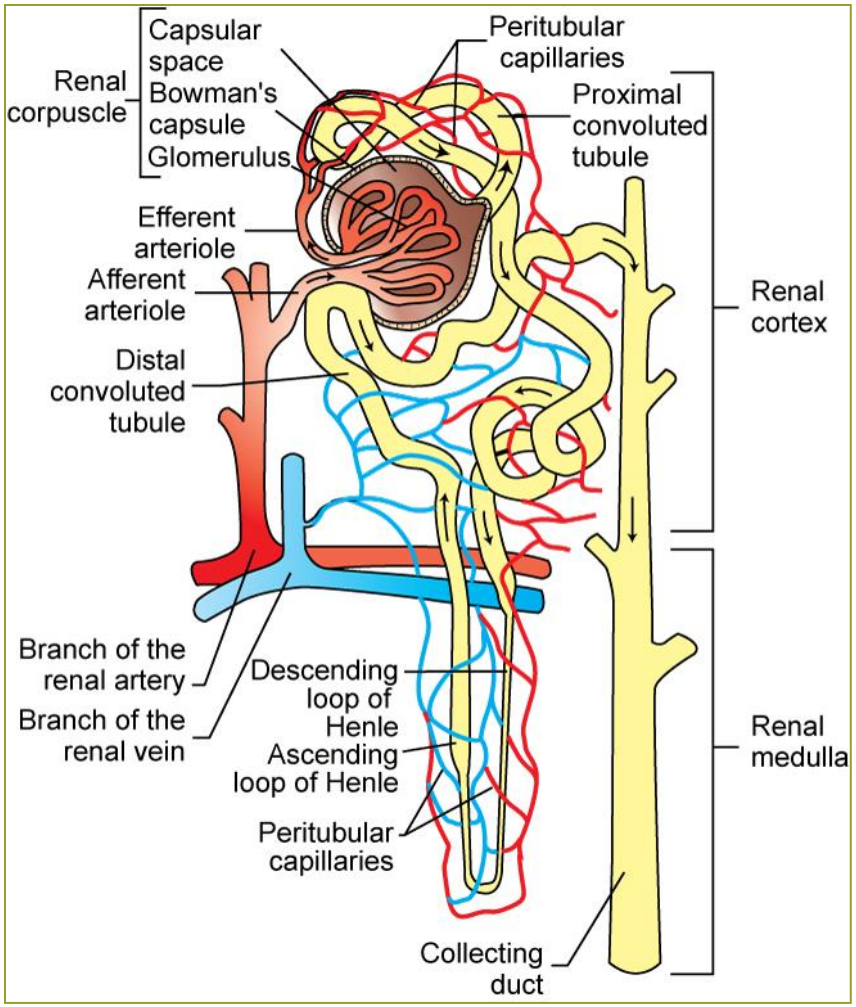
Renal Corpuscle

- Located in renal cortex
- Function: filters blood in first stage of urine production
- Composed of **glomerulus** surrounded by **Bowman's capsule**
  - Glomerulus: "tuft" of capillaries
- Fluid filtered out of blood is called **glomerular filtrate**



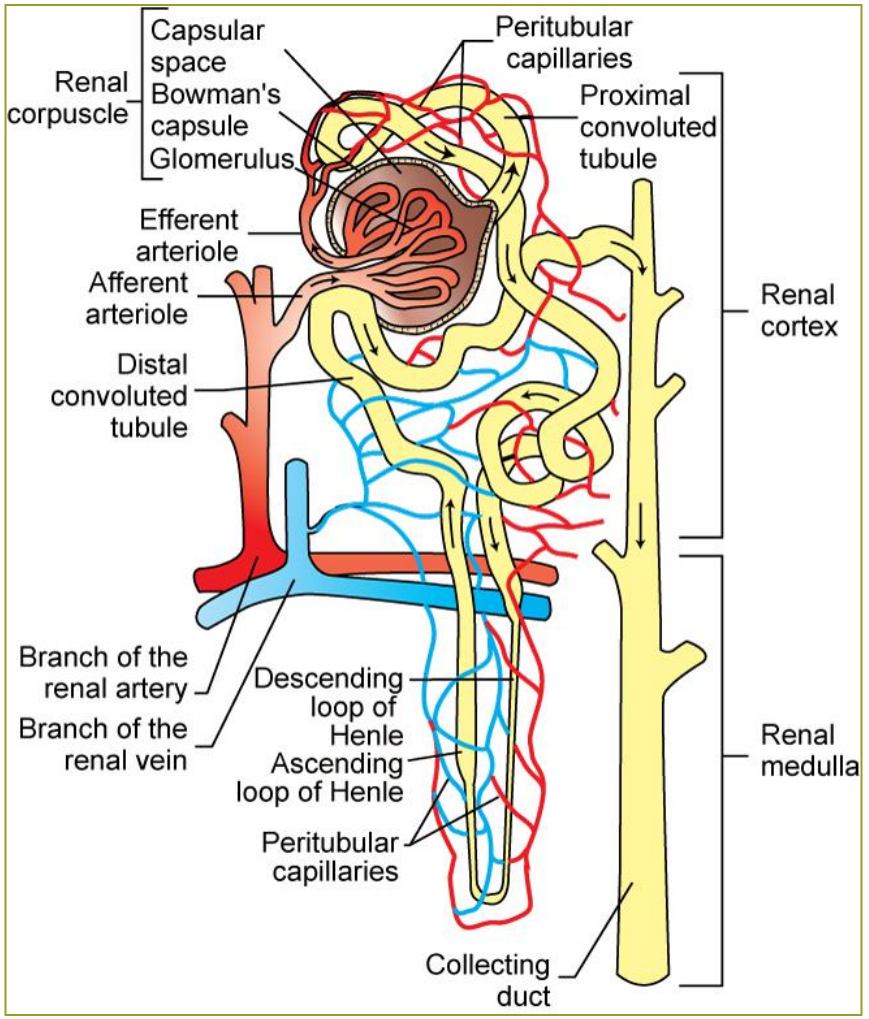
Proximal Convoluted Tubule (PCT)

- Continuation of capsular space of Bowman's capsule
- Lined with cuboidal epithelial cells with a brush border on lumen side
- Twisting path through the cortex
- Glomerular filtrate now called the **tubular filtrate**



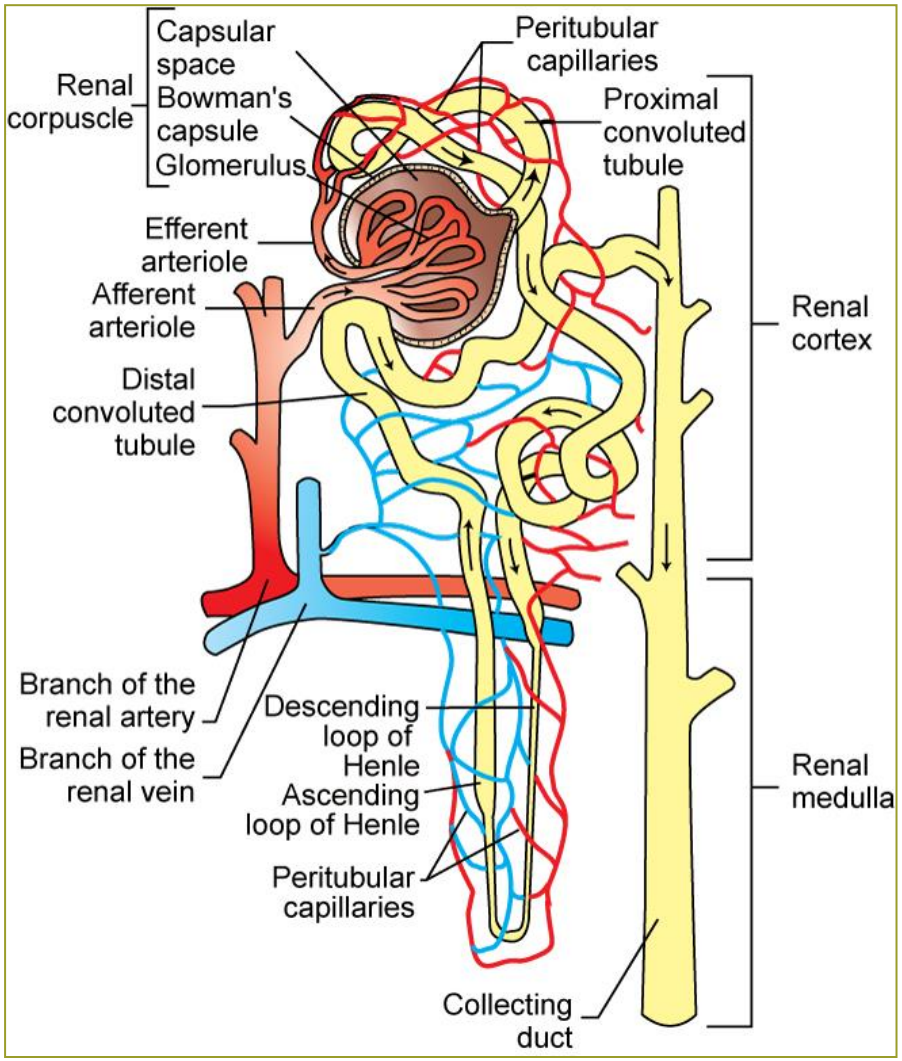
Loop of Henle

- Descends from PCT into medulla, turns, heads upward into cortex
- Descending loop has epithelial cells similar to those of PCT
- At bottom of loop, epithelial cells flatten to simple squamous epithelial cells and lose their brush border
- Ascending loop wall becomes thicker again



Distal Convoluted Tubule (DCT)

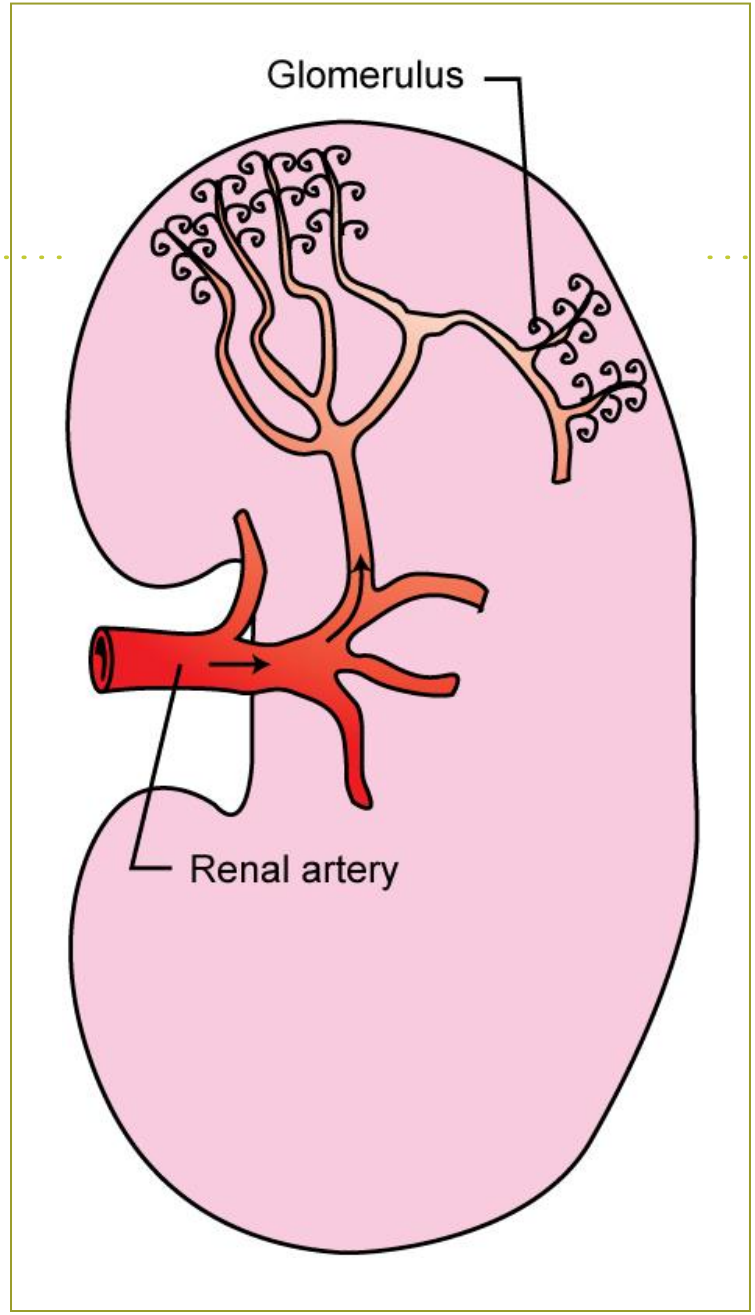
- Continuation of ascending loop of Henle
- DCT from all nephrons in the kidney empty into collecting ducts
  - Carry tubular filtrate through medulla
  - Empty into renal pelvis
  - Primary site of action of ADH and regulation of potassium and acid-base balance



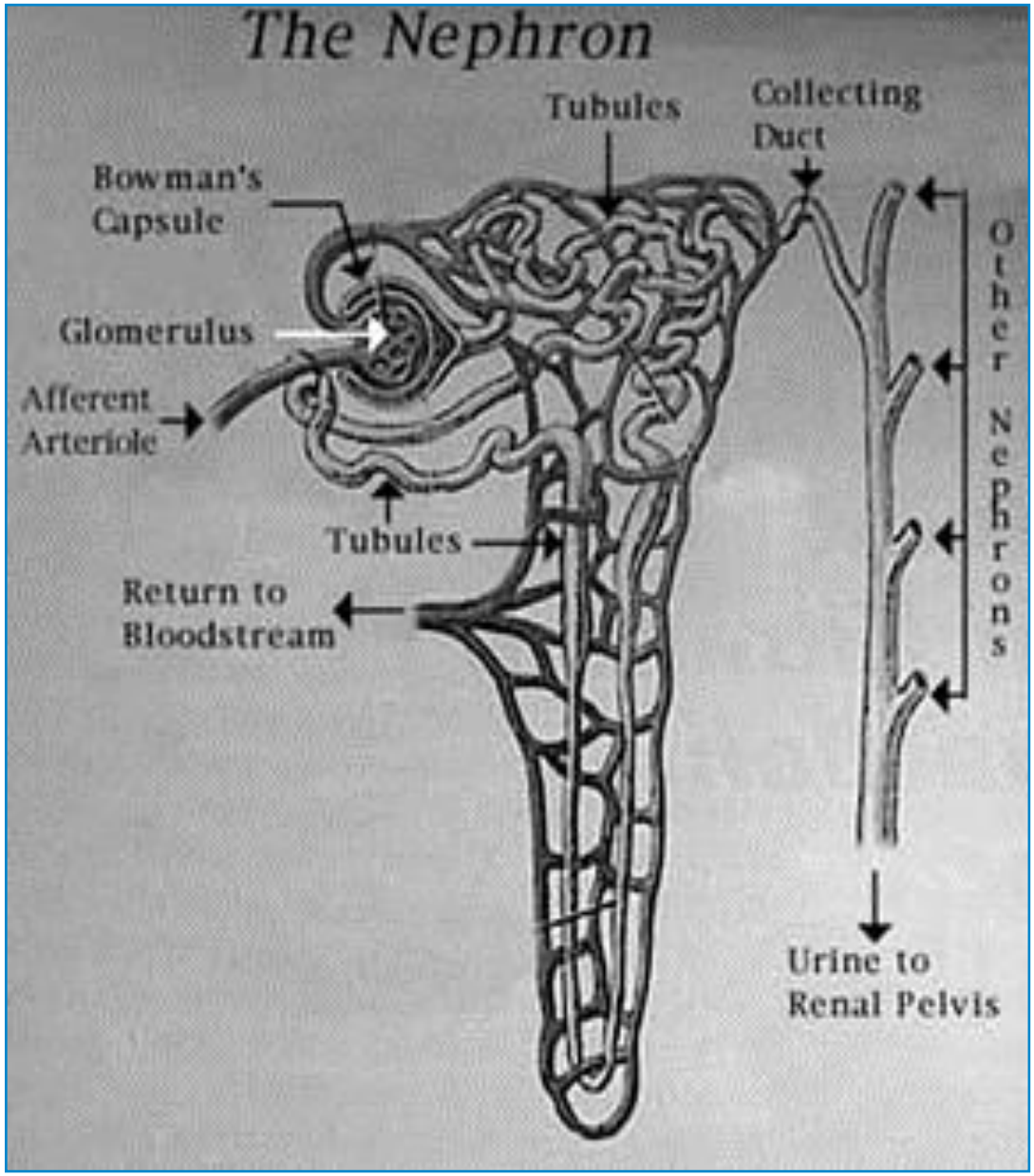
Blood Supply

Figure 16-4, Page 378

- Renal artery enters the kidney at the **hilus**
- Divides into smaller arteries and arterioles



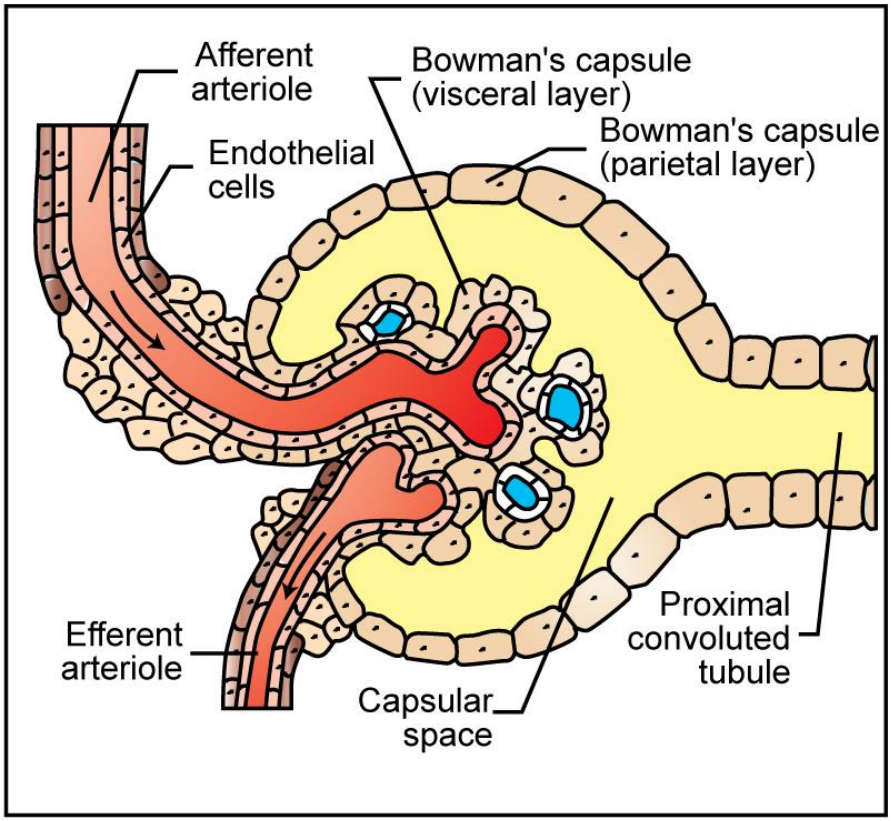
Look at That Blood Supply!



Blood Supply

Figure 16-4, Page 378

- **Afferent glomerular arterioles** carry blood into the glomerular capillaries of renal corpuscle
- **Glomerular capillaries** filter some of the plasma out of blood and put it in the capsular space of Bowman's capsule

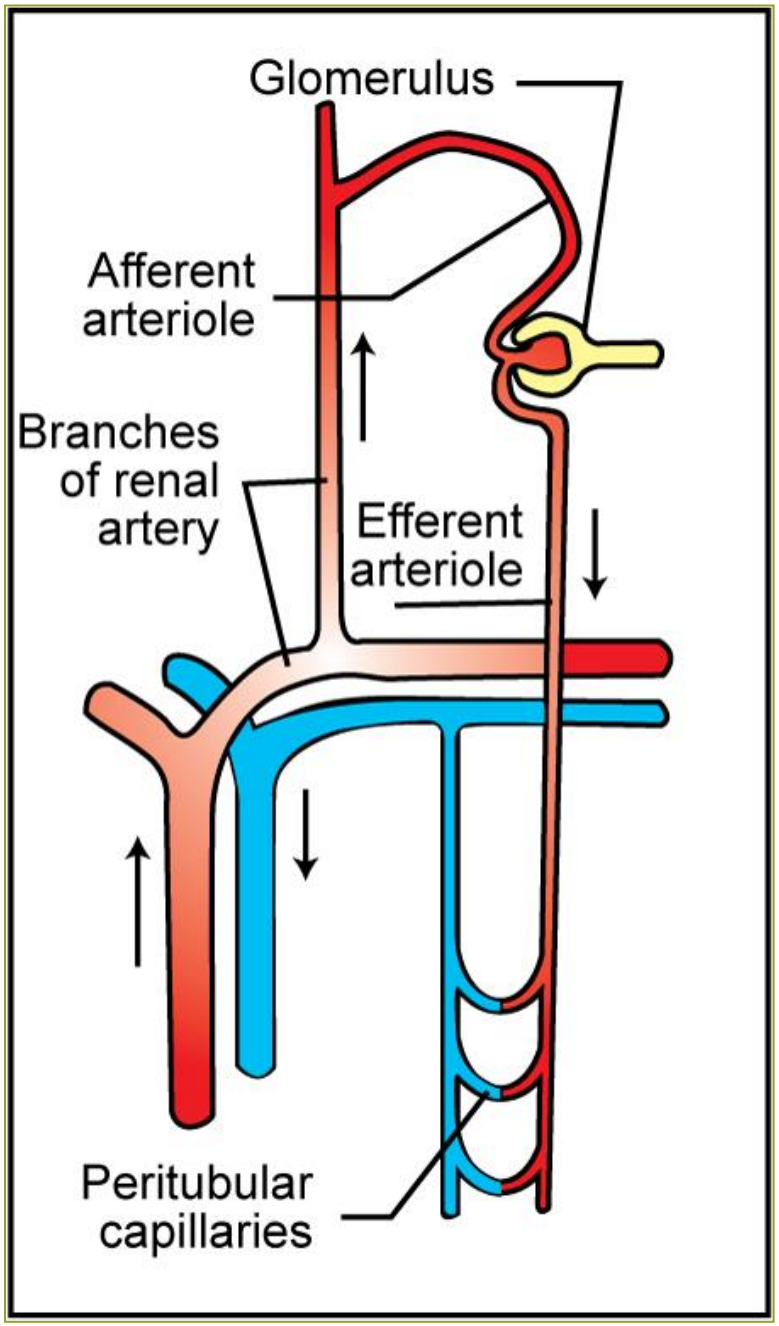


Glomerulus

Blood Supply

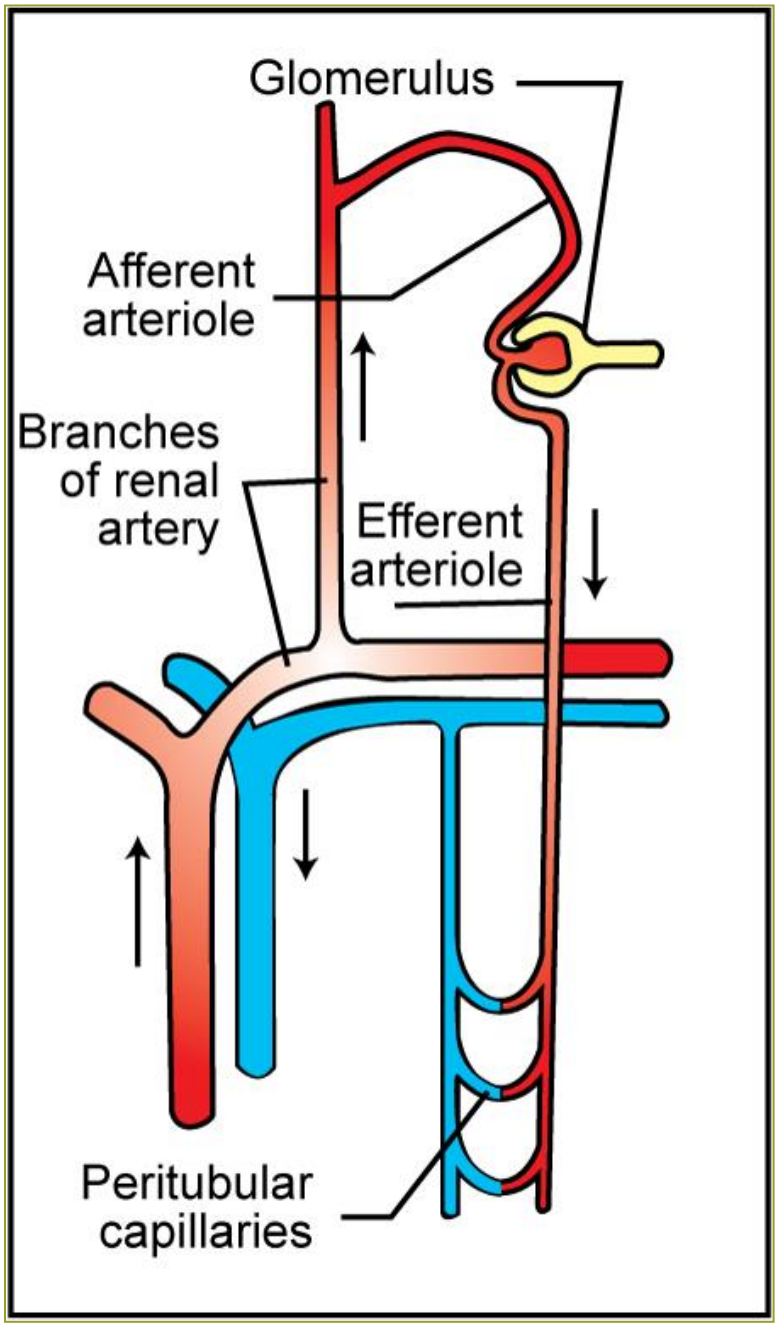
Figure 16-4, Page 378

- **Efferent glomerular arterioles** receive blood form glomerular capillaries



Blood Supply

- Efferent glomerular arterioles divide to form the **peritubular capillaries**
  - Surrounds the rest of the nephron
  - Oxygen transfer to the cells of the nephron takes place here
  - Tubular reabsorption and secretion also occurs here



Blood Supply

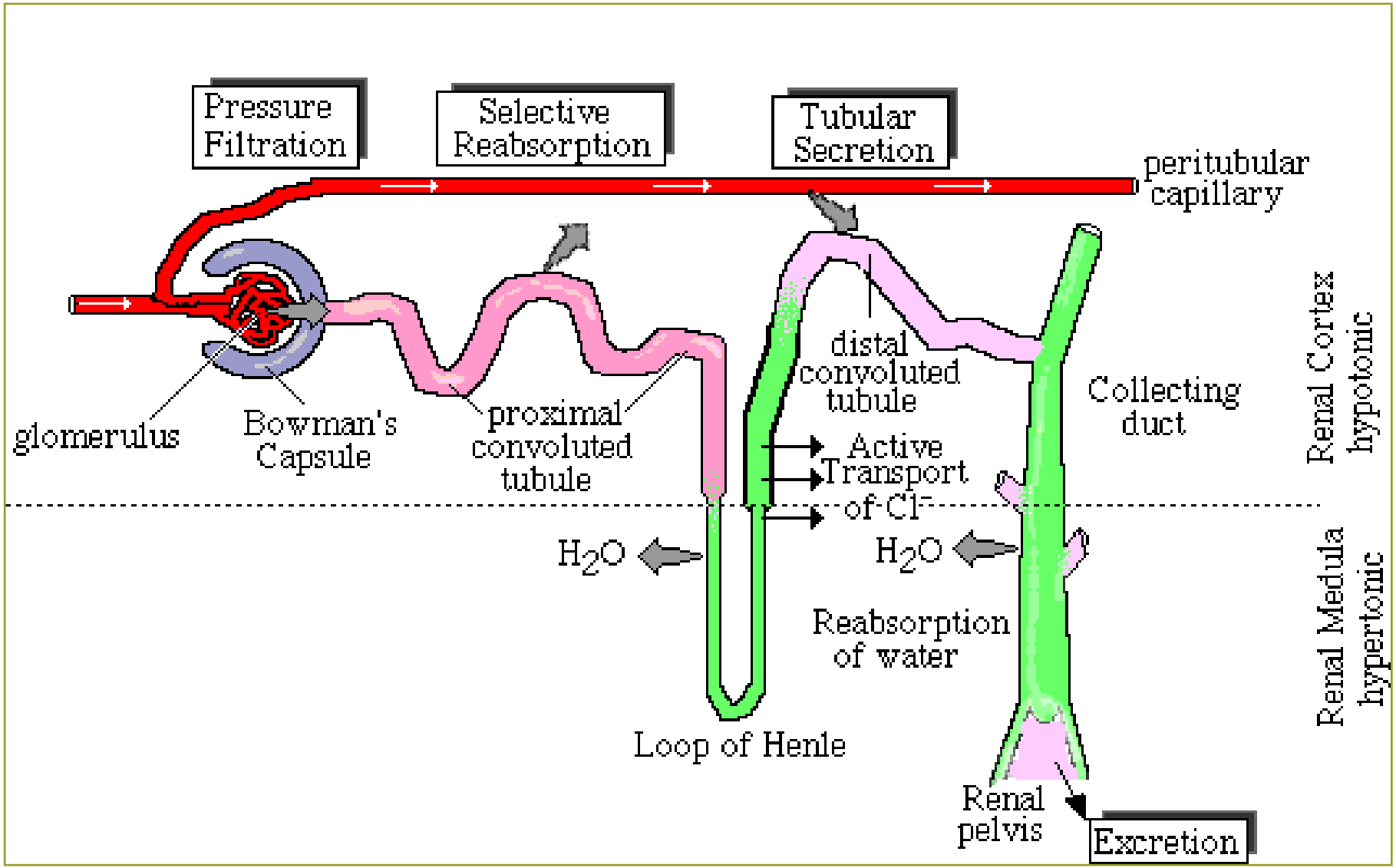
- Peritubular capillaries converge to form venules, then larger veins, and finally the renal vein.
- The renal vein leaves the kidney at the hilus and joins the abdominal portion of the caudal vena cava.

Urine Formation Review

Clinical Application – Pages 383-384

- **Filtration** – glomerulus
- **Reabsorption** – PCT
  - Na^+
  - H_2O
  - Glucose, amino acids
  - Other nutrients
- **Secretion** – DCT
  - Ammonium
  - H^+
  - Some antibiotics

Nephron Review



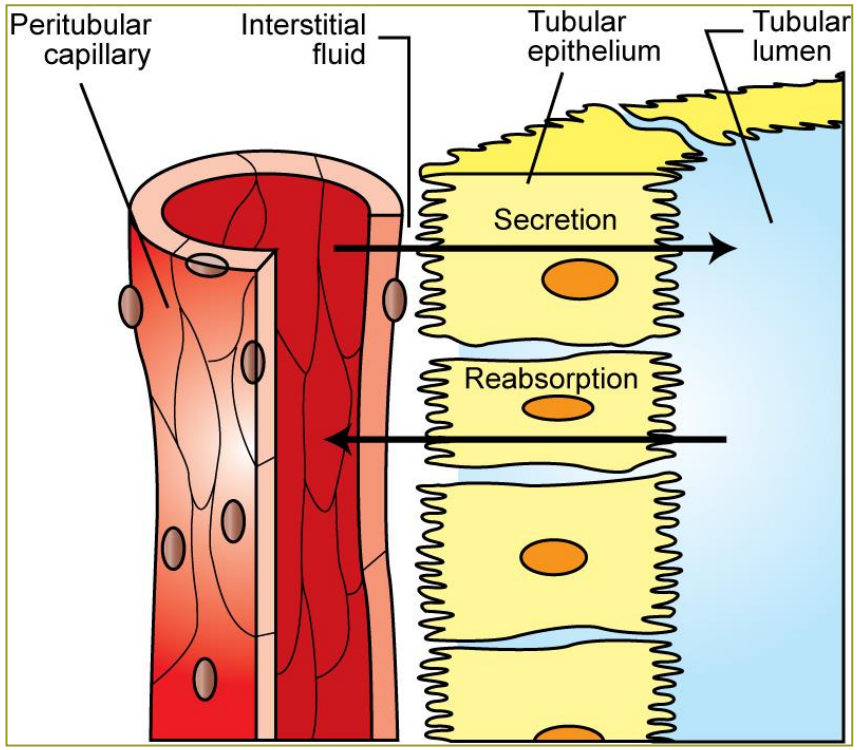
Filtration of Blood

- Glomerular capillaries contain many large fenestrations in capillary endothelium
  - Fenestrations **not large enough to allow blood cells or large proteins to pass through**
- **High blood pressure** in the glomerular capillaries forces some plasma out of the capillaries and into the capsular space of Bowman's capsule
- **Glomerular filtration rate** (GFR): how fast plasma is filtered through glomerulus

Reabsorption

Figure 16-5, Page 379

- Substances to be reabsorbed pass out of the tubular lumen through or between tubular epithelial cells
- Substances to be reabsorbed then enter interstitial fluid and pass through endothelium into peritubular capillaries

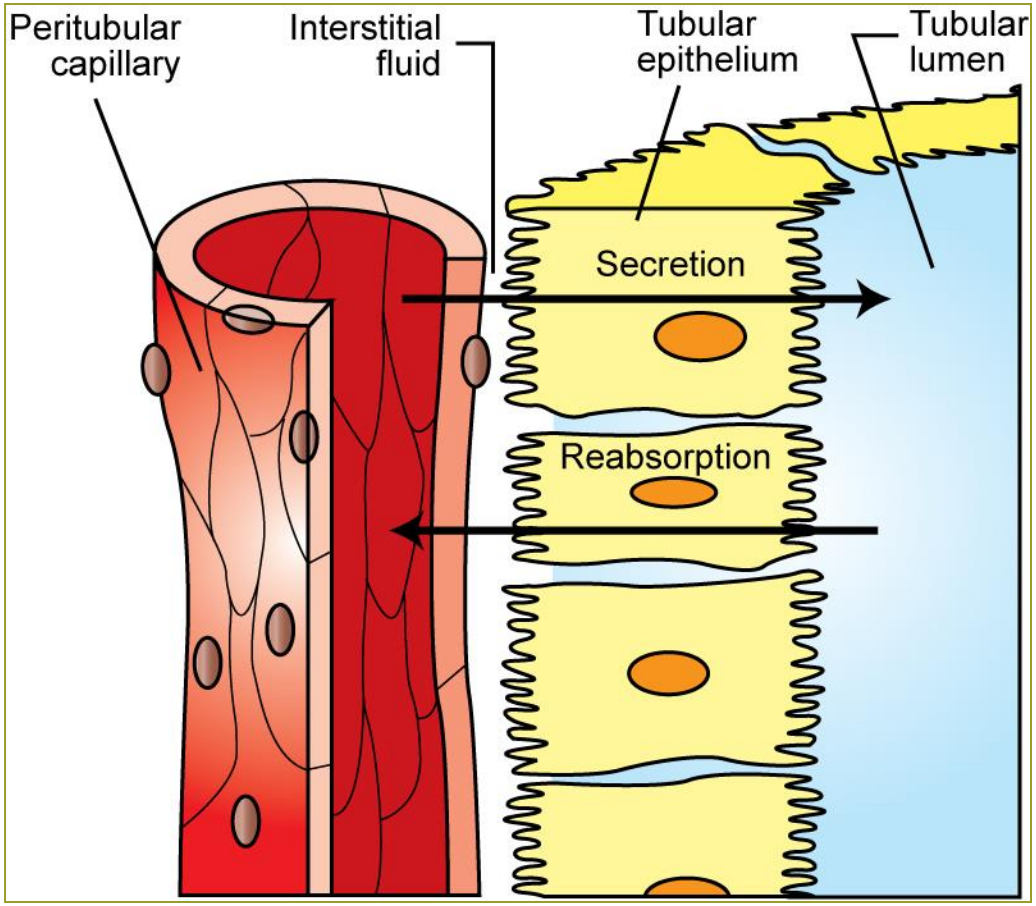


Sodium Reabsorption

- Sodium in tubular filtrate attaches to carrier protein that moves it into the cytoplasm of the PCT epithelial cell
- Glucose and amino acids attach to same carrier protein and follow sodium into the cell by **passive transport** (sodium co-transport)

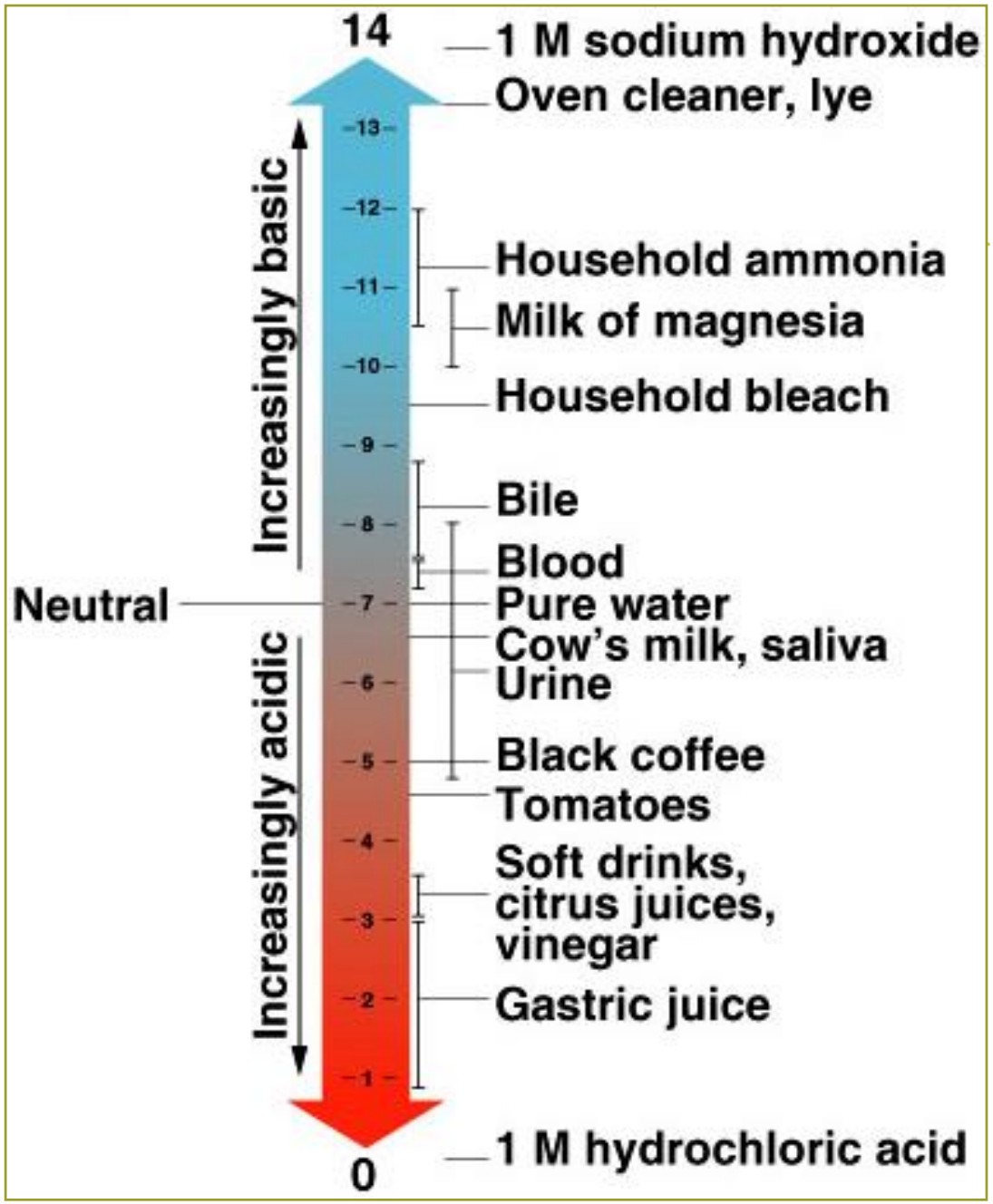
Secretion

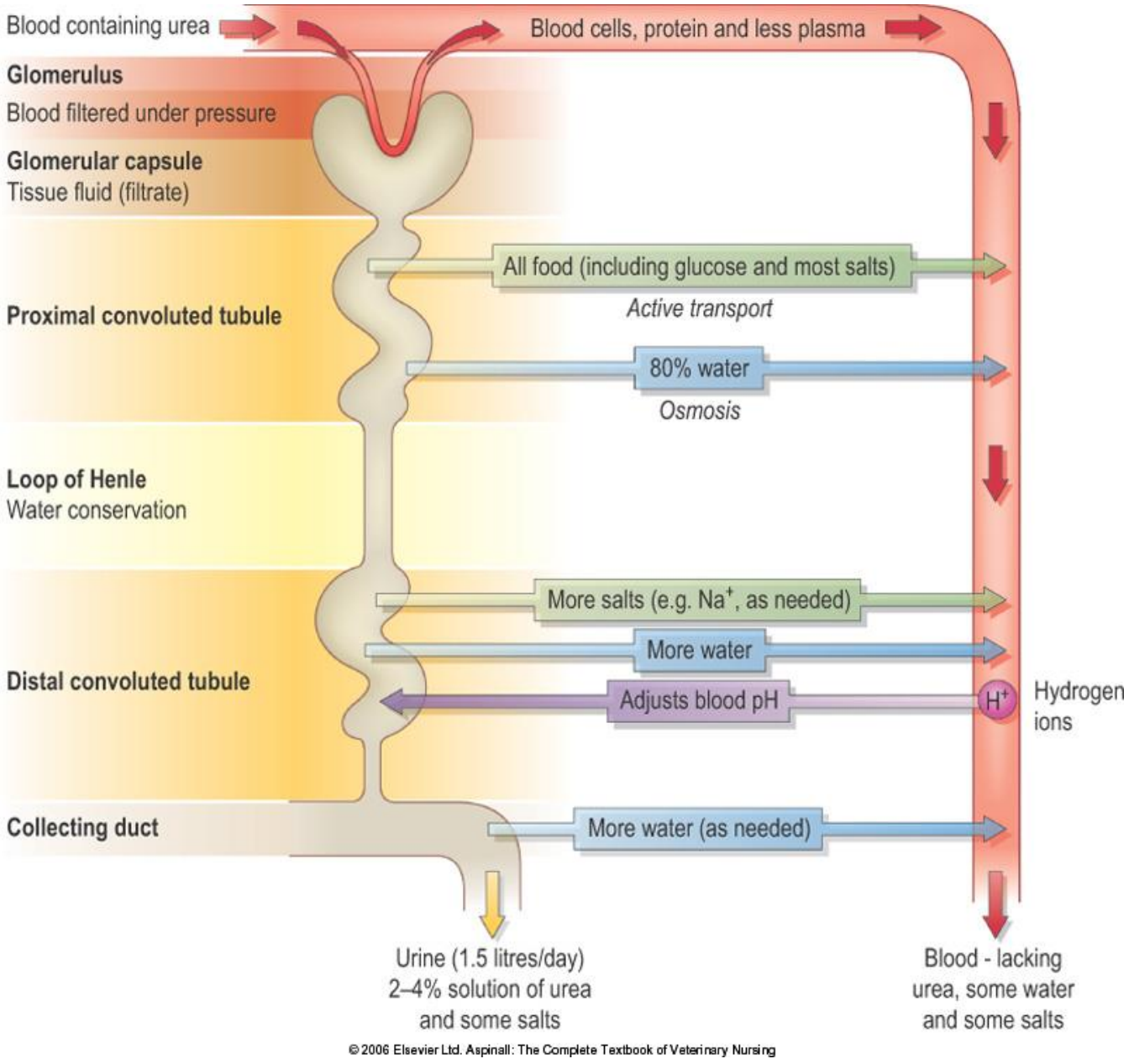
- Primarily occurs in the DCT
- **Hydrogen**, potassium, and ammonia are eliminated by secretion
- Some medications are also eliminated from the body by secretion



Urine pH

- What is pH?
- Plasma pH – 7.4
- Glomerular filtrate pH – 7.4
- Urine pH – “It depends” ☺
  - Carnivores
  - Herbivores




Blood containing urea
Blood cells, protein and less plasma
Glomerulus
Blood filtered under pressure
Glomerular capsule
Tissue fluid (filtrate)
Proximal convoluted tubule
All food (including glucose and most salts)
Active transport
80% water
Osmosis
Loop of Henle
Water conservation
Distal convoluted tubule
More salts (e.g. Na+, as needed)
More water
Adjusts blood pH
H+
Hydrogen ions
Collecting duct
More water (as needed)
Urine (1.5 litres/day)
2–4% solution of urea
and some salts
Blood - lacking
urea, some water
and some salts
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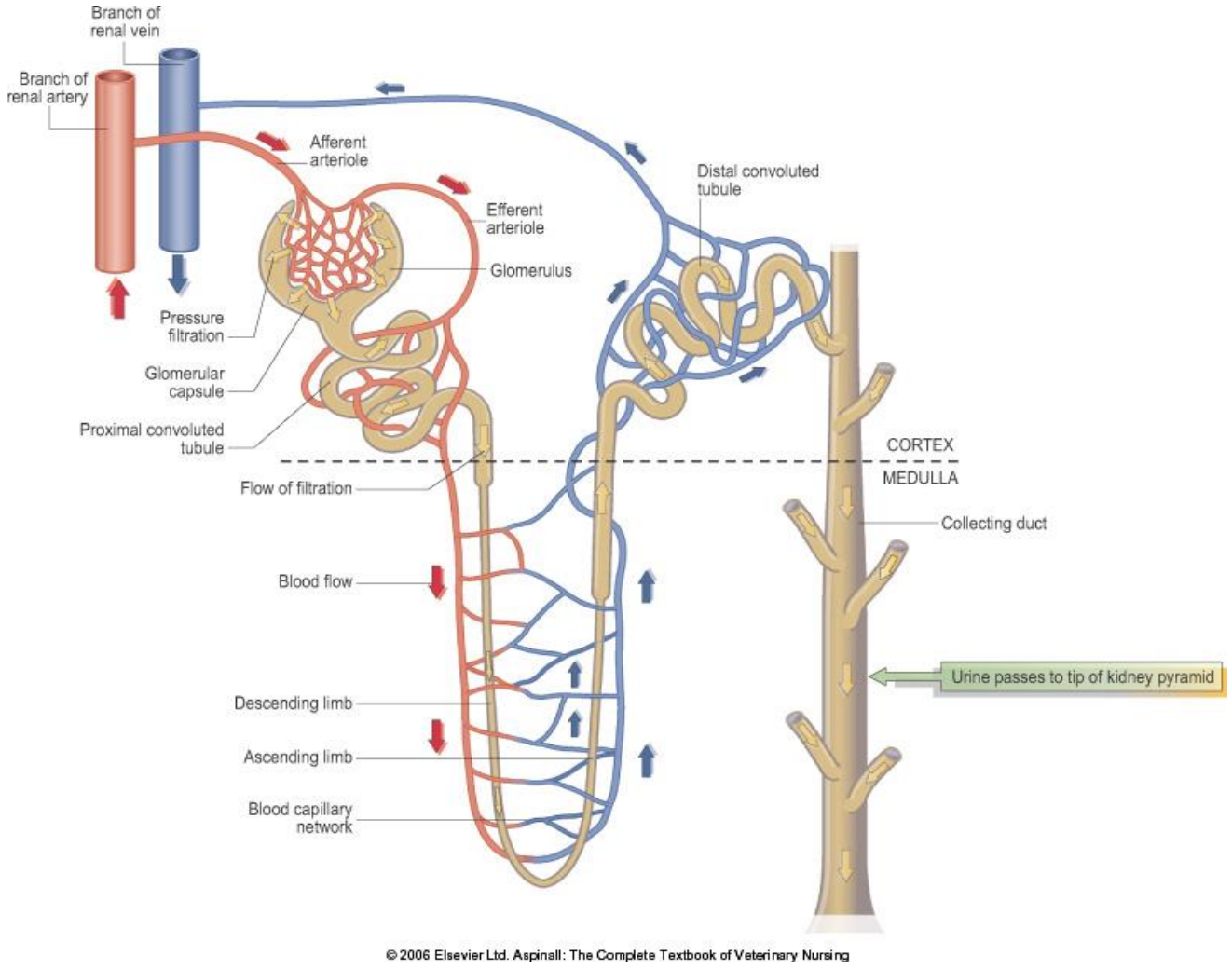
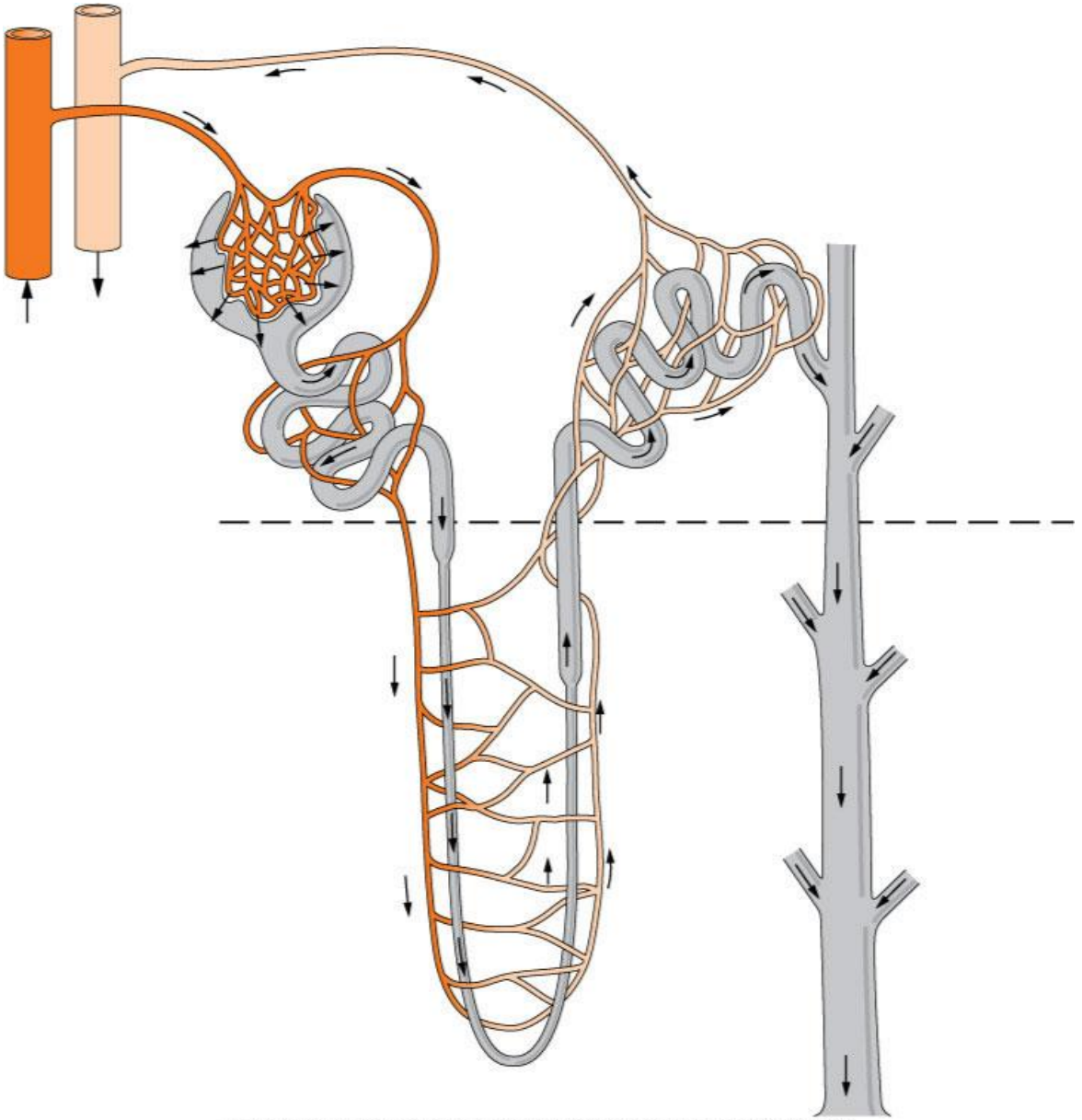
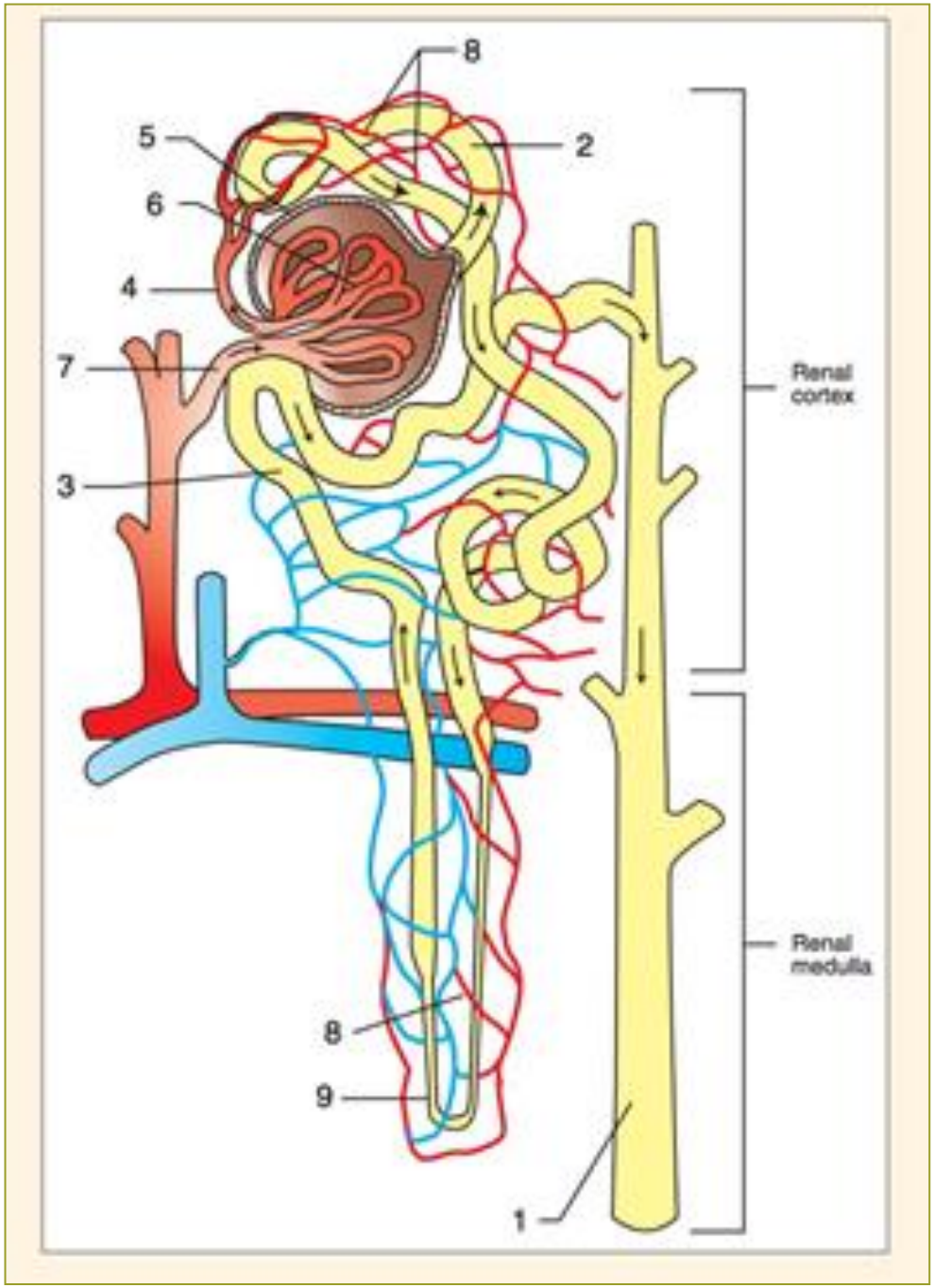
Summary – Through the Nephron



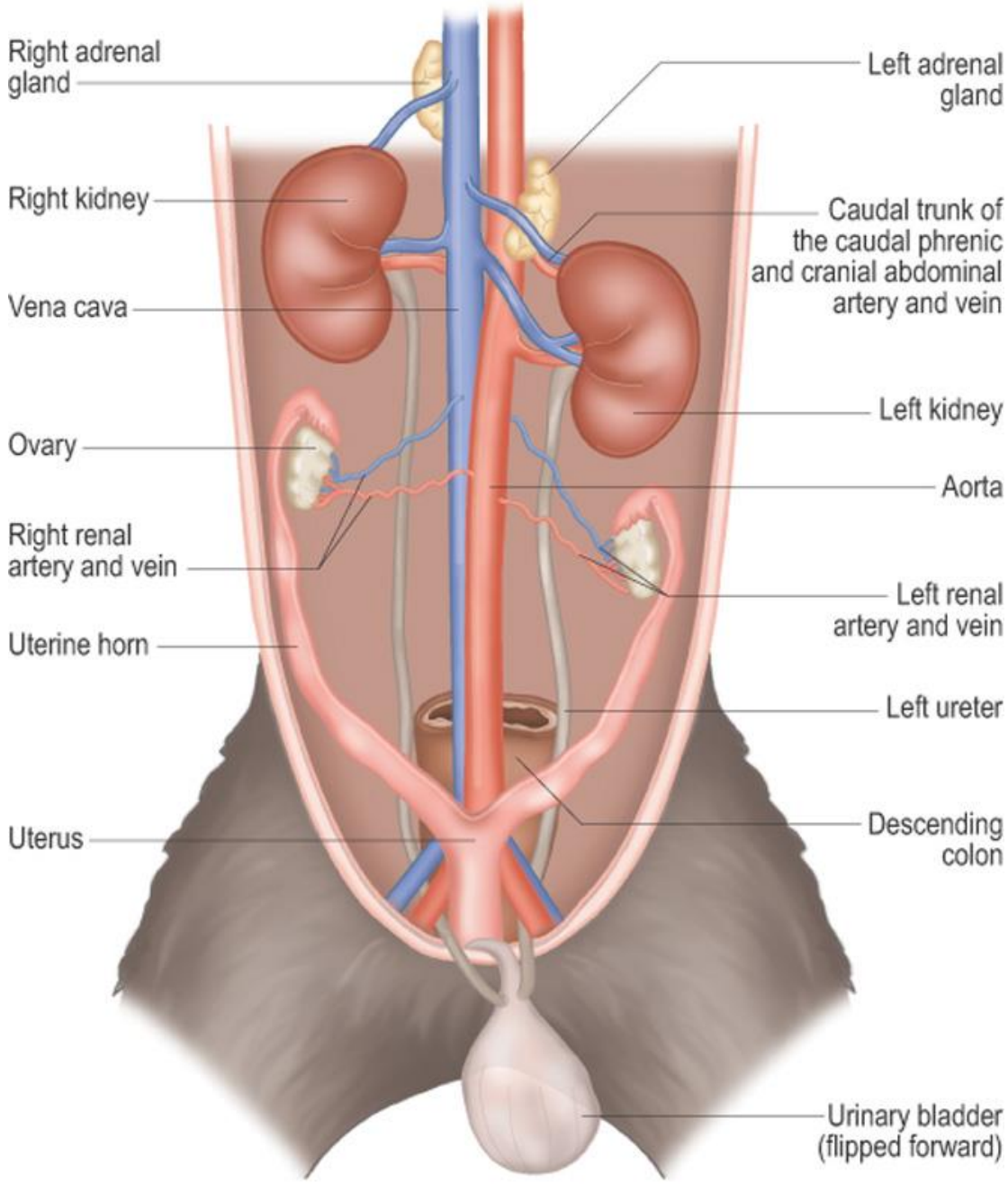


Identify the Structures of the Nephron

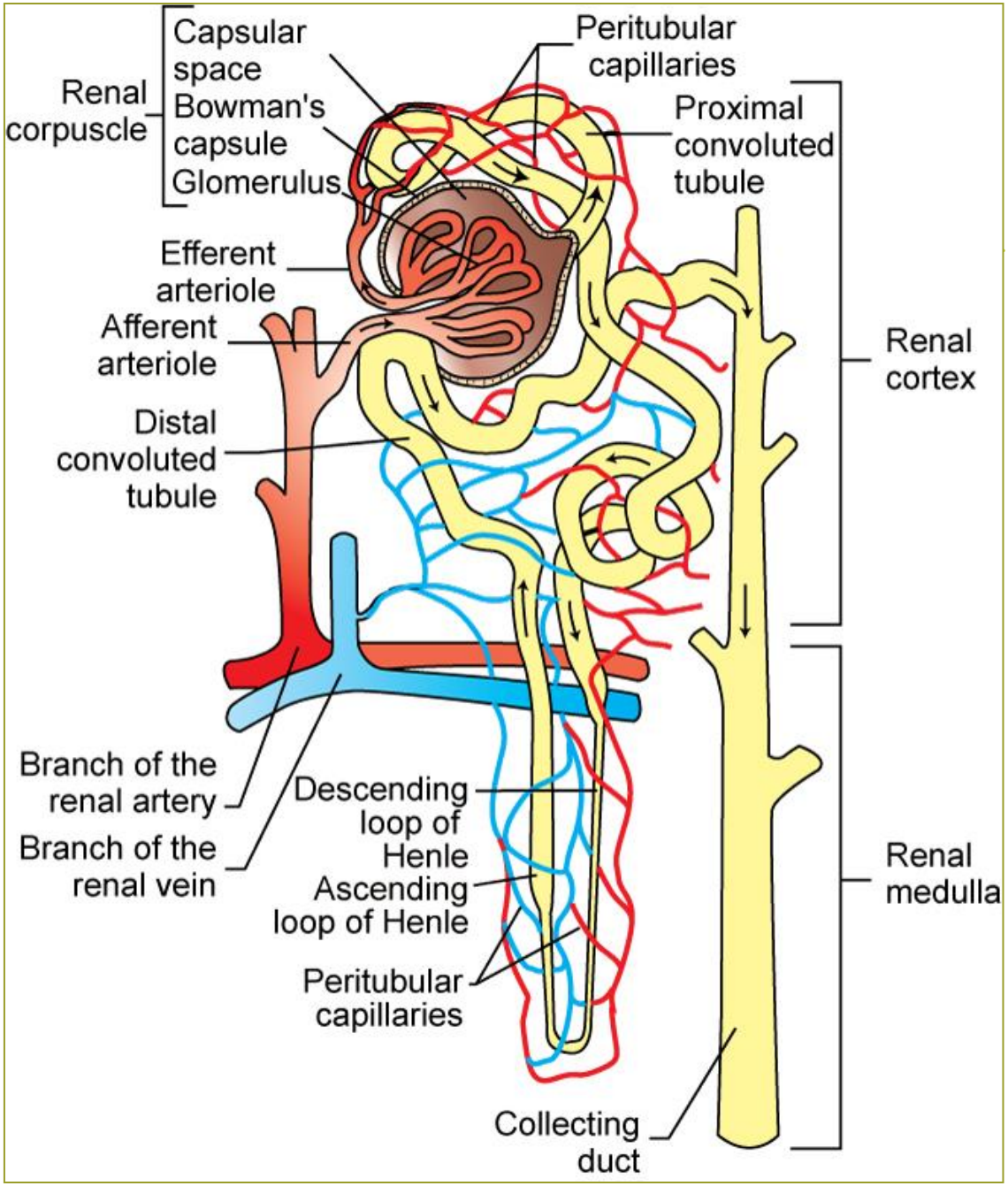
Bassert Lab Manual – Page 407



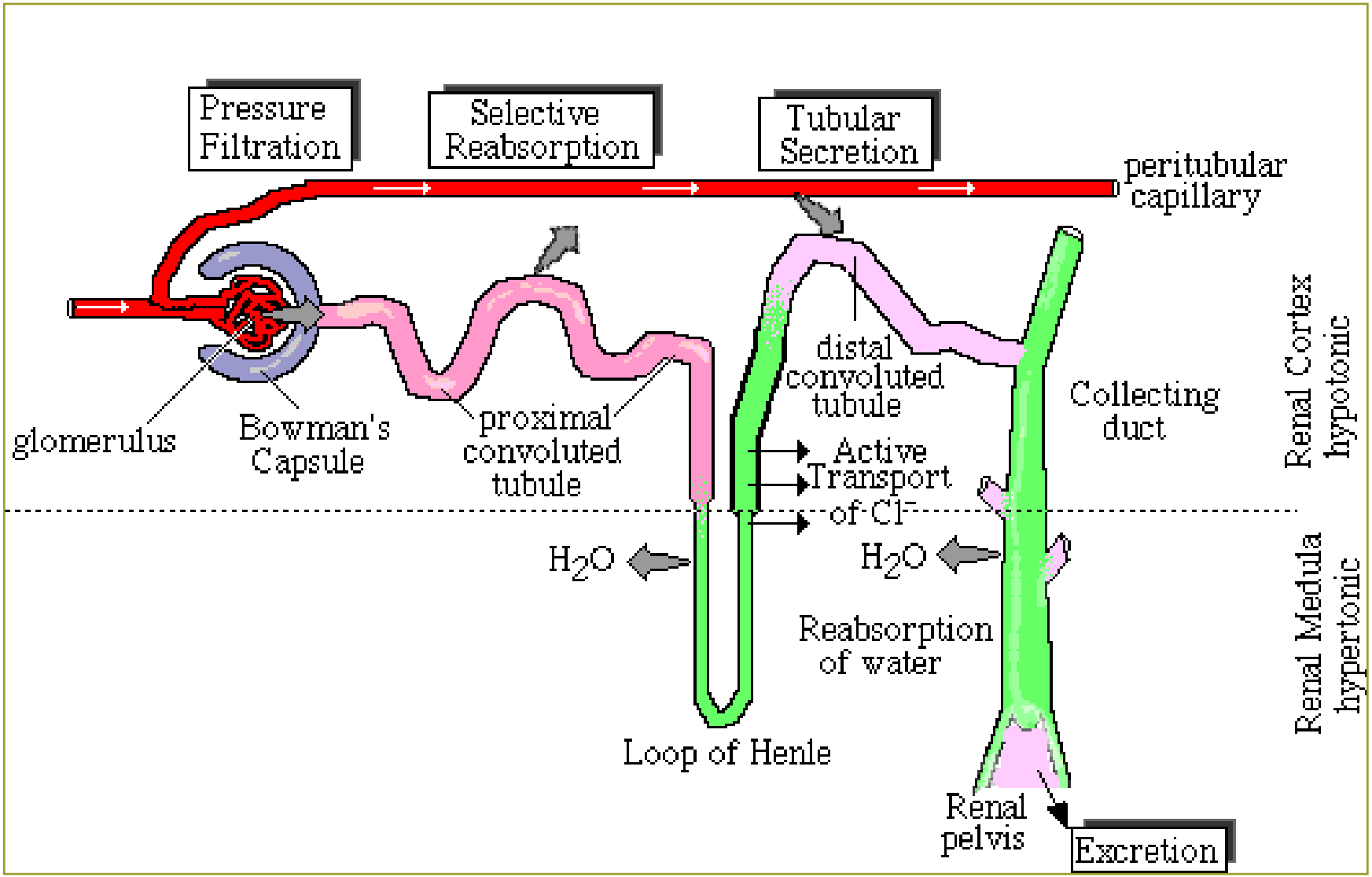
Trace a Urea Molecule



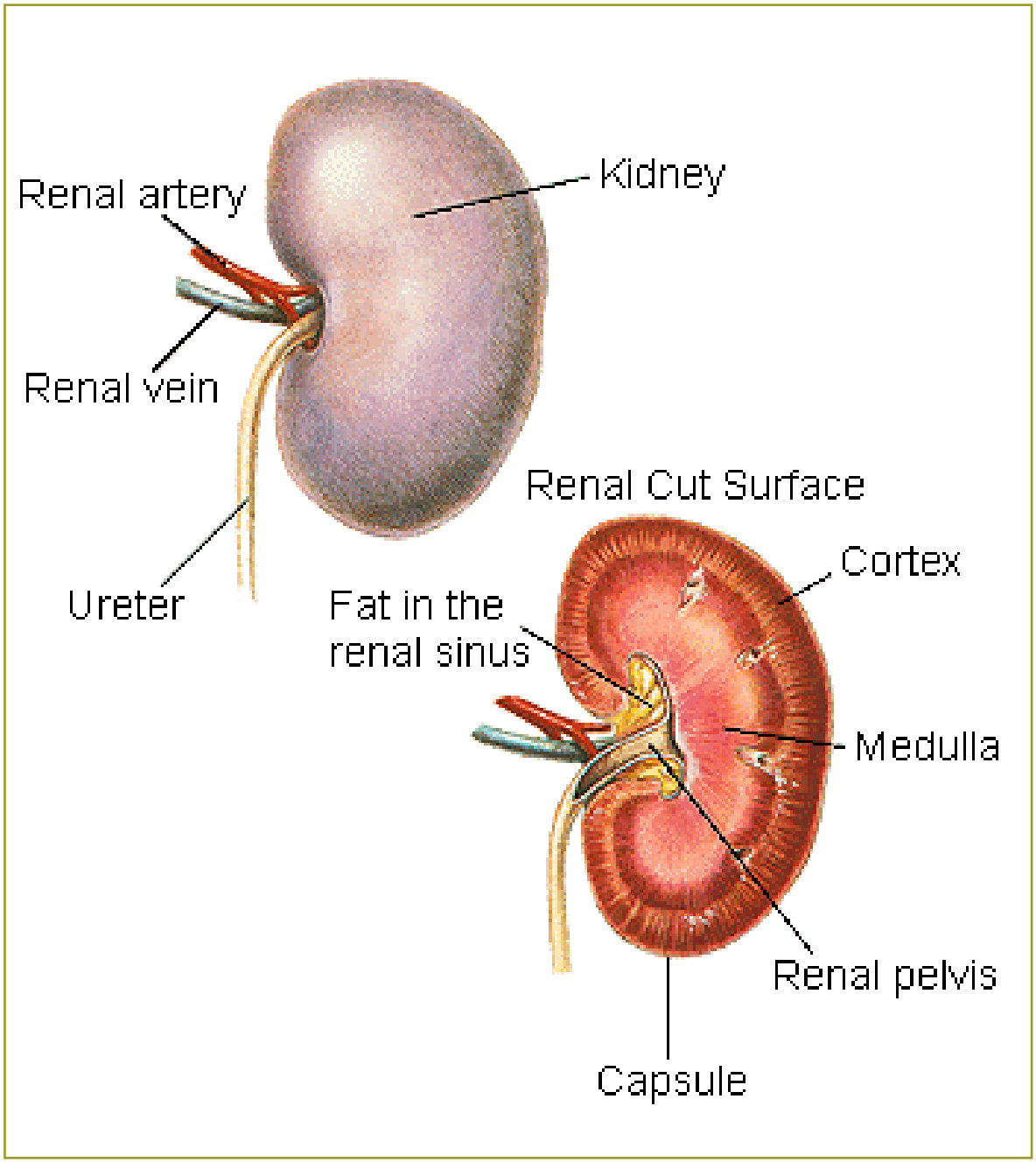
Through the Nephron

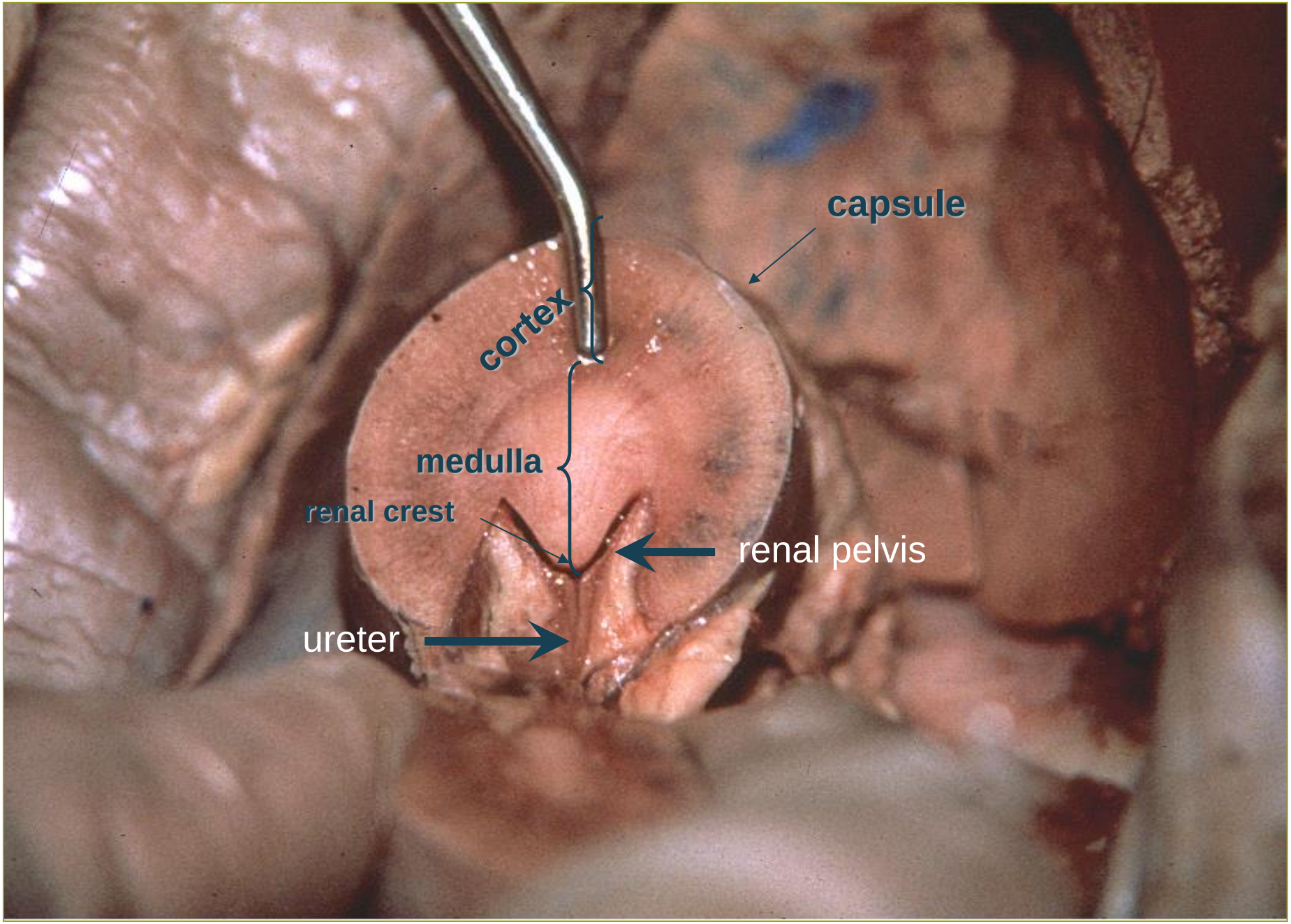


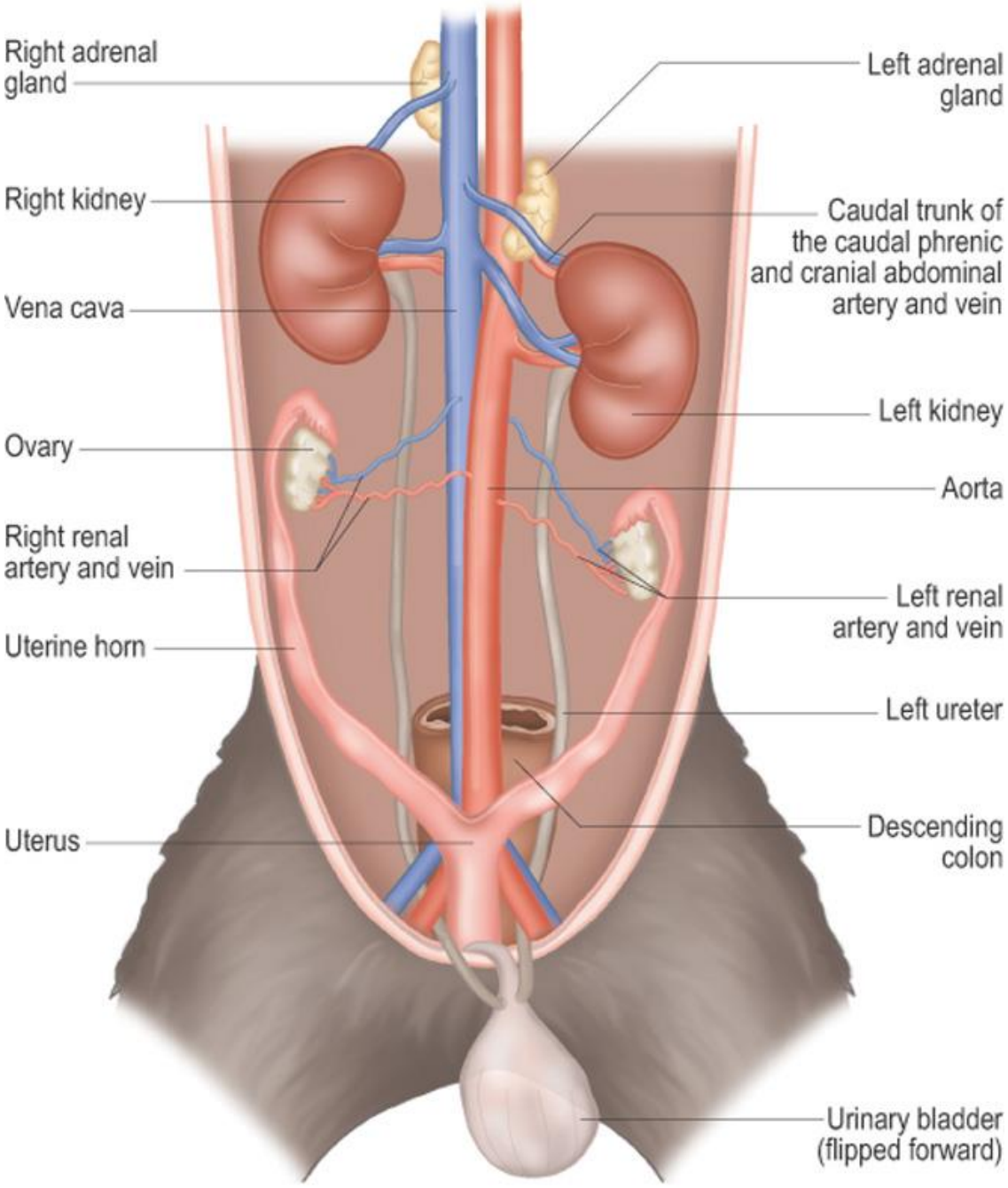
Nephron Review



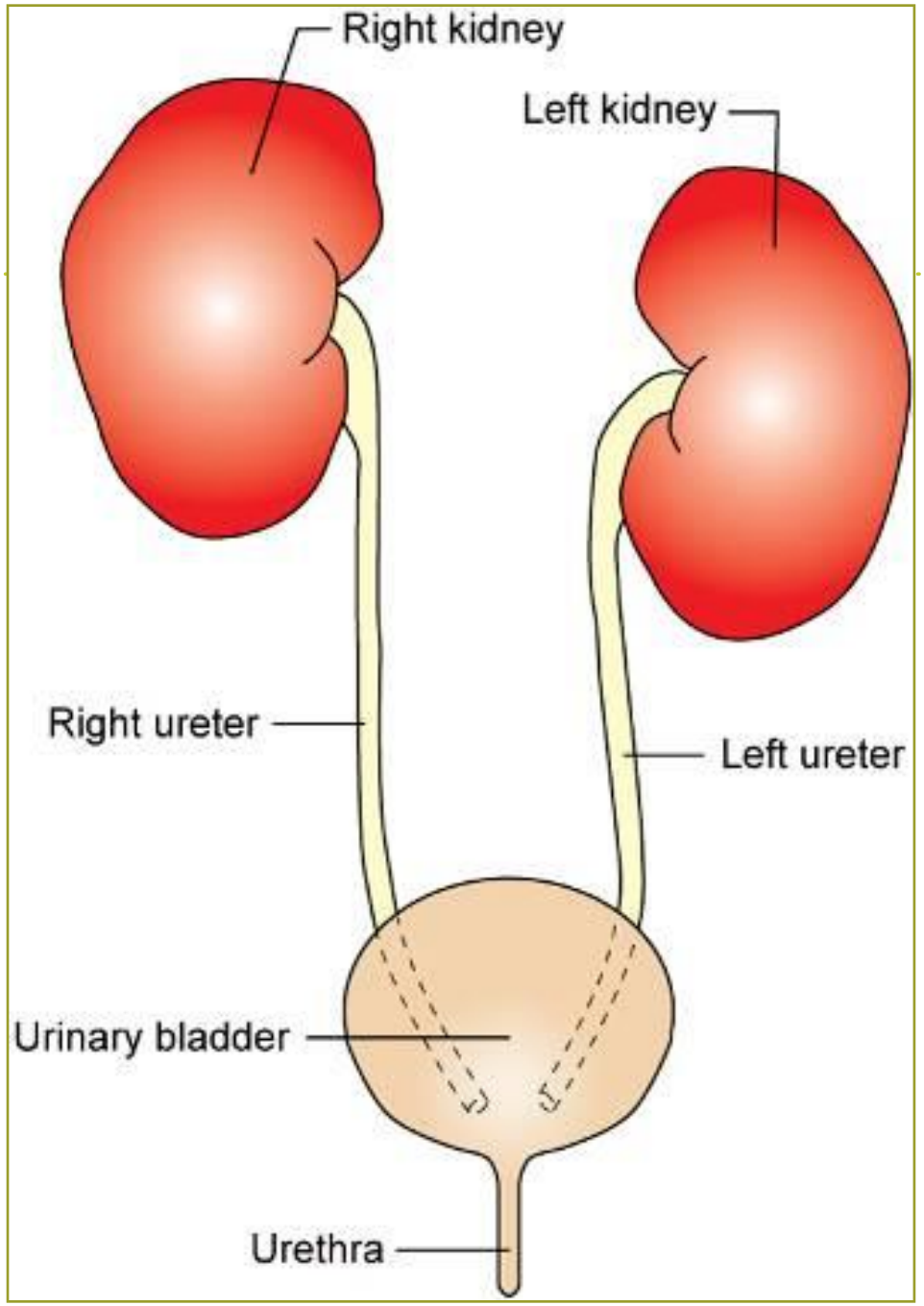
Through the Renal Medulla (Collecting Ducts→Renal Pelvis →Ureter




capsule
cortex
medulla
renal crest
renal pelvis
ureter



To the Ureter → Urinary Bladder → Urethra → Urethral Orifice



Ureters & Urinary Bladder

- **Ureters**
  - Paired tubes from the kidneys to the urinary bladder
- **Urinary bladder**
  - Urine storage
  - Sphincter muscle (skeletal)
  - Joins the urethra

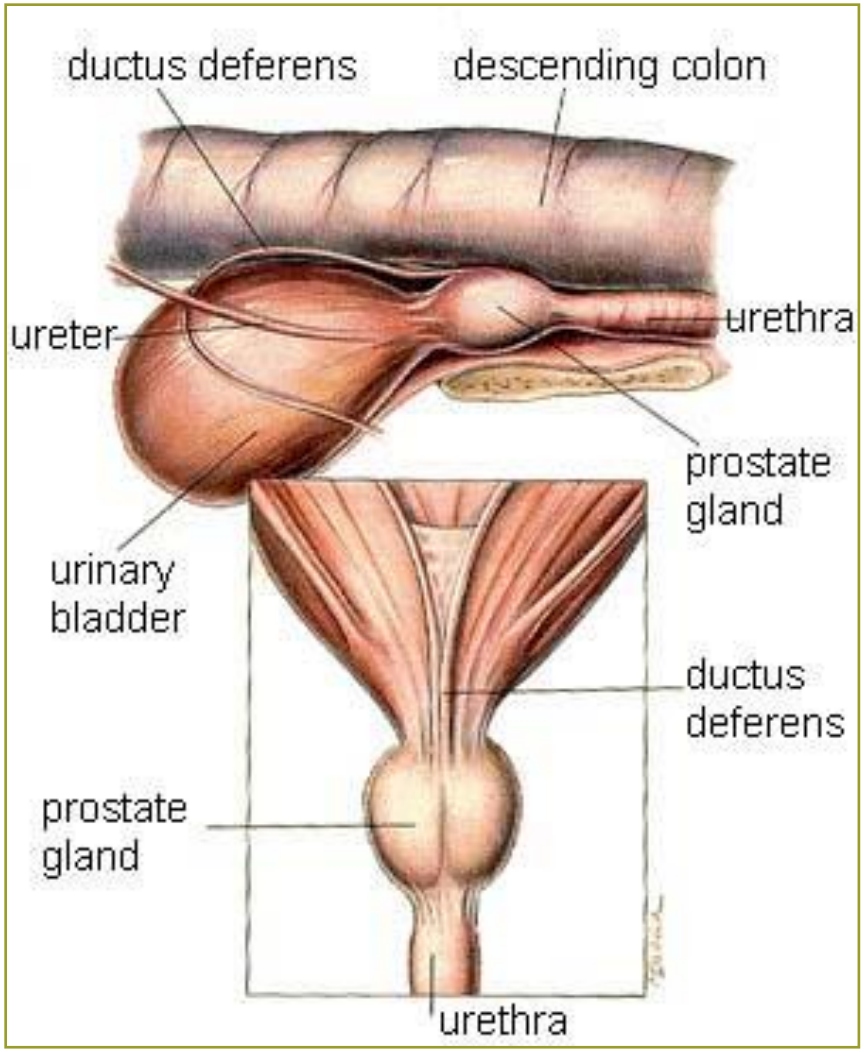
Urinary Bladder

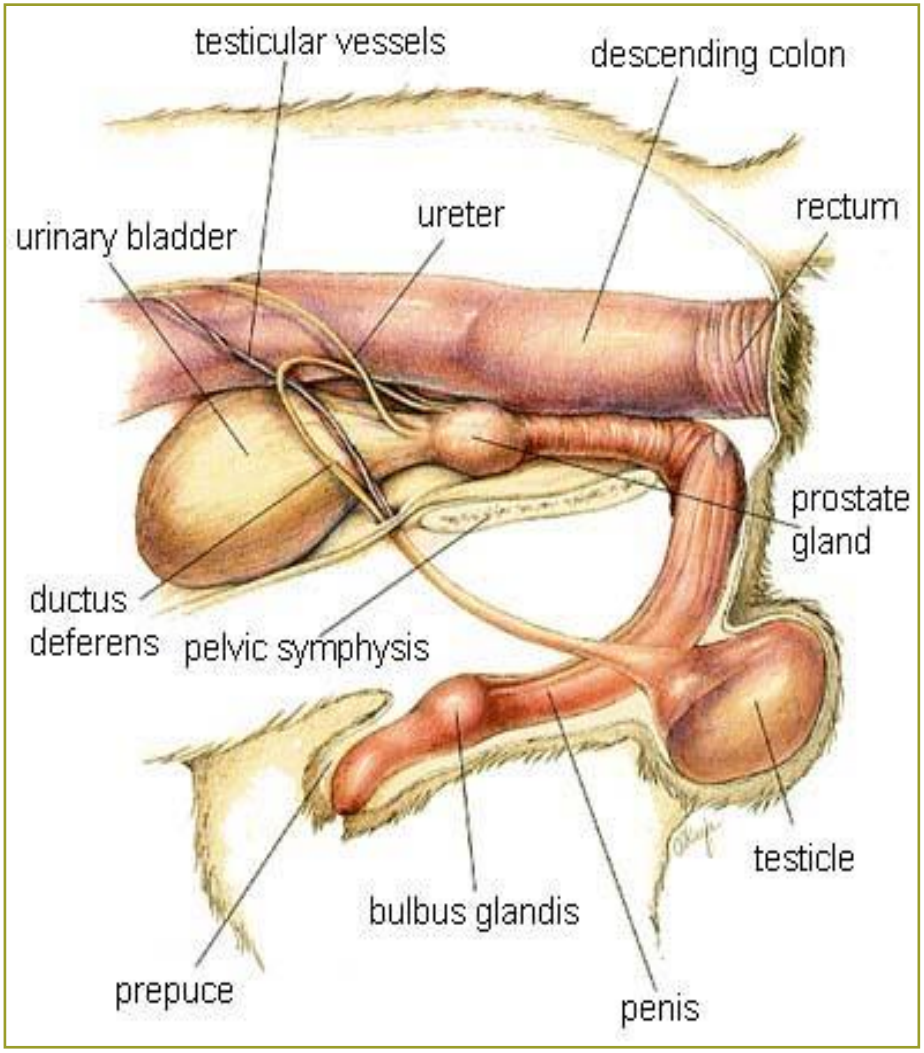
- Lined with **transitional epithelium** that stretches as the bladder becomes filled with urine
- Wall of the urinary bladder contains smooth muscle bundles

Urethra

- The female urethra is shorter and straighter than the long, curved male urethra.
  - In the female the urethra opens on the ventral portion of the vestibule of the vulva.
- In the male the urethra runs down the center of the penis and also functions in the reproductive system.

Canine Male Urethra





Canine Female Urethra

Bassert Lab Manual – Page 400

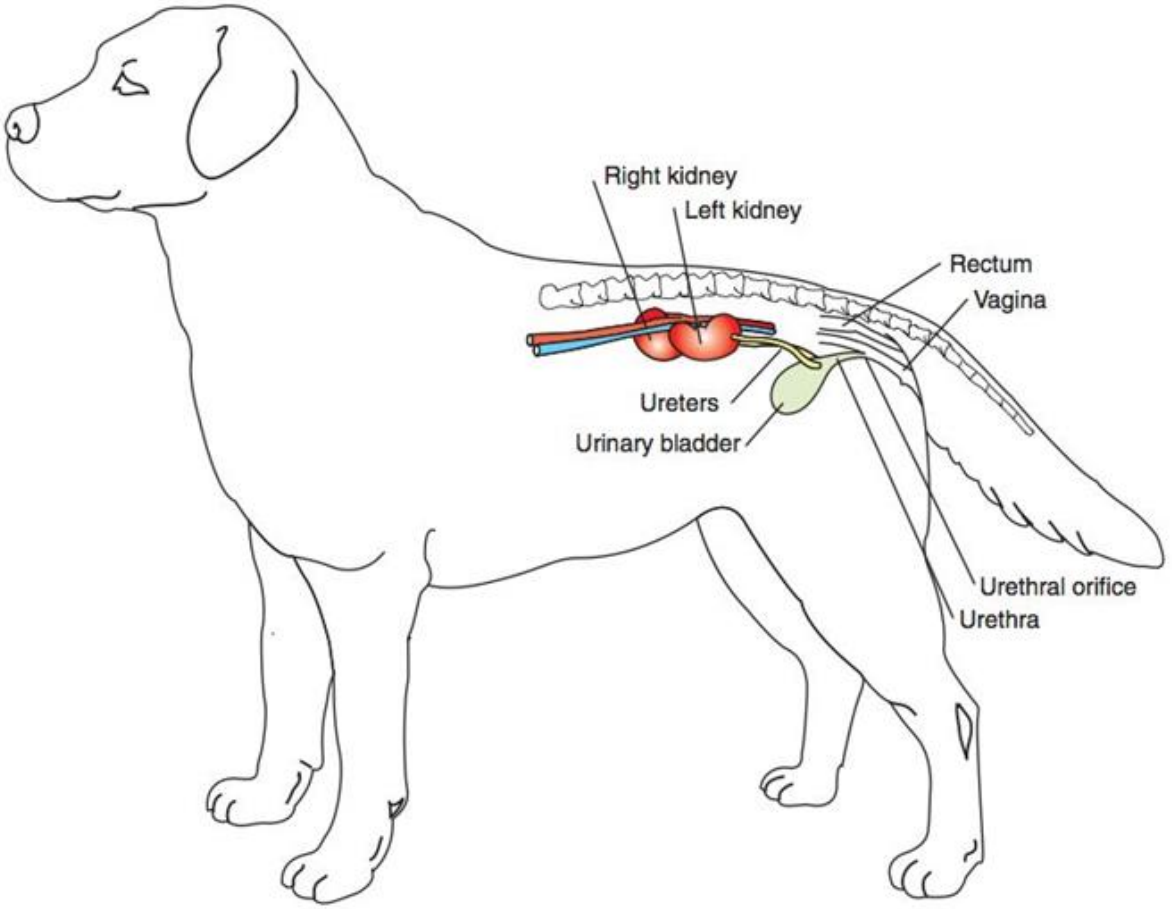


Figure 14-17 In the female (in this case a dog), the urethra opens onto the floor (ventral surface) of the vulva, not directly to the outside of the animal.

Kidneys, Urinary Bladder