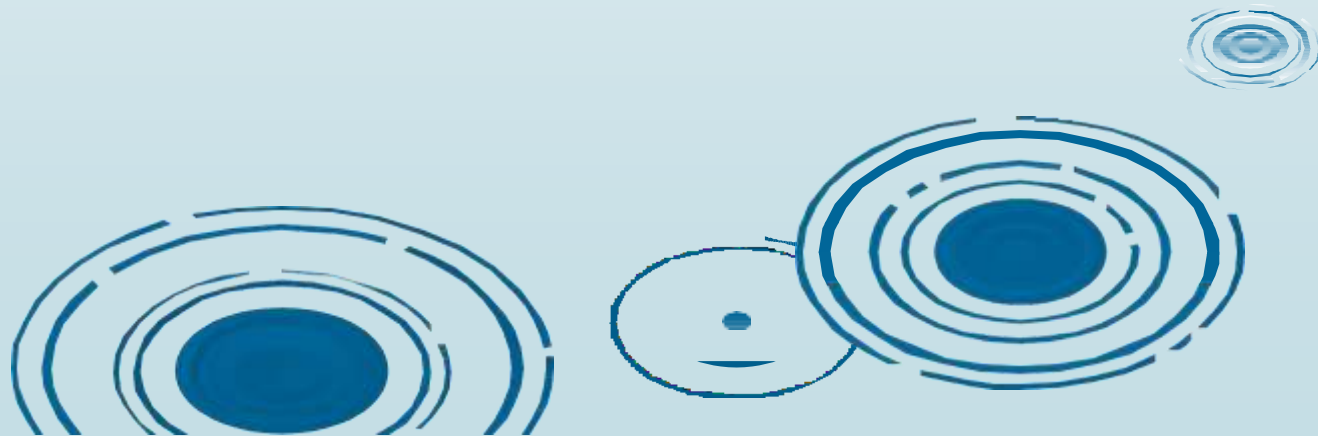




# Urinary System

# Introduction

- The **urinary system**, also known as the **renal system**
- The urinary system refers to the structures that produce and conduct urine to the point of excretion.



# URINARY SYSTEM ORGANS

- Kidneys (2)
- Ureters (2)
- Urinary bladder
- Urethra
- Kidneys – produce urine
- Ureters –transport urine to bladder
- Urinary bladder - stores urine
- Urethra transports urine to exterior



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# Urinary System

Inferior vena cava

Adrenal gland

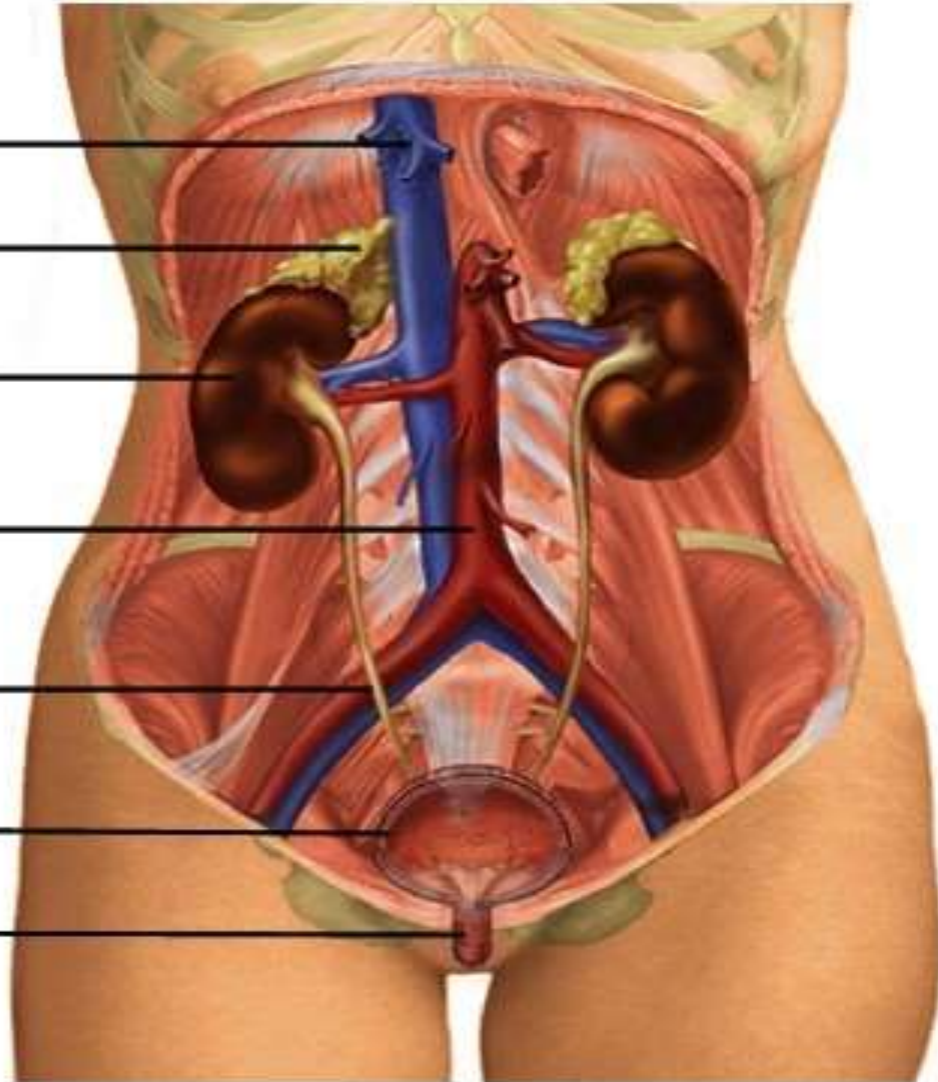
Kidney

Aorta

Ureter

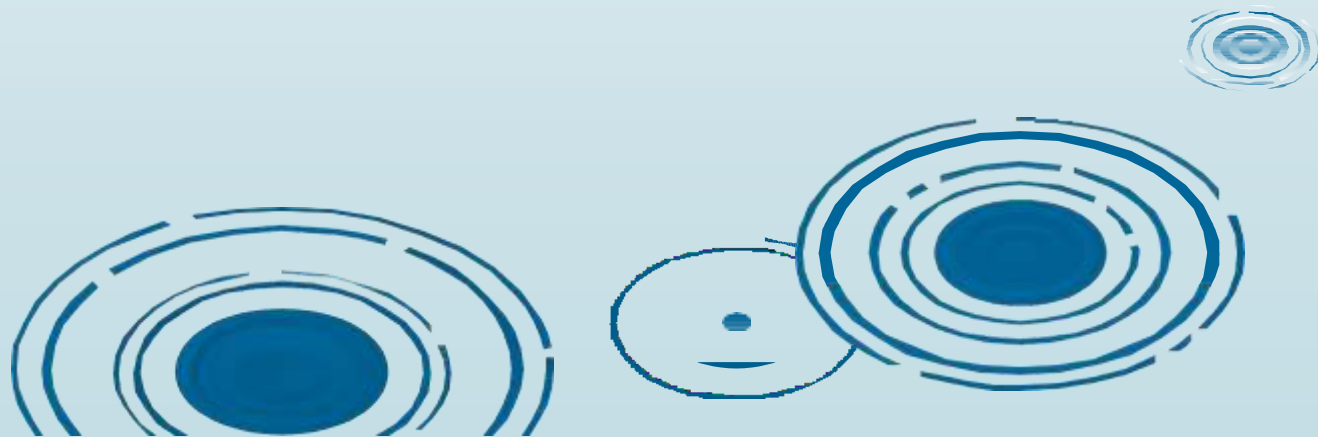
Bladder

Urethra



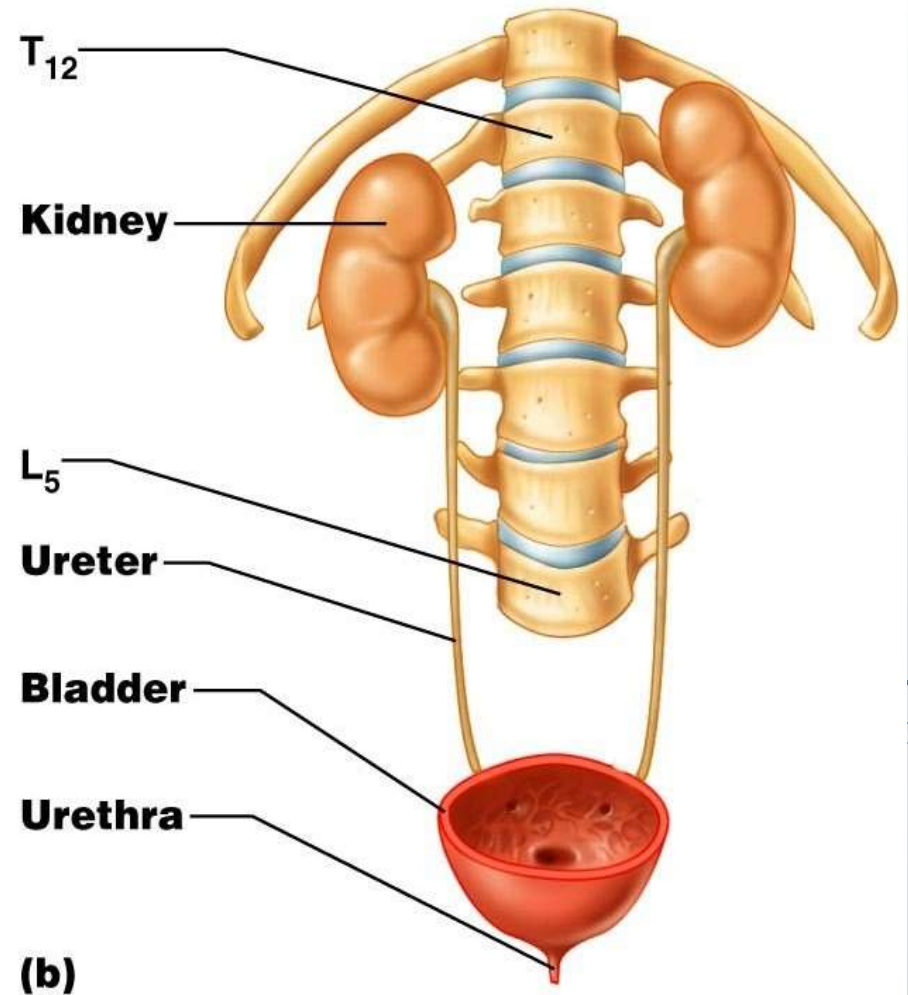
# Kidney

- The human body normally has two kidneys, one on the left and one on the right.
- The functional unit of the kidney is nephron.
- Urine is formed by nephrons




# Location and External Anatomy of kidney

- Located Lateral to  $T_{12}$ – $L_3$  vertebrae
- Average kidney  
12 cm tall, 6 cm wide,  
3 cm thick

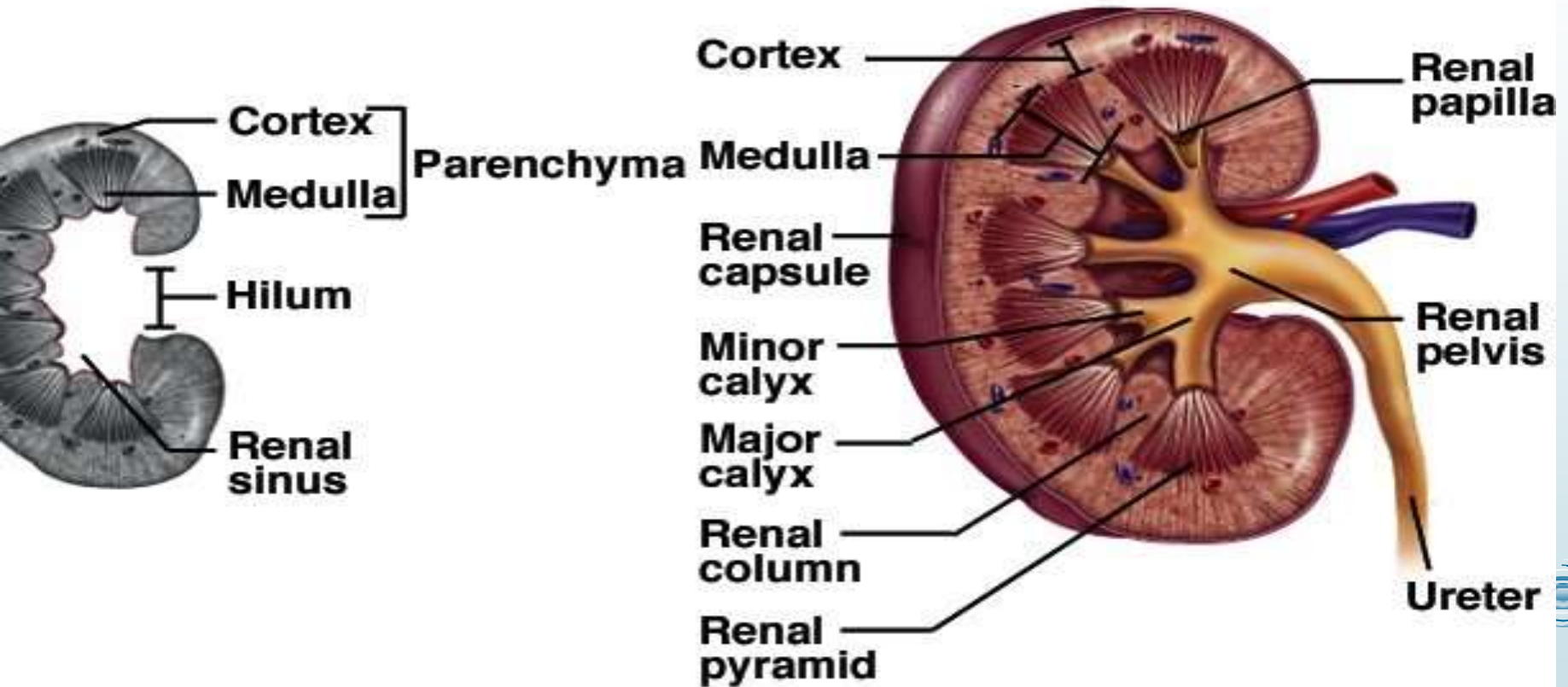




# Protected by three connective tissue

- 
- Renal fascia
    - Attaches to abdominal wall
  - Adipose capsule
    - Fat cushioning kidney
  - Renal capsule
    - Fibrous sac
    - Protects from trauma and infection
- 

# Anatomy of Kidney

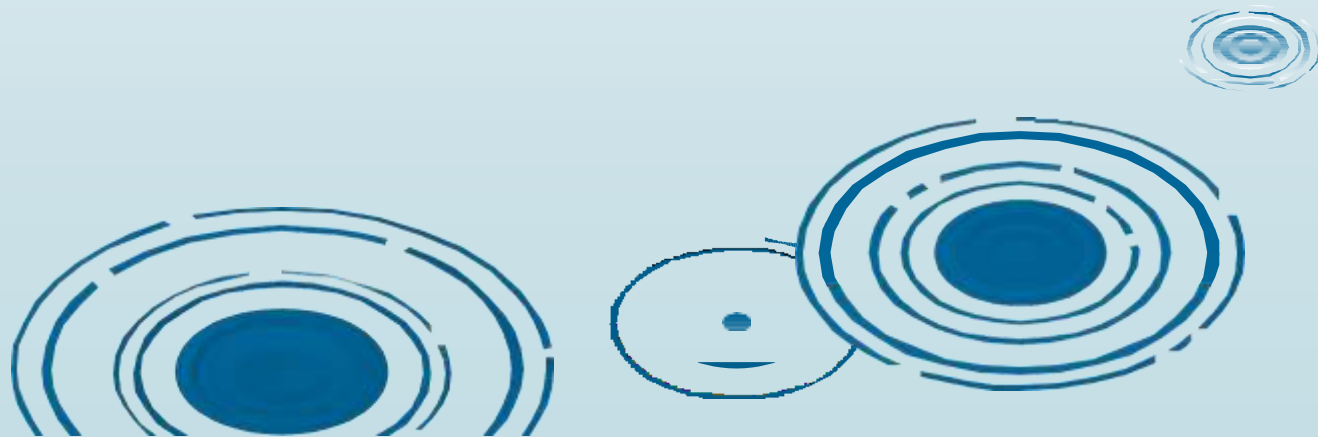




# KIDNEY

## Gross anatomy

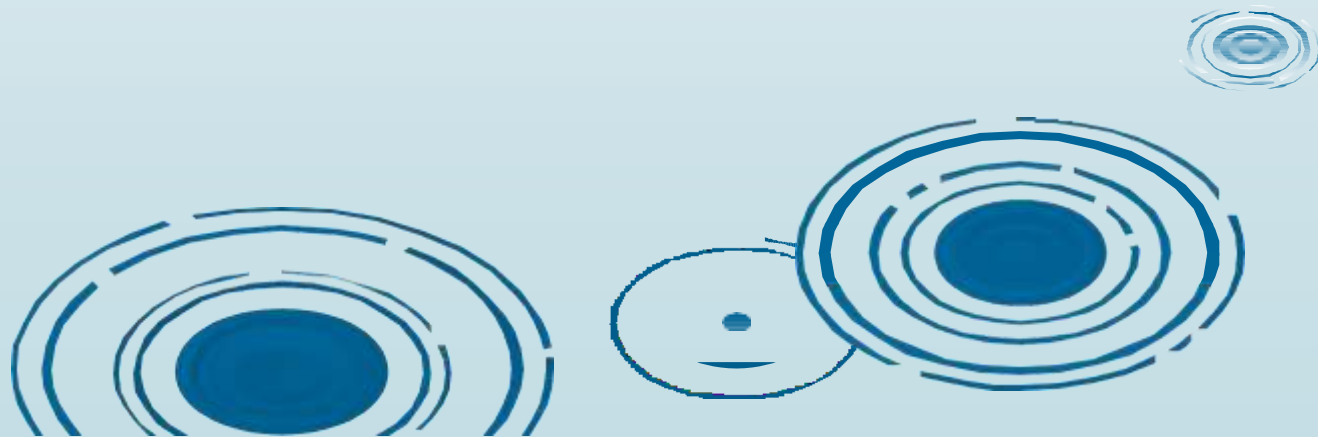
- Renal parenchyma
- Renal sinus

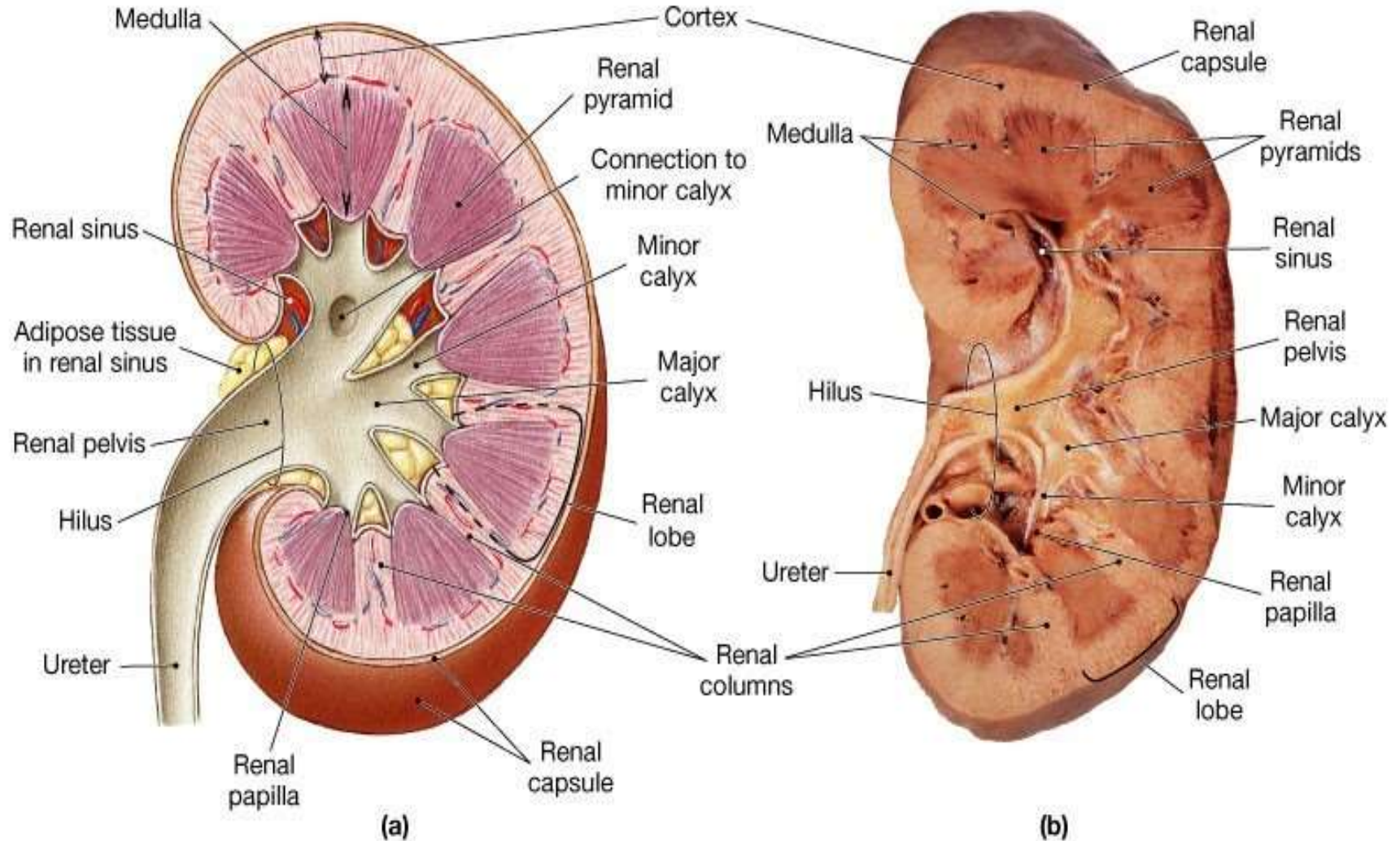


# KIDNEY ANATOMY

## Renal parenchyma

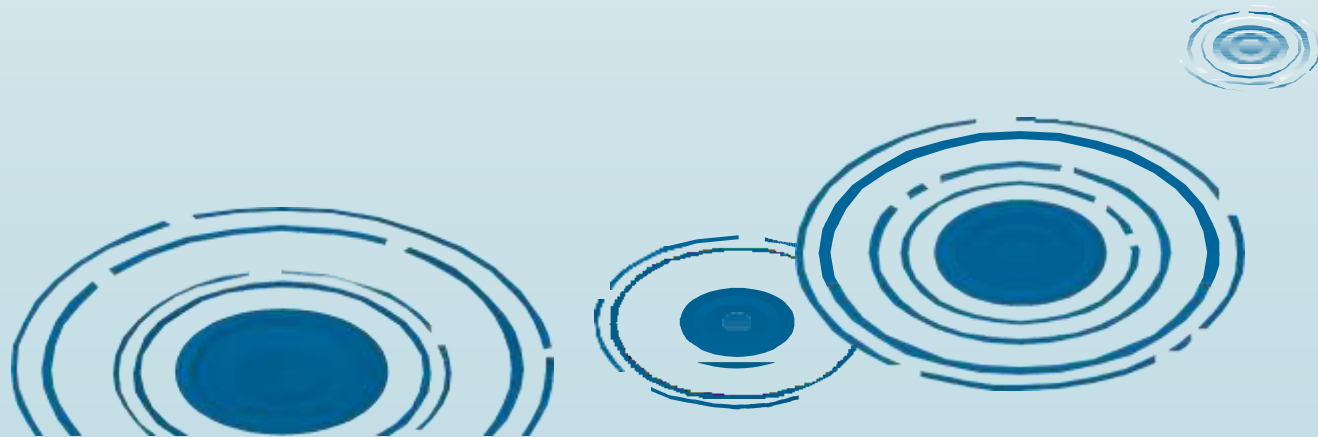
- Two zones
  - Outer cortex
  - Inner medulla





## Anatomy of the kidneys

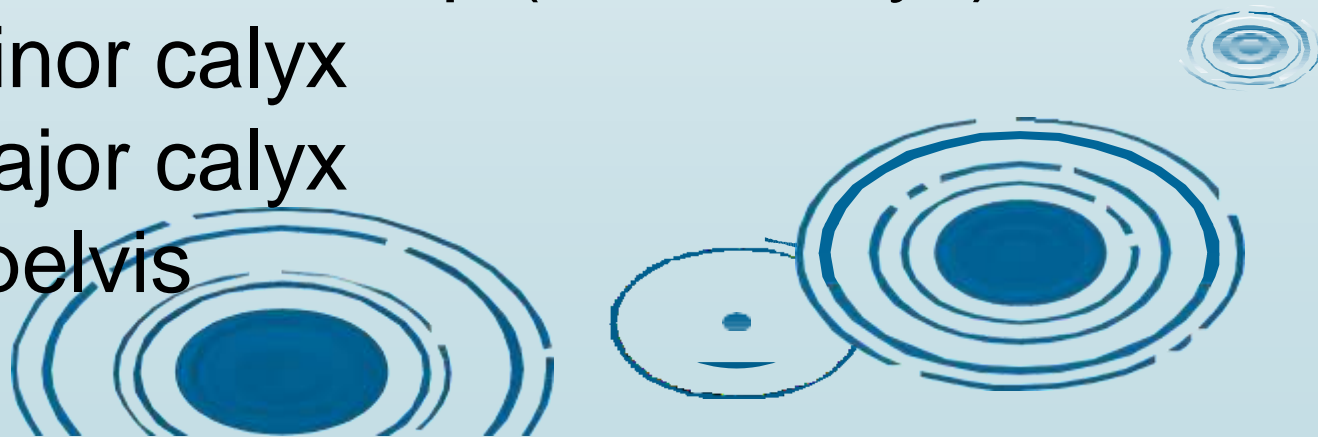
- Superficial outer cortex and inner medulla
  - The medulla consists of 6-18 renal pyramids
  - The cortex is composed of roughly 1.25 million nephrons



# KIDNEY ANATOMY

## Renal parenchyma

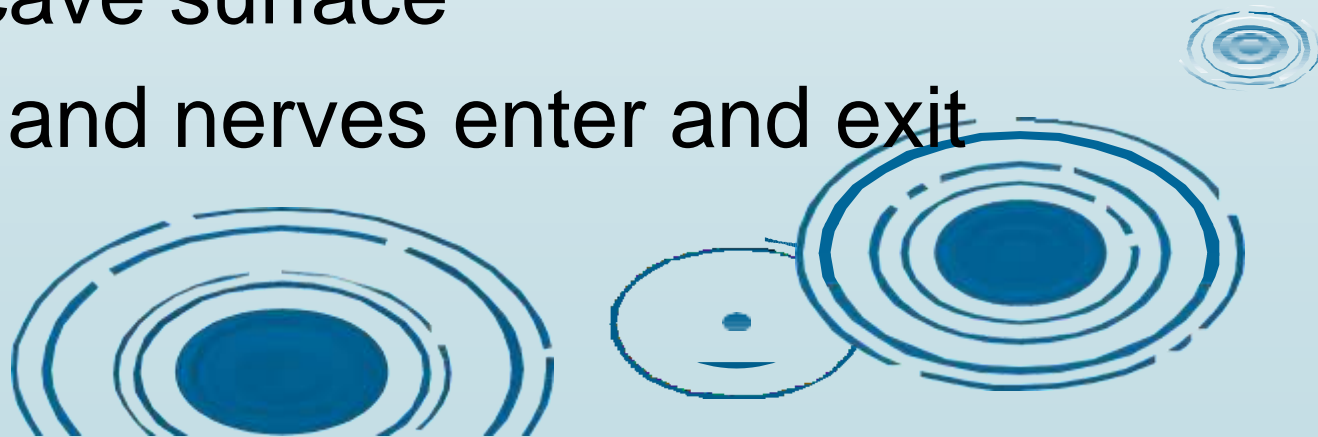
- Renal pyramids
  - Extensions of cortex (renal columns) divide medulla into 6 – 10 renal pyramids
  - Pyramid + overlying cortex = Lobe
  - Point of pyramid = Papilla
  - Papilla nested in cup (minor calyx)
  - 2 – 3 minor calyx
  - 2 – 3 major calyx
  - Renal pelvis
  - Ureter



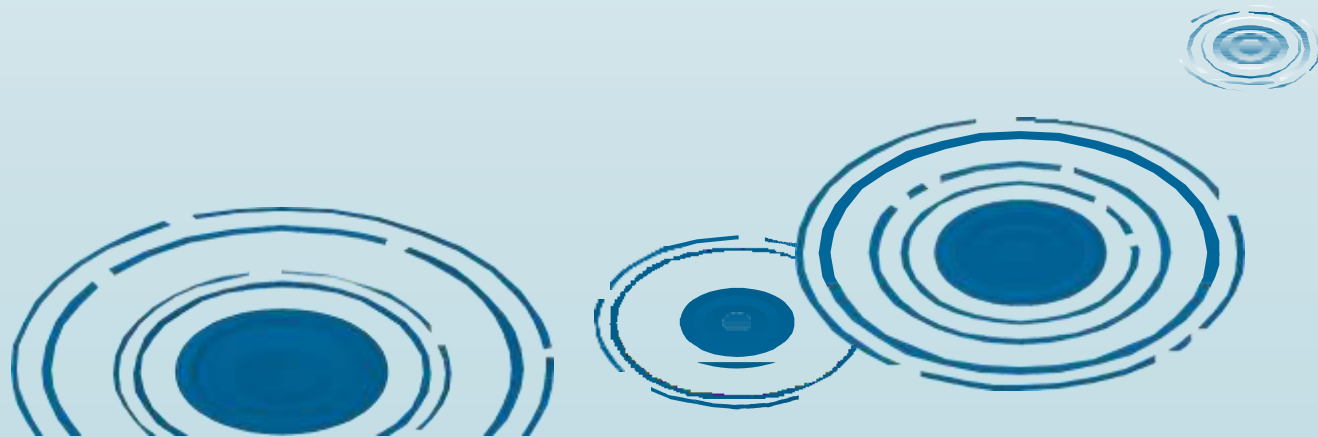
# KIDNEY ANATOMY

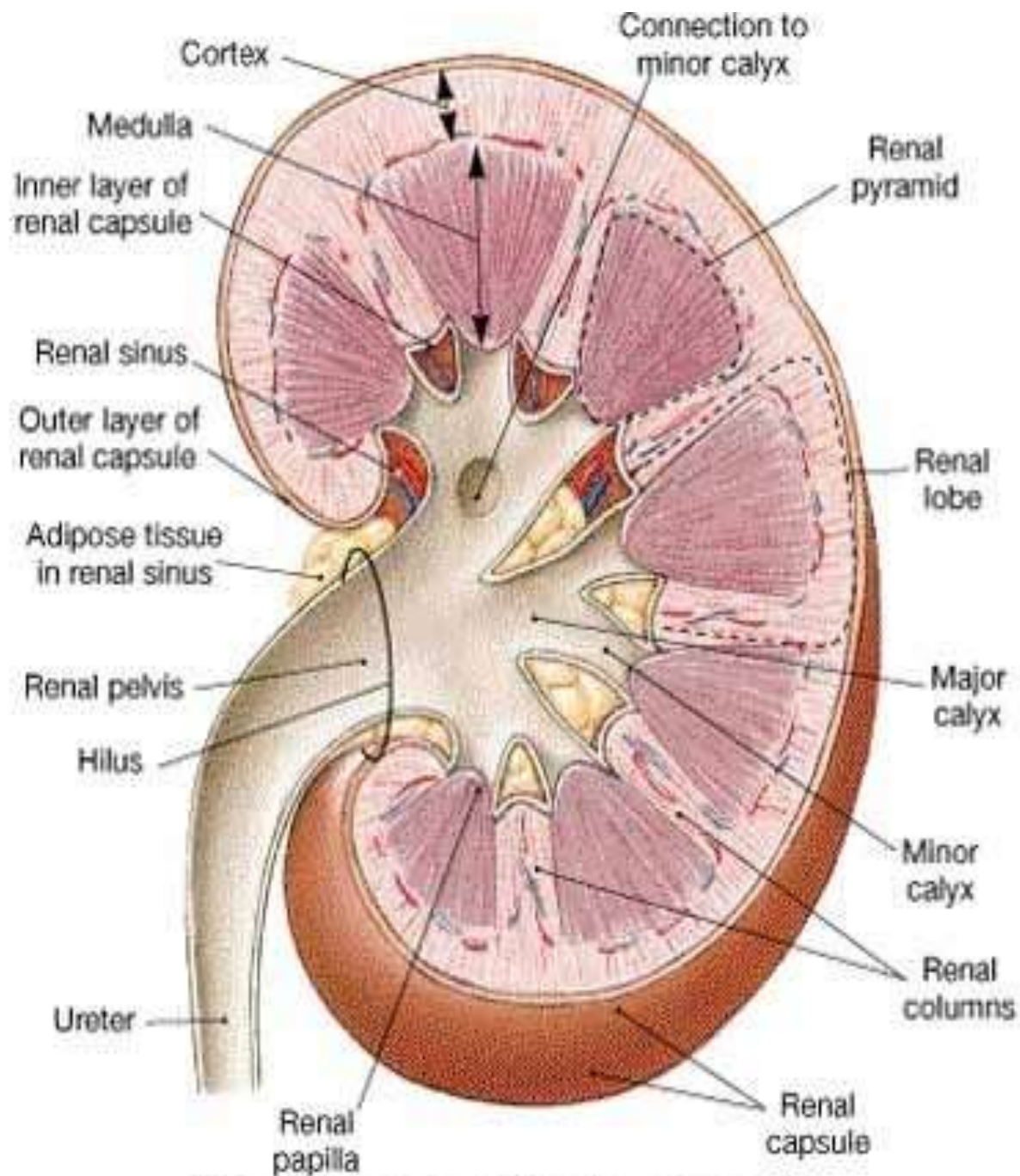
## Renal sinus

- Surrounded by renal parenchyma
- Contains blood & lymph vessels, nerves, urine-collecting structures
- **Hilus**
  - On concave surface
  - Vessels and nerves enter and exit



- 
- Major and minor calyx along with the pelvis drain urine to the ureters

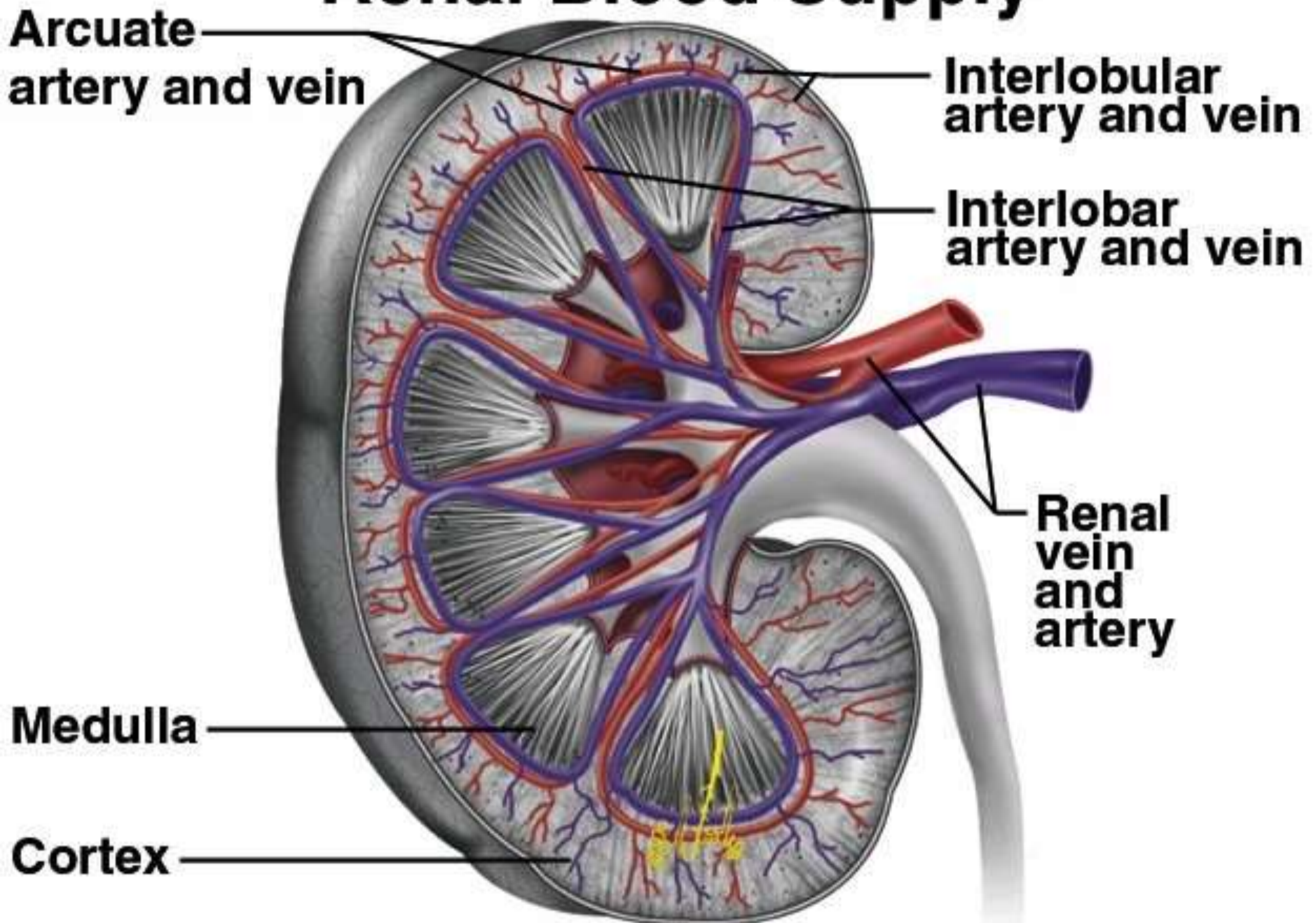




**(a) Frontal section of left kidney, anterior view**



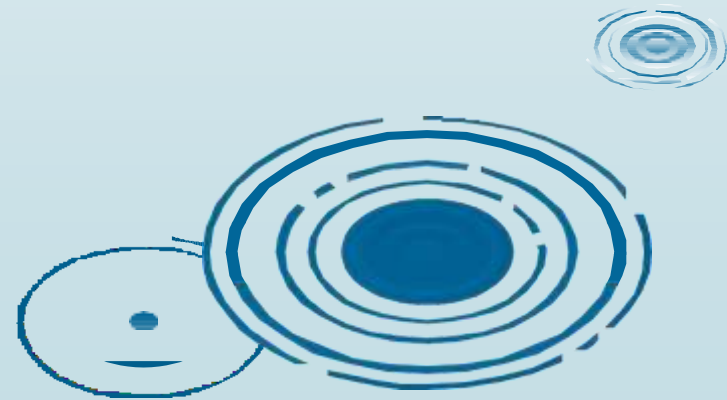
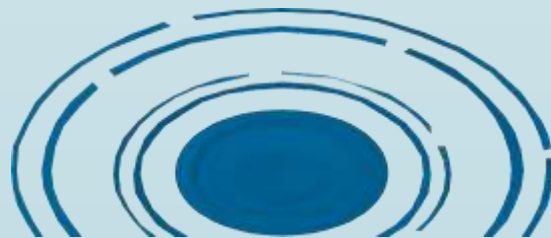
# Renal Blood Supply

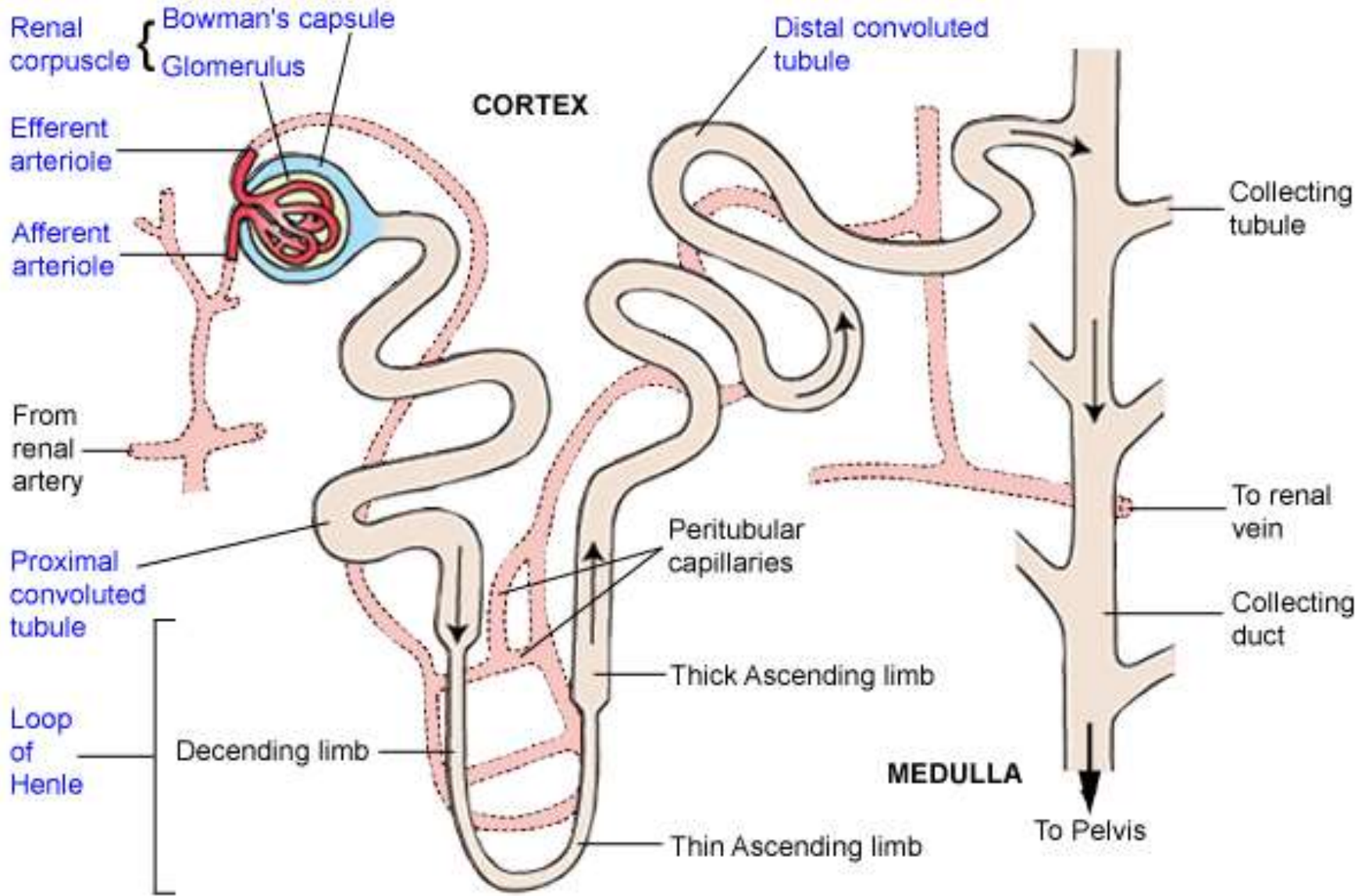


# NEPHRONS

## Nephrons

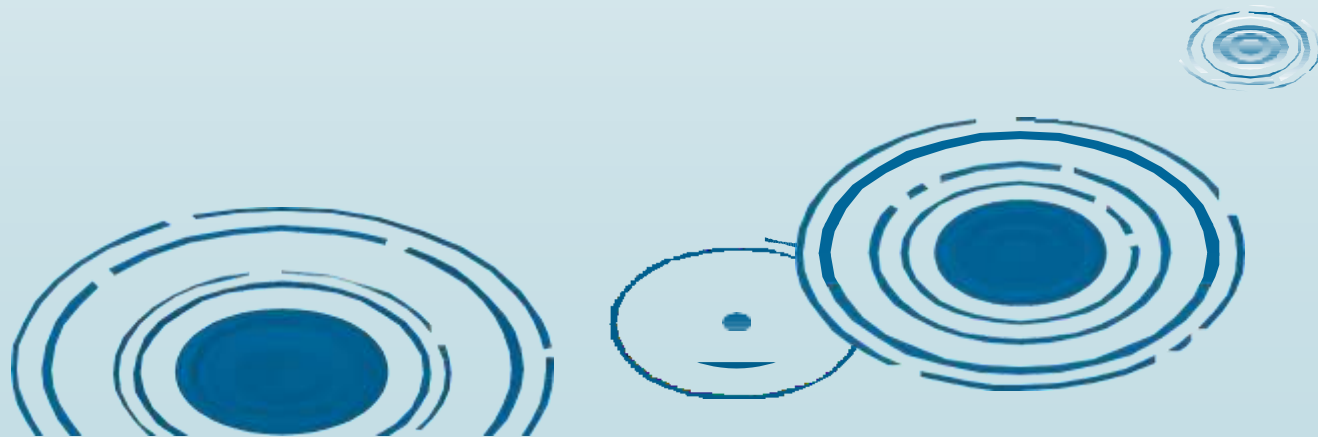
- Functional units of kidney
- ~1.2 million per kidney
- Three main parts
  - Blood vessels
  - Renal corpuscle
  - Renal tubule





# Renal corpuscle

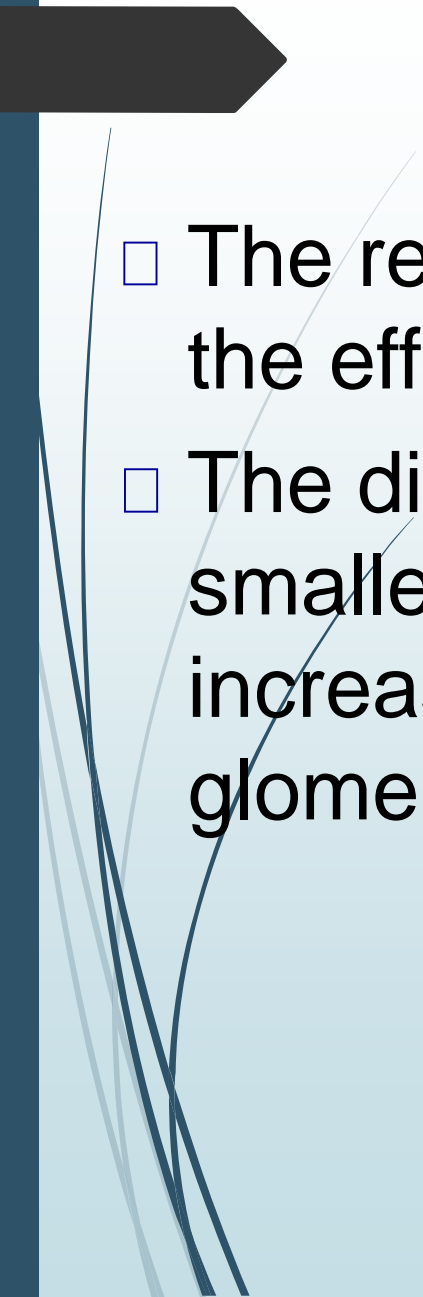
- Composed of a glomerulus and the Bowman's capsule,
- The renal corpuscle is the beginning of the nephron.
- It is the nephron's initial filtering component.

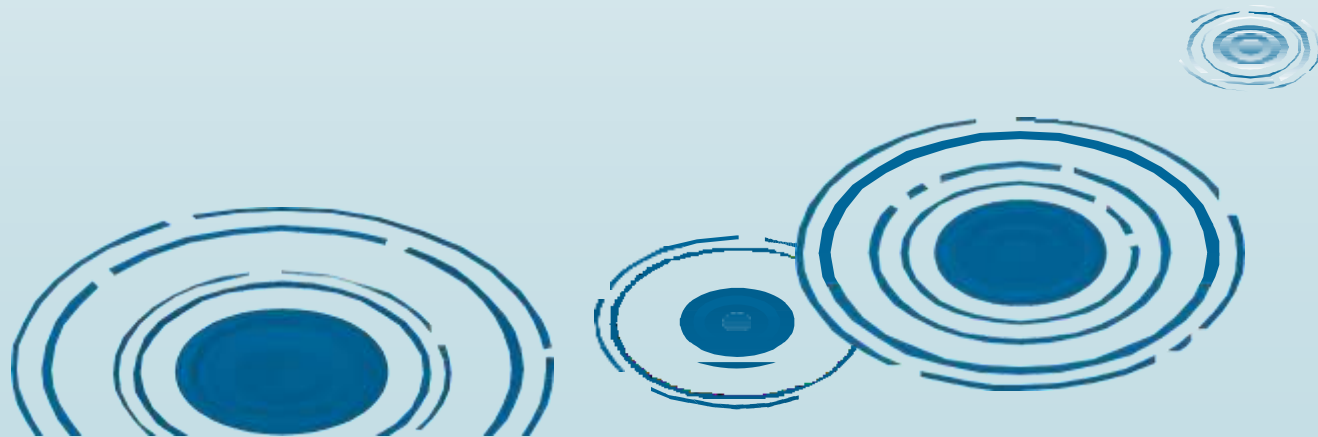


# Glomerulus

- The glomerulus is a capillary tuft that receives its blood supply from an afferent arteriole of the renal circulation.
- The glomerular blood pressure provides the driving force for water and solutes to be filtered out of the blood and into the space made by Bowman's capsule

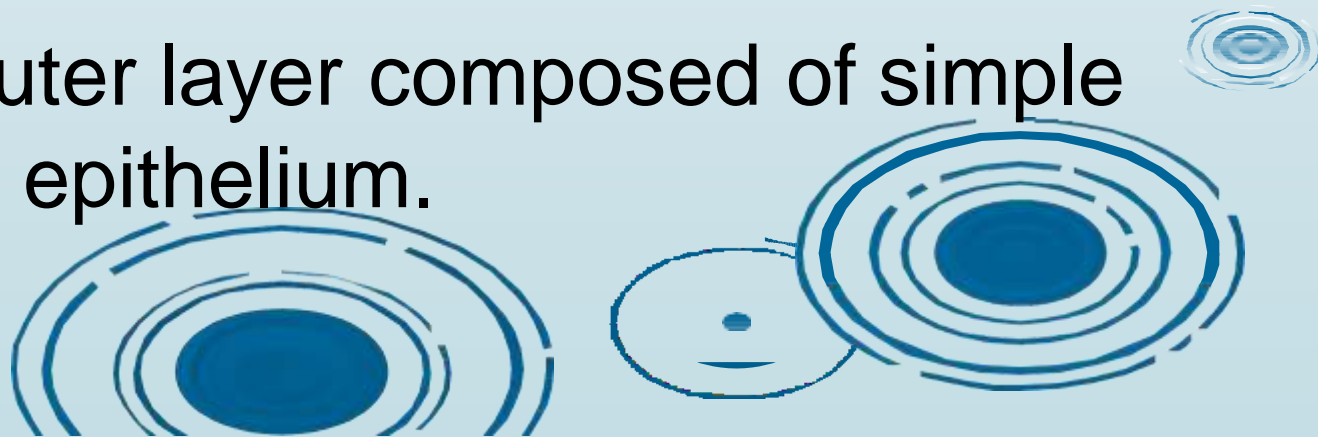


- 
- A dark grey arrow points to the right from the left edge of the slide. Several thin, light blue lines curve downwards from the top left towards the bottom left.
- The remainder of the blood passes into the efferent arteriole.
  - The diameter of efferent arterioles is smaller than that of afferent arterioles, increasing the hydrostatic pressure in the glomerulus.

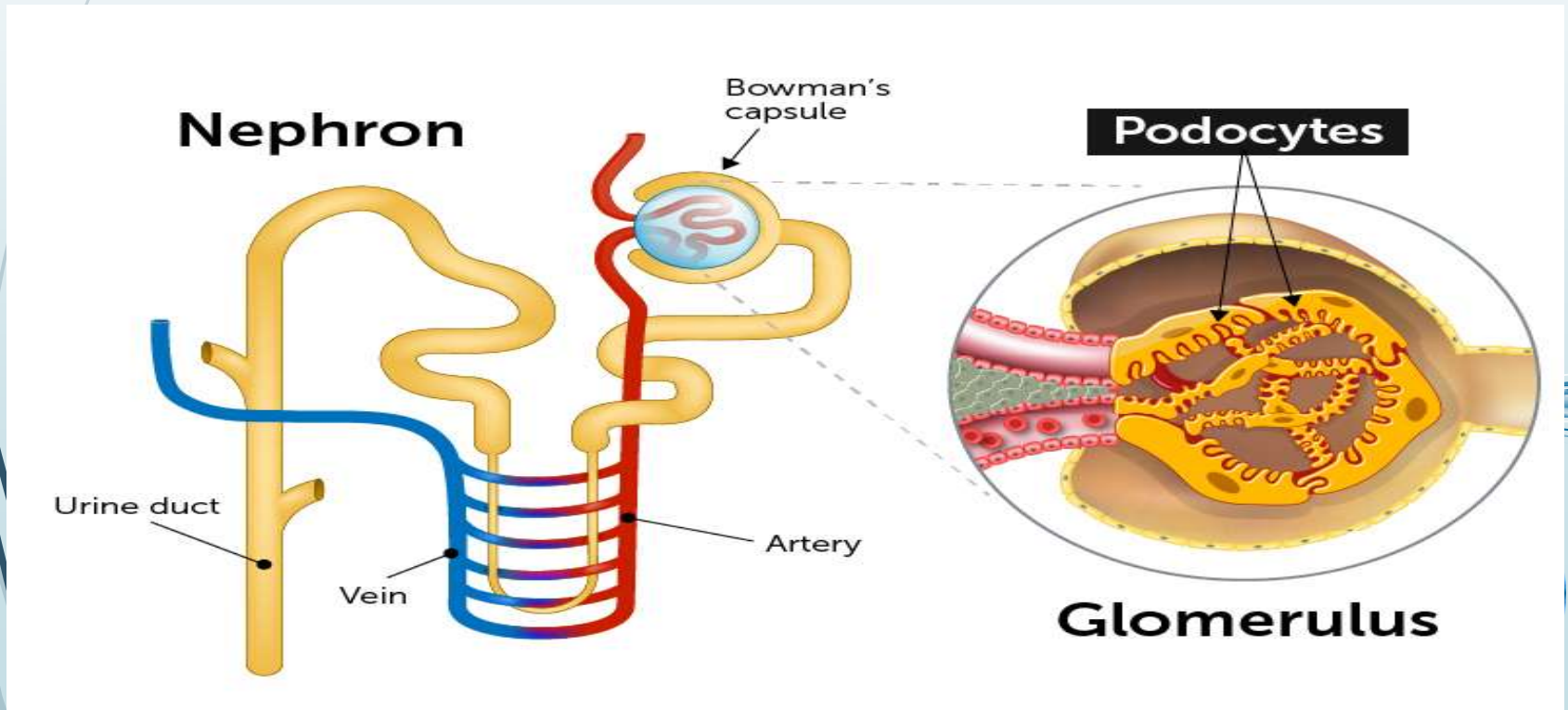


# Bowman's capsule

- The Bowman's capsule, also called the glomerular capsule.
- surrounds the glomerulus.
- It is composed of a visceral inner layer formed by specialized cells called podocytes.
- Parietal outer layer composed of simple squamous epithelium.



- Fluids from blood in the glomerulus are filtered through the visceral layer of podocytes, resulting in the glomerular filtrate.





# NOTE

## Renal corpuscle

- Glomerulus plus capsule
- Glomerulus enclosed in two-layered glomerular capsule
  - “Bowman’s capsule”
- Fluid filters from glomerular capillaries
  - “Glomerular filtrate”
- Fluid collects in capsular space
- Fluid flows into renal tubule

# Renal Corpuscle

Glomerular capsule

Parietal layer

Afferent arteriole

Blood flow

Efferent arteriole

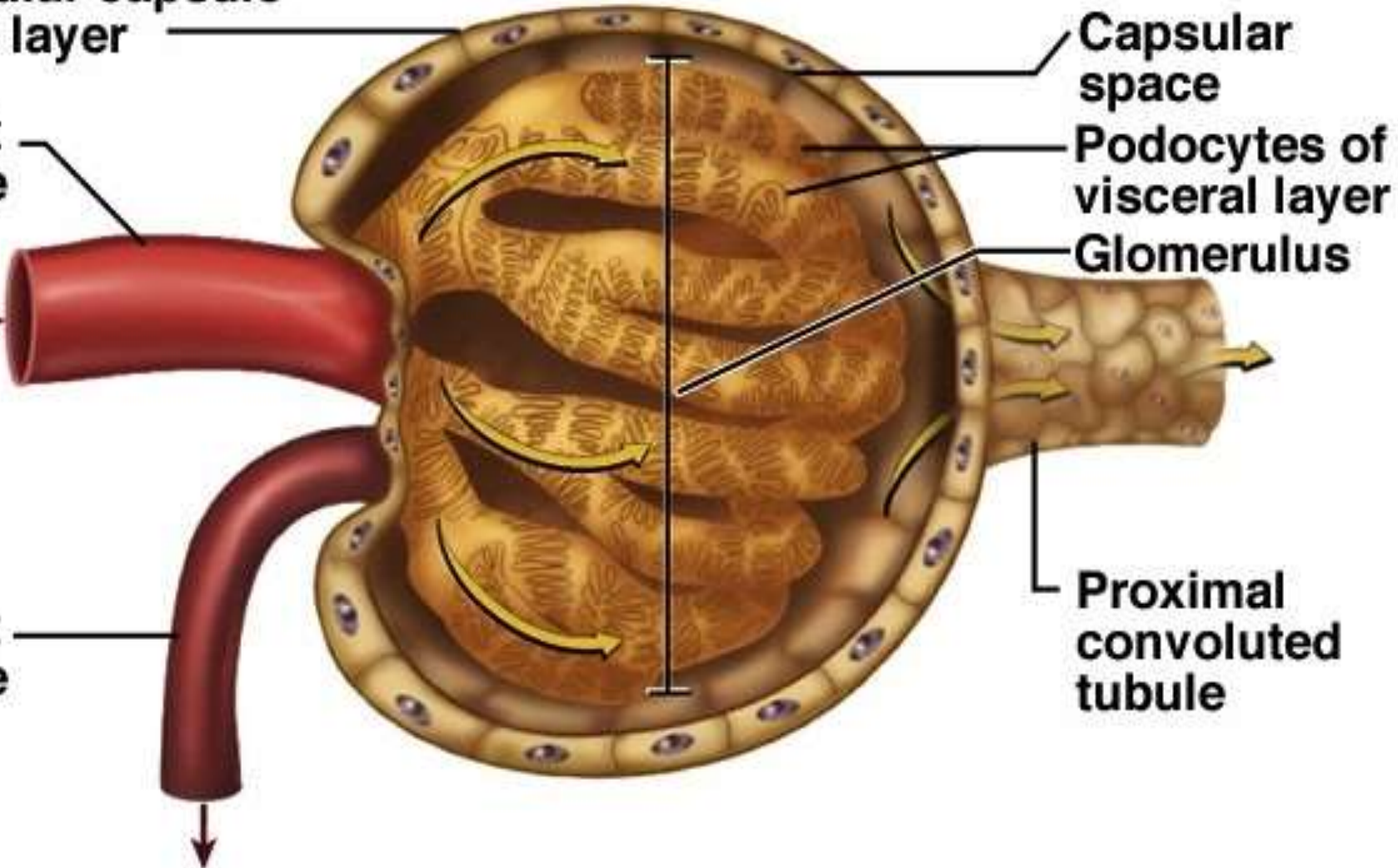
Blood flow

Capsular space

Podocytes of visceral layer

Glomerulus

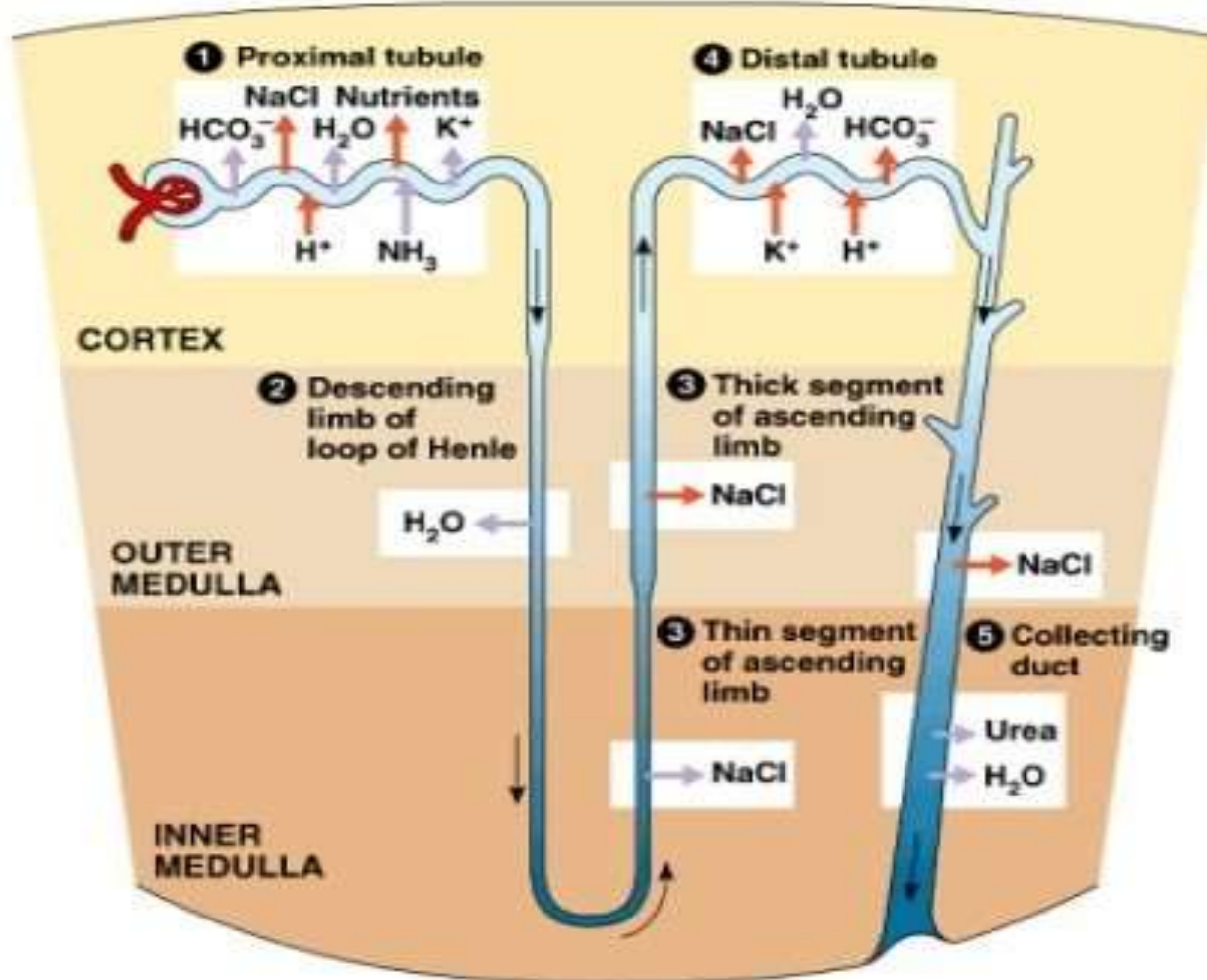
Proximal convoluted tubule



# Renal tubule

- Leads from glomerular capsule
- Ends at tip of medullary pyramid
- ~3 cm long
- Four major regions
  - Proximal convoluted tubule
  - Nephron loop/ loop of Henle
  - Distal convoluted tubule
  - Collecting duct

# Nephron-Tubular System



1. Proximal convoluted tubule
2. Descending loop of Henle
3. Ascending loop of Henle
4. Distal convoluted tubule
5. Collecting duct

# Proximal convoluted tubule (PCT)

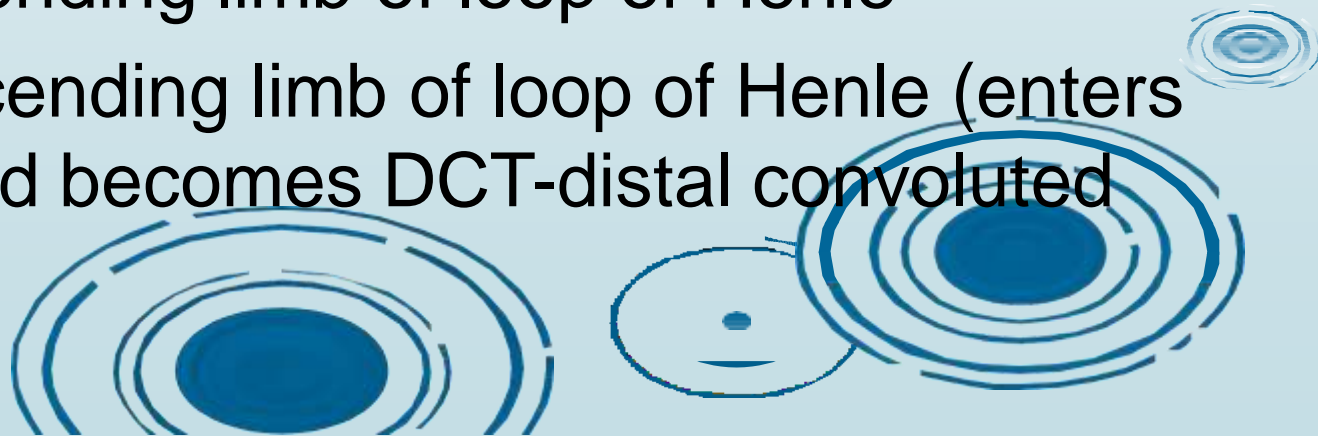
- Arises from glomerular capsule
- Longest, most coiled region
- lies in cortex
- lined by **simple cuboidal epithelium** with brush borders which help to increase the area of absorption greatly.
- Prominent microvilli
  - Function in absorption

# Nephron loop (“Loop of Henle”)

- “U” – shaped, distal to PCT
  - lies in medulla
- 2 parts
- Descending limb of loop of Henle
  - Ascending limb of loop of Henle

# Ascending limb of loop of Henle

- The ascending limb of loop of Henle is divided into 2 segments:
- **Lower end of ascending limb** is very thin and is lined by simple squamous epithelium.
- **The distal portion of ascending limb** is thick and is lined by simple cuboidal epithelium.
- Thin ascending limb of loop of Henle
- Thick ascending limb of loop of Henle (enters cortex and becomes DCT-distal convoluted tubule.)

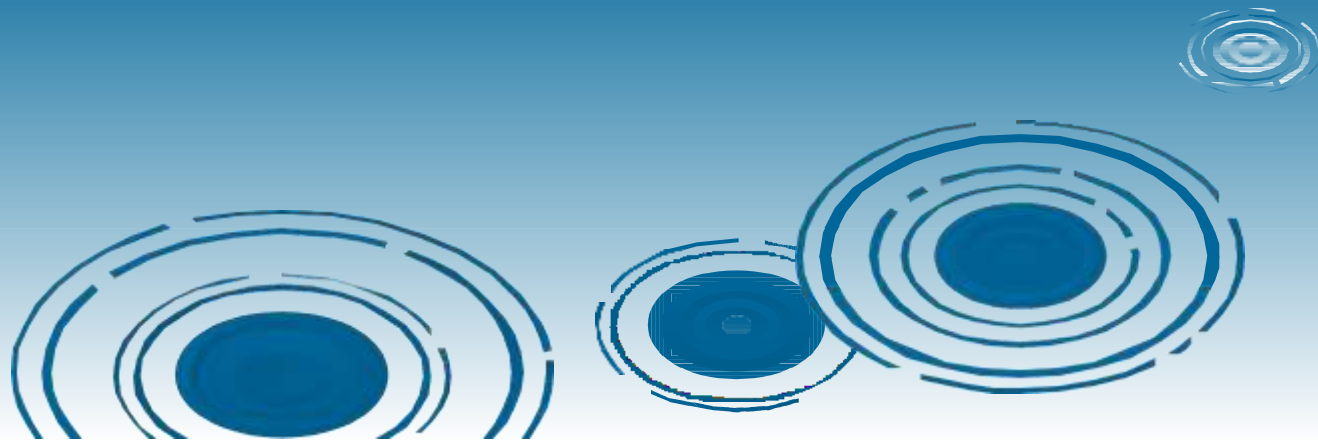


## □ Thick segments

- Active transport of salts
- High metabolism, many mitochondria

## □ Thin segments

- Permeable to water
- Low metabolism





# Distal convoluted tubule (DCT)

- Coiled, distal to nephron loop
- Shorter than PCT
- Less coiled than PCT
- Very few microvilli
- Contacts afferent and efferent arterioles
- Contact with peritubular capillaries

# Collecting duct

- DCTs of several nephrons empty into a collecting duct
- Passes into medulla
- Several merge into papillary duct (~30 per papilla)
- Drain into minor calyx

# CLASSES

The two general classes of nephrons are

- Short Cortical nephrons (80%)
- Juxtamedullary nephrons (20%)

which are classified according to the

- length of their Loop of Henle
- location of their renal corpuscle.

# URINE FORMATION

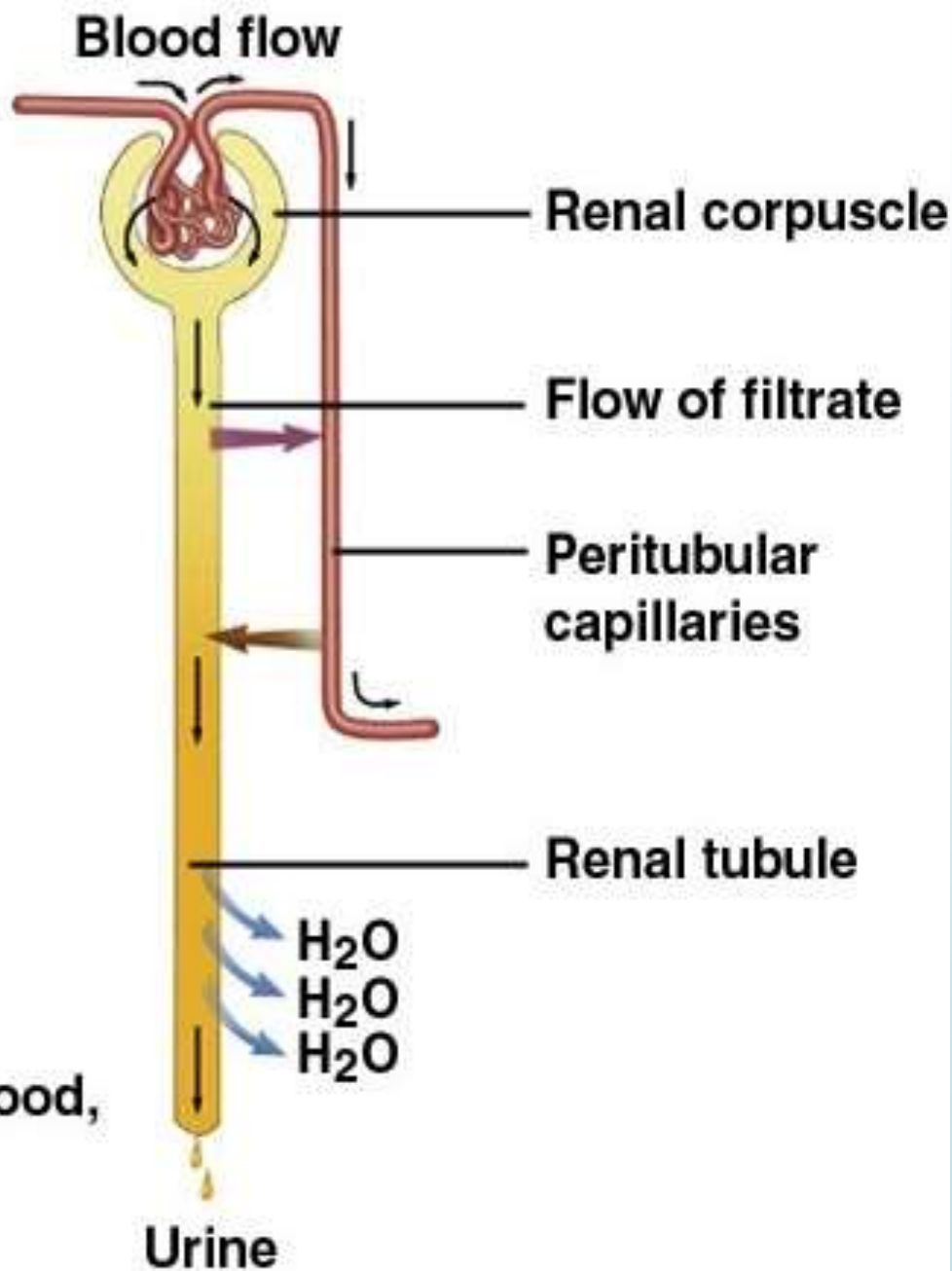
- About 1300 ml of blood enters the kidney ( 20% of the cardiac output ) every minute. Normal urine output-1-1.5l /day. About 180 liter of fluid is filtered by the glomerulus everyday of which 99% get reabsorbed and about 1.5 liters of urine is formed.

## Overview

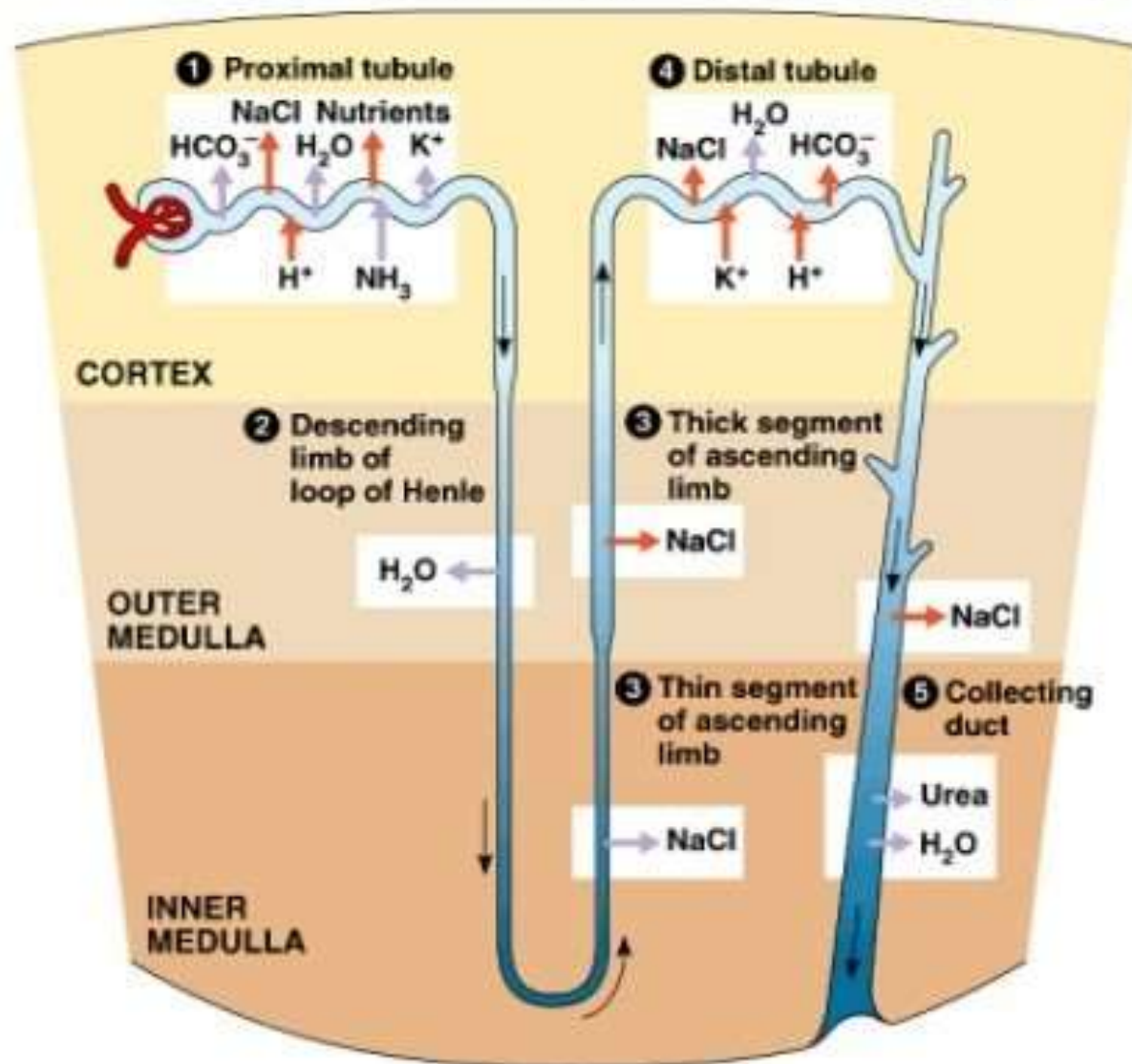
- Blood plasma Urine
- Three steps
  - Glomerular filtration
  - Tubular reabsorption
  - Tubular secretion
  - Water conservation

# Urine Formation

- ① Glomerular filtration**  
Creates a plasma-like filtrate of the blood
- ② Tubular reabsorption**  
Removes useful solutes from the filtrate, returns them to the blood
- ③ Tubular secretion**  
Removes additional wastes from the blood, adds them to the filtrate
- ④ Water conservation**  
Removes water from the urine and returns it to blood, concentrates wastes

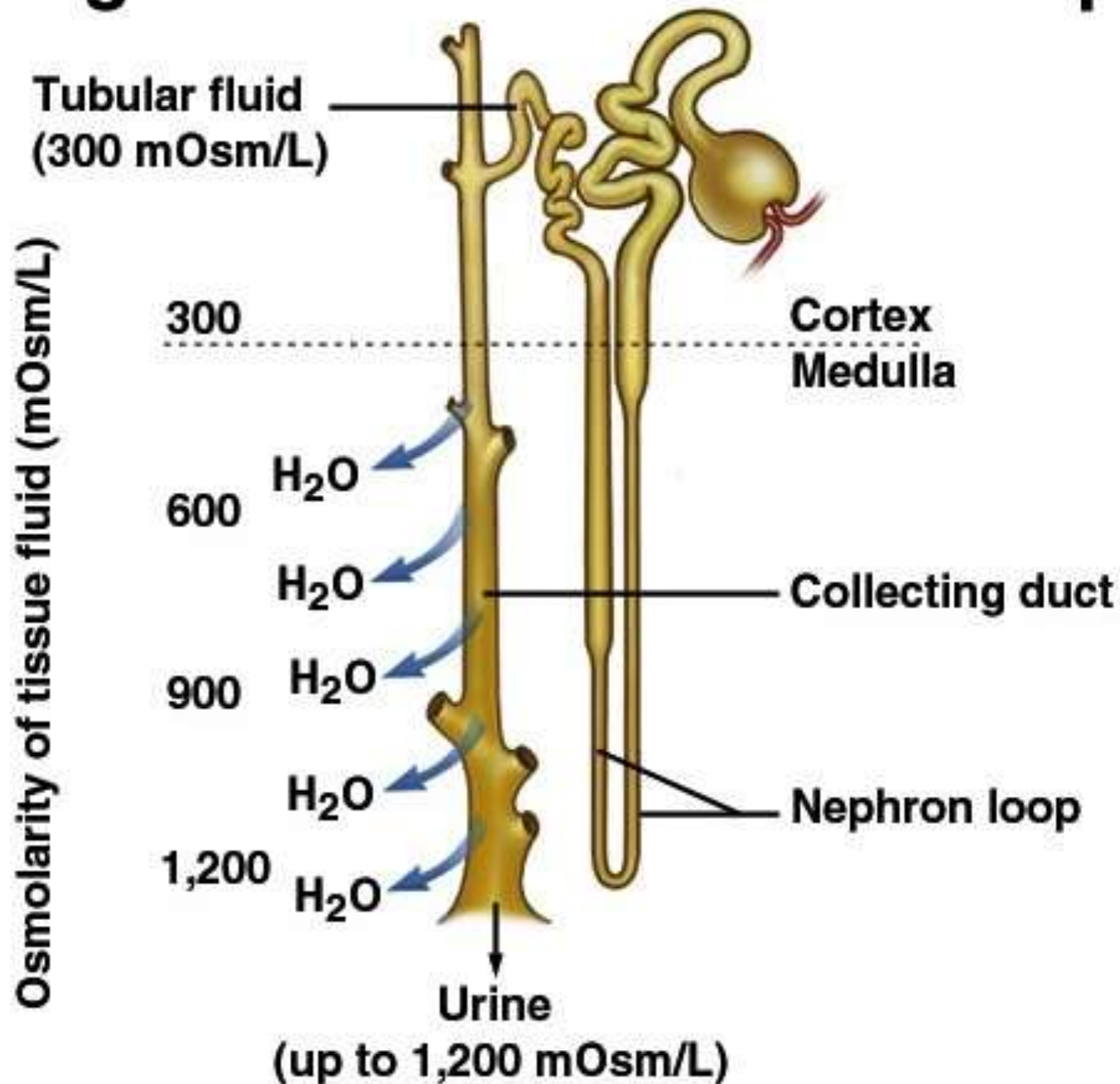


# Nephron-Tubular System



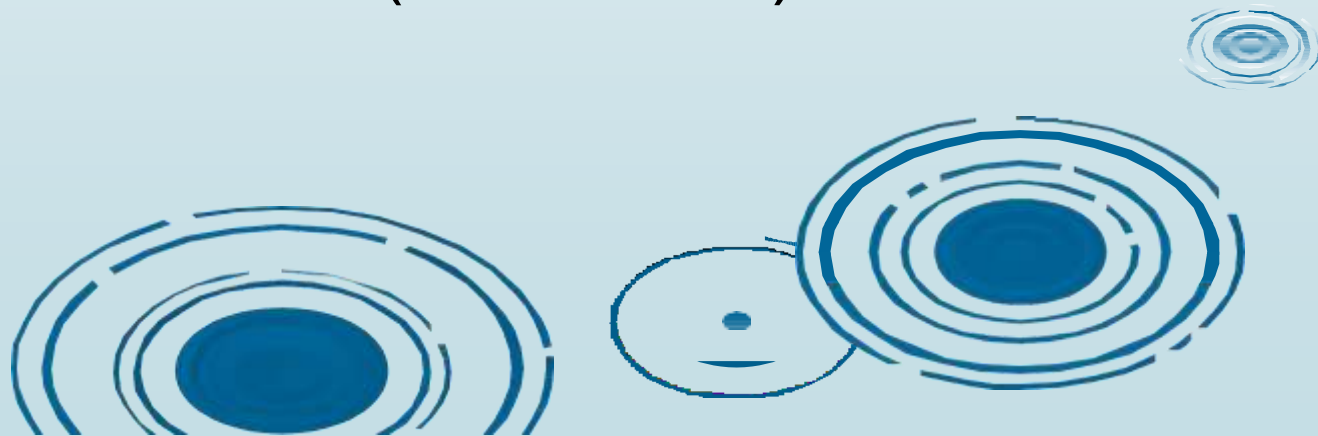
1. Proximal convoluted tubule
2. Descending loop of Henle
3. Ascending loop of Henle
4. Distal convoluted tubule
5. Collecting duct

# Collecting Duct and Water Reabsorption



# KIDNEY FUNCTIONS

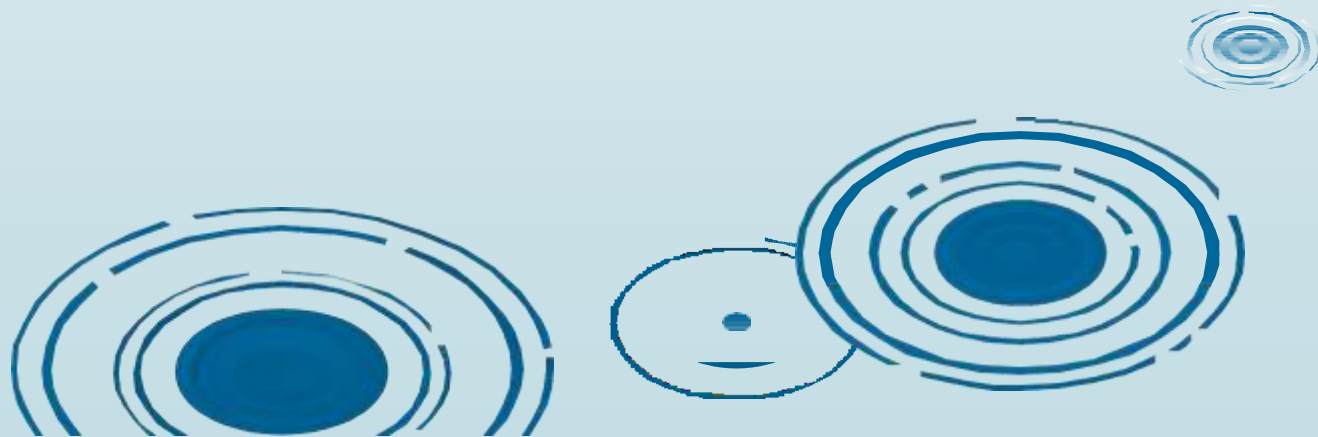
- Regulate blood volume, pressure
- Regulate fluid osmolarity
- Secrete renin
- Secrete erythropoietin (EPO)
- Acid-Base balance
- Synthesize calcitriol (Vitamin D)





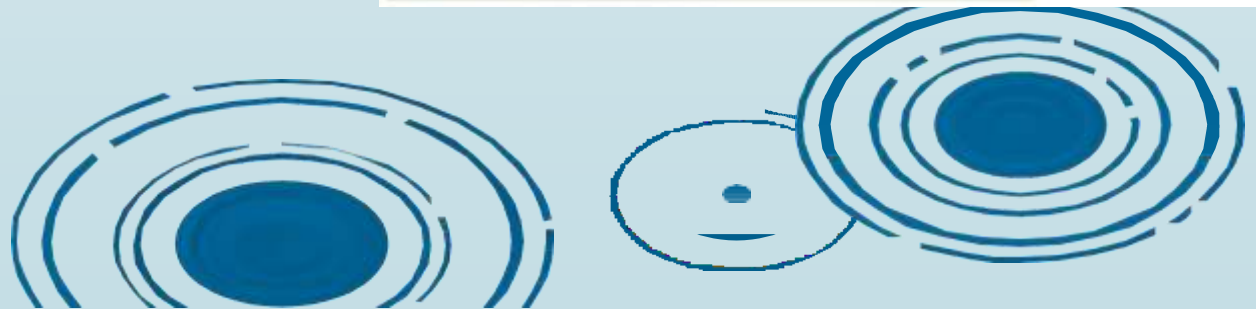
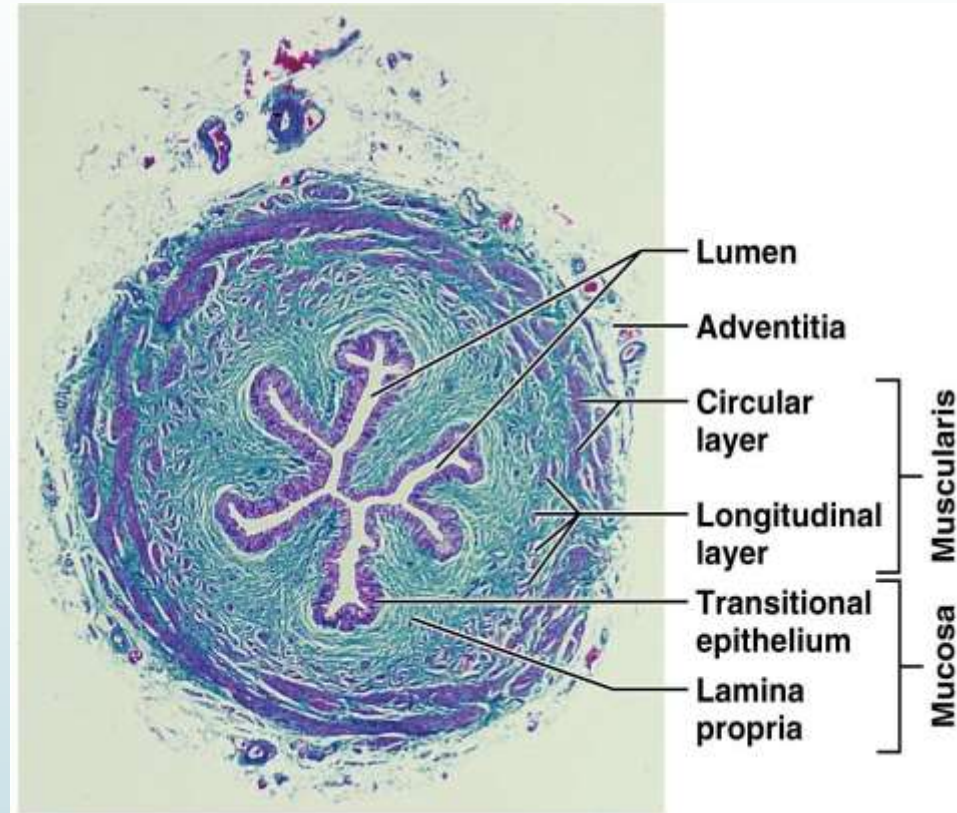
# The Ureters

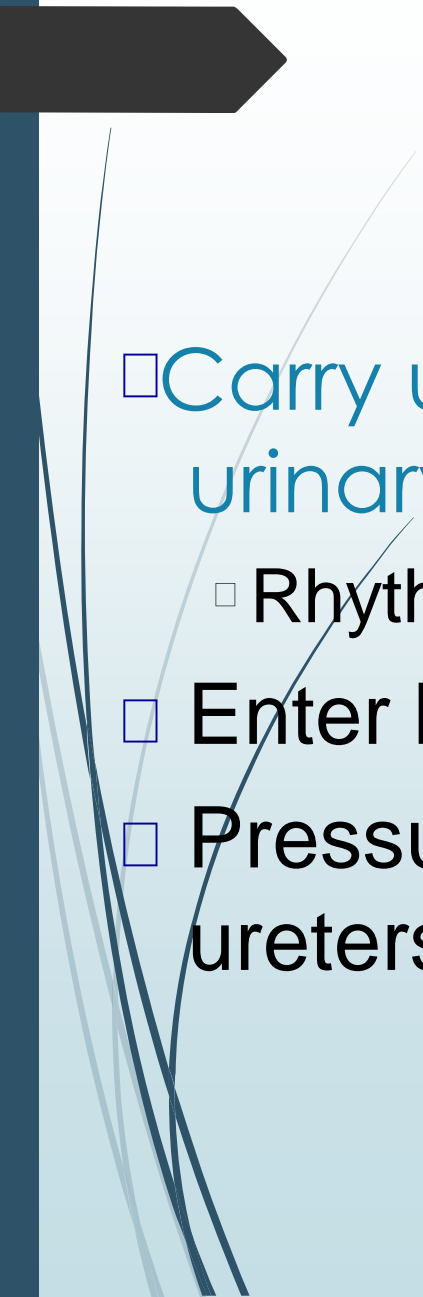
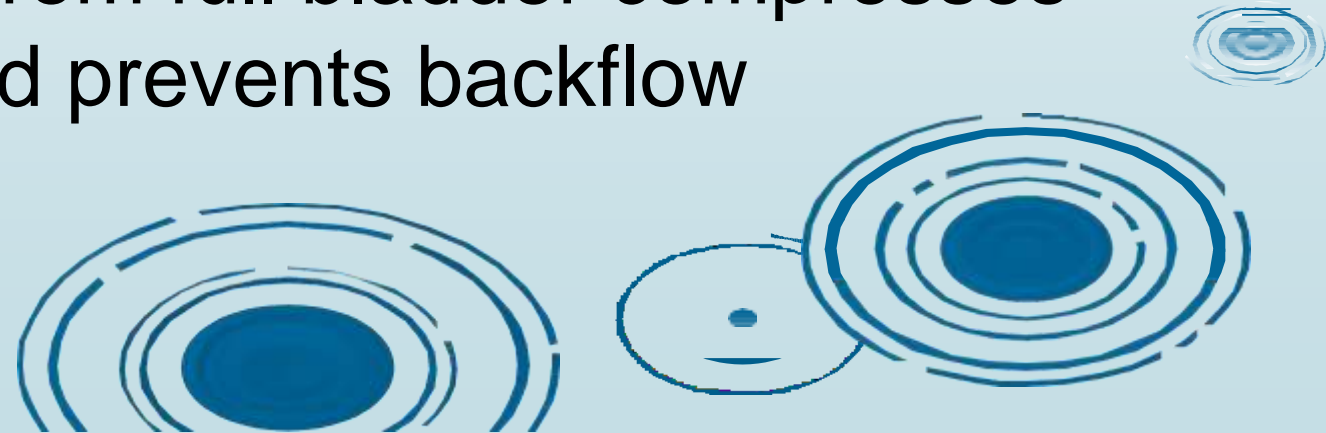
- Pair of muscular tubes
- Extend from renal pelvis to the bladder
- Oblique entry into bladder prevents backflow of urine



# Histology of Ureter

- Mucosa – **transitional epithelium**
- **Muscularis** – two layers
  - Inner longitudinal layer
  - Outer circular layer
- **Adventitia** – typical connective tissue



- 
- A dark grey arrow points to the right from the left edge of the slide. Several thin, light blue lines curve across the left side of the slide.
- Carry urine from kidneys to urinary bladder via peristalsis
    - Rhythmic contraction of smooth muscle
  - Enter bladder from below
  - Pressure from full bladder compresses ureters and prevents backflow
- 
- A series of blue concentric circles representing water ripples are located at the bottom of the slide. There are three distinct sets of ripples, with the largest one on the right and two smaller ones on the left.

# Urinary Bladder

- A collapsible muscular sac
- Stores and expels urine
  - Full bladder – spherical
    - Expands into the abdominal cavity
  - Empty bladder – lies entirely within the pelvis

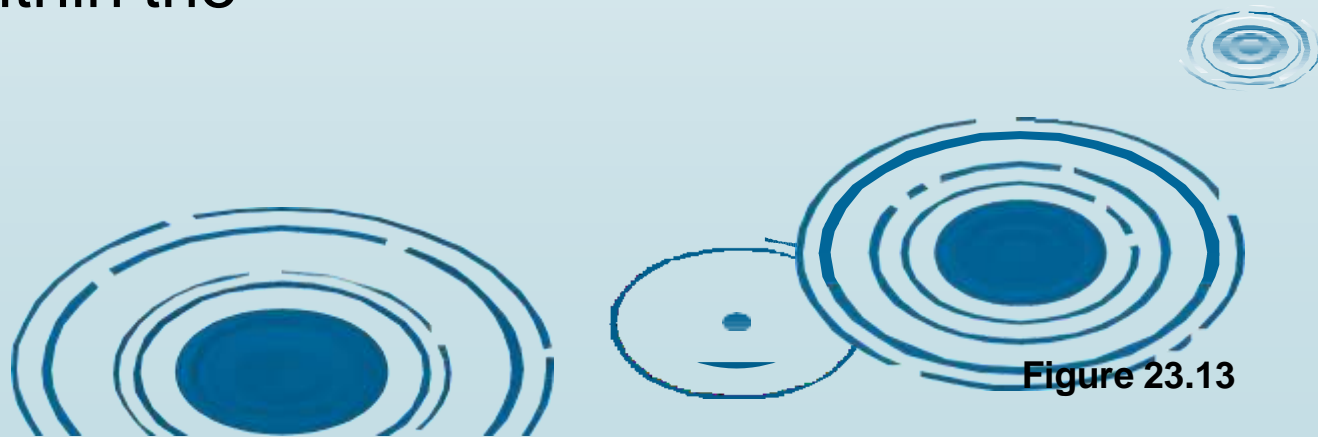
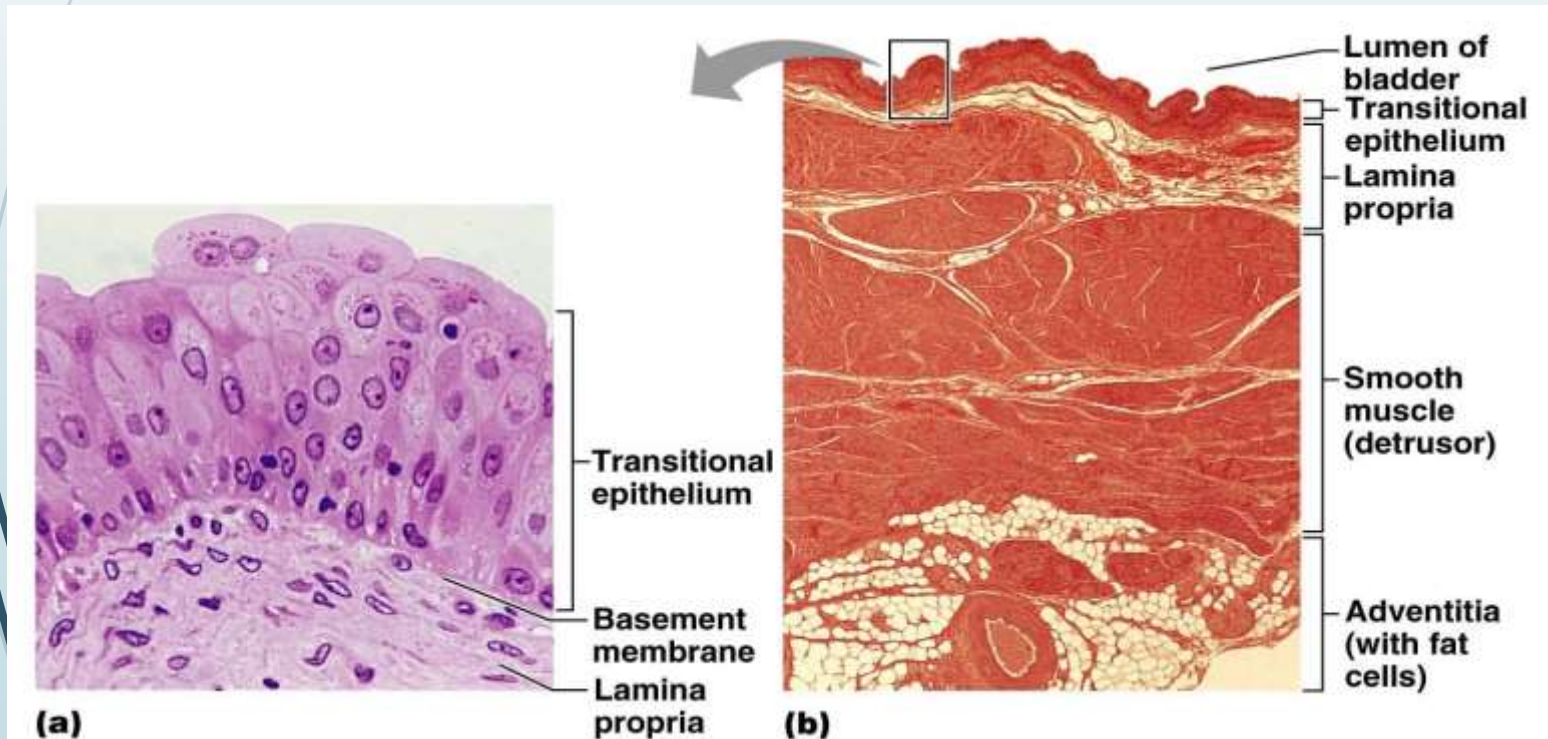


Figure 23.13

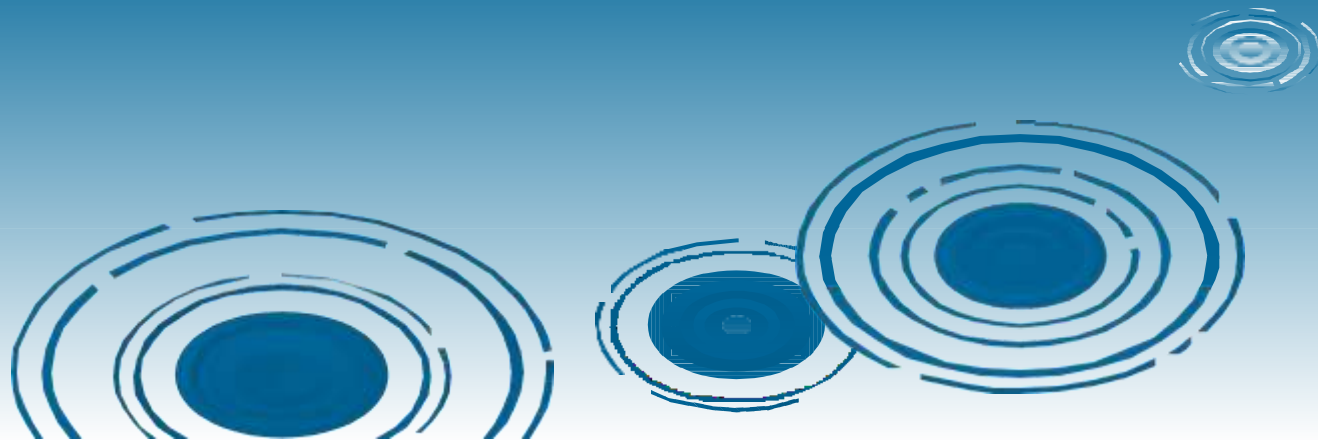
# Urinary Bladder

- Wall of bladder
  - Mucosa - transitional epithelium
  - Muscular layer - detrusor muscle
  - Adventitia



# Urinary bladder

- Wrinkles termed rugae
- Openings of ureters common site for bladder infection



# Urethra

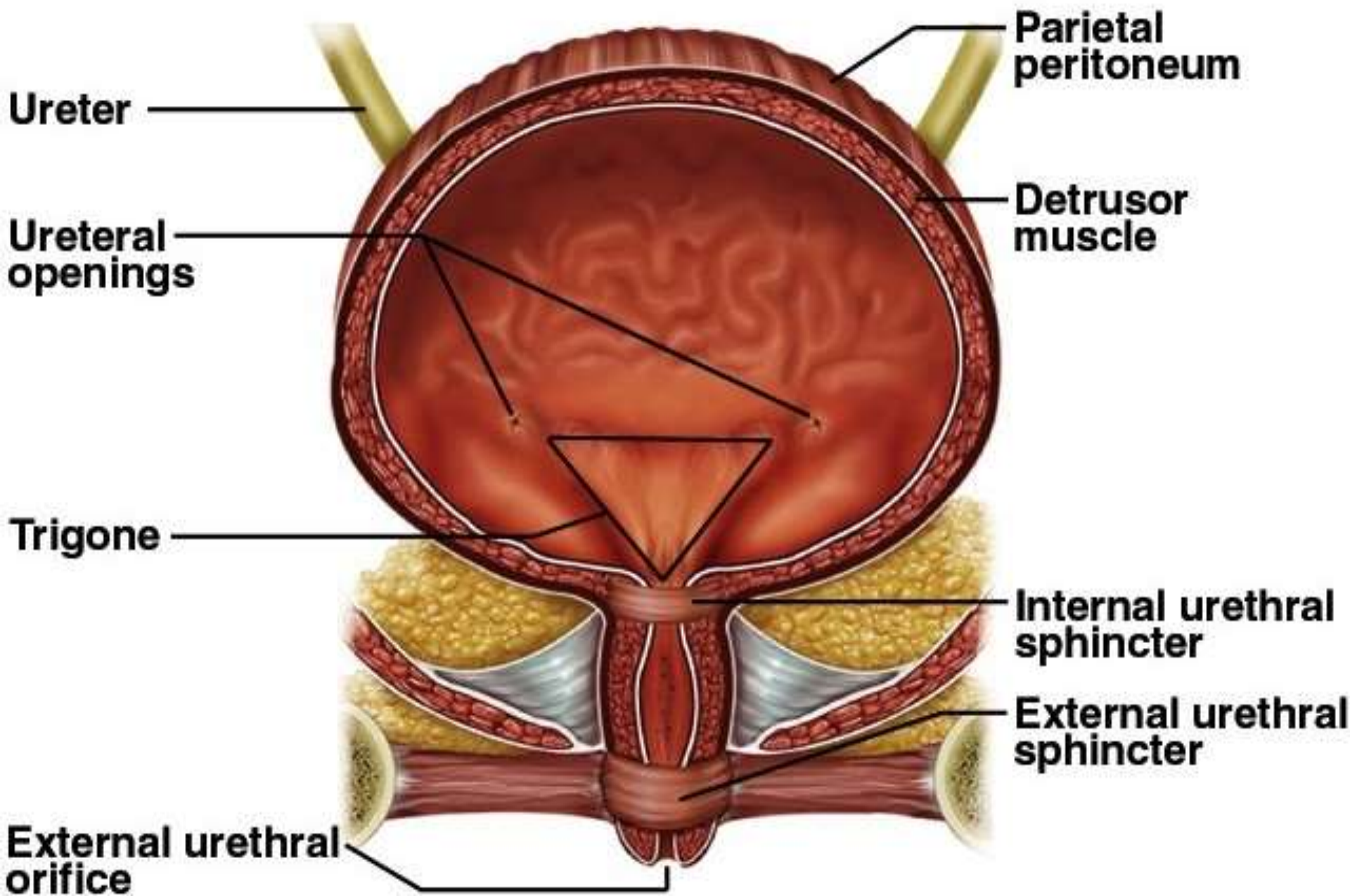
- Conveys urine from body
- Internal urethral sphincter
  - Retains urine in bladder
  - Smooth muscle, involuntary
- External urethral sphincter
  - Provides voluntary control over voiding of urine

# Urethra in female

- 3 – 4 cm long in females
  - Bound by connective tissue to anterior wall of vagina
  - Urethral orifice exits body between vaginal orifice and clitoris



# Urinary Bladder and Urethra, Female



# Urethra in male

- ~18 cm long in males
- Prostatic urethra
  - ~2.5 cm long, urinary bladder , prostate
- Membranous urethra
  - ~0.5 cm, passes through floor of pelvic cavity
- Penile urethra
  - ~15 cm long, passes through penis

# Urinary Bladder and Urethra, Male

