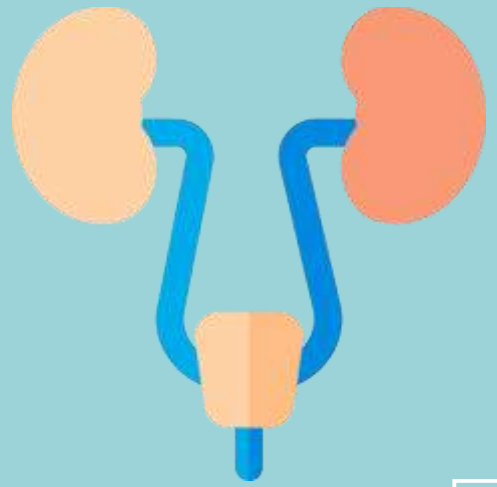
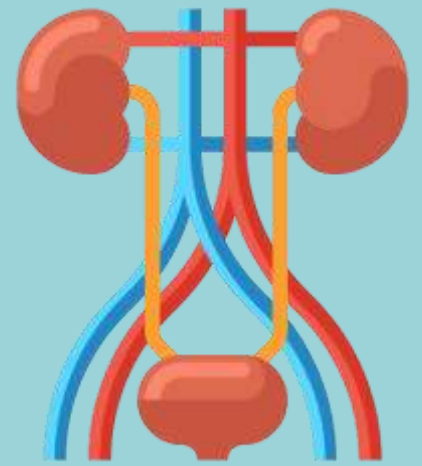


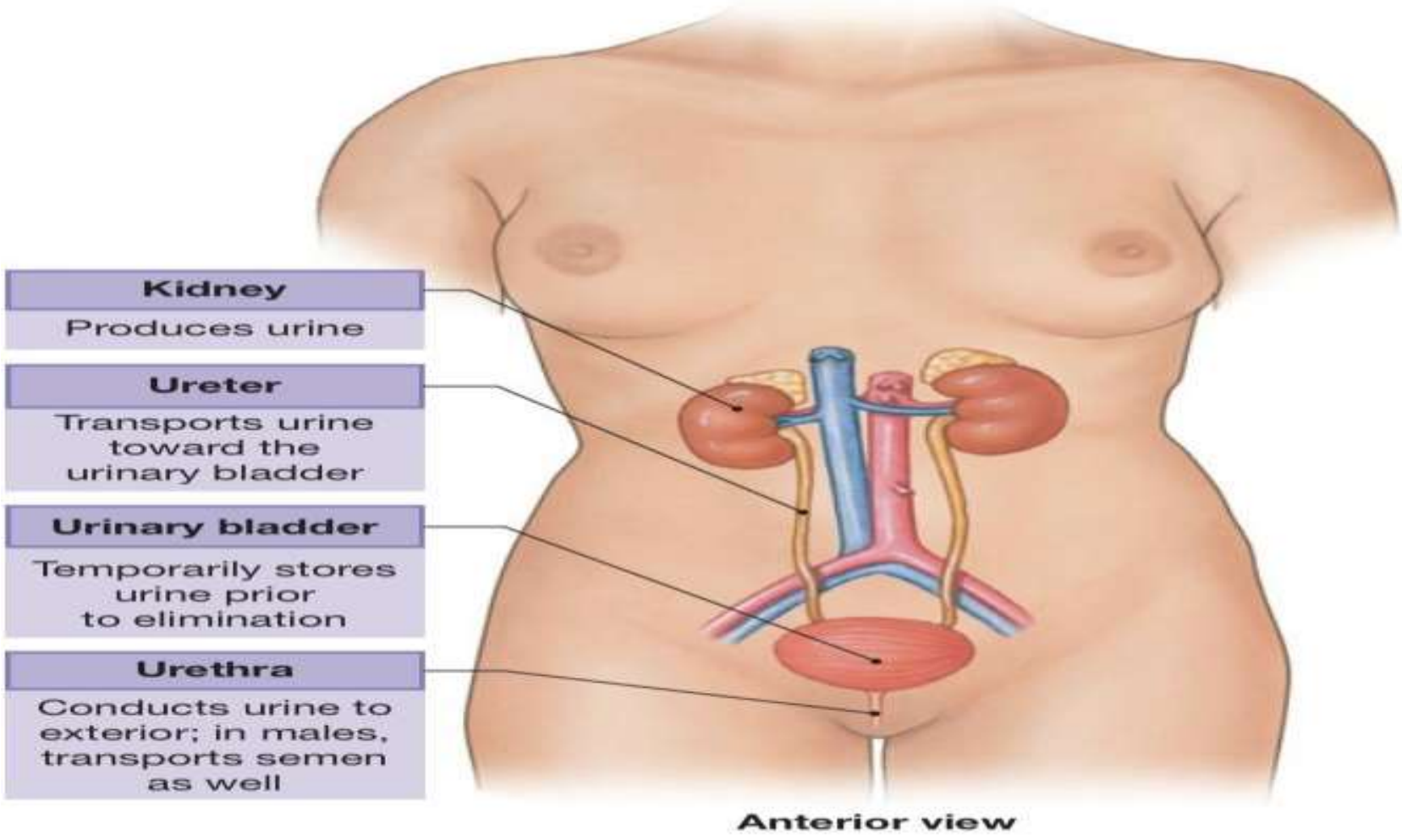
Regulation of Excretion
Urinary system



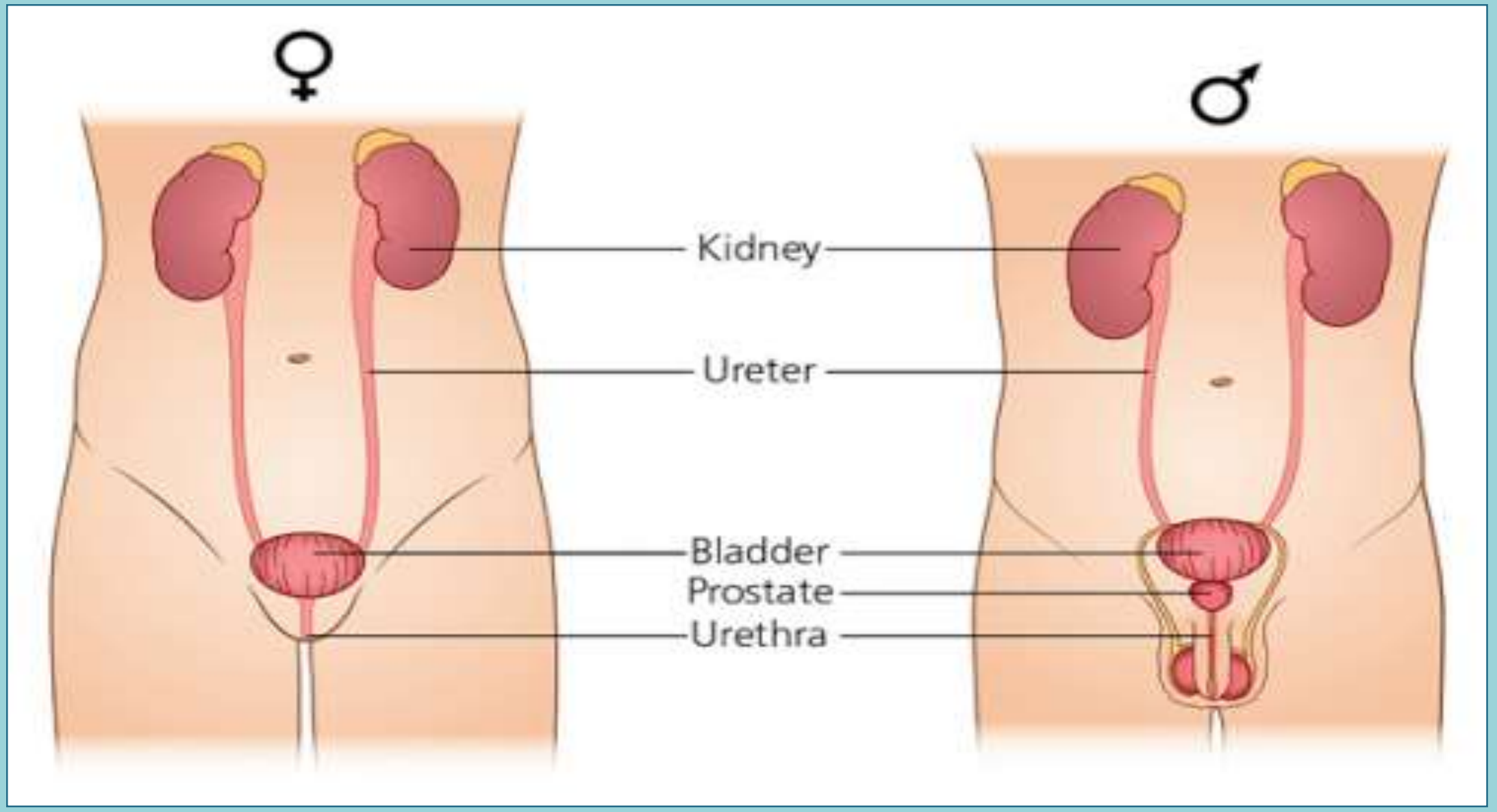
Introduction to the Urinary System

The principal function of the urinary system is to maintain the volume and composition of body fluids within normal limits.
One aspect of this function is to rid the body of waste products that accumulate as a result of cellular metabolism, and, because of this, it is sometimes referred to as the excretory system.
The urinary system maintains an appropriate fluid volume by regulating the amount of water that is excreted in the urine.
Other aspects of its function include regulating the concentrations of various electrolytes in the body fluids and maintaining normal pH of the blood.
And maintaining fluid homeostasis in the body, the urinary system controls red blood cell production by secreting the hormone erythropoietin. The urinary system also plays a role in maintaining normal blood pressure by secreting the enzyme renin.

Components of the Urinary System



Urinary system

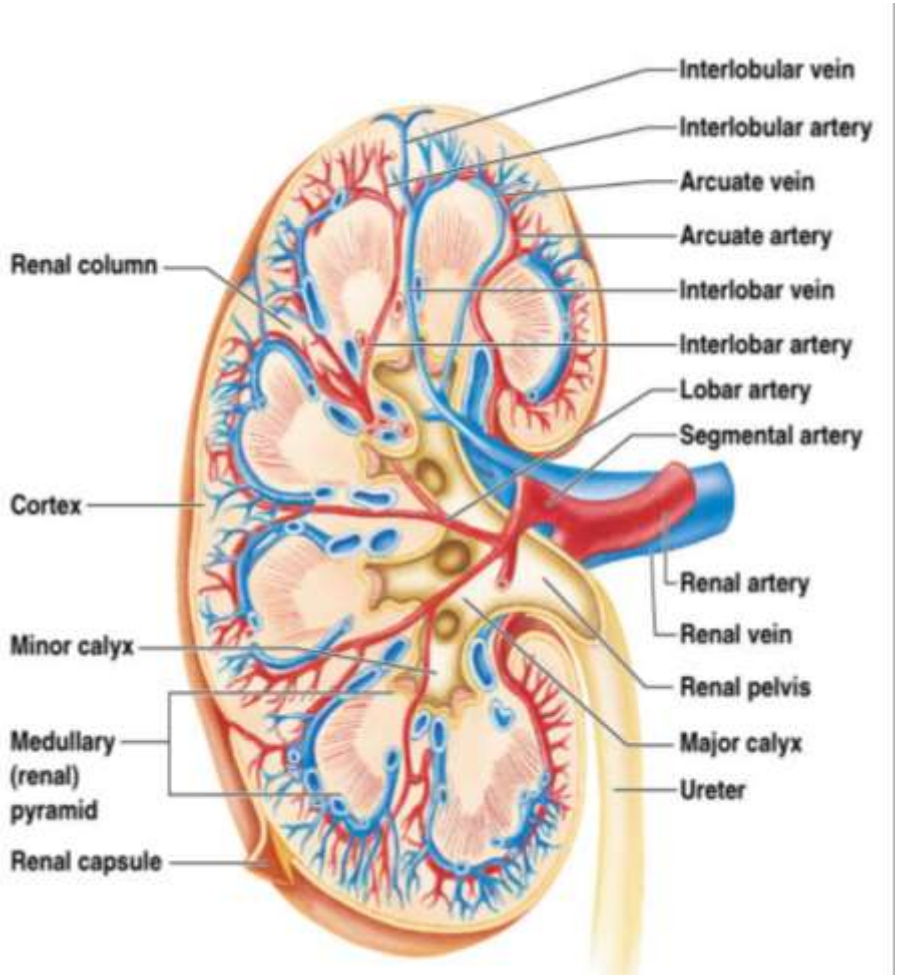


Kidney

- ✓The kidneys are the primary organ of the urinary system.
- ✓It’s the organ that filter the blood, remove the wastes, and excrete the wastes in the urine.
- ✓it is the organ that perform the functions of the urinary system.
- ✓The other components are accessory structures to eliminate the urine from the body.

The location of the Kidney

- ✓ The paired kidneys are located at the level of T12 to L3
- ✓ one on each side of the vertebral column.
- ✓ The right kidney is slightly lower than the left.
- ✓ Attached to ureters, renal blood vessels, and nerves at renal hilus
- ✓ Atop each kidney is an adrenal gland



Regions of the Kidney

- ✓ Renal cortex – outer region
- ✓Renal medulla – inside the cortex
- ✓Renal pelvis – inner collecting tube

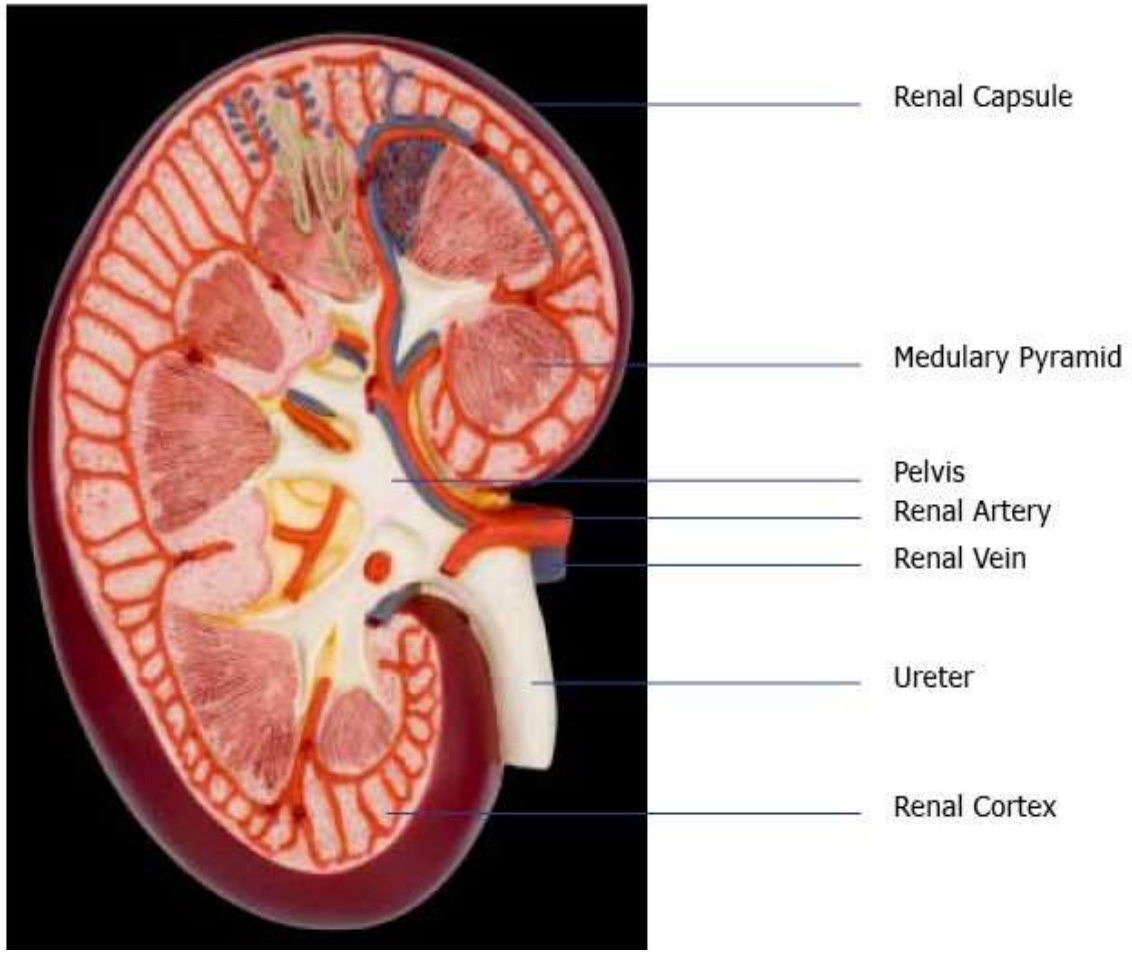
Coverings of the Kidneys

✓Renal capsule

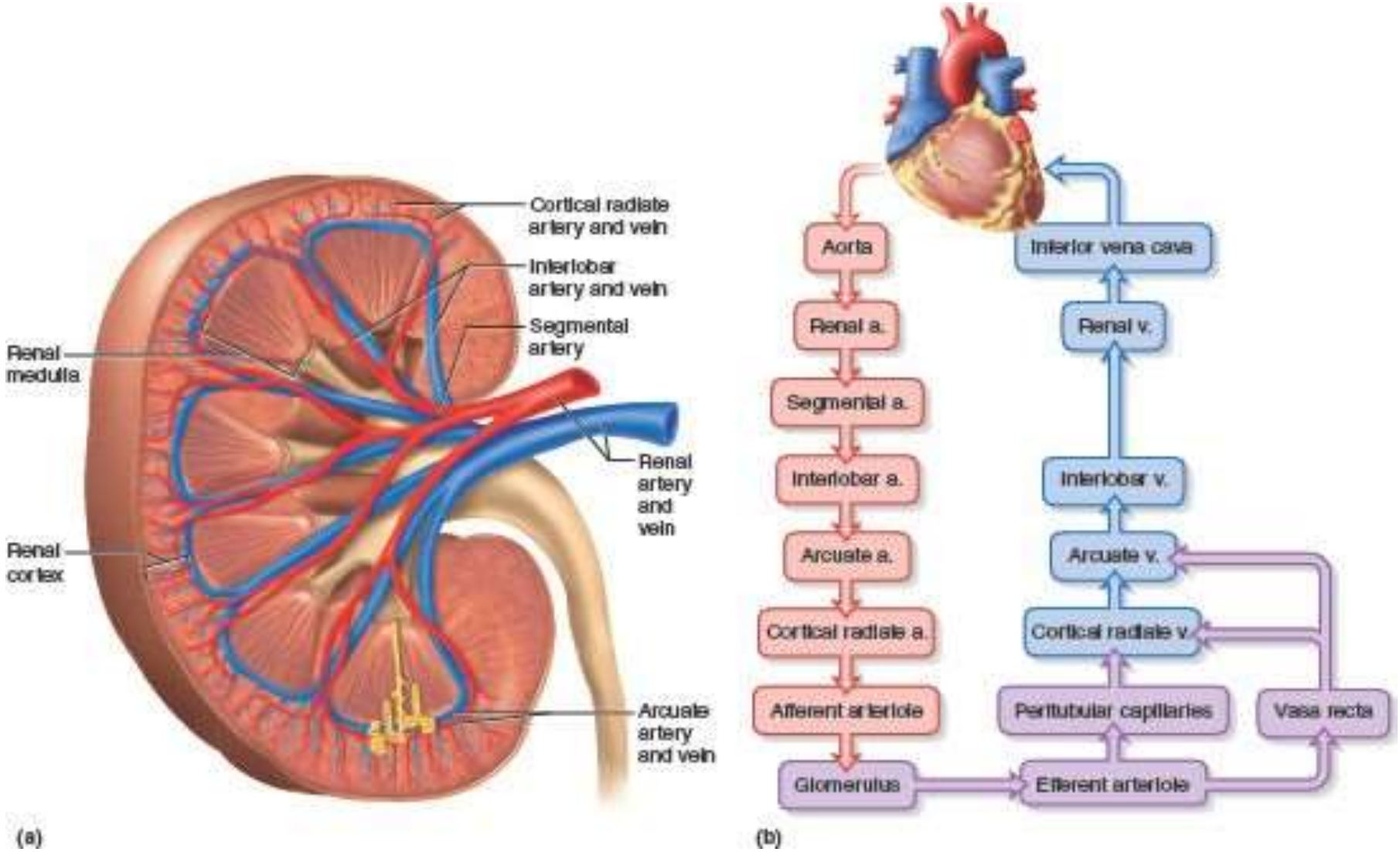
- Surrounds each kidney

✓ Adipose capsule

- Surrounds the kidney
- Provides protection to the kidney
- Helps keep the kidney in its correct location

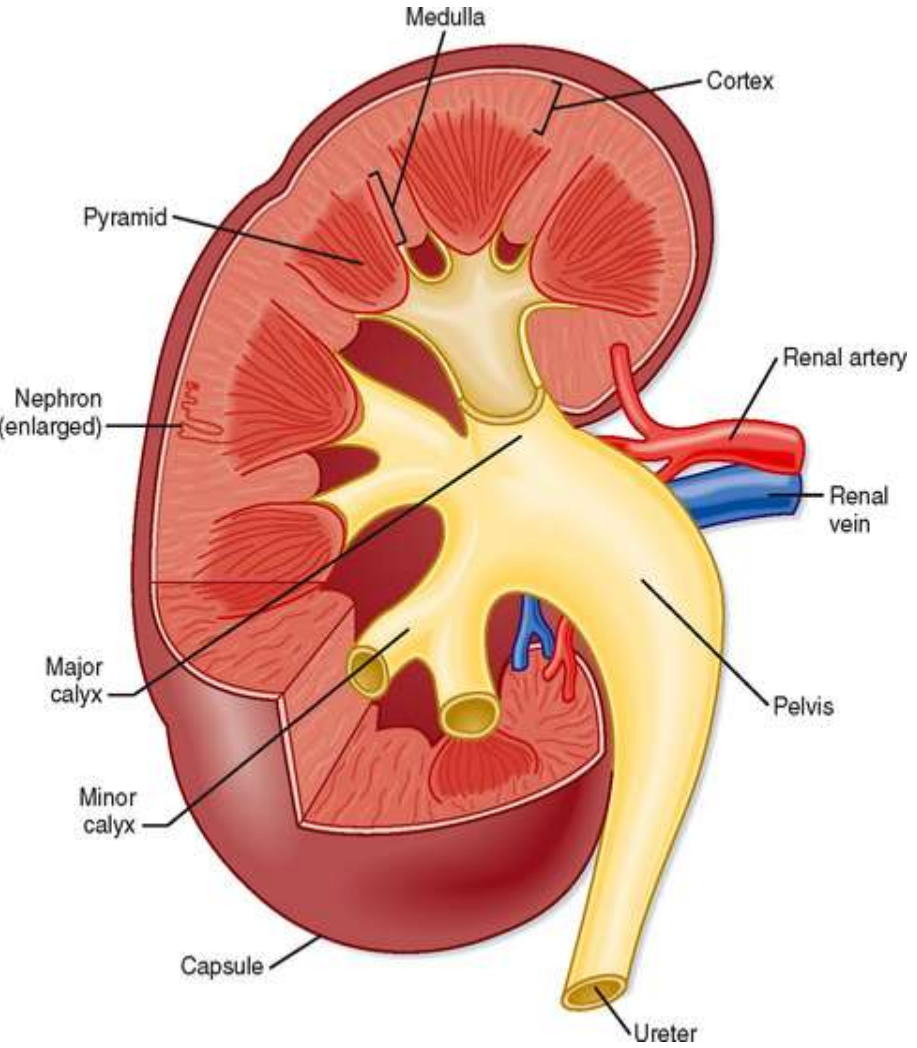


Blood Flow in the Kidneys



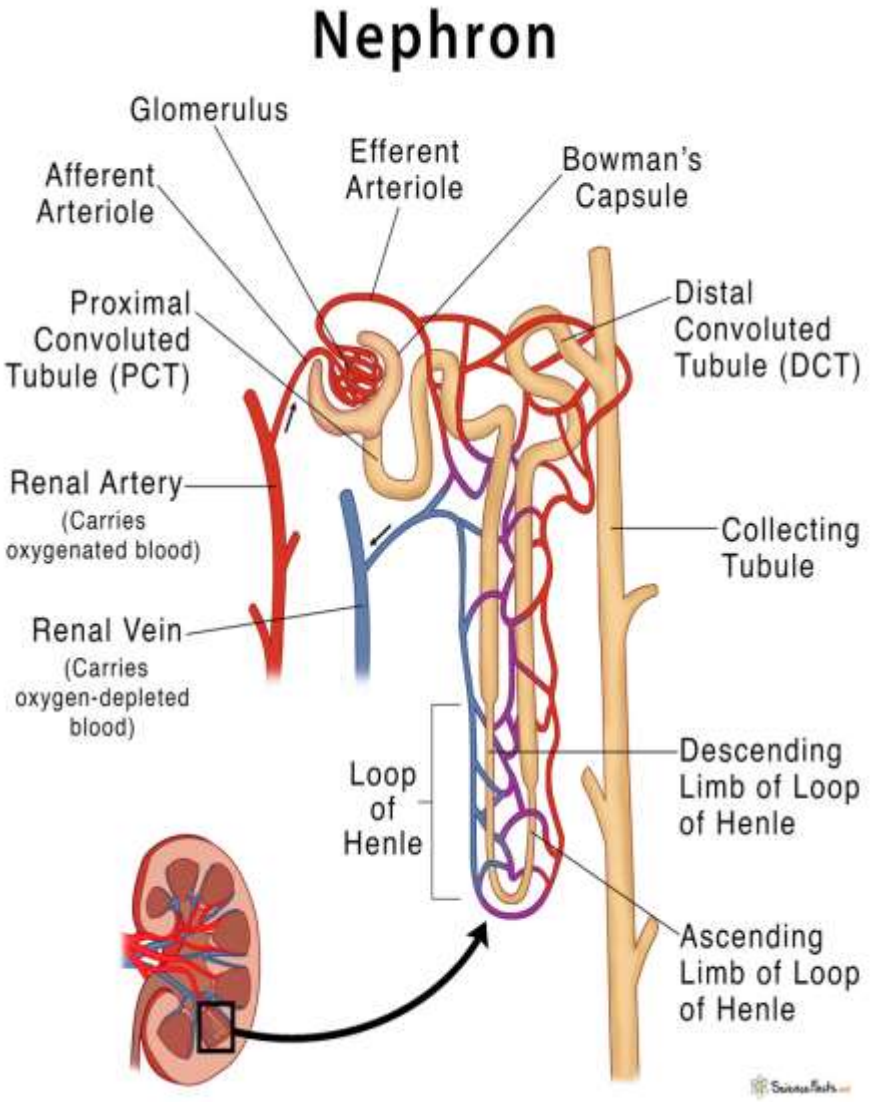
Kidney Structures

- Medullary pyramids – triangular regions of tissue in the medulla
- Renal columns – extensions of cortex-like material inward
- Calyces – cup-shaped structures that funnel urine towards the renal pelvis



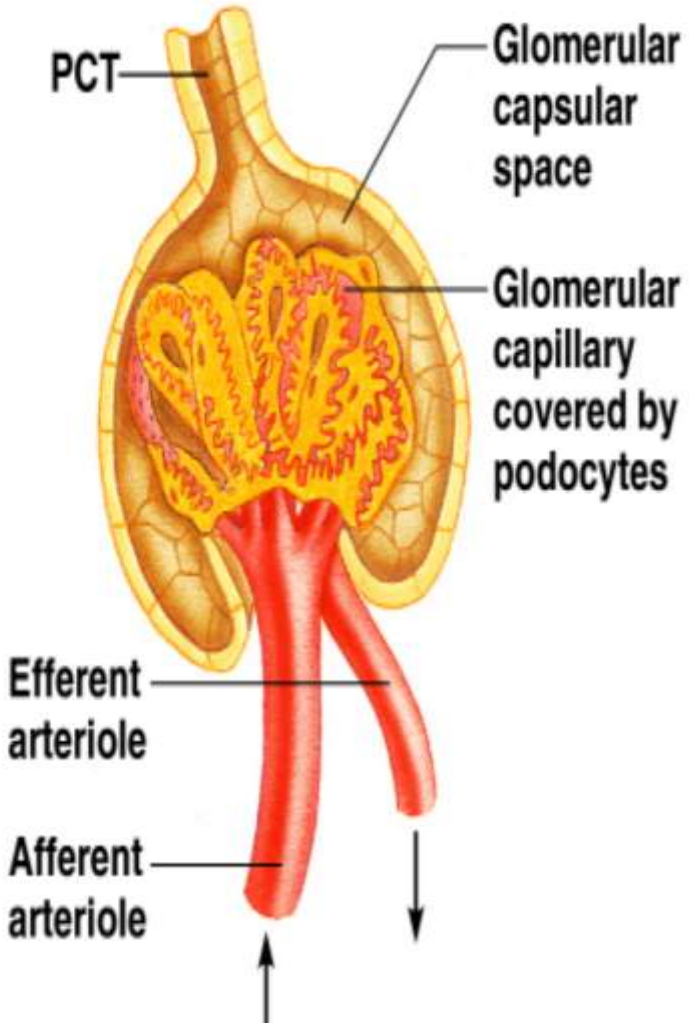
Nephrons

- ✓The structural and functional units of the kidneys
- ✓Responsible for forming urine
- ✓Main structures of the nephrons
- •Glomerulus
- • Renal tubule



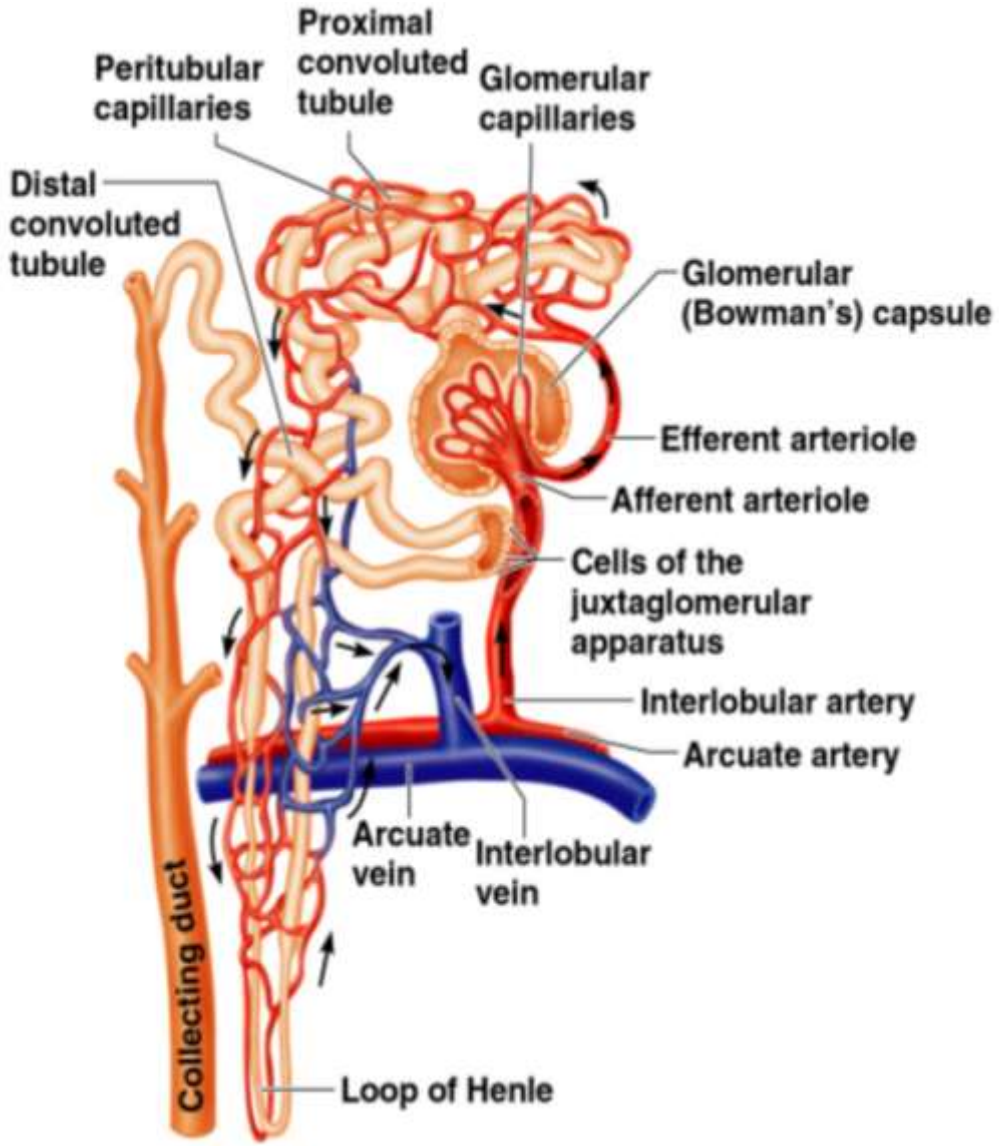
Glomerulus

- ✓A specialized capillary bed
- ✓ Attached to arterioles on both sides (maintains high pressure)
- ✓Large afferent arteriole
- ✓ Narrow efferent arteriole
- ✓The glomerulus sits within a glomerular capsule (the first part of the renal tubule)



Renal Tubule

- Glomerular (Bowman's) capsule
- Proximal convoluted tubule
- Loop of Henle
- Distal convoluted tubule



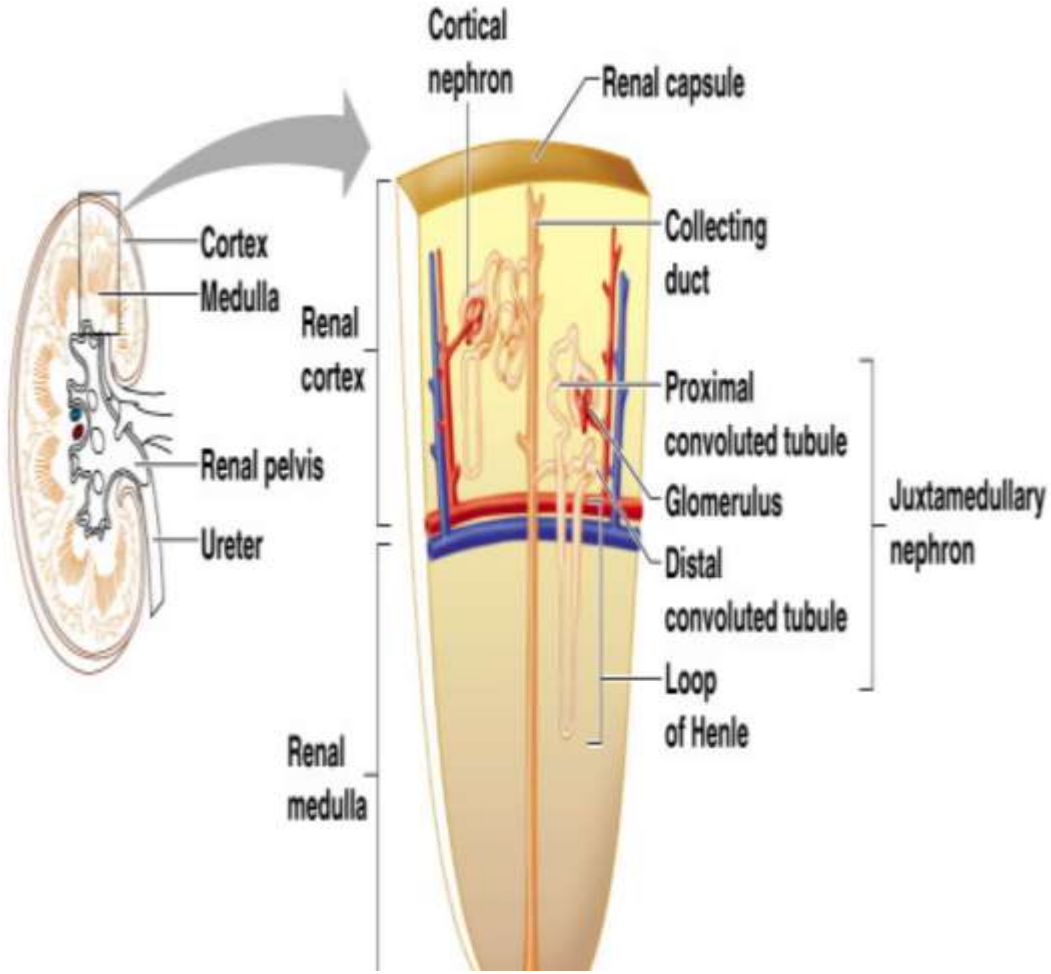
Types of Nephrons

Cortical nephrons

- Located entirely in the cortex
- Includes most nephrons

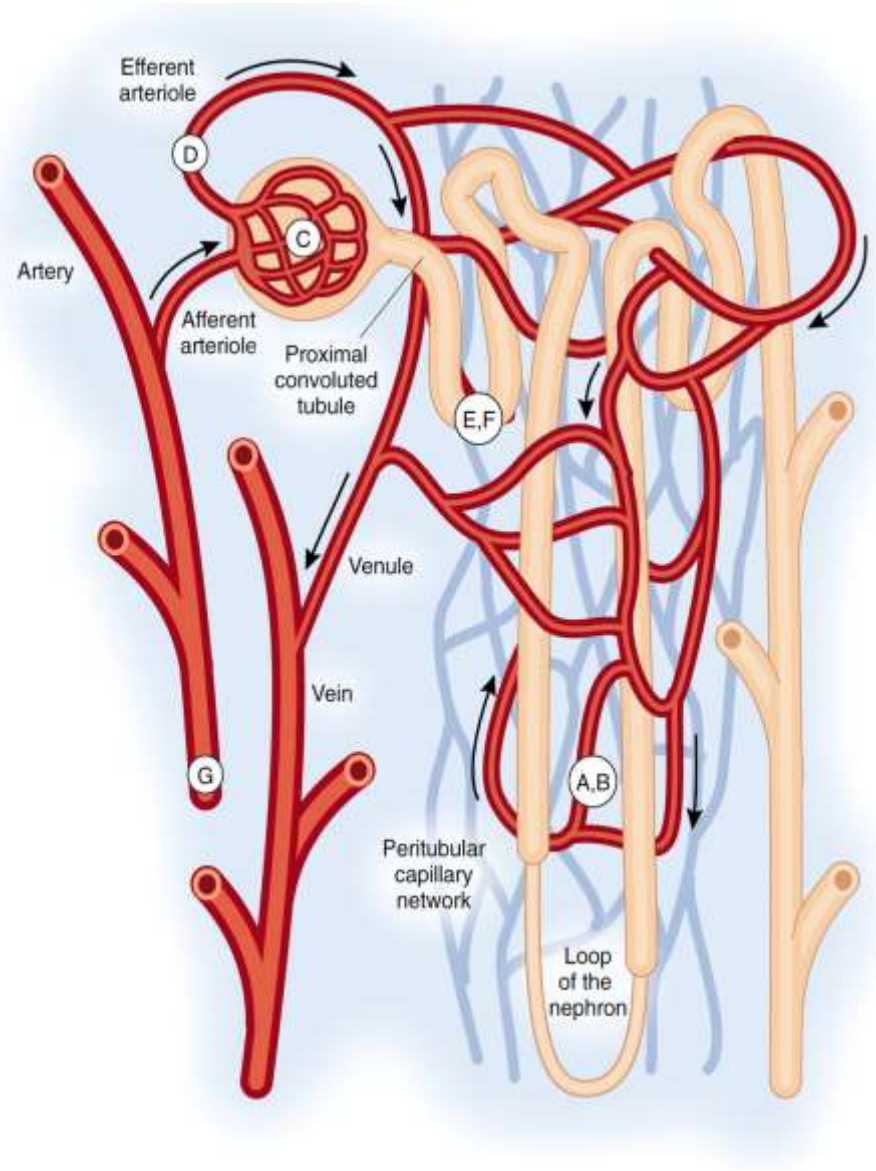
Juxtamedullary nephrons

- Found at the boundary of the cortex and medulla



Peritubular Capillaries

- ✓ Arise from efferent arteriole of the glomerulus
- ✓ Normal, low pressure capillaries
- ✓ Attached to a venule
- ✓ Cling close to the renal tubule
- ✓ Reabsorb (reclaim) some substances from collecting tubes



Urine Formation Proces

- ✓Filtration Reabsorption
- ✓ Secretion

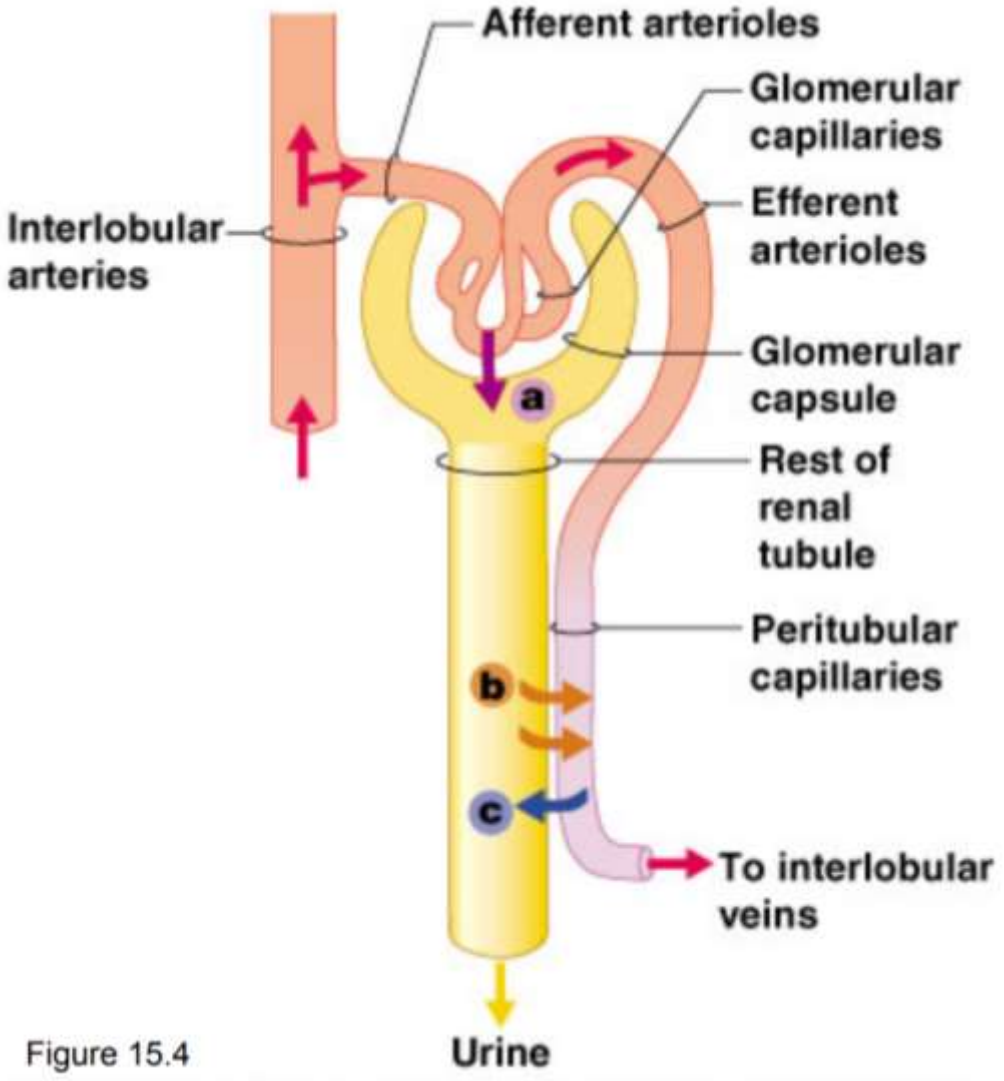


Figure 15.4

Filtration

- ✓Nonselective passive process
- ✓Water and solutes smaller than proteins are forced through capillary walls
- ✓Blood cells cannot pass out to the capillaries
- ✓ Filtrate is collected in the glomerular capsule and leaves via the renal tubule

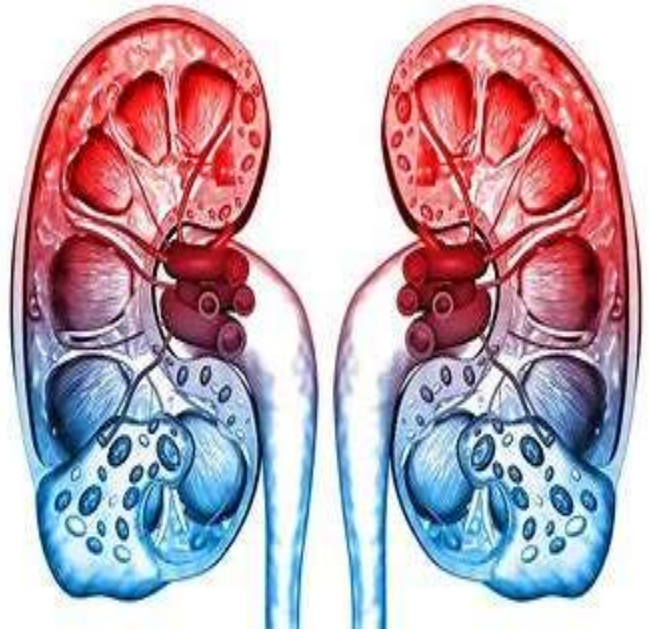
Reabsorption

The peritubular capillaries reabsorb several materials such as:

- Some water
- Glucose
- Amino acids
- Ions

Some reabsorption is passive, most is active.

Most reabsorption occurs in the proximal convoluted tubule.



Materials Not Reabsorbed

Nitrogenous waste products such as:

- Urea
- Uric acid
- Creatinine

Excess water

Secretion – Reabsorption in Reverse

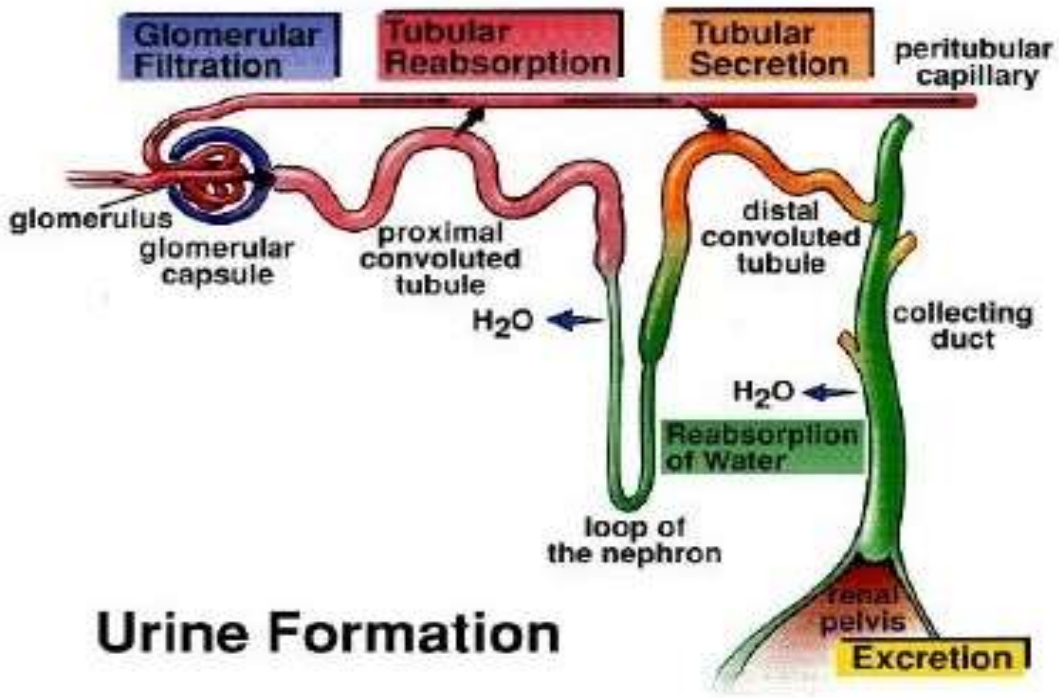
Some materials move from the peritubular capillaries into the renal tubules such as:

- Hydrogen and potassium ions
- Creatinine

Materials left in the renal tubule move toward the ureter

Urine Production - Formation

1. ***Filtration***
   - Glomerular-capsular membrane
2. ***Reabsorption***
   - Renal tubule
3. ***Secretion***



Urine Formation

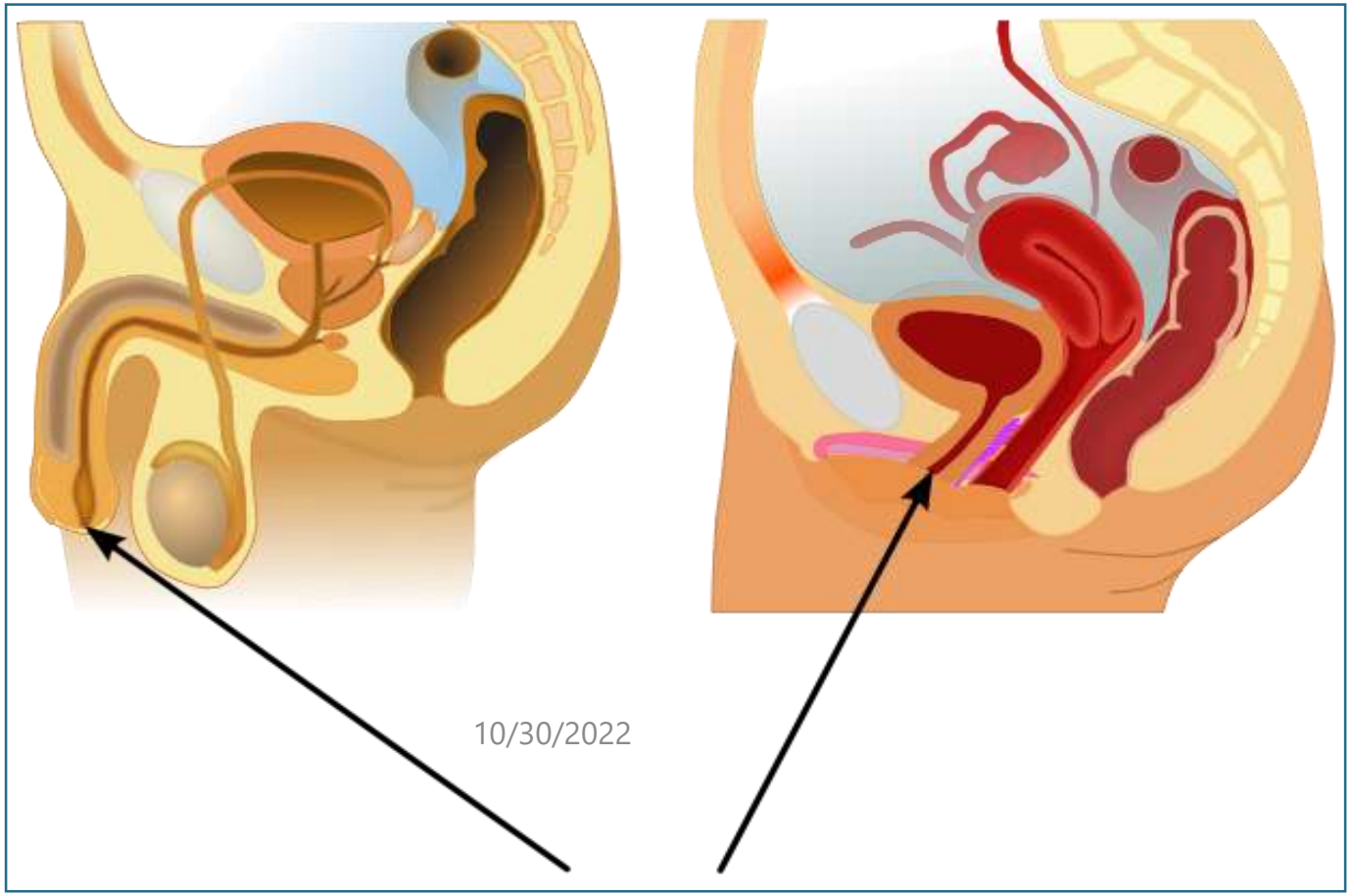
Renal regulation of extracellular fluid volume and osmolality

- ✓In order for our body cells to function properly, they must be surrounded in extracellular fluid that is relatively constant with regard to osmolality.

- ✓The kidneys, in concert with neural and endocrine input, regulate the volume and osmolality of the extracellular fluid by altering the amount of sodium and water excreted.

- ✓This is accomplished primarily through alterations in sodium and water reabsorption, the mechanisms of which differ within each nephron segment.

Urethra



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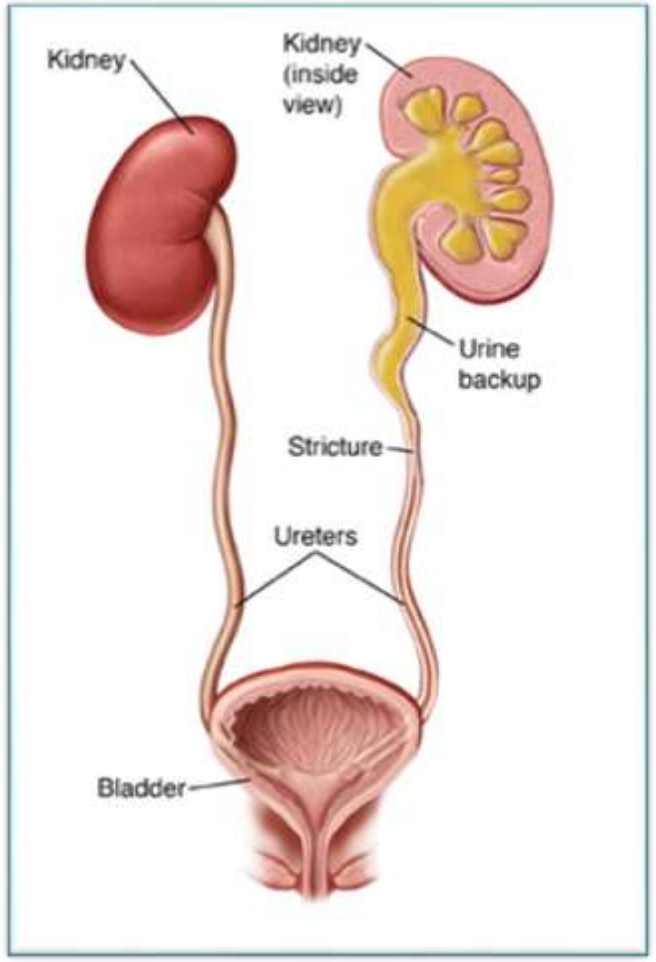
Ureter

- Each ureter is a small tube, about 25 cm long, that carries urine from the renal pelvis to the urinary bladder. It descends from the renal pelvis, and enters the urinary bladder.

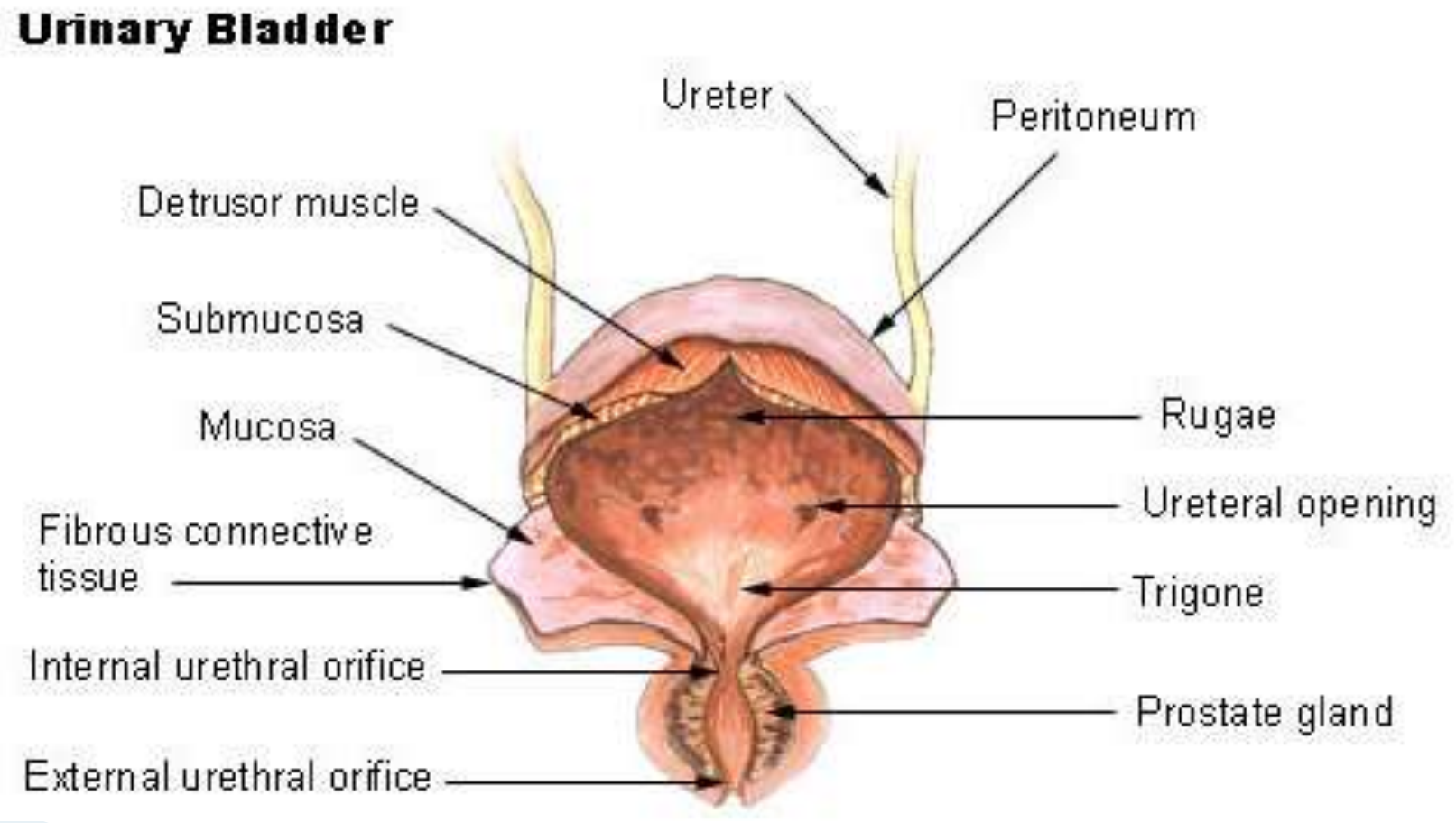
- **The wall of the ureter consists of three layers:**
- (1)The outer layer, the fibrous coat, is a supporting layer of fibrous connective tissue.

- (2)The middle layer, the muscular coat, consists of the inner circular and outer longitudinal smooth muscle. The main function of this layer is peristalsis: to propel the urine.

- (3) The inner layer, the mucosa, is transitional epithelium that is continuous with the lining of the renal pelvis and the urinary bladder. This layer secretes mucus, which coats and protects the surface of the cells.



Urinary bladder



Urinary bladder

The urinary bladder is a temporary storage reservoir for urine.
The size and shape of the urinary bladder varies with the amount of urine it contains and with the pressure it receives from surrounding organs.

(1)The inner lining of the urinary bladder is a mucous membrane of transitional epithelium that is continuous with that in the ureters. When the bladder is empty, the mucosa has numerous folds called rugae. The rugae and transitional epithelium allow the bladder to expand as it fills.

(2)The second layer in the walls is the submucosa, which supports the mucous membrane. It is composed of connective tissue with elastic fibers.

(3)The next layer is the muscularis, which is composed of smooth muscle. Contraction of this muscle expels urine from the bladder.

Urinary bladder

There is a triangular area, called the trigone, formed by three openings in the floor of the urinary bladder. Two of the openings are from the ureters and form the base of the trigone. Small flaps of mucosa cover these openings and act as valves that allow urine to enter the bladder but prevent it from backing up from the bladder into the ureters. The third opening, at the apex of the trigone, is the opening into the urethra. A band of the detrusor muscle encircles this opening to form the internal urethral sphincter.

Urethra

The final passageway for the flow of urine is the urethra, a thin-walled tube that conveys urine from the floor of the urinary bladder to the outside. The opening to the outside is the external urethral orifice. The mucosal lining of the urethra is transitional epithelium. The wall also contains smooth muscle fibers and is supported by connective tissue.

Urethra

The internal urethral sphincter surrounds the beginning of the urethra, where it leaves the urinary bladder. This sphincter is smooth (involuntary) muscle. Another sphincter, the external urethral sphincter, is skeletal (voluntary) muscle and encircles the urethra where it goes through the pelvic floor. These two sphincters control the flow of urine through the urethra.

In females, the urethra is short, only 3 to 4 cm (about 1.5 inches) long. The external urethral orifice opens to the outside just anterior to the opening for the vagina.

Urethra

In males, the urethra is much longer, about 20 cm (7 to 8 inches) in length, and transports both urine and semen. The first part, next to the urinary bladder, passes through the prostate gland and is called the prostatic urethra. The second part, a short region that penetrates the pelvic floor and enters the penis, is called the membranous urethra.

The third part, the spongy urethra, is the longest region. This portion of the urethra extends the entire length of the penis, and the external urethral orifice opens to the outside at the tip of the penis.

Review: Introduction to the Urinary System

Here is what we have learned from *Introduction to the Urinary System*:

- The urinary system rids the body of waste materials, regulates fluid volume, maintains electrolyte concentrations in body fluids, controls blood pH, secretes erythropoietin, and renin.
- The components of the urinary system are the kidneys, ureters, urinary bladder, and urethra.
- The primary organs of the urinary system are the kidneys, which are located retroperitoneally between the levels of the twelfth thoracic and third lumbar vertebrae.
- The cortex and medulla make up the parenchyma of the kidney.

Here is what we have learned from *Introduction to the Urinary System*:

- The functional unit of the kidney is a nephron, which consists of a renal corpuscle and a renal tubule.
- The ureters transport urine from the kidney to the urinary bladder.
- The urinary bladder is a temporary storage reservoir for urine.
- The urethra is the final passageway for the flow of urine.
- The flow of urine through the urethra is controlled by an involuntary internal urethral sphincter and voluntary external urethral sphincter.

References

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- Review: Introduction to the Urinary System | SEER Training (cancer.gov)

- Human physiology, Stuart Ira Fox.
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