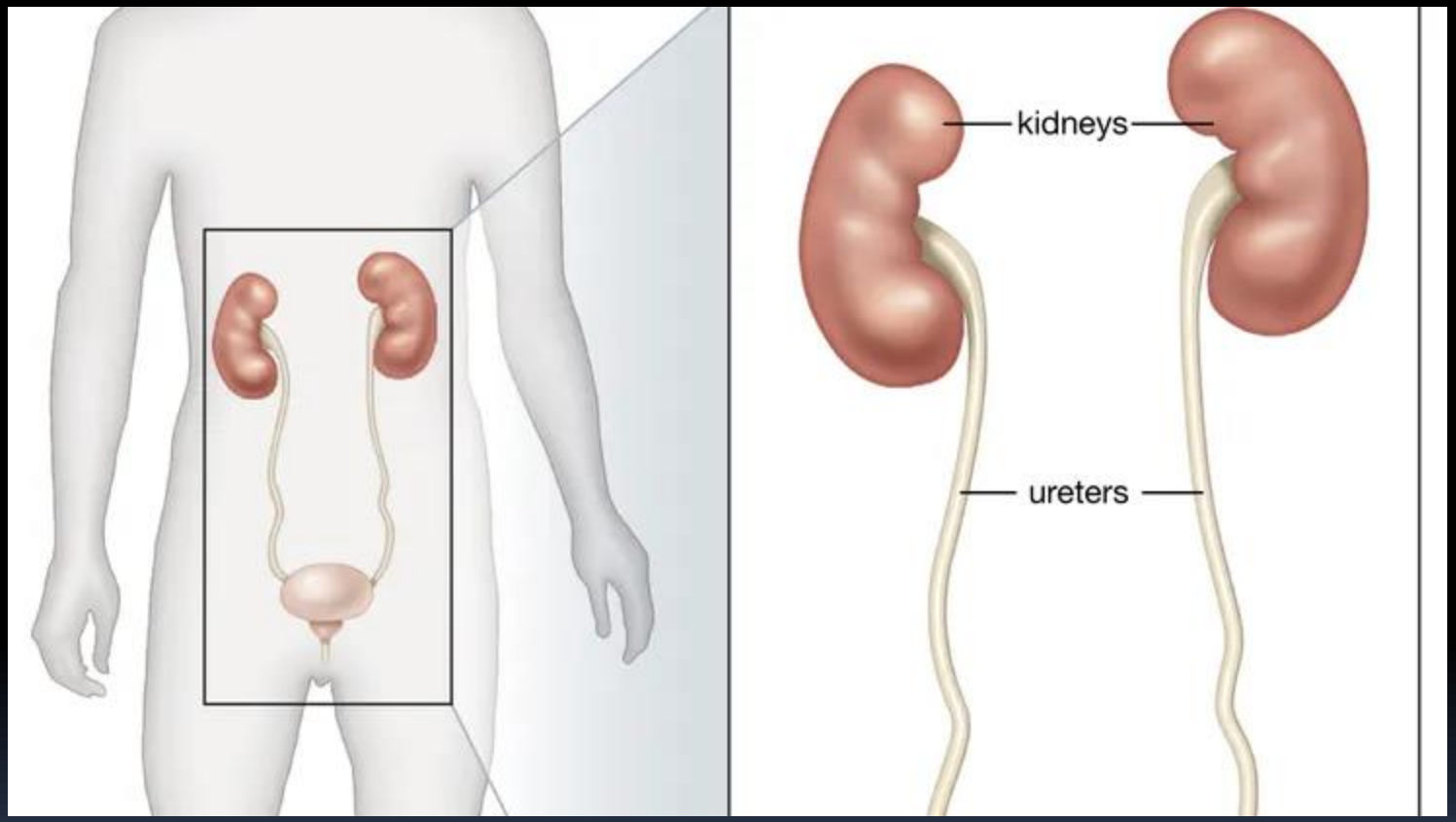
Physiology of Renal System

8th Lecture

2nd Term


kidneys
ureters

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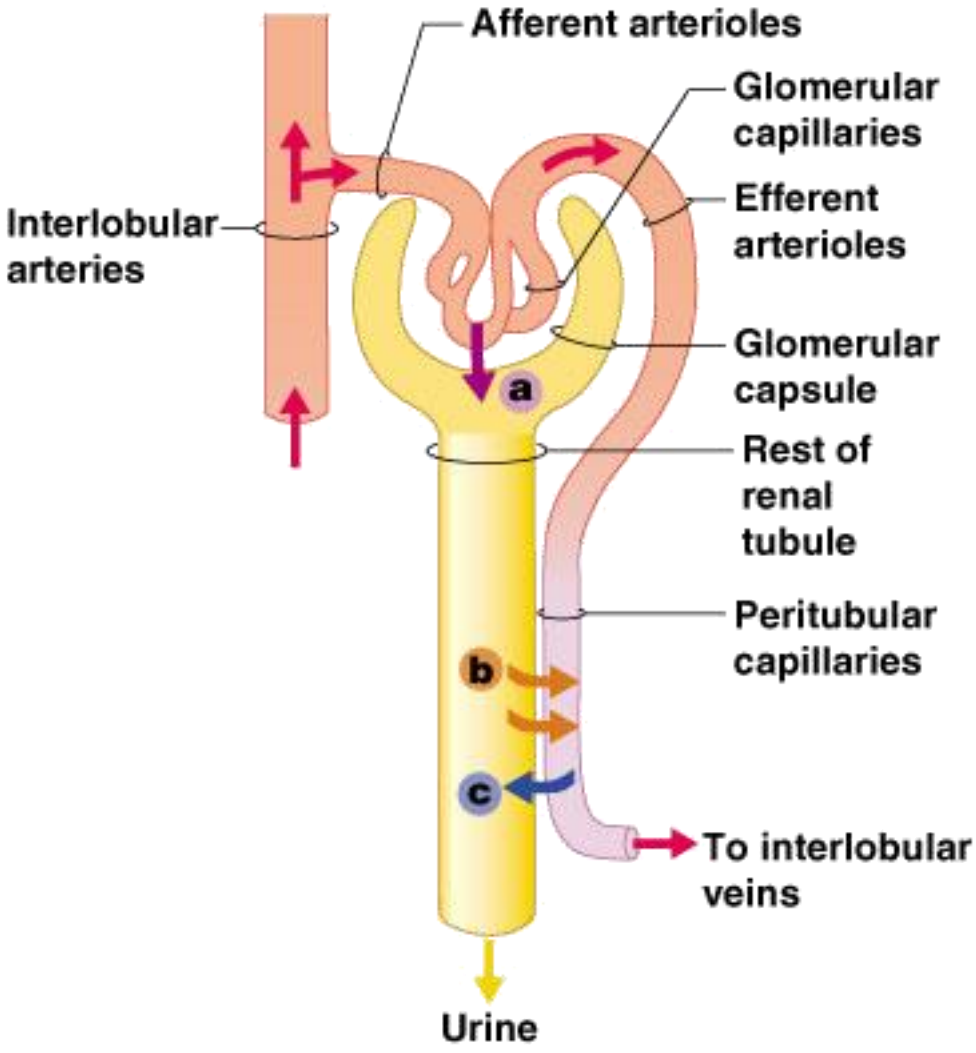
Urine Formation Processes

Filtration- Water & solutes smaller than proteins are forced through the capillary walls and pores (of the glomerulus) into the renal tubule (Bowman's capsule).

Reabsorption- Water, glucose, amino acids & needed ions are transported out of the filtrate into the peritubular capillary cells and then enter the capillary blood.

Secretion- Hydrogen ions, Potassium ions, creatinine & drugs are removed from the peritubular capillaries (blood) and secreted by the peritubular capillary cells into the filtrate.


Afferent arterioles
Glomerular capillaries
Efferent arterioles
Interlobular arteries
Glomerular capsule
a
Rest of renal tubule
Peritubular capillaries
b
c
To interlobular veins
Urine

Filtration

Beginning step of urine formation

Occurs at the glomerulus, nonselective passive process

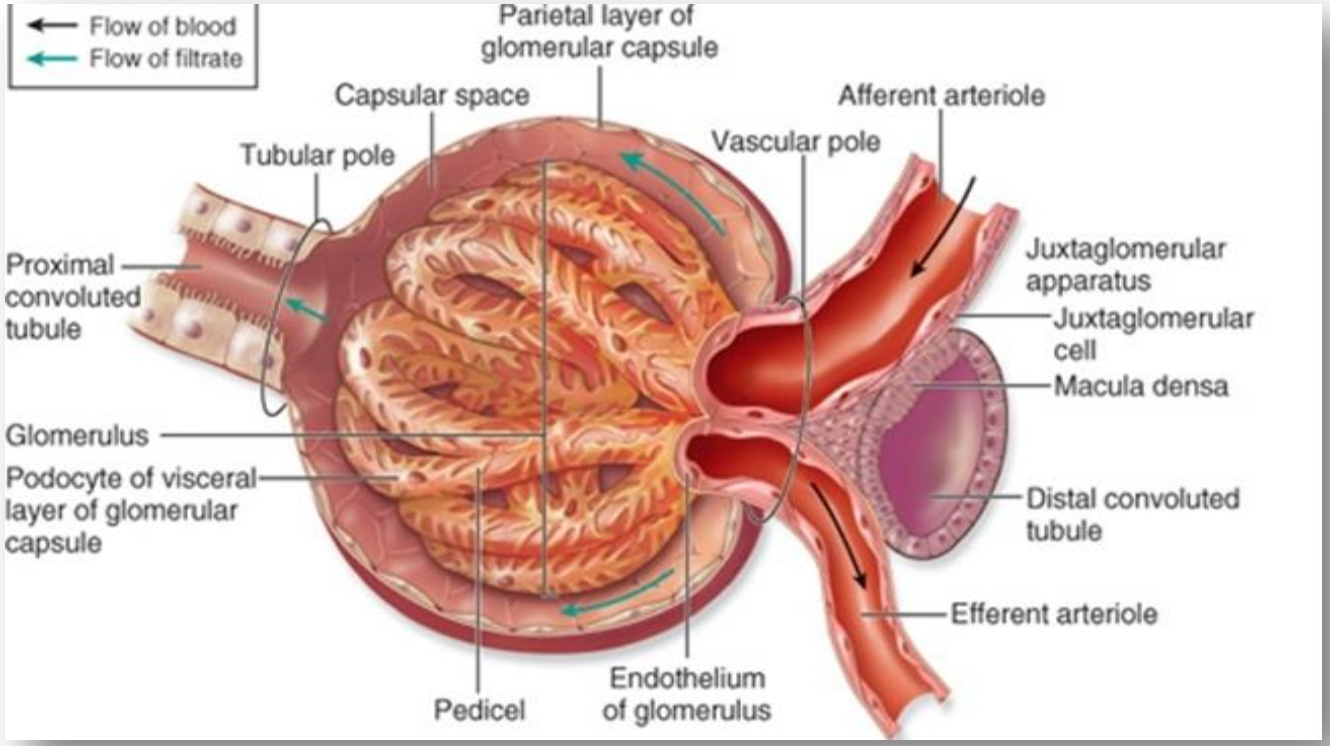
- **Water and solutes smaller than proteins are forced through capillary walls of the glomerulus, which act as a filter.**

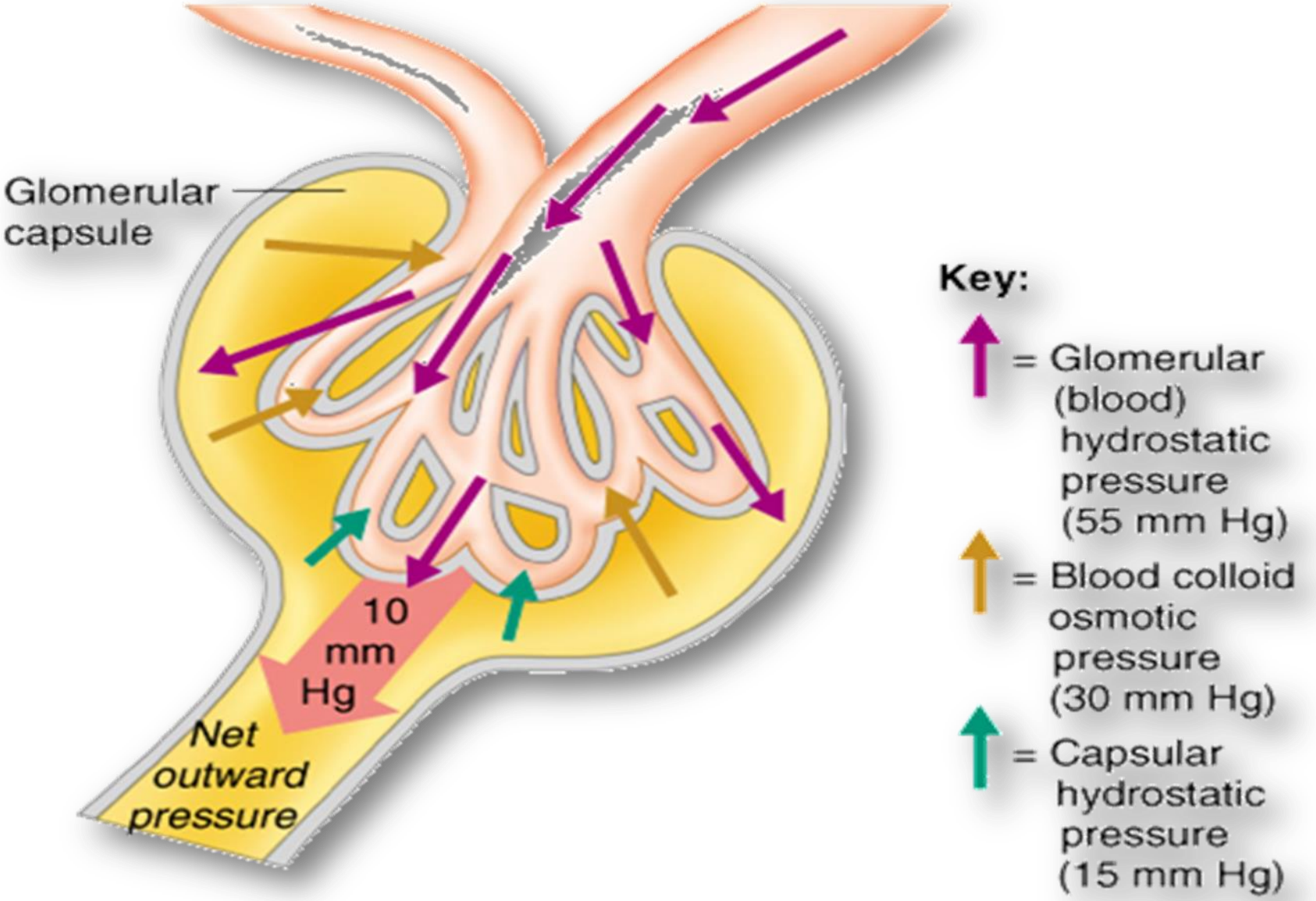
Fenestrations – (openings in glomerular walls) make glomerulus more permeable than other arterioles.

Podocytes cover capillaries, make membrane impermeable to plasma proteins.

- **Blood cells cannot pass out to the capillaries; filtrate is essentially blood plasma w/o blood proteins, blood cells.**

Filtrate is collected in the glomerular (Bowman's) capsule and leaves via the renal tubule.


Flow of blood
Flow of filtrate
Parietal layer of glomerular capsule
Capsular space
Afferent arteriole
Tubular pole
Vascular pole
Proximal convoluted tubule
Juxtaglomerular apparatus
Juxtaglomerular cell
Macula densa
Glomerulus
Podocyte of visceral layer of glomerular capsule
Distal convoluted tubule
Efferent arteriole
Pedicel
Endothelium of glomerulus


Glomerular capsule
10 mm Hg
Net outward pressure
Key:
= Glomerular (blood) hydrostatic pressure (55 mm Hg)
= Blood colloid osmotic pressure (30 mm Hg)
= Capsular hydrostatic pressure (15 mm Hg)

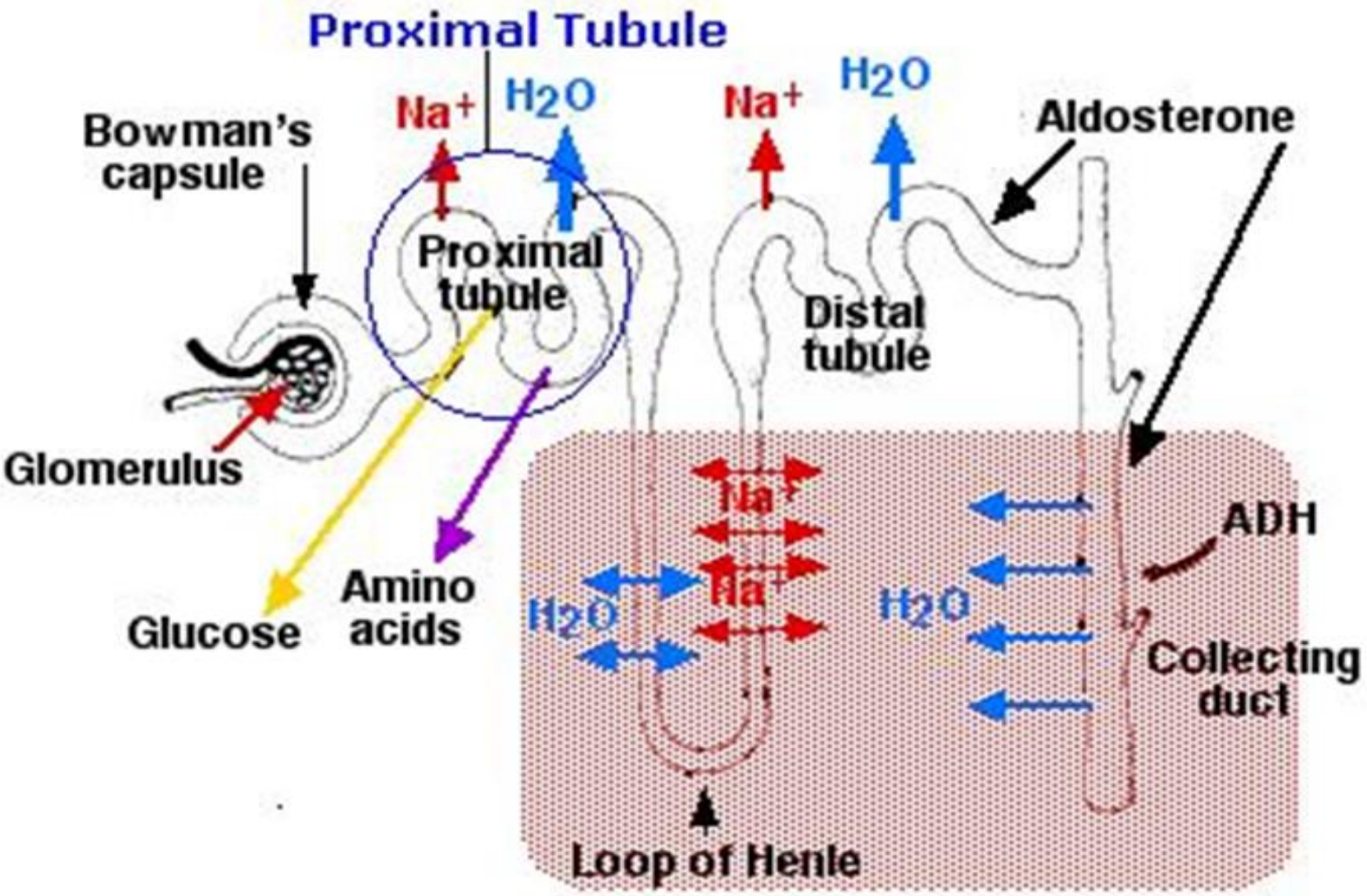
Reabsorption – sodium and water

The sodium potassium pump reabsorbs 70% of sodium ions in the PCT.

- **The positive sodium ions attract negative ions across the membrane as well**
- **Water reabsorption occurs passively across the membrane to areas of high solute concentration**
  - **Therefore, more sodium reabsorption = more water reabsorption**

Active transport of sodium ions occurs along remainder of nephron and collecting duct.

- **Almost all sodium ions and water are reabsorbed.**


Proximal Tubule
Na+
H2O
Na+
H2O
Aldosterone
Bowman's capsule
Proximal tubule
Distal tubule
Glomerulus
Glucose
Amino acids
Na+
Na+
H2O
H2O
ADH
Collecting duct
Loop of Henle

Materials Not Reabsorbed

- **Nitrogenous waste products**
  - **Urea – formed by liver; end product of protein breakdown when amino acids are used to produce energy**
  - **Uric acid – released when nucleic acids are metabolized**
  - **Creatinine – associated with creatine metabolism in muscle tissue**
- **Excess water**

Secretion – Reabsorption in Reverse

Some materials move from the peritubular capillaries into the renal tubules to be eliminated in urine.

Example:

Hydrogen ions; potassium ions

Creatinine

Drugs; penicillin; histamine

Process is important for getting rid of substances not already in the filtrate or for controlling pH.

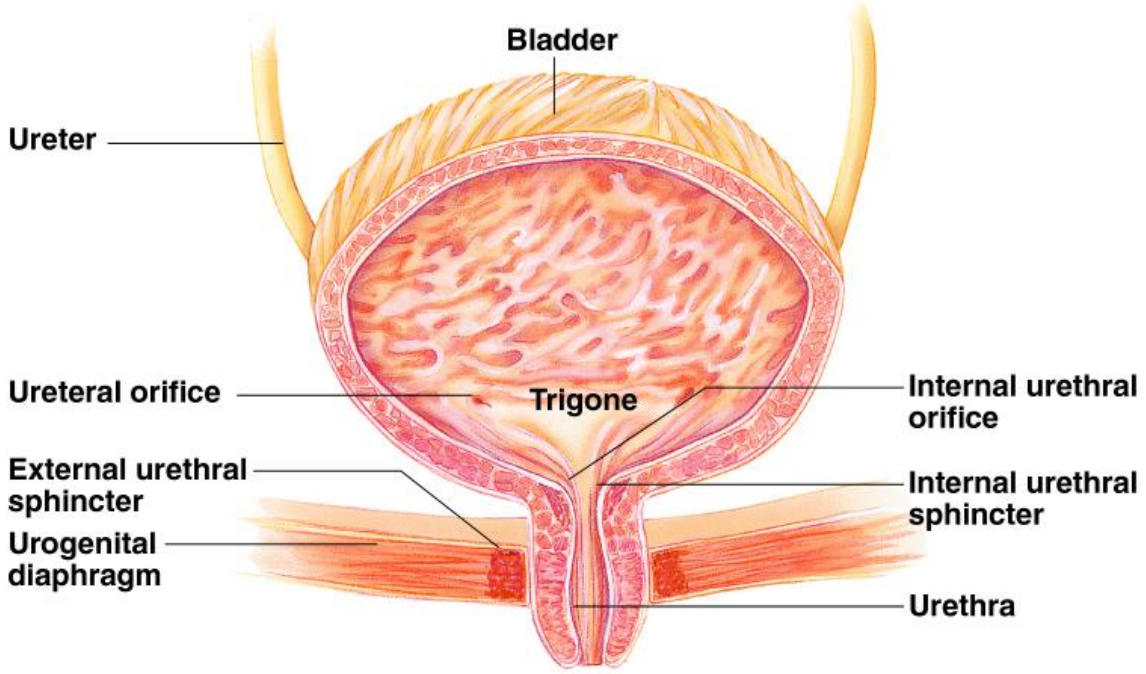
Materials left in the renal tubule move toward the ureter

Urinary Bladder

Smooth, collapsible, muscular sac

Temporarily stores urine

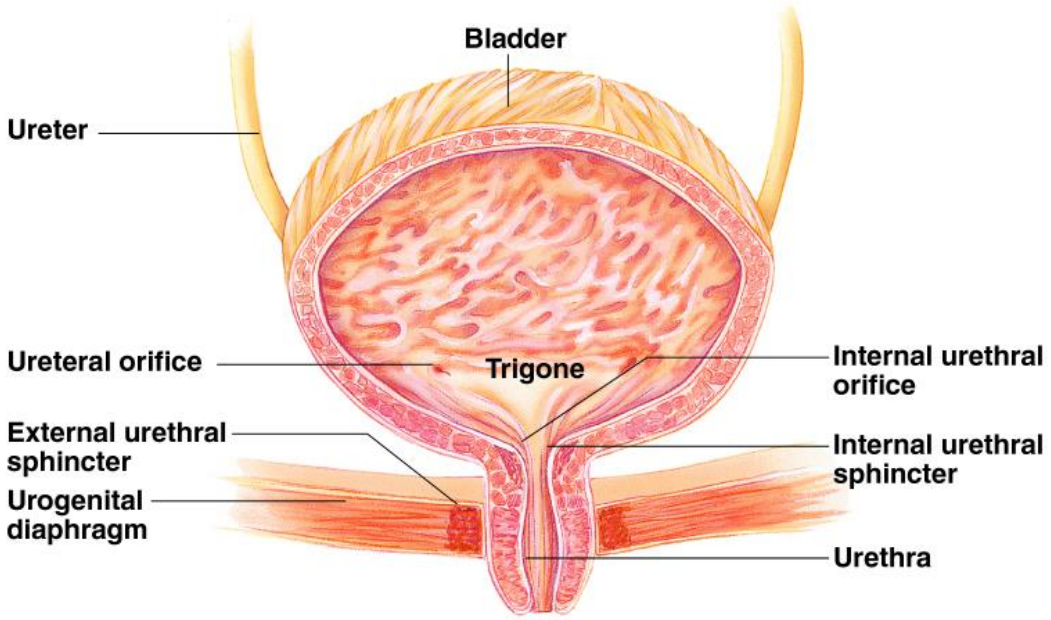
Located retroperitoneally in the pelvis posterior to the pubic symphysis.



Urinary Bladder

Trigone – three openings

- **Two from the ureters (ureteral orifices)**
- **One to the urethra (internal urethral orifice) which drains the bladder.**
- **Common site for bacterial infections**
- **In males, prostate gland surrounds the neck of the bladder where it empties into the urethra.**



Urethra

Thin-walled tube that carries urine from the bladder to the outside of the body by peristalsis

Release of urine is controlled by two sphincters

- **Internal urethral sphincter (involuntary) – a thickening of smooth muscle at the bladder-urethra jxn. keeps urethra closed when urine is not being passed.**
- **External urethral sphincter (voluntary) -- skeletal muscle that controls urine as the urethra passes through the pelvic floor.**

Micturition (Voiding)

Both sphincter muscles must open to allow voiding

- **The internal urethral sphincter is relaxed after stretching of the bladder ~200mL**
- **Activation is from an impulse sent to the spinal cord and then back via the pelvic nerves**
- **The external urethral sphincter must be voluntarily relaxed**
- **Incontinence-inability to control micturition**
- **Retention-inability to micturate**