

HUMAN ANATOMY AND PHYSIOLOGY-II

URINARY SYSTEM

(Physiology of urine formation)



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Physiology of the Urine formation

Every day, the kidneys filter gallons of fluid from the bloodstream. The normal physiology that takes place in the urinary system are as follows:

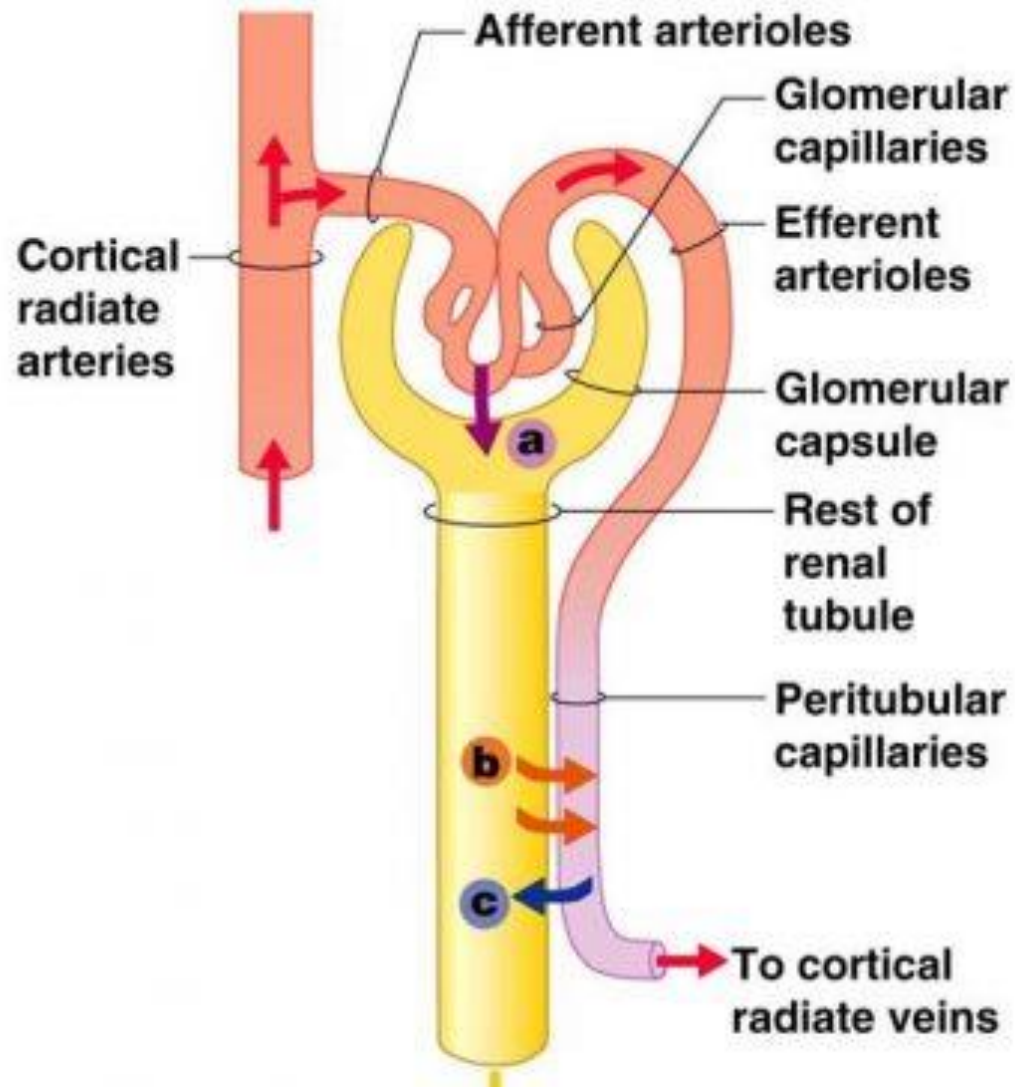
Urine Formation:

Urine formation is a result of three processes:

Glomerular filtration. Water and solutes smaller than proteins are forced through the capillary walls and pores of the glomerular capsule into the renal tubule.

Tubular reabsorption. Water, [glucose](#), amino acids, and needed ions are transported out of the filtrate into the tubule cells and then enter the capillary blood.

Tubular secretion. Hydrogen, [potassium](#), [creatinine](#), and drugs are removed from the peritubular blood and secreted by the tubule cells into the filtrate.

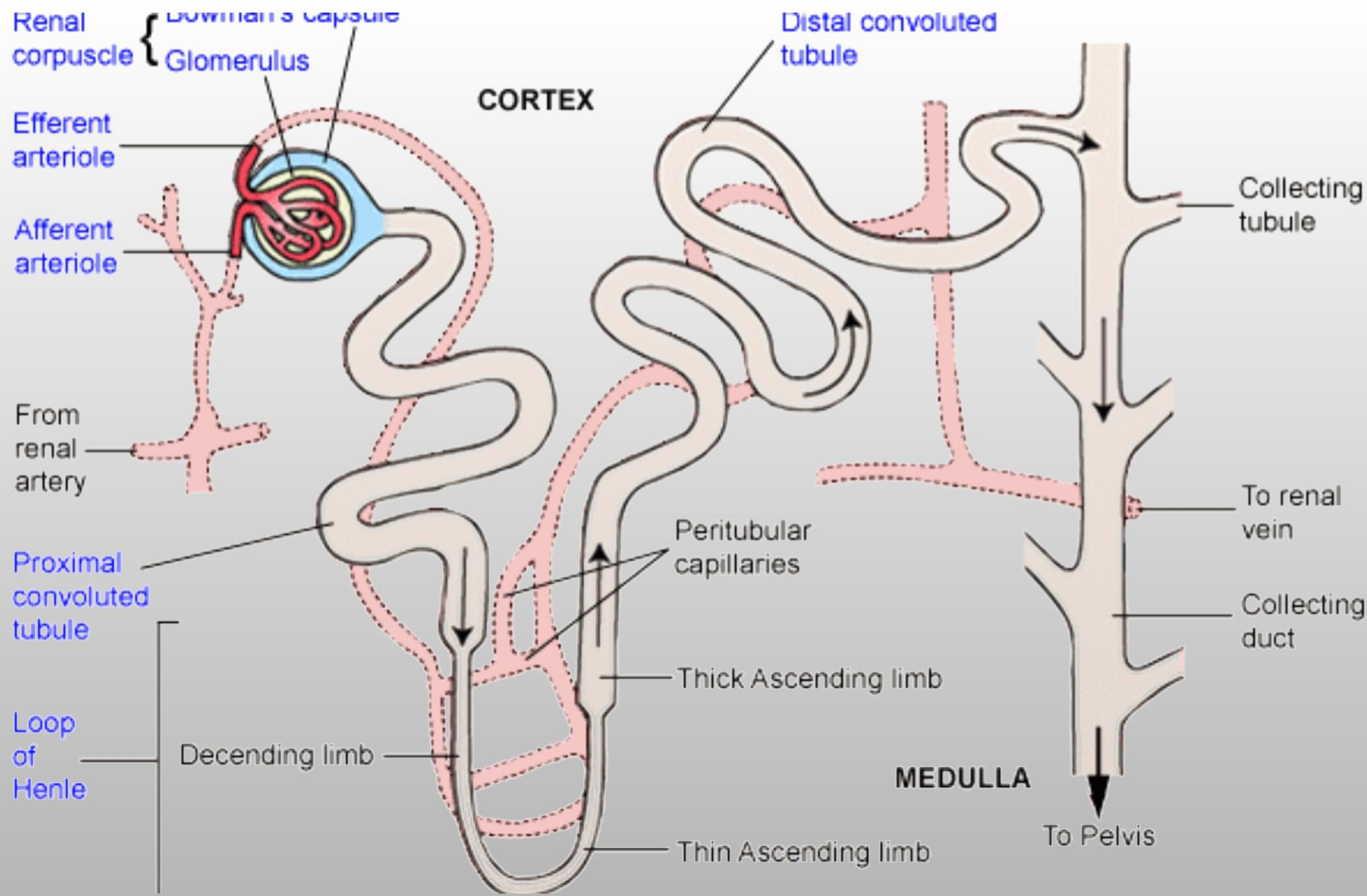


KEY:

a **Glomerular Filtration:** Water and solutes smaller than proteins are forced through the capillary walls and pores of the glomerular capsule into the renal tubule.

b **Tubular Reabsorption:** Water, glucose, amino acids, and needed ions are transported out of the filtrate into the tubule cells and then enter the capillary blood.

c **Tubular Secretion:** H^+ , K^+ , creatinine, and drugs are removed from the peritubular



Glomerular Filtration

Glomerular filtration occurs as blood passes into the glomerulus producing a plasma-like filtrate (minus proteins) that gets captured by the Bowman's (glomerular) capsule and funneled into the renal tubule.

This filtrate produced then becomes highly modified along its route through the nephron by the following processes, finally producing urine at the end of the collecting duct.

Tubular Reabsorption

- As the filtrate travels along the length of the nephron, the cells lining the tubule selectively, and often actively, take substances from the filtrate and move them out of the tubule into the blood.
- Recall that the glomerulus is simply a filter and anything suspended in the plasma that can fit through the holes in the filtration membrane can end up in the filtrate.
- This includes very physiologically important molecules such as water, sodium, chloride, and bicarbonate (along with many others) as well as molecules that the digestive system used a lot of energy to absorb, such as glucose and amino acids.
- These molecules would be lost in the urine if not reclaimed by the tubule cells.
- These cells are so efficient that they can reclaim all of the glucose and amino acids and up to 99% of the water and important ions lost due to glomerular filtration.
- The filtrate that is not reabsorbed becomes urine at the base of the collecting duct.

Tubular Secretion

- Tubular secretion occurs mostly in the PCT and DCT where unfiltered substances are moved from the peritubular capillary into the lumen of the tubule.
- Secretion usually removes substances from the blood that are too large to be filtered (ex: antibiotics, toxins) or those that are in excess in the blood (ex: H^+ , K^+).
- These substances secreted into the tubule are destined to leave the body as components of urine.

Characteristics of Urine

- In 24 hours, the marvelously complex kidneys filter some 150 to 180 liters of blood plasma through their glomeruli into the tubules.
- **Daily volume:** In 24 hours, only about 1.0 to 1.8 liters of urine are produced.
- **Components:** Urine contains nitrogenous wastes and unneeded substances.
- **Color:** Freshly voided urine is generally clear and pale to deep yellow.
- **Odor:** When formed, urine is sterile and slightly aromatic, but if allowed to stand, it takes on an ammonia odor caused by the action of bacteria on the urine solutes.
- **pH :** Urine pH is usually slightly acidic (around 6), but changes in body metabolism and certain foods may cause it to be much more acidic or basic.
- **Specific gravity:** Whereas the specific gravity of pure water is 1.0, the specific gravity of urine usually ranges from 1.001 to 1.035.
- **Solutes:** Solutes normally found in urine include sodium and potassium ions, urea, uric acid, creatinine, ammonia, bicarbonate ions, and various other ions.

Micturition

- Micturition or voiding is the act of emptying the bladder.
- **Accumulation:** Ordinarily, the bladder continues to collect urine until about 200 ml have accumulated.
- **Activation:** At about this point, stretching of the bladder wall activates stretch receptors.
- **Transmission:** Impulses transmitted to the sacral region of the spinal cord and then back to the bladder via the pelvic splanchnic nerves cause the bladder to go into reflex contractions.
- **Passage:** As the contractions become stronger, stored urine is forced past the internal urethral sphincter into the upper part of the urethra.
- **External sphincter :** Because the lower external sphincter is skeletal muscle and voluntarily controlled, we can choose to keep it closed or it can be relaxed so that urine is flushed from the body.