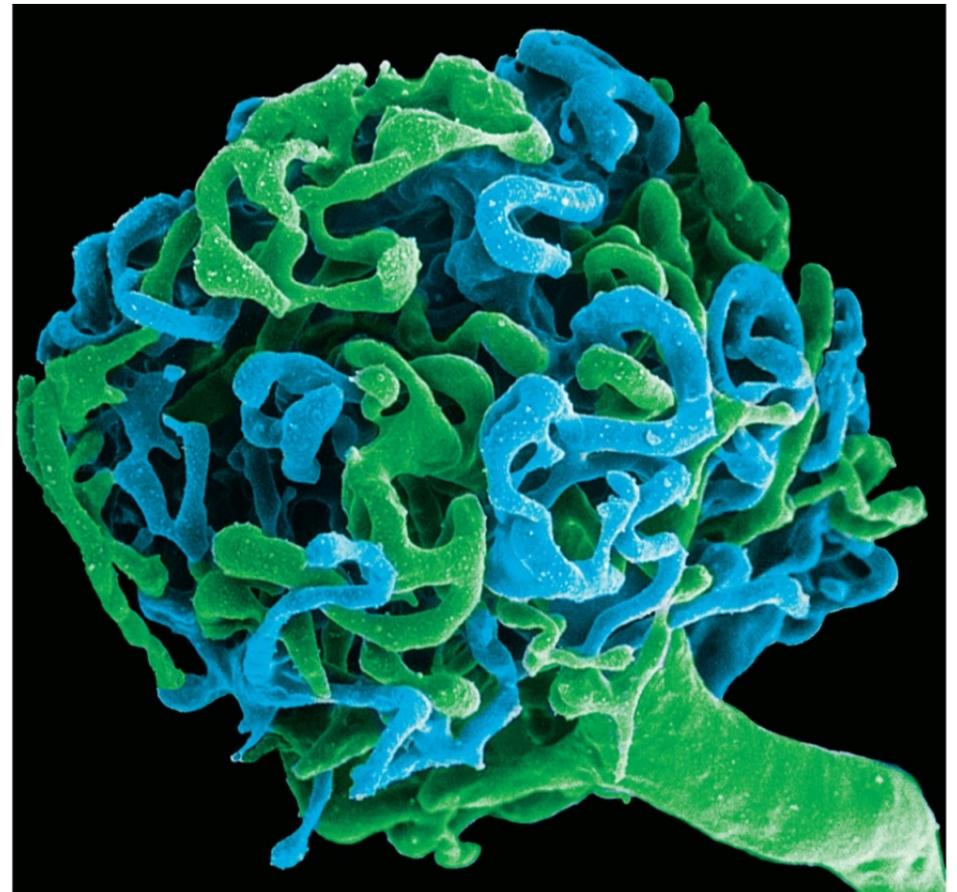


Chapter 23

The Nephron (functional unit of the kidney)



The Nephron

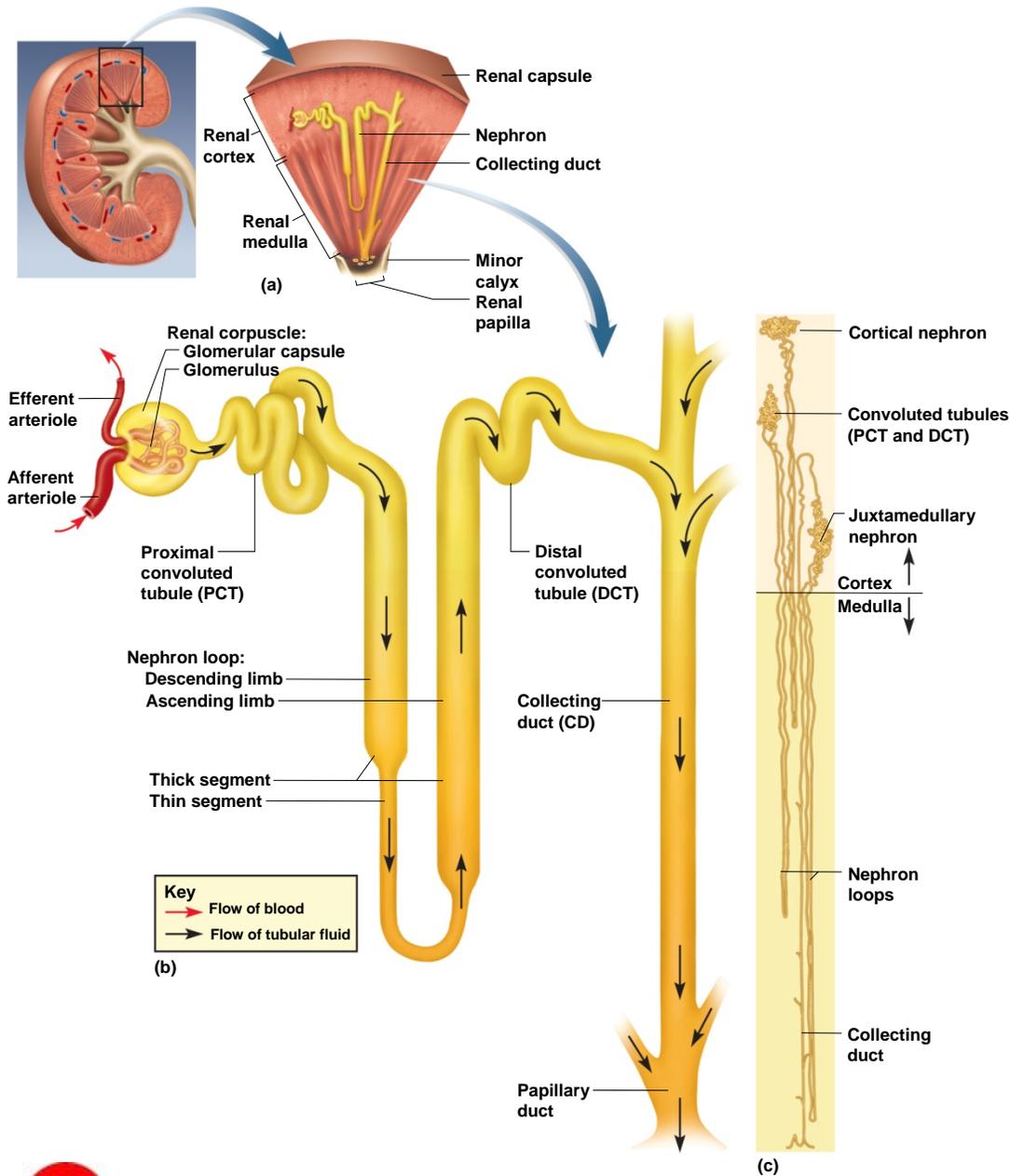
The nephron is the “functional unit” of a kidney

each kidney has about 1.2 million nephrons

The nephron is composed of two principal parts:

renal corpuscle – filters the blood plasma

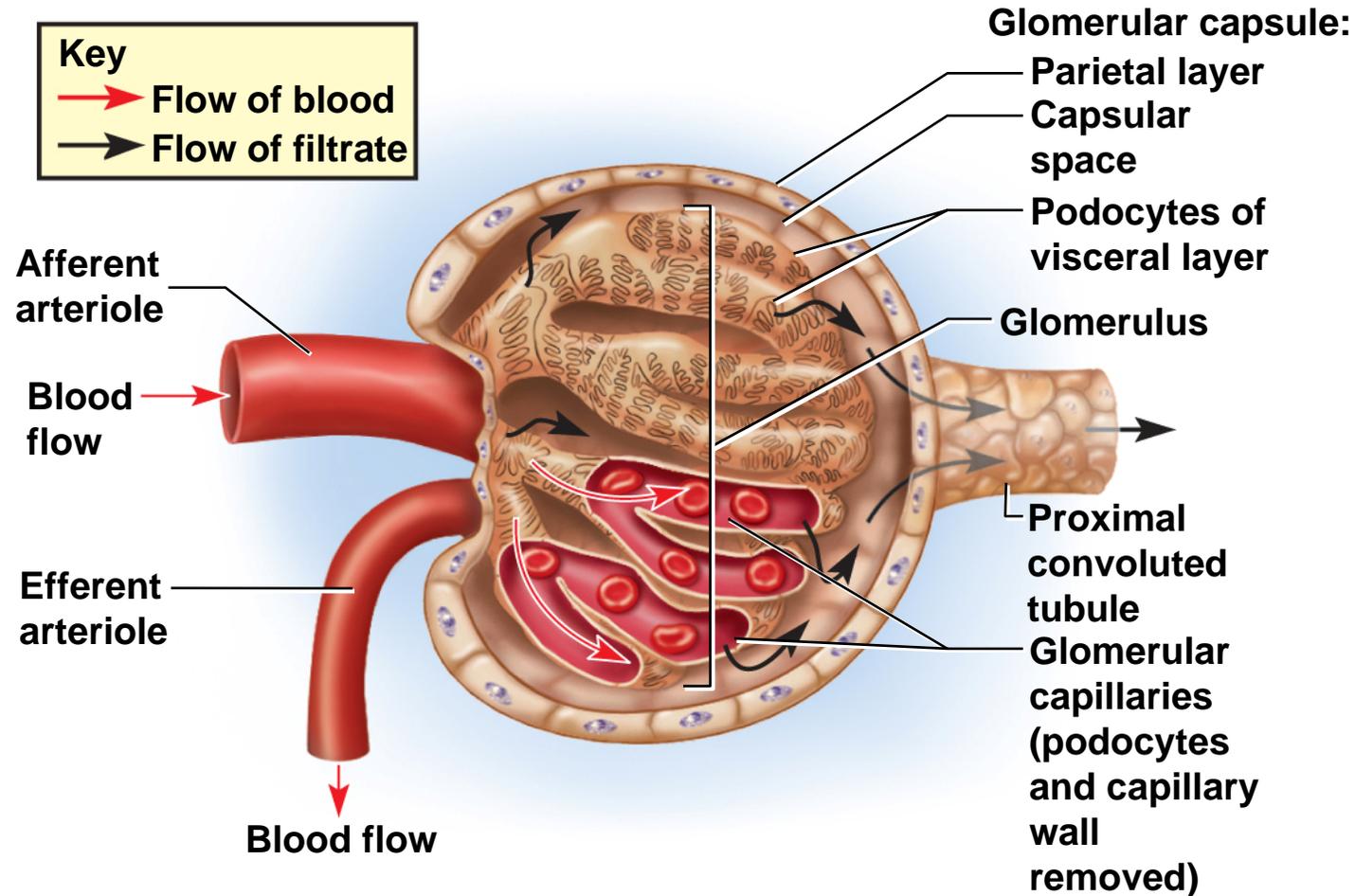
renal tubule – long coiled tube that converts the filtrate into urine



The Renal Corpuscle

- **renal corpuscle**
 - **Glomerulus**
 - Unique capillary bed
 - Designed to selectively filter solutes
 - **glomerular capsule (Bowman capsule)** that encloses glomerulus
 - **parietal (outer) layer of Bowman capsule** is simple squamous epithelium
 - **visceral (inner) layer of Bowman capsule** consists of elaborate cells called **podocytes** that wrap around the capillaries of the glomerulus
 - **capsular space** separates the two layers of Bowman capsule
 - Extension of this space at the “urinary pole” creates the nephron’s tubules
- **vascular pole** – the side of the corpuscle where the afferent arterial enter the corpuscle and the efferent arteriole leaves
- **urinary pole** – the opposite side of the corpuscle where the renal tubule begins

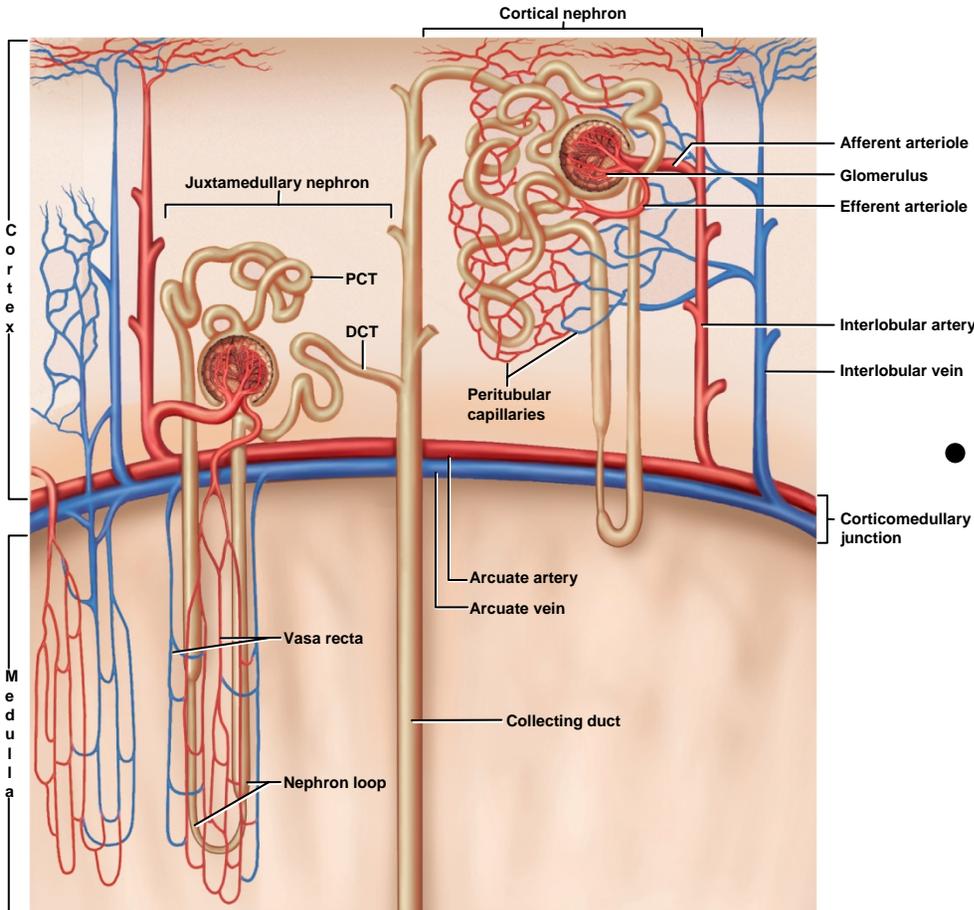
Renal Corpuscle



- glomerular filtrate collects in capsular space, flows into proximal convoluted tubule. *Note the vascular and urinary poles. Note the afferent arteriole is larger than the efferent arteriole.*

Cortical and Juxtamedullary Nephrons

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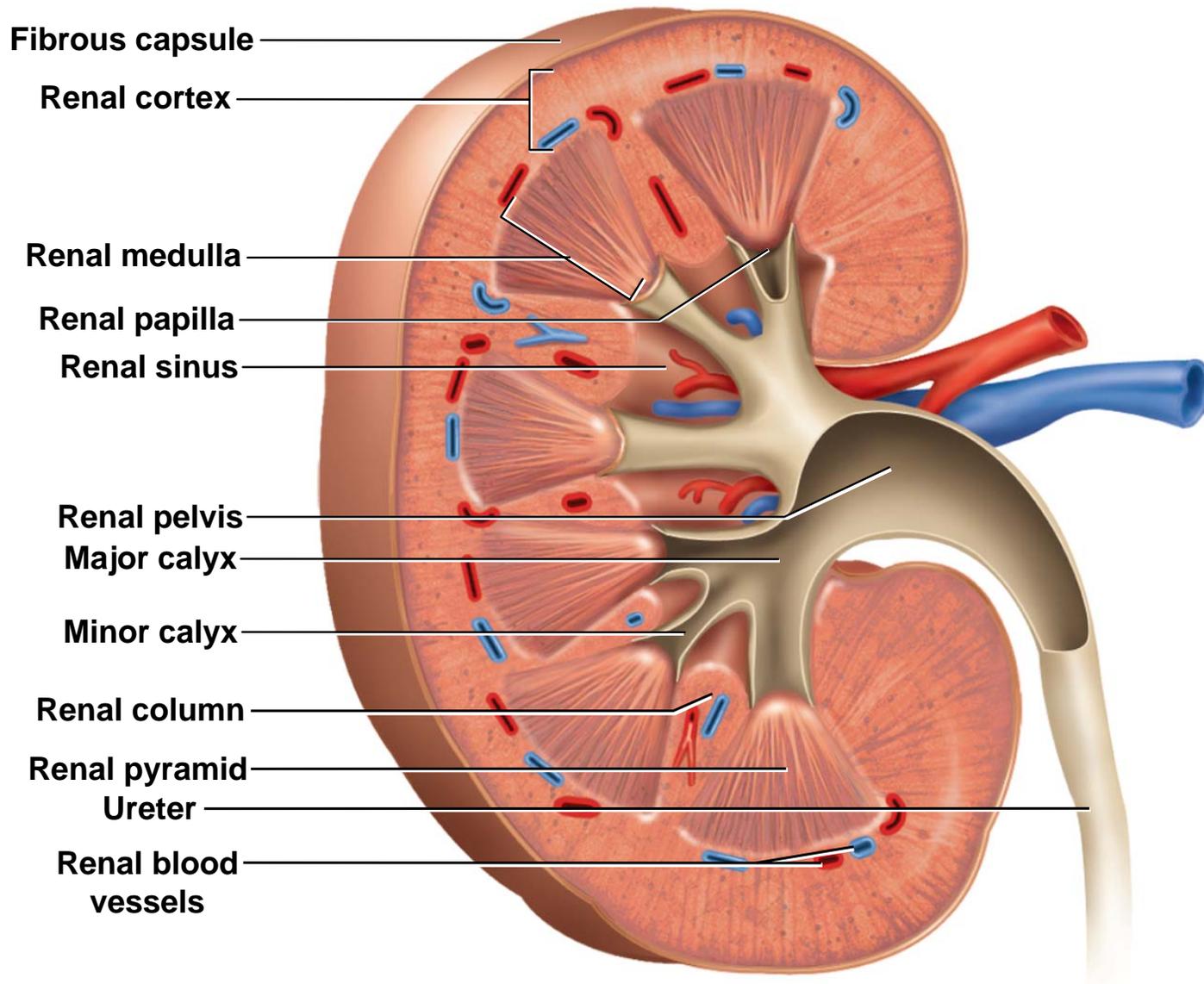
- **cortical nephrons**

- 85% of all nephrons
- short nephron loops
- efferent arterioles branch into **peritubular capillaries** around PCT and DCT

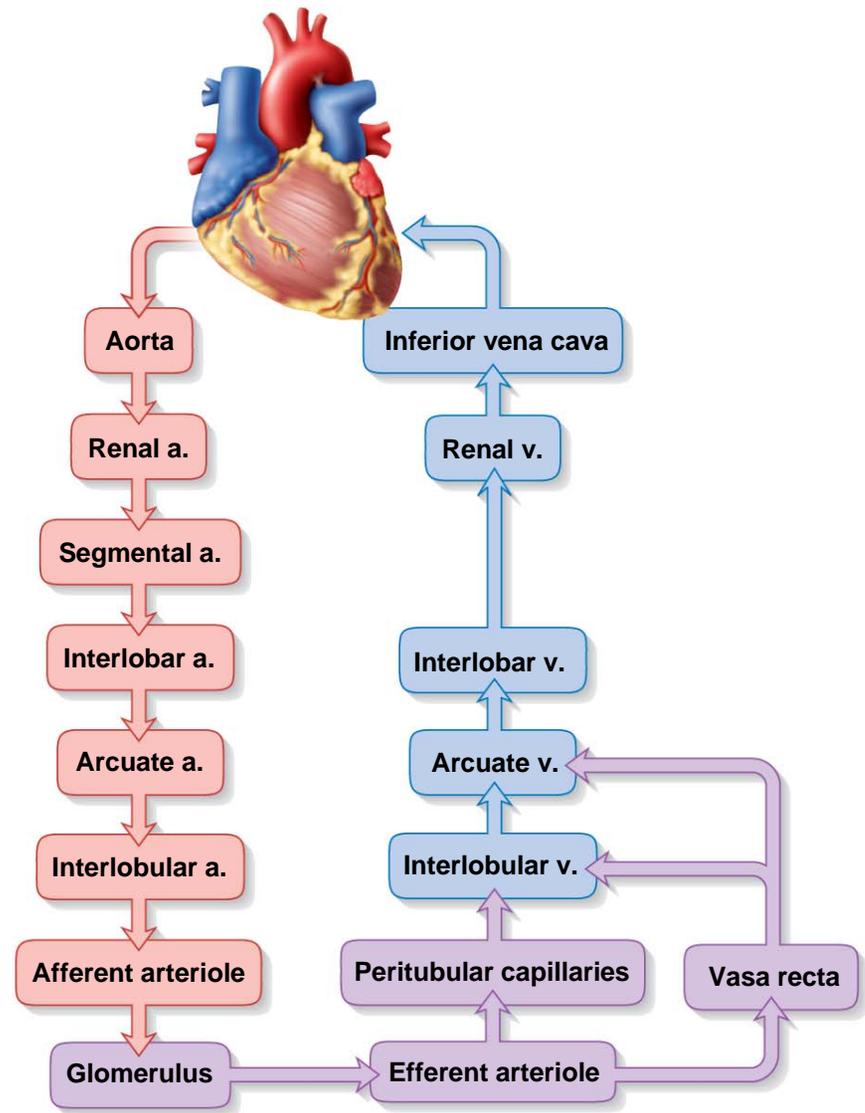
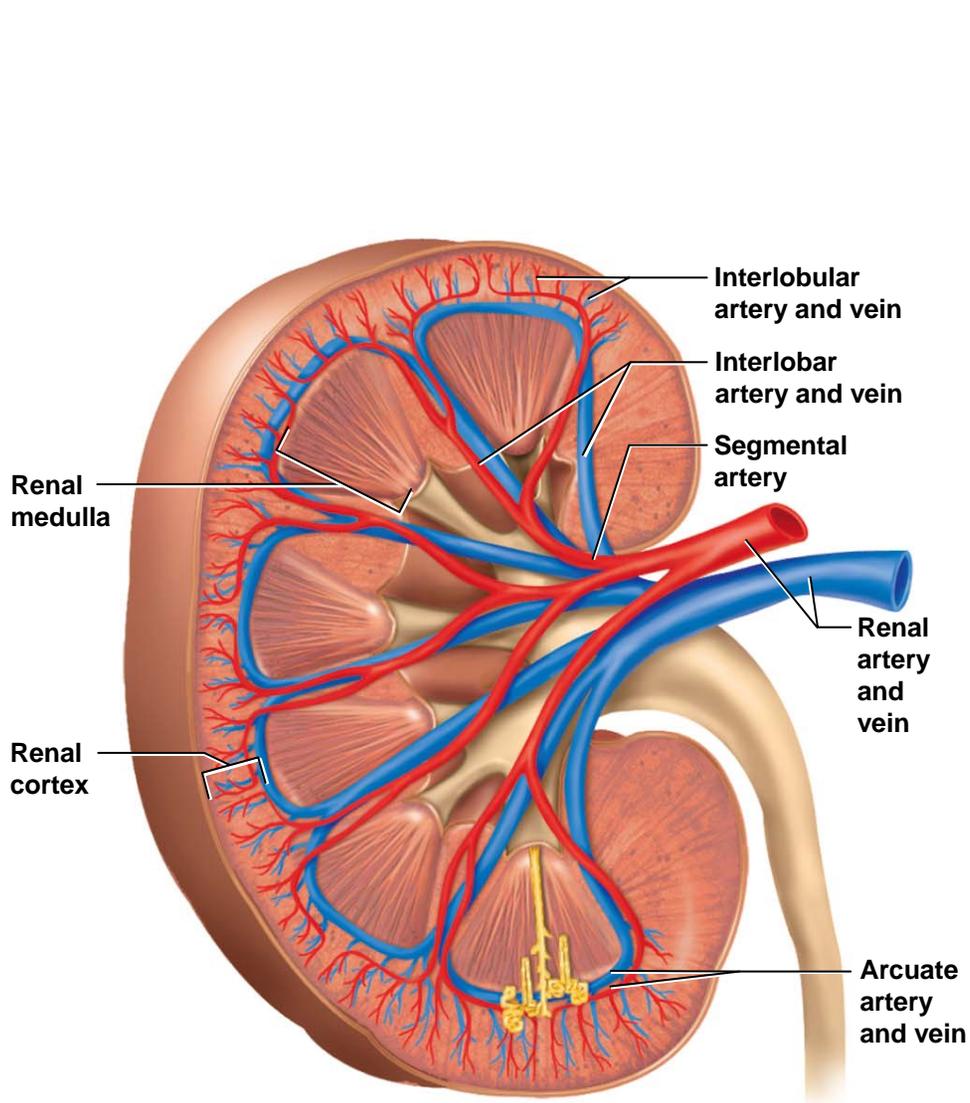
- **juxtamedullary nephrons**

- 15% of all nephrons
- very long nephron loops, maintain salinity gradient in the medulla and helps conserve water
- efferent arterioles branch into **vasa recta** around long nephron loop

Anatomy of Kidney



Blood Supply Diagram

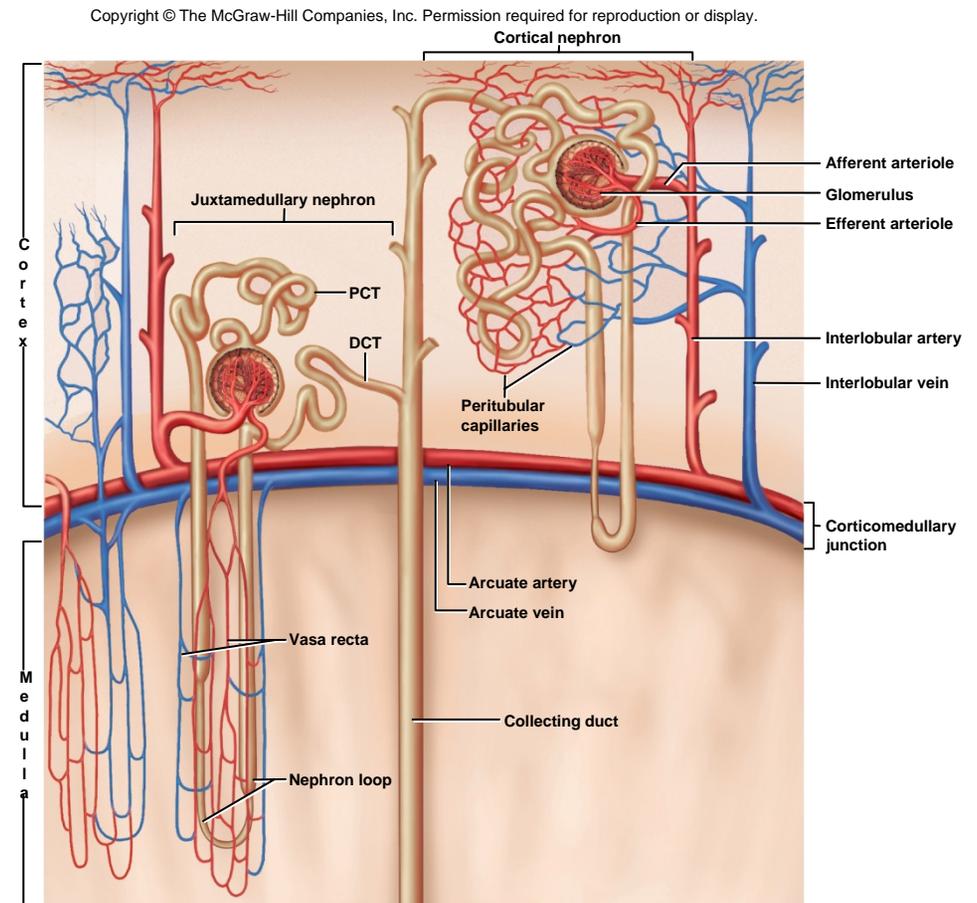


(b)

kidneys receive 21% of cardiac output

Microcirculation of the Kidney

- in the cortex,
peritubular capillaries branch off of the efferent arterioles supplying the tissue near the glomerulus, the proximal and distal convoluted tubules
- in medulla, the efferent arterioles give rise to the **vasa recta**, supplying the nephron loop portion of the nephron.



Renal Tubule

- **renal tubules (uriniferous)** – a duct that leads away from the glomerular capsule and ends at the tip of the medullary pyramid
- **divided into four regions –**
 - *proximal convoluted tubule*
 - *nephron loop*
 - *distal convoluted tubule*
 - *collecting duct*

Renal Tubule

- **proximal convoluted tubule (PCT)** – arises from glomerular capsule
 - longest and most coiled region
 - simple cuboidal epithelium with **prominent microvilli** for majority of absorption
- **nephron loop (loop of Henle)** – long U-shaped portion of renal tubule
 - descending limb and ascending limb
 - **thick segments** have simple cuboidal epithelium
 - initial part of descending limb and part or all of the ascending limb
 - heavily engaged in the active transport of salts and have many mitochondria
 - **thin segment** has simple squamous epithelium
 - forms lower part of descending limb
 - cells very permeable to water

Renal Tubule

- **distal convoluted tubule (DCT)** – begins shortly after the ascending limb reenters the cortex
 - shorter and less coiled than PCT
 - cuboidal epithelium without microvilli
 - DCT is the end of the nephron
- **collecting duct** – receives fluid from the DCTs of several nephrons as it passes back into the medulla
 - numerous collecting ducts converge toward the tip of the medullary pyramid
 - **papillary duct** – formed by merger of several collecting ducts
 - 30 papillary ducts end in the tip of each papilla
 - collecting and papillary ducts lined with simple cuboidal epithelium

Renal Tubule

This is the path for the flow of fluid from the point where the glomerular filtrate is formed to the point where urine leaves the body:

glomerular capsule →

proximal convoluted tubule →

nephron loop →

distal convoluted tubule →

collecting duct →

papillary duct →

minor calyx →

major calyx →

renal pelvis →

ureter →

urinary bladder →

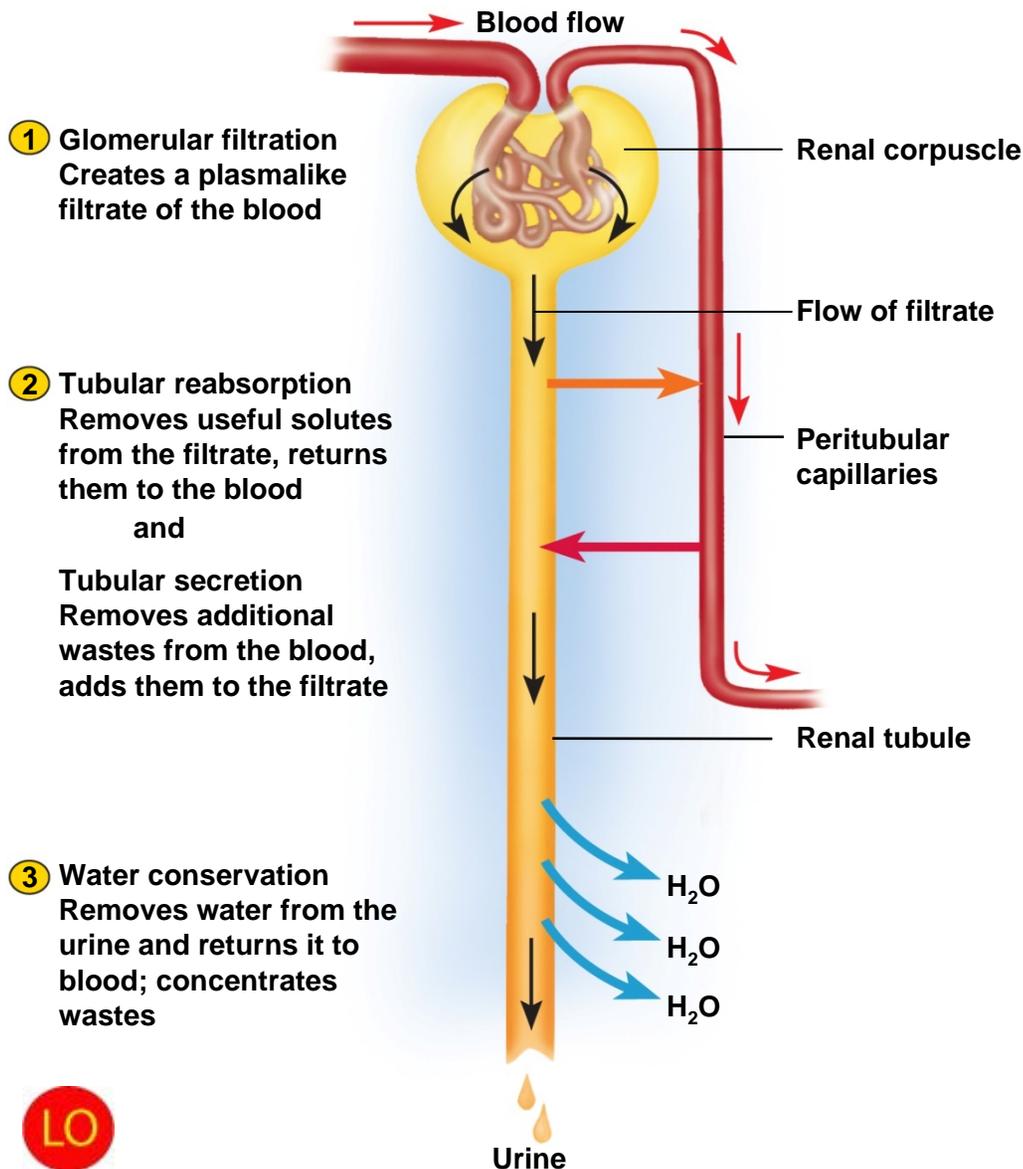
urethra → (use urethra to pass urine from body)



Renal Innervation

- **renal plexus** – nerves and ganglia wrapped around each renal artery
 - follows branches of the renal artery into the parenchyma of the kidney
 - issues nerve fibers to the blood vessels and convoluted tubules of the nephron
 - carries **sympathetic** innervation from the abdominal aortic plexus
 - stimulation **reduces glomerular blood flow and rate of urine production**
 - respond to falling blood pressure by stimulating the kidneys to secrete **renin**, an enzyme that activates hormonal mechanisms to restore blood pressure
 - carries **parasympathetic** innervation from the vagus nerve – **increases rate of urine production**

Overview of Urine Formation



- kidneys convert blood plasma to urine in four stages
 - **glomerular filtration**
 - **tubular reabsorption**
 - **tubular secretion**
 - **water conservation**
- **glomerular filtrate**
 - fluid in capsular space
 - blood plasma without protein
- **tubular fluid**
 - fluid in renal tubule
 - similar to above except tubular cells have removed and added substances
- **urine**
 - once it enters the collecting duct
 - only remaining change is water content