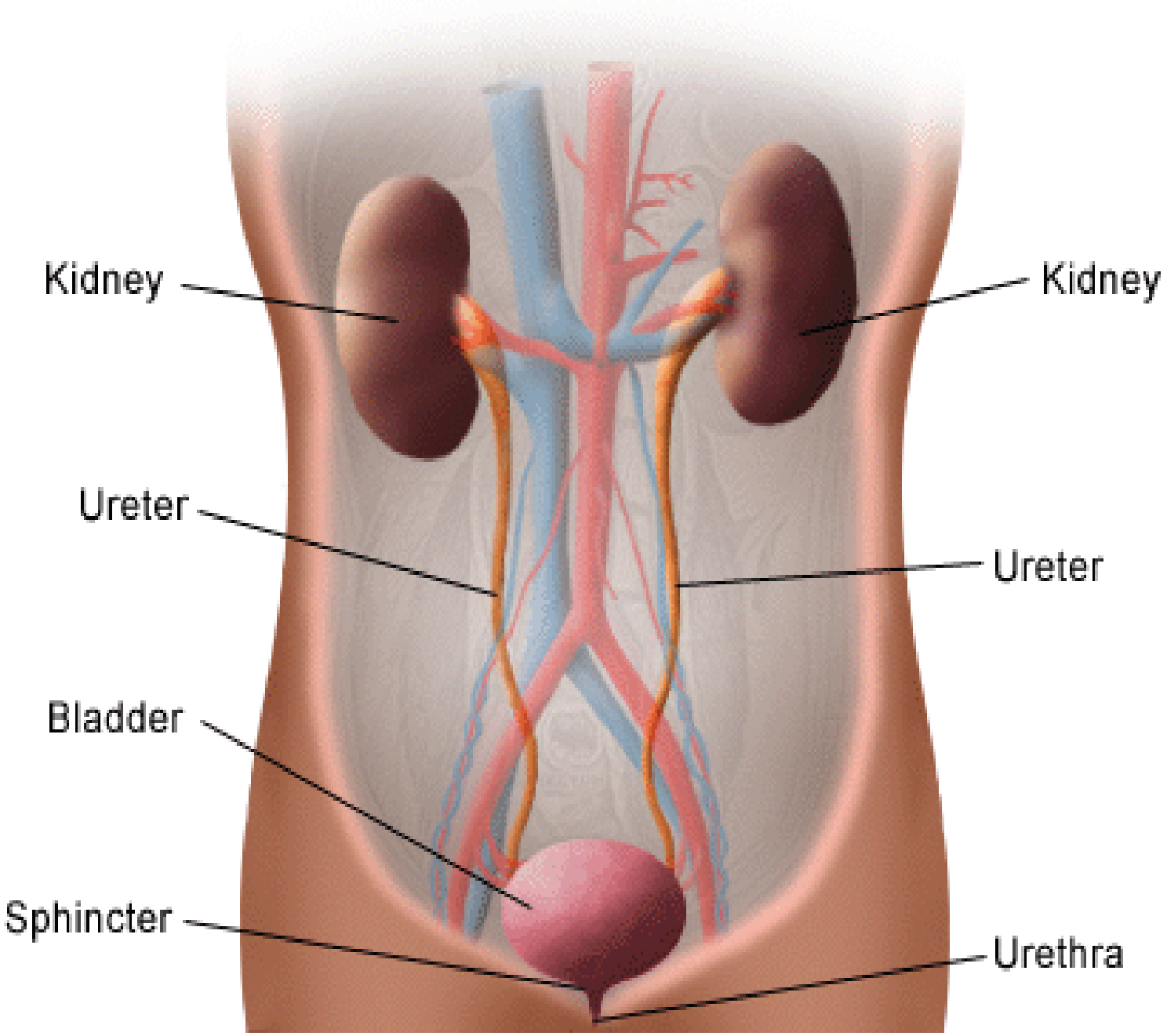
Genitourinary

Chapter 36

Anatomy and Physiology

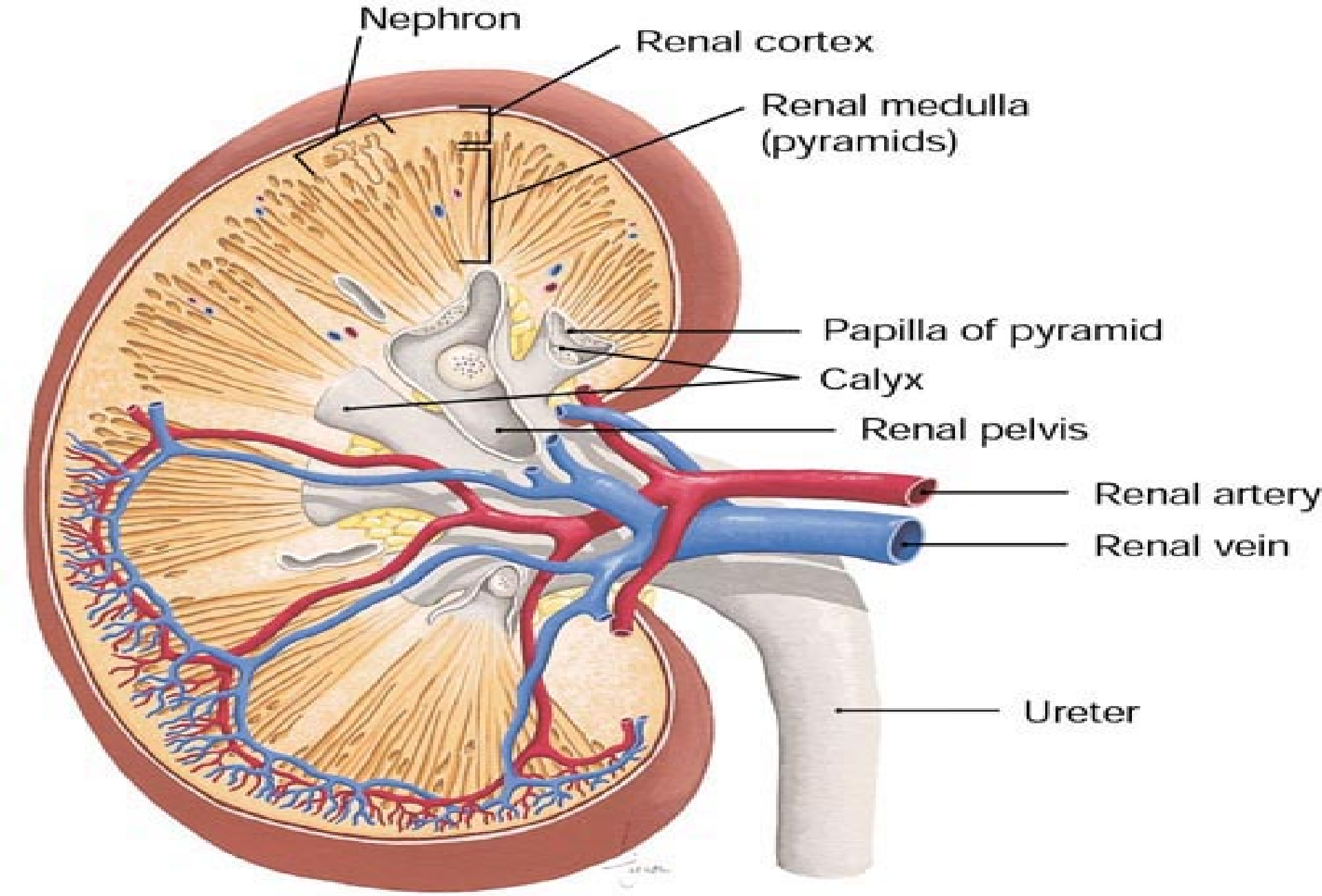
- The urinary system consists of:
  - Two kidneys
  - Two ureters
  - Urinary bladder
  - Urethra

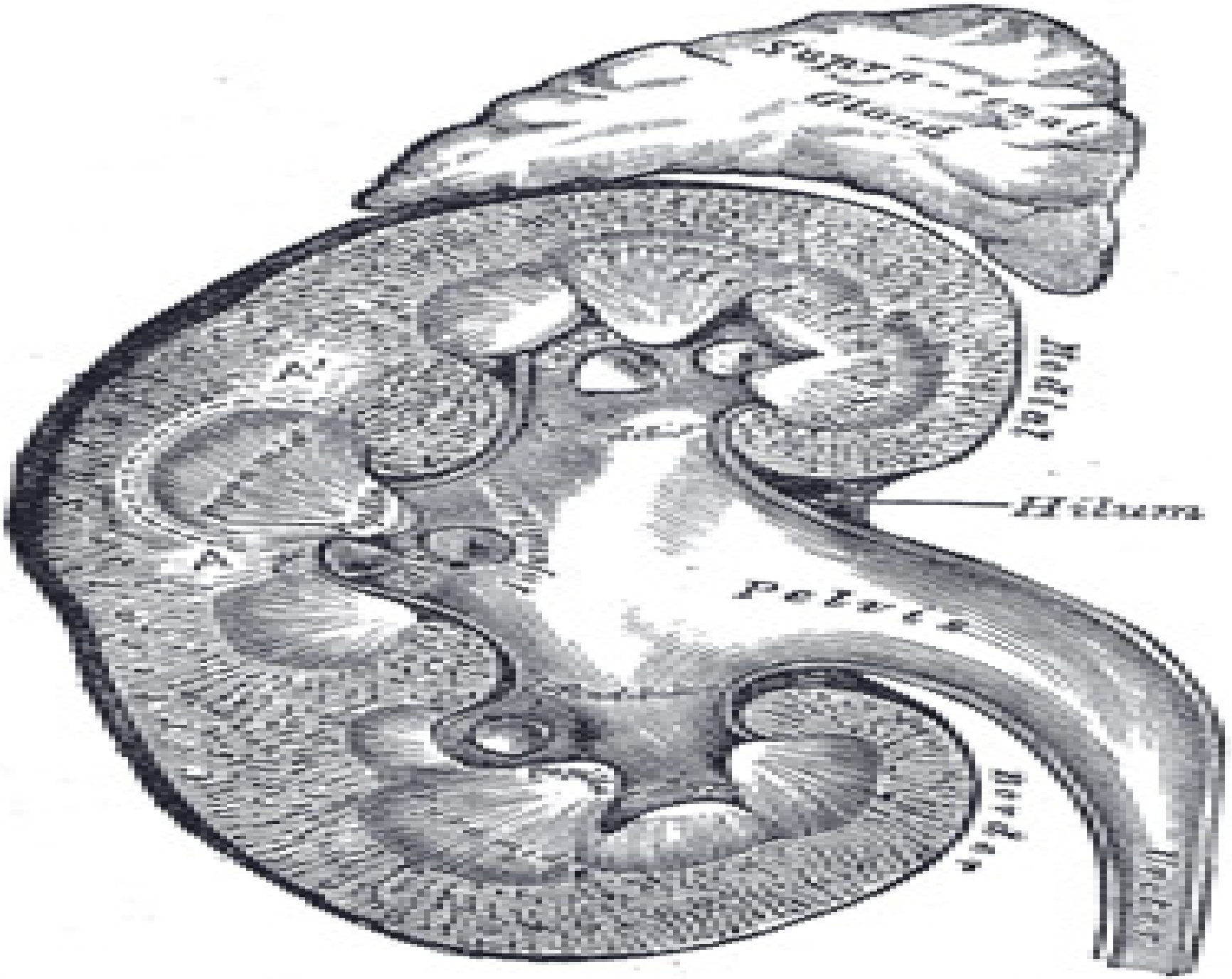
Front View of Urinary Tract



Internal Structures of the Kidney

- Renal cortex: outermost area
  - Renal corpuscles
  - Convoluted tubules
- Renal medulla: middle area
  - Renal pyramids
- Renal pelvis
  - Expansion of ueter



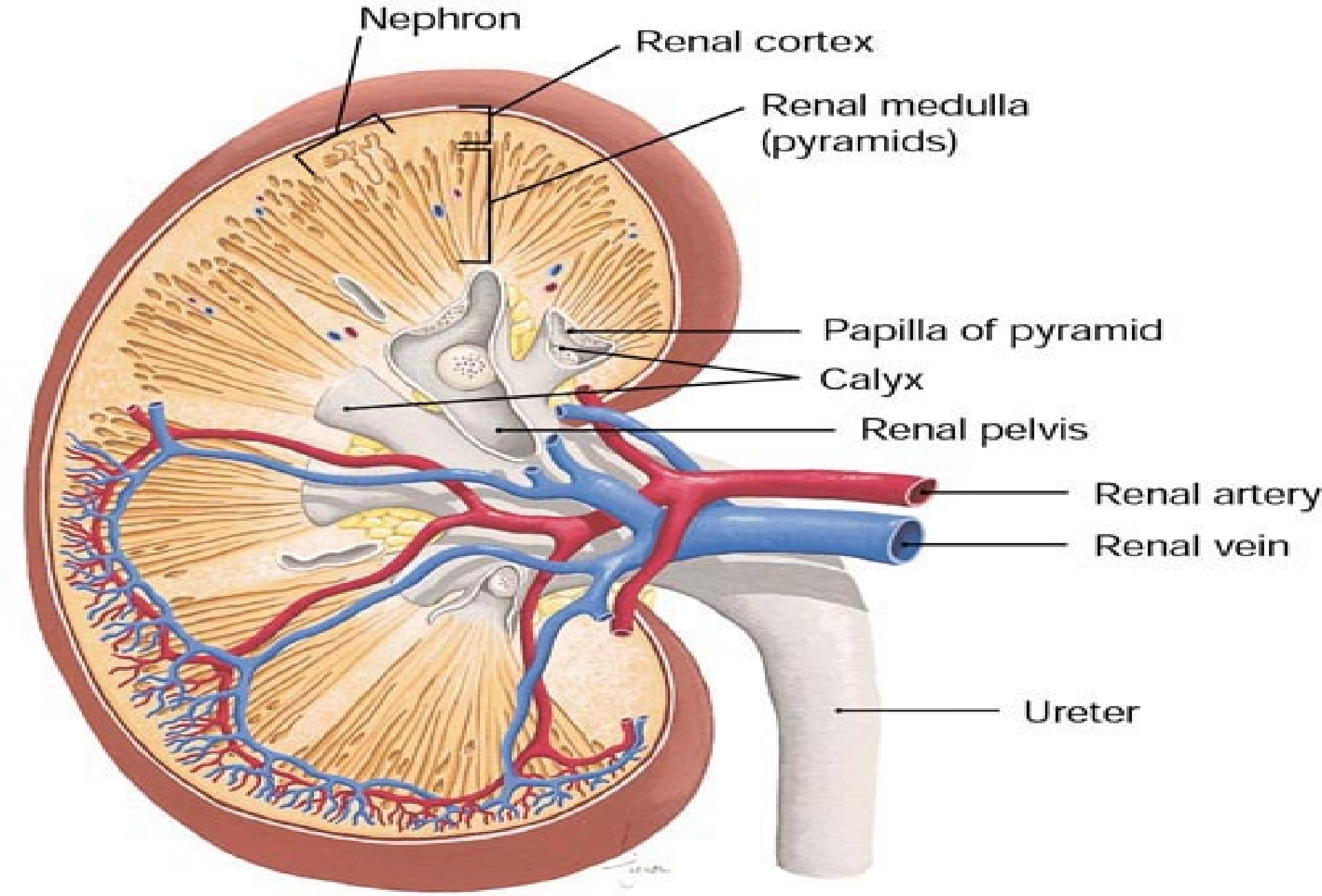

Sacro-iliac
Ilium
Ilium
Pelvis

Kidney

- Medial side of each kidney has an indentation called the hilus. This is the entry and exit area for the blood vessels, nerves and the ureter.

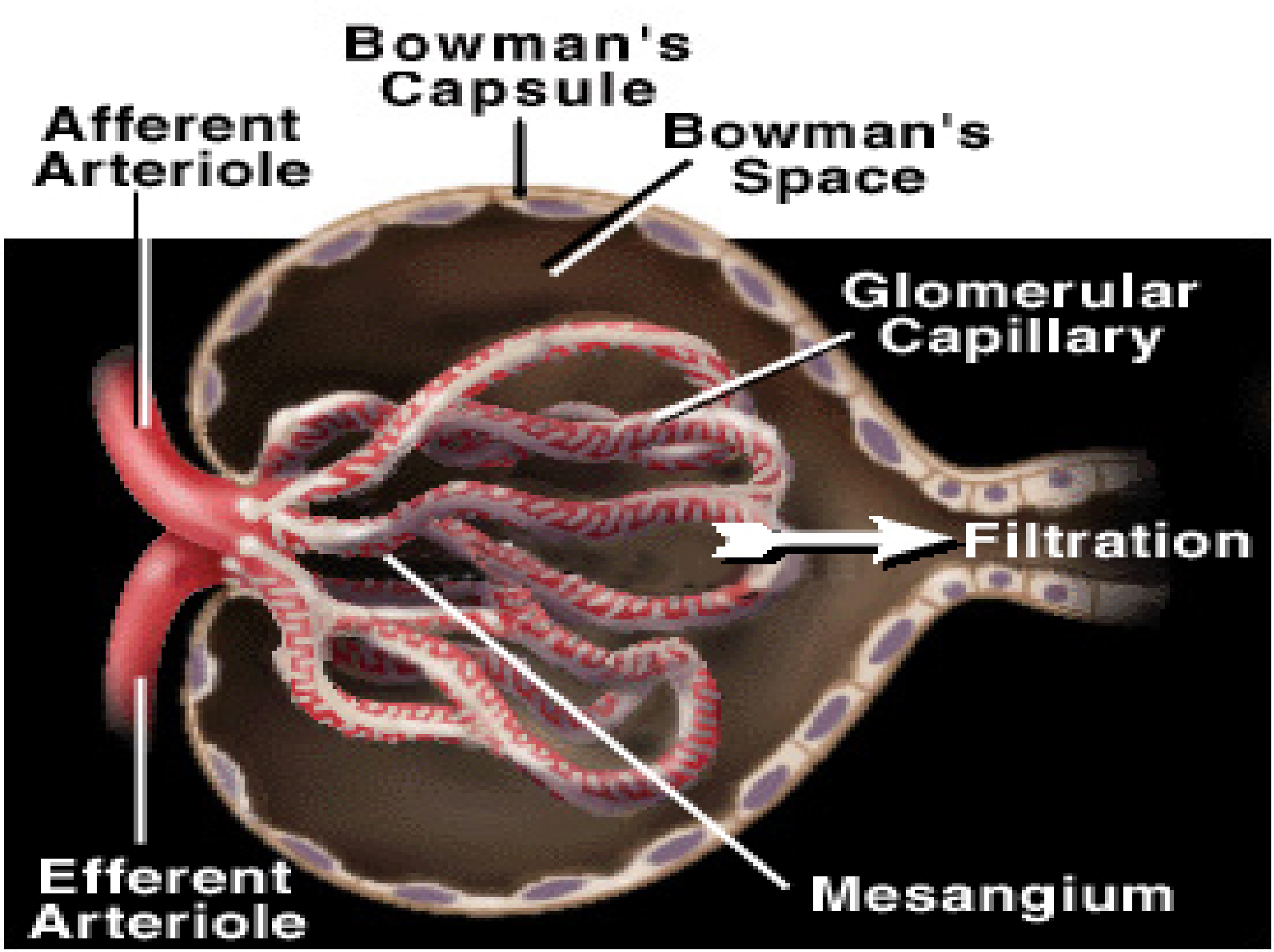
Blood Supply to the Kidney

- The pathway of blood flow through the kidney is an essential part of the process of urine formation.
  - Blood is brought to the kidney by the renal artery which arises from the abdominal aorta
  - Enters kidney, branches into a series of smaller and smaller arteries
  - Eventual contact with nephron units (the urine making structures of the kidney)
  - Blood leaves through a series of veins that eventually merge to form the renal vein
  - Renal vein empties into the inferior vena cava



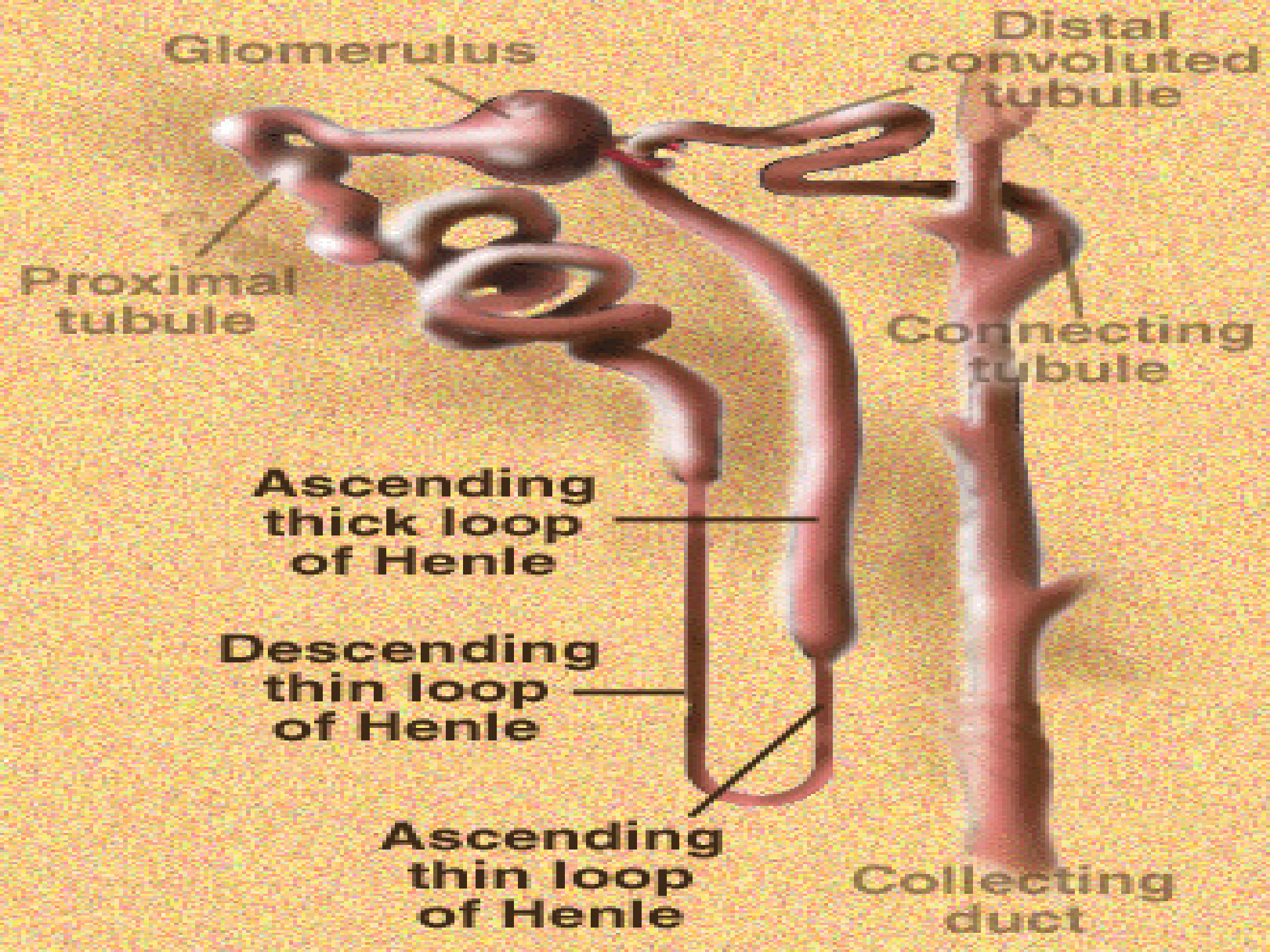
Blood Vessels of the Kidney

- Blood supply to kidney by renal artery
- Renal artery branches into smaller blood vessels that form the afferent arteriole
- Afferent arteriole branches into a cluster of capillaries called the glomerulus.


Bowman's Capsule
Afferent Arteriole
Bowman's Space
Glomerular Capillary
Filtration
Efferent Arteriole
Mesangium

Blood Vessels of the Kidney

- Blood vessels exit Bowman's capsule as the efferent arteriole
- Efferent arterioles form the peritubular capillaries
- Peritubular capillaries empty into venules, larger veins and then renal vein


Glomerulus
Distal convoluted tubule
Proximal tubule
Connecting tubule
Ascending thick loop of Henle
Descending thin loop of Henle
Ascending thin loop of Henle
Collecting duct

Functions of the Kidneys

- Urine production
- Regulation of blood volume
- Regulation of electrolyte balance
- Regulation of acid-base balance
- Regulation of blood pressure
- Regulation of red blood cell production

Nephron

- Urine making unit of the kidney
- Approximately one million nephron units per kidney
- Consists of two parts:
  - Renal corpuscle
  - Renal tubule

Nephron

- Renal corpuscle consists of a glomerulus surrounded by Bowman's capsule
- Bowman's capsule has an inner layer and an outer layer
- Renal tubule continues from Bowman's capsule and consists of the proximal convoluted tubule, the loop of Henle, and the distal convoluted tubule

Urine Formation

- Formation of urine involves 3 processes:
    - Glomerular filtration (renal corpuscles)
    - Tubular reabsorption
    - Tubular secretion

Glomerular Filtration

- Filtration is the process by which blood pressure forces plasma and dissolved materials out of capillaries.
- In glomerular filtration blood pressure forces plasma, dissolved substances, and small proteins out of the glomeruli and into Bowman's capsule.
- The fluid is called renal filtrate.

Glomerular Filtration

- Blood pressure in glomeruli: is high 60 mmHg
- Blood pressure in Bowman's capsule is low and its inner layer is permeable
- 20 to 25% of the blood that enters glomeruli becomes renal filtrate in Bowman's capsules.
- Renal filtrate is similar to plasma except less protein and no blood cells are present

Glomerular Filtration

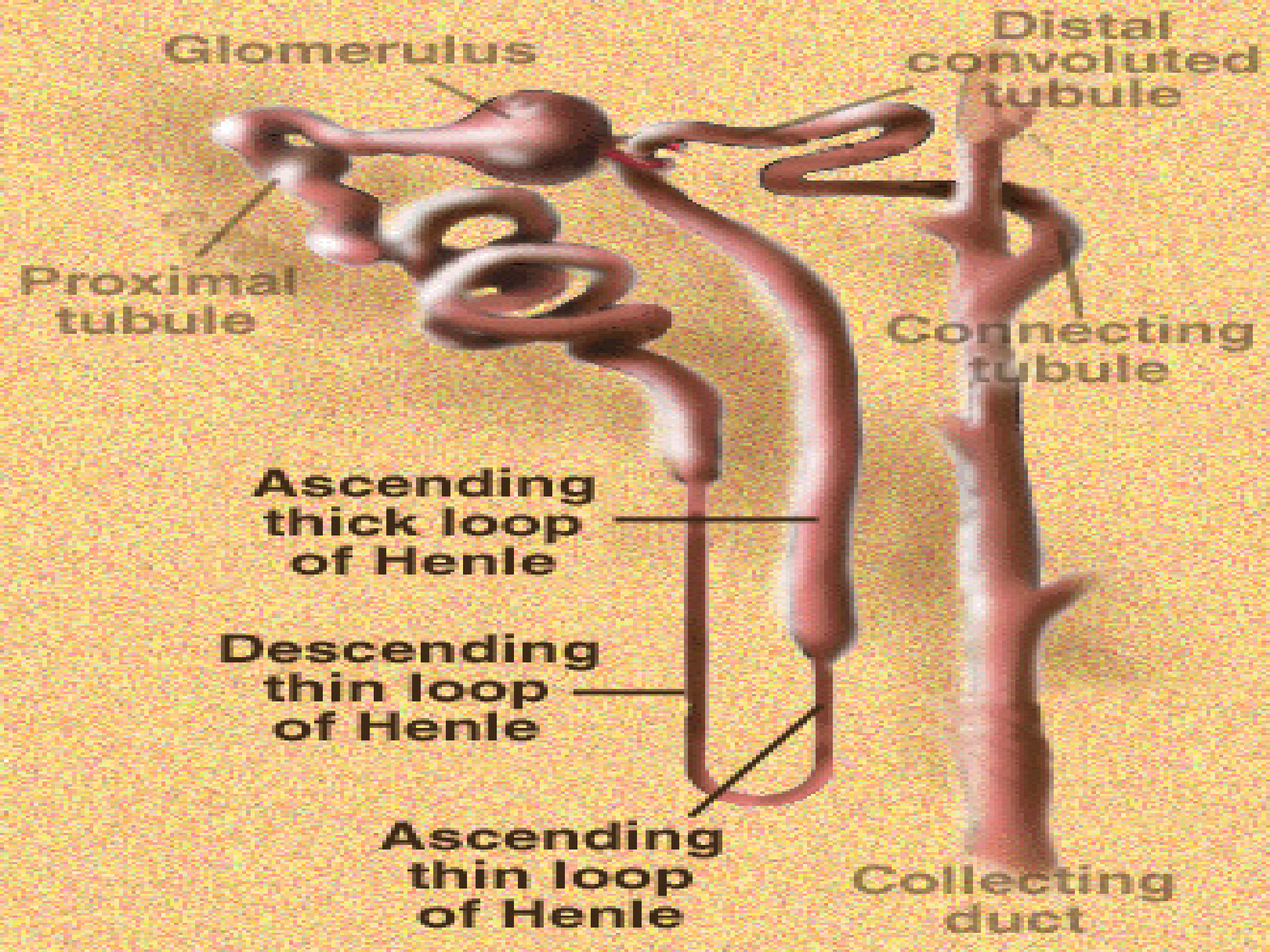
- Glomerular filtration rate (GFR)
  - Amount of renal filtrate formed by the kidneys in one minute
  - Averages 100 to 125 ml
- GFR is affected by the amount of blood flow through the kidney
  - If blood flow increases—GFR increases—more filtrate formed—urinary output increases
  - If blood flow decreases—GFR decreases—less filtrate formed—urinary output decreases

Tubular Reabsorption

- Tubular reabsorption is the recovery of useful materials from the renal filtrate and their return to the blood in the peritubular capillaries.
- Approximately 99% of the renal filtrate formed is reabsorbed
- Normal urine output is 1000 to 2000 ml per 24 hours

Tubular Reabsorption

- Proximal convoluted tubules
  - Most reabsorption takes place here
- Other sites:
  - Distal convoluted tubules
  - Collecting tubules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Tubular Reabsorption

- Mechanisms of reabsorption
  - Active transport
  - Passive transport
  - Osmosis
  - Pinocytosis

Tubular Secretion

- Substances are actively secreted from the blood in the peritubular capillaries into the filtrate in the renal tubules
- Waste products (such as ammonia and creatinine) and the metabolic products of medications may be secreted into the filtrate to be eliminated in the urine.
- Hydrogen ions may be secreted by the tubule cells to maintain normal pH of the blood

Acid-Base Balance

- The kidneys are the organs primarily responsible for maintaining the normal pH of blood and tissue fluid.
- If body fluids become to acidic, the kidneys secrete more hydrogen ions into the renal filtrate and return more bicarbonate ions back to the blood. The pH is then raised.

Acid-Base Balance

- If the body fluids become too alkaline, the kidneys return hydrogen ions to the blood and excrete bicarbonate ions in the urine. The pH is then lowered.

Kidney Functions

- Other functions of the kidney that are not related to the formation of urine:
    - Secretion of renin
    - Activation of vitamin D
    - Production of erythropoietin

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Effects of Hormones on the Kidneys

- Aldosterone
  - Secreted by the adrenal cortex
  - Stimulates the reabsorption of sodium and water
  - Stimulates the excretion of potassium
  - Acts primarily on the distal tubule
  - Renin secretion stimulates the release of aldosterone

Effects of Hormones on the Kidneys

- Atrial Natriuretic Factor (ANF)
  - Secreted by the walls of the atria of the heart in response to increase in blood volume
  - Decreases the reabsorption of sodium
  - Causes greater excretion of sodium and water by the kidney
  - Presence of ANF decreases the secretion of aldosterone by adrenal cortex

Effects of Hormones on the Kidneys

- Antidiuretic Hormone (ADH)
  - Secreted by the posterior pituitary gland
  - Stimulates the reabsorption of water primarily by the collecting ducts
  - Allows the kidneys to concentrate urine

Effects of Hormones on the Kidneys

- Parathyroid hormone
  - Secreted by the parathyroid gland
  - Stimulates the reabsorption of calcium and excretion of phosphate in renal tubules
  - Stimulated by low calcium blood level

Characteristics of Urine

- Urine is approximately 95% water. The water is the solvent for waste products and salts.
- Nitrogenous wastes:
  - Urea (formed by breakdown of amino acids used for energy production)
  - Creatinine (metabolism of creatine phosphate, energy source in muscles)
  - Uric acid (metabolism of nucleic acids, the breakdown of DNA and RNA)

Characteristics of Urine

- Amount
  - 1000 to 2000 cc in 24 hours
- Color
  - Straw (dilute urine- lighter in color)
  - Amber
  - Freshly voided urine is clear
  - Cloudy urine may indicate an infection

Characteristics of Urine

- Specific gravity
  - 1.010 to 1.025
  - This is a measure of the dissolved materials in urine.
  - The higher the specific gravity, means more dissolved material is present.

Characteristics of Urine

- Measures the concentrating ability of the kidneys

- pH of the urine
  - 4.6 to 8.0 range. 6.0 average.
  - Diet has a large impact on urinary pH
    - » Vegetarian diet- urine more alkaline
    - » High protein diet- urine more acidic

Characteristics of Urine

- Protein
  - Protein is not a normal finding in urine
  - Persistent proteinuria related to renal disease

Characteristics of Urine

- Glucose—presence in urine indicates
  - Diabetes mellitus
  - Excessive glucose intake
  - Low renal threshold for glucose reabsorption

Characteristics of Urine

- Ketones presence in urine indicates
  - Diabetes mellitus with ketonuria
  - Starvation—breakdown of body fat into ketones

Characteristics of Urine

- Bilirubin presence in urine indicates
    - Liver disorders causing jaundice
- Nitrite
    - Indicates infection

Characteristics of Urine

- Leukocyte esterase
    - Presence indicates infection
- Red blood cells
    - Kidneys stones
    - Infection
    - Cancer
    - Renal disease
    - trauma

Characteristics of Urine

- White blood cells
    - Infection
    - Inflammation
- Casts
    - Renal damage
    - Infection

Aging and the Urinary System

- Number of nephrons in the kidneys decreases (often half of the original number by age 70 to 80).
- GFR decreases due to decreased renal blood flow.
- Urinary bladder decreases in size.
- Tone of the detrusor muscle decreases.

Aging and the Urinary System

- More prone to urinary tract infections.
- Tubular function and the exchange of substances decrease.

Most drugs are excreted through the kidneys. Changes in renal function become a serious consideration for older adults who need drug therapy.

Aging and the Urinary System

Decreased renal function slows the excretion of some drugs, keeping them in the body longer. This can increase the risk of adverse drug reactions, such as toxicity and overdose. It is important to monitor kidney function, including creatinine, and blood urea nitrogen (BUN) levels in an older person receiving drug therapy.

Nursing Assessment

- Subjective
  - Health history
- Objective
  - Inspection
    - »Skin (color, texture)
  - Palpation
  - Percussion

Nursing Assessment

- Most assessment of the urinary system is done using indirect measures such as assessment of:
  - Vital signs
  - Lung sounds
  - Edema
  - Daily weights
  - Intake and output