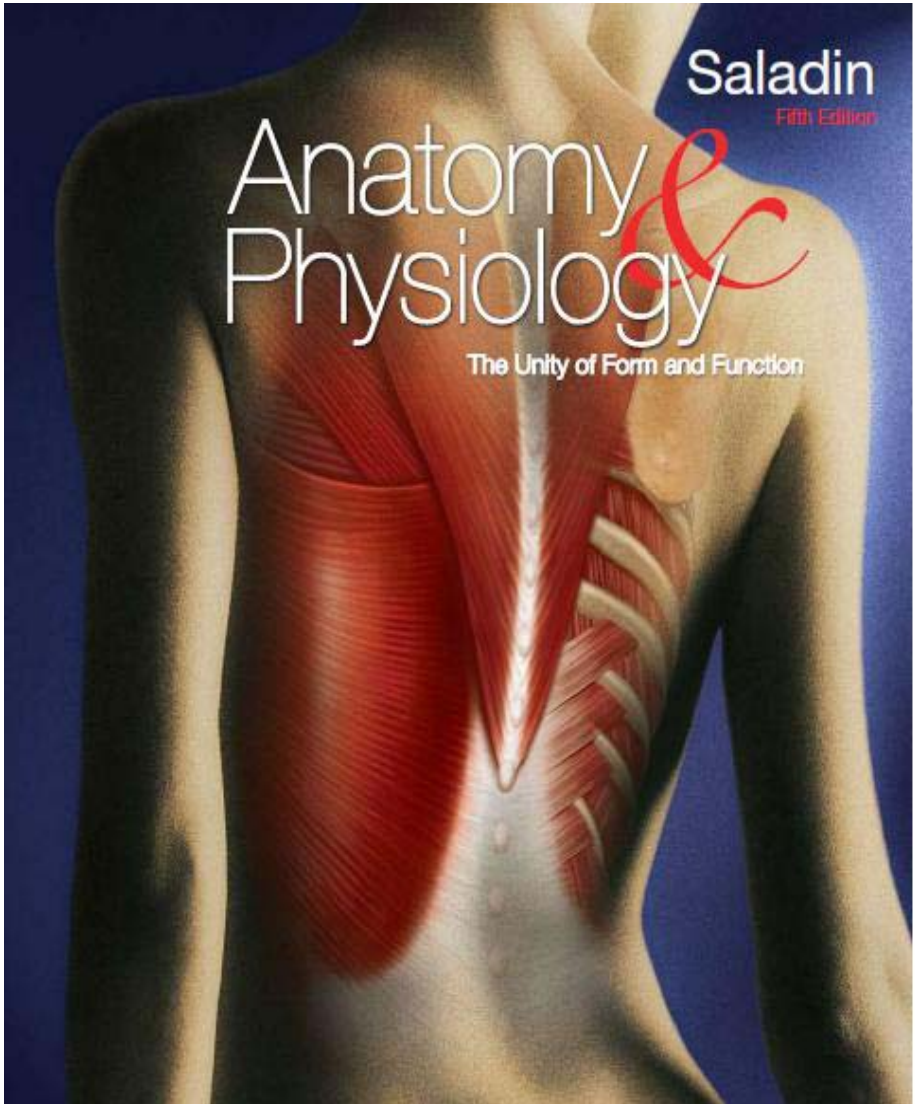

Chapter 23

Composition and Properties of Urine

Composition and Properties of Urine

- **urinalysis –** the examination of the physical and chemical properties of urine
  - **appearance -** clear, almost colorless to deep amber - yellow color due to urochrome pigment from breakdown of hemoglobin (RBCs) – other colors from foods, drugs or diseases
    - cloudiness or blood could suggest urinary tract infection, trauma or stones
    - **pyuria** – pus in the urine
    - **hematuria** – blood in urine due to urinary tract infection, trauma, or kidney stones
  - **odor** - bacteria degrade urea to ammonia, some foods impart aroma
  - **specific gravity -** compared to distilled water
    - density of urine ranges from 1.001 -1.028
  - **osmolarity** - (blood = 300 mOsm/L)
    - ranges from 50 mOsm/L to 1,200 mOsm/L in dehydrated person
  - **pH** - range: 4.5 to 8.2, usually 6.0 (mildly acidic)
  - **chemical composition**: 95% water, 5% solutes
    - **Normal** to find
      - urea, NaCl, KCl, creatinine, uric acid, phosphates, sulfates, traces of calcium, magnesium, and sometimes bicarbonate, urochrome and a trace of bilirubin
    - **Abnormal** to find
      - glucose, free hemoglobin, albumin, ketones, bile pigments

LO

Urine Volume

- **normal** volume for average adult - **1 to 2 L/day**
- **polyuria** - output in excess of 2 L/day
- **oliguria** – output of less than 500 mL/day
- **anuria** - 0 to 100 mL/day
  - low output from kidney disease
  - Dehydration
  - circulatory shock
  - prostate enlargement
- low urine output of less than **400 mL/day**
  - the body cannot maintain a safe
  - low concentration of waste in the plasma

Diabetes

- **diabetes** – any metabolic disorder resulting in chronic polyuria

- at least four forms of diabetes
  - **diabetes mellitus type 1**, **type 2**, and **gestational diabetes**
    - high concentration of glucose in renal tubule
    - glucose opposes the osmotic reabsorption of water
    - more water passes in urine (osmotic diuresis)
    - glycosuria – glucose in the urine
  - **diabetes insipidus**
    - **ADH hyposecretion** causing not enough water to be reabsorbed in the collecting duct
    - more water passes in urine

LO

Diuretics

- any chemical that increases urine volume
  - some increase GFR
    - caffeine dilates the afferent arteriole
  - reduce tubular reabsorption of water
    - alcohol inhibits ADH secretion
  - act directly on nephron loop (loop diuretic)
  - inhibit Na^+ - K^+ - Cl^- symport
    - impairs countercurrent multiplier reducing the osmotic gradient in the renal medulla
    - collecting duct unable to reabsorb as much water as usual
  - Osmotic diuretics
    - Filtered but not reabsorbed
    - Solute may exceed Tubular Transport Maximum (i.e. glucose)
- commonly used to treat hypertension and congestive heart failure by reducing the body's fluid volume and blood pressure

LO

Renal Function Tests

- tests for diagnosing kidney disease
- evaluating their severity
- monitoring their progress
- determine renal clearance
- determine glomerular filtration rate

Renal Clearance

- the volume of blood plasma from which a particular waste is completely removed in 1 minute
- represents the net effect of three processes:

glomerular filtration of the waste
\+ amount added by **tubular secretion**
– amount removed by **tubular reabsorption**
renal clearance

Renal Clearance

- **determine renal clearance** (C) by collecting blood and urine samples, measuring the waste concentration in each, and measuring the rate of urine output:
  - U - waste concentration in urine – 6.0 mg/mL (urea example)
  - V - rate of urine output – 2 mL/min
  - P - waste concentration in plasma – 0.2 mg/mL
  - C – renal clearance in mL/min of waste cleared
  - C = UV/P = 60 mL/min (60 mL of blood plasma is completely cleared of urea per minute
- compare C to normal GFR of 125 mL/min to see if normal rate of clearance is occurring - 48% which is normal for urea

Glomerular Filtration Rate

- kidney disease often results in lowering of GFR
  - need to measure patient's GFR
  - can not use clearance rate of urea
    - some urea filtered by glomerulus is reabsorbed in the tubule
    - some urea is secreted into the tubule
- need a substance that is not secreted or reabsorbed at all so that all of it in the urine gets there by glomerular filtration
  - use **inulin,** a plant polysaccharide to determine GFR
    - neither reabsorbed or secreted by the renal tubule
    - inulin GFR = renal clearance on inulin
- clinically GFR is estimated from **creatinine excretion**
  - does not require injecting a substance or drawing blood to determine its blood concentration
  - In plasma and we know concentration