I) (slide 2) Introduction

A) Terms
1) _ describes getting rid of the metabolic wastes produced by the body
2) _ the release of a substance that can be useful to the body
3) _ the elimination of feces from the digestive tract
4) Note: There are different organs involved with excretion of metabolic wastes by the body.

B) (slide 3) Excretory Organs
1) _
   a) Water
   b) Salts
   c) Urea
2) _
   a) Water
   b) Salts
   c) Urea
3) _
   a) Carbon dioxide
4) _
   a) Bile

C) (slide 4) General Functions of the Urinary System
1) Excretion
2) Water-salt balance
3) Acid-base balance
4) Hormones
   a) Erythropoieten: produced in response to low oxygen to stimulate erythrocyte production
   b) Renin (more later—water-salt balance)
D) (slide 5-6) **Excretion:**

1)  
   a) the nitrogenous waste product produced from amino acid metabolism  
   b) The amino acids produce ammonia—toxic to the body, so the liver by converting the ammonia to urea

2)  
   the end product of creatine phosphate metabolism

3)  
   a) the end product of nucleotide degradation  
   b) gout is an excess of uric acid crystals that precipitate and collect in the joints causing joint pain

E) (slide 7) **Organs of the Urinary System**

1)  
   produce urine

2)  
   move urine by peristalsis from the renal pelvis of each kidney to the urinary bladder

3)  
   temporary storage of urine

4)  
   carries urine from the bladder to the external opening

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F) **Kidney Structure**

- **renal medulla**
- **renal cortex**
- **renal pyramid**
- **renal pelvis**
- **Ureter**

- Space where urine drains before exiting out kidney
- Carries urine to bladder

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*Lecture Notes: Urinary System*
II) (slide 9) **Excretion: Urine Formation**

A) _

The smallest structural unit of a kidney that functions in producing urine

(1) In general, a nephron:
   (a) Microscopic
   (b) about 1 million nephrons per kidney
   (c) functions in Urine formation

B) (slide 10) **Nephron Structure:**

1) Bowman’s or Glomerular Capsule
2) Proximal convoluted tubule (PCT)
3) Loop of Henle (Loop of Nephron)
4) Distal Convoluted Tubule (DCT)
5) Collecting duct

C) (slide 11) **Processes of Urine Formation**

(1) Glomerular filtration
(2) Tubular secretion
(3) Tubular reabsorption

D) (slide 12) **Blood Vessels:**

(1) **Afferent arteriole**
   Brings blood to glomerular capsule of the nephron
(2) **Glomerulus**
   Capillary that filters blood
(3) **Efferent arteriole**
   Takes blood away from glomerular capsule
(4) **Peritubular capillary network**
   Surrounds nephron leaving kidney
(5) **Renal vein**
   Returns blood to inferior vena cava
E) (slide 13) **Glomerular Filtration**: The movement of water and small molecules from the glomerulus to the glomerular capsule

1) Nonfilterable Substances
   a) Formed elements
   b) proteins

2) Filtrate
   a) water
   b) nitrogenous wastes
   c) nutrients
   d) salts

**NOTE:**
(a) Approximately 180 quarts of filtrate are formed every 24 hours
(b) Approximately 1.8 quarts of urine are given off every 24 hours.
(c) The remaining 178.5 quarts of filtrate are reabsorbed.

F) **Tubular Reabsorption**: the passive and active reabsorption of molecules and ions from the nephron into the blood in the peritubular capillary network which returns substances to the blood

1) Filtrate components after tubular reabsorption
   a) some water
   b) N wastes (urea)
   c) excess salts (ions)

2) Substances reabsorbed from filtrate
   a) most water
   b) glucose
   c) amino acids
   d) required salts (ions)
G) **Tubular Secretion:** describes the removal of molecules from the blood and added to filtrate/urine

1) substances are actively transported from the peritubular capillaries INTO the nephron tubule
   (a) H+
   (b) penicillin

2) Urine drains from the collecting ducts (apex of renal pyramids) to renal pelvis and out ureter, to be temporarily stored in the bladder.

H) **Caffeine:**

1) Increases the rate of glomerular filtration—

2) deceases the tubular reabsorption of sodium ions—less filtrate reabsorbed

3) Result: increased urine output.

I) **Urination (Micturition)**

1) when the bladder is stretched (250 mL) stretch receptors send sensory impulses to the spinal cord.

2) Motor nerve impulses from the spinal cord cause the urinary bladder to contract and the sphincter muscles to relax.
III) Maintaining water-salt balance

A) Water-salt balance maintains
1) blood volume
2) blood pressure

B) Structures:

1) descending limb of Loop of Henle
   (a) relatively impermeable to solutes
   (b) permeable to water (osmosis)

2) ascending limb limb of Loop of Henle
   (a) permeable to solutes (creates hypertonic environment)
   (b) impermeable to water

3) Collecting Duct
   (a) reabsorbs water and urea
   (b) ADH increases water reabsorption
C) Molecules that influence Water-Salt Balance:

(1) 
(a) anti-not, diuretic-dilute (not dilute)  
(b) concentrate urine (darker yellow/smellier)  
(c) posterior pituitary gland hormone secretes  
(d) results in the reabsorption of water back into the body from the filtrate by the nephron  
(e) 

(f) NOTE: Diuretics increase urine output  
   Alcohol: Inhibits the secretion of ADH

(2) 
(a) secreted by the adrenal (cortex) gland  
(b) Regulates salt concentration in blood  
(c) increases reabsorption of sodium from DCT and collecting duct  
(d) Leads to reabsorption of water—increase blood volume → increase blood pressure

(3) 
(a) produced by cells near glomerulus in response to low BP  
(b) promotes aldosterone secretion  
(c) leads to Na+ and water reabsorption

(4) **Atrial Natriuretic Hormone**  
(a) produced by the heart to prevent aldosterone release  
(b) inhibits sodium reabsorption so blood volume decreases → decreases blood pressure

IV) Acid-Base Balance

A) The buffer / breathing mechanism:
   1) General reaction:
      \[ \text{H}^+ + \text{HCO}_3^- \leftrightarrow \text{H}_2\text{CO}_3 \leftrightarrow \text{H}_2\text{O} + \text{CO}_2 \]
   
   2) Lungs  
      (a) bicarbonate converted to CO2  
      (b) H+ decreases (pH increases)

   3) Kidneys will excrete hydrogen ions and reabsorb bicarbonate (buffer) ions.  
      (a) Blood >pH 7.4 (need to lower pH)  
         Excrete Bicarbonate  
      (b) Blood <pH 7.4 (raise pH)  
         Excrete Hydrogen ions  
      (c) note: urine has a pH of 6 or lower
Homeostatic Imbalance: Kidney stones

(1) urine (renal calculus, calculus = 'little stones')

(2) formed by the precipitation of calcium, magnesium and uric acid in the renal pelvis

(3) usually less than 5 mm in diameter and pass through without causing problems

(4) larger stones can cause pain and obstruct passage of urine out of the body

(5) sharp stones are painful as pass through ureter by peristalsis

(6) treatment: noninvasive procedure that uses ultrasonic shock waves to break up the stones into smaller pieces that can pass through easily by the flow of urine