14.1 Overview

- Role in removal of wastes to maintain homeostasis
  - Acts as filtering system of the blood
    - Produces urine
- Removes wastes, maintains pH, electrolyte composition, and water content of blood
**Gross Anatomy of Urinary System**

- **Kidneys** – form urine
  - Pair – true workhorses of system
  - Form in early week 5
  - Early kidneys drain into umbilical cord
    - Not functional until week 9

- **Ureters**
  - Tubes that send urine from the kidneys to the bladder

- **Urinary bladder**
  - Sac-like organ that serves as reservoir for urine storage

- **Urethra**
  - Tube that transfers urine from the bladder to the body’s exterior
Kidney – External Anatomy

- Bean-shaped – located bilaterally near the midline of abdomen
  - Left a little superior to the right
- Not in the abdominal cavity
  - Lie retroperitoneal – behind peritoneum
- Adipose (fat) – encases each organ
- Renal fascia – CT that secures kidneys to posterior abdominal wall
- Each kidney capped by adrenal gland (produce different steroid)
- Positioned so that the hilus, concave indentation, is medial to the body
  - Entry point for renal artery and exit point for renal vein
    - Artery – carried blood to kidney
    - Vein – blood from kidney to vena cava
Kidney – External Anatomy
Kidney – Internal Anatomy

• 3 easily distinguishable areas (superficial to deep)
  • Renal cortex
  • Renal medulla
    • Soft, marrow-like
      • Renal pyramids
        • Renal columns – separate renal pyramids
        • Collects urine
  • Renal pelvis
    • Where formed urine is collected before it enters the ureter
    • Calcyes (calyx) – extension of renal pelvis; transfers urine from renal pyramids
      • Connected to ureter at each kidney’s hilus
Ureters

- Long, thin muscular tubes that are also in retroperitoneal position
  - Extend inferiorly from the hilus and enter the urinary bladder posteriorly at separate locations on bladder floor
- Function only in urine transport
  - Help gravity through peristaltic contractions
- Do not have valves that close to prevent urine from passing into the bladder
  - Bladders exerts upward pressure on them as it fills
    - Pressure pinches tube ends and closes them off
Ureters
Urinary Bladder

- Inferior in pelvic cavity
- Accumulates and temporarily stores urine
- In females, structure is located anterior and slightly inferior to uterus
  - Explains need for frequent urination during pregnancy
- In males, superior to prostate gland
  - when enlarged, can cause urination problems
- Transitional epithelium – tissue that can change shape with expansion and contraction
  - Lining of bladder
• **Detrusor muscle** – smooth muscle of urinary bladder
  • Wall of bladder – crisscross arrangement
• **Trigone** – smooth triangular area of urinary bladder floor
  • Has three openings
    • 2 for ureters at the corners
    • Urethra at base
• **Internal urinary sphincter** – involuntary circular muscle
  • Keeps the ureter closed
• **Can hold up to 1 liter of urine**
  • Causes extremely uncomfortable pressure
    • Need to void typically is felt at 20% capacity
Urinary Bladder

- Median umbilical ligament
- Ureter
- Peritoneum
- Detrusor muscle
- Ureteral openings
- Trigone
- Neck of urinary bladder
- Internal urethral sphincter
- External urethral sphincter (in urogenital diaphragm)

- Transitional epithelium
- Lamina propria
- Submucosa
- Detrusor muscle
- Adventitia
Urethra

- Forms passageway from bladder to body’s exterior
- Single muscular tube, closure is controlled by voluntary muscle called external urethral sphincter
- Urethral orifice – external opening when urine exits body
- Male urethra longer than females
  - Descends through prostrate and the full length of penis
  - Also carries semen
- Female – sole function is to carry urine
  - Bladder is closer to body’s exterior – more susceptible to entry of bacteria because of proximity to anal area
  - More prone to UTI or urinary bladder infections
14.2 Urine Voiding

- Urination = emptying the bladder
  - Micturition – medical term for elimination of urine from the bladder
- Infant – immature nervous system – external urethral sphincter not yet under voluntary control
  - Urination occurs reflexively as bladder detects accumulated urine
- As nervous system matures, voluntary control is gained
- Incontinence, inability to hold urine
  - Decrease competence of urinary sphincter muscles
Urine Voiding, cont.

- Anuria – inability to produce urine
  - Can be indicator of health disorders like renal failure
    - Can be fatal if waste is not eliminated from body
- Urinary retention – inability to expel urine from bladder
- Catheter – tube inserted into urethra to expel urine
  - Can relieve urinary retention
- Oliguria – decreased urine production
  - Can indicate kidney damage or ureter obstruction
- Polyuria – production of excess urine
  - Can indicate diabetes mellitus
- Nephrons – tubular structures that filter the urine in kidneys
  - Responsible for many physiological processes involved in urine formation
The Nephrons

- Thousands are present in each kidney
- Carry out several of kidney’s many jobs
- Each is composed of an arrangement of renal tubules – has intricate vascular network
- Consists of uniquely folded capillary network called the glomerulus
  - Originates from the afferent arteriole (blood vessel that narrows to become glomerulus)
- Glomerulus is surrounded by Bowman’s capsule
  - Expanded portion of renal tube
- Bowman’s capsule and the glomerulus are tucked within a structure called the renal corpuscle
- Distal end exits efferent arteriole – formed by glomerulus
Urine Formation

- Three Stages
  - Glomerular filtration
  - Tubular reabsorption
  - Tubular secretion
Urine Formation definitions

- **Glomerular Filtration**
  - The process by which plasma and many dissolved substances are moved from the blood into Bowman’s capsule

- **Tubular Reabsorption**
  - A process in the peritubular capillary system in which water, nutrients, and electrolytes travel back into the blood

- **Tubular Secretion**
  - The process by which certain waste products and ions are removed from the blood into the tubular fluid
Hormonal Regulation of Urine Formation

- Various hormones involved in controlling rate and volume of urine production
  - Release of hormone is elicited by specific change detected in body
- Anti-diuretic hormone (ADH)—produced by pituitary gland in response to dehydration
  - Greatly influences diuresis, or excretion of water from body
- Aldosterone—adrenal cortex steroid
  - In response to high levels of blood potassium ions, is produced to increase water movement out of distal tubule
    - Creates concentration gradient for outward movement of water
Hormones, cont.

- Atrial natriuretic factor (ANF) – secreted by special cardiac cells
  - Lowers blood volume and blood pressure
  - Antagonistic to aldosterone
  - Lowers sodium ion reabsorption
- Angiotensin II elevates blood pressure through vasoconstriction
  - the consequent increase in pressure within the glomerular capillaries increases filtration and elevates urine output.
**Most urinary system disorders fall under one or more of the following categories:**

- Congenital disorders
- Infection and inflammation
- Immune disorders
- Hormonal disorders
- Degenerative disorders
- Tumors
Congenital Disorders

- *Present @ birth
- Polycystic kidney disease – inherited disease that causes the growth of kidney cysts
  - Can require hemodialysis – allows for artificial filtering of the blood
    - Has risks such as infection, but is better than the alternative which is renal failure, then death
- Glycosuria – presence of glucose in blood
  - Increases solute of urine
  - From failure of renal absorption of glucose
- Aminoaciduria – presence of amino acids in the urine
  - Can result in crystallization and subsequent formation of painful “stones” of calculi, in the kidney or bladder
  - Nephrolith – alternate name for a calculi
Infection and Inflammation

- Urinary tract infection (UTI) – inflammation caused by bacteria
  - Can be anywhere in urinary tract
- Urethritis – inflammation of urethra
- Cystitis – inflammation of urinary bladder
- Pyelitis – inflammation of the renal pelvis
- Pyelonephritis – inflammation of the nephrons
- Dysuria – painful urination
  - Accompanies UTIs
- Pyuria – presence of white blood cells in urine
  - Indicates UTI
  - In addition to WBC (leukocytes), also high in nitrate levels
Immune Disorders

- Glomerulonephritis – autoimmune disorder causing inflammation and deterioration of the glomerular membranes
  - Can be caused by streptococcal bacteria infection
  - Causes edema – accumulation of fluids in the body tissues
- Hematuria – presence of red blood cells in urine
- Proteinuria – presence of abnormal protein levels in the urine
- Cast – abnormal aggregate of cells found in urine
Hormonal Disorders

- Addison’s disease – abnormally low aldosterone
  - Causes sodium excretion, excess water loss, dehydration, and hypertension
- Diuretics – increase volume of water in urine
  - Due to decrease in sodium absorption
  - Can be used to treat hypertension because increased water loss decreases blood volume and lowers blood pressure
  - Can also treat edema
Degenerative Disorders

- Chronic renal failure – irreparable nephron damage and loss of kidney function
  - causes buildup of urea in the blood
- Acute renal failure – temporary loss of kidney function
  - Proper nephron function in only 1/3 of a single kidney can keep a person alive
  - Still need hemodialysis
- Renal cell carcinoma – malignancy of the cells of the renal tubular lining
  - Most common form of kidney cancer
- Bladder cancer – malignancy of the tissue of the bladder
  - Hard to detect without medical imaging and symptoms present as a UTI.
Aging of Urinary System

- Nephroptosis – movement of the kidneys from its proper anatomical position to an inferior position
  - Due to forces of gravity and loss of fat – usually in elderly
- Cystocele – herniation of the bladder into the vagina
  - From continual pressure of the bladder on the structural connections that hold it in place
  - Pregnancy and multiple pregnancies increases this risk
- Incontinence due to degradation of the sphincter muscles surrounding urethra
- Urinary retention is seen in males due to hypertrophy of the prostate gland as early as 40
  - Restricts urethral passageway