URINARY SYSTEM
Components

- Kidneys
- Ureters
- Urinary bladder
- Urethra
Functions

- **Storage of urine**
  - Bladder stores up to 1 L of urine

- **Excretion of urine**
  - Transport of urine out of body

- **Regulation:**
  - Plasma pH
  - Blood volume/pressure
  - Plasma ion concentrations \((Ca^{2+}, Na^{+}, K^{+}, Cl^-)\)
  - Assist liver in detoxification, amino acid metabolism
Kidney Gross Anatomy

• Retroperitoneal
  – Anterior surface covered with peritoneum
  – Posterior surface directly against posterior abdominal wall
• Superior surface at about T12
• Inferior surface at about L3
• Ureters enter urinary bladder posteriorly
• Left kidney 2cm superior to right
  – Size of liver
Structure of the Kidney

• Hilum = the depression along the medial border through which several structures pass
  – renal artery
  – renal vein
  – ureter
  – renal nerves
Surrounding Tissue

- **Fibrous capsule**
  - Innermost layer of dense irregular CT
  - Maintains shape, protection
- **Adipose capsule**
  - Adipose ct of varying thickness
  - Cushioning and insulation
- **Renal fascia**
  - Dense irregular CT
  - Anchors kidney to peritoneum & abdominal wall
- **Paranephric fat**
  - Outermost, adipose CT between renal fascia and peritoneum
Frontal Section of the Kidney

- **Cortex**
  - Layer of renal tissue in contact with capsule
  - Renal columns
    - parts of cortex that extend into the medulla between pyramids

- **Medulla**
  - Striped due to renal tubules

- **Renal pyramids**
  - 8-15 present in medulla of adult
  - Conical shape
  - Wide base at corticomedullary junction
Flow of Filtrate/Urine

- Collecting ducts
  - Collect from multiple nephrons
- Minor calyx
  - Collect from each pyramid
- Major calyx
  - Collect from minor calyx
- Renal pelvis
  - Collects from calyces, passes onto
- Ureter
  - Collects from pelvis
- Urinary Bladder
  - Collects from ureters
Histology

Renal Cortex

Renal Medulla
Renal Tubules

• Nephron
  – functional unit of the kidney.

• Each kidney contains approximately 1 million nephrons

• Form urine by filtering and adjusting composition of blood carried by renal vasculature
Renal Portal System

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Renal Portal System

(b) Cortical circulation

(c) Flowchart of renal circulation
Histological Structure of a Nephron

- **Renal corpuscle**
  - Glomerulus
  - Bowman’s capsule
- **Renal tubules**
  - Proximal convoluted tubule
  - Descending limb of LOH
  - Loop of Henle
  - Ascending limb of LOH
  - Distal convoluted tubule
  - Collecting duct
- **Associated blood vessels**
  - Peritubular capillaries
  - Vasa recta
Types of Nephrons

- Cortical nephron
- Juxtamedullary nephron
- Distal convoluted tubule
- Renal corpuscle
- Connecting tubules
- Proximal convoluted tubule
- Thin descending limb
- Thick ascending limb
- Collecting duct
- Papillary duct
- Renal papilla
- Minor calyx
- Renal medulla
- Renal cortex
- Renal capsule
- Collecting duct
- Minor calyx
- Renal papilla

(a) Cortical and juxtamedullary nephrons
The Glomerulus

- Bowman’s capsule
- Glomerulus
- Afferent arteriole
- Efferent arteriole
- Podocytes
The Collecting System

- Collecting ducts receive filtrate from DCT of nephrons
- Collecting ducts empty into minor calyces
- Minor calyces empty into major calyces
- Major calyces drain into renal pelvis
- Renal pelvis drains into ureter
  - Now urine
The Ureters

- Expandable tubes that exit the renal pelvis
- 3 walls
  - Mucosa
    - Transitional epithelium
  - Muscularis
    - smooth muscle layer
  - Adventitia
    - protective fibrous CT
- Ureters drain into the posterior portion of the urinary bladder
The Urinary Bladder

- Functions to store urine
- Structure
  - Rugae
    - macroscopic folds as in the stomach
    - flatten when the urinary bladder is distended
  - Trigone
    - triangular region of the bladder
    - no rugae
    - location of openings to the ureters and urethra
Histology of the Urinary Bladder

- **Mucosal lining**
  - transitional epithelium

- **Submucosa**
  - fibrous CT

- **Muscularis**
  - detrusor muscle
    - 3 layers of smooth muscle

- **Serosa**
  - loose CT
  - visceral peritoneum
The Female Urethra

- Drains urine from urinary bladder to exterior
- 1-2 inches
- higher risk for bladder infections
The Male Urethra

- 3 regions:
  - prostatic
  - membranous
  - penile
Histology of the Urethra

- **Mucosa**
  - varies from bladder to exterior especially in males

- **Muscularis layer**

- **Adventitia**

- **Sphincters**
  - internal = smooth muscle (involuntary)
  - external = skeletal muscle (voluntary)