Urinary system

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Functions

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

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

• **Blood volume regulation**
  - Effects of hormones on kidneys

• **Regulation of erythrocyte production**
  - Kidneys
    • Monitor oxygen content of blood
    • Produce EPO = enothrocyte production
Components

- Kidneys
- Ureters
- Urinary Bladder
- Urethra
Kidneys
Gross Anatomy

- Kidneys approx weight = 125-150g each
- 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
surface features of kidney

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

- **Fibrous capsule**
  - Innermost layer of dense irregular CT
  - Maintains shape, protection

- **Adipose capsule** (perinephric fat)
  - 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
Coronal section

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

- **Medulla**
  - Innermost
  - striped due to renal tubules

- **Renal pyramids**
  - 8-15 present in medulla of adult
  - conical shape
  - Wide base at corticomedullary junction
Coronal section

- **Renal pelvis**
  - collects from calyces, passes onto ureter
- **Calyces (pl)**
  - funnel shaped regions
  - collect urine into pelvis
    - **Minor calyx (s)**
      - in contact with each pyramid
    - **Major calyx (s)**
      - collect from minor
Microscopic Anatomy

cortex

medulla
Microscopic anatomy
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.
Structure of 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
blood vessels of nephron

- Afferent arteriole
- Glomerulus
- Efferent arterioles
- Peritubular capillaries
  - Allow for removal of additional substances and reabsorption of substances being returned to blood
- Vasa recta
  - Peritubular capillaries deepest in the medulla
  - Associated with juxtamedullary nephrons
① Glomerular filtration
Creates a plasmalike filtrate of the blood

② Tubular reabsorption
Removes useful solutes from the filtrate, returns them to the blood and
Tubular secretion
Removes additional wastes from the blood, adds them to the filtrate

③ Water conservation
Removes water from the urine and returns it to blood, concentrates wastes
Filtration slits
Podocyte
Capillary endothelium
Pedicels
Filtration slits
Basement membrane
Endothelial cell
Filtration pores
Capillary lumen
Podocyte cell body
Erythrocyte
(d)
Renal portal system

- Renal capsule
- Renal cortex
- Renal pyramid in renal medulla
- Renal sinus
- Interlobular artery
- Arcuate artery
- Interlobar artery
- Segmental artery
- Renal artery
- Renal vein
- Segmental vein
- Interlobar vein
- Arcuate vein
- Interlobular vein
Renal Portal System

1) Renal artery
2) Segmental arteries
3) interlobar arteries
4) arcuate arteries
5) interlobular arteries
6) afferent arterioles
7) glomerular capillaries
8) efferent arterioles
9) peritubular capillaries/vasa recta
10) interlobular veins
11) arcuate veins
12) interlobar veins
13) segmental veins
14) renal vein
15) inferior vena cava
Pathway of urine formation

- Filtrate into Bowman’s capsule
- Proximal convoluted tubule
- Descending limb of the loop of Henle
- Loop of Henle
- Ascending limb of the loop of Henle
- Distal convoluted tubule
- Collecting duct to minor calyces
- To major calyces
- To renal pelvis to ureter
Collecting Ducts

- Receive filtrate from nephrons
- Site of action of several hormones which regulate water content
  - Anti-diuretic hormone (ADH)
  - Aldosterone
The Ureters

- expandable tubes that exit the renal pelvis
- 3 walls
  - Mucosa
    - Transitional epithelium
  - Muscularis
    - smooth muscle layer
  - Adventitia
    - protective fibrous CT
Histology of ureter

Note smooth muscle layer and transitional epithelium surrounding the lumen.
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
• mucosal lining
  - transitional epithelium

• Submucosa
  - fibrous CT

• muscularis
  - detrusor muscle
    • 3 layers of smooth muscle

• Serosa
  - loose CT
  - visceral peritoneum
The Urethra

• carries urine from urinary bladder to exterior

• Female
  - 1-2 inches
  - higher risk for bladder infections

• Male
  - 3 regions:
    • prostatic (from bladder through prostate
    • membranous (between prostate and penis
    • penile
Histology of urethra

- mucosa
  - varies from bladder to exterior especially in males
- smooth muscularis layer
- Adventitia
- Sphincters
  - internal = smooth muscle (involuntary)
  - external = skeletal muscle (voluntary)
Kidney transplant

Donor: Functioning kidneys

Recipient: Non-functioning kidneys
Kidney transplant

• Chronic kidney failure ≈ 260,000 patients
• Major causes of kidney disease
  - Diabetes (32%)
  - High blood pressure (25%)
  - Autoimmune disorders
  - Congenital abnormalities
  - Acute infections
Kidney transplant:
Harvesting donor organs

• Two punctures and 3-inch abdominal incision allow for laparoscopic harvest of kidney from living donor
Kidney transplant

- Patients own kidneys remain in place
- Transplanted kidney connected via transplanted ureter directly to bladder
- Blood supply to new kidney redirected from blood vessels supplying recipient's leg
- Surgical procedure usually requires approx 3 hours