URINARY SYSTEM OVERVIEW (P. 1104-1120)

STRUCTURES AND FUNCTIONS TO THE URINARY SYSTEM

KIDNEYS

- Macrostructure
  - Two bean shaped organs located behind the peritoneum on either side of the vertebral column (T12 –L3)
  - About 5 inches long, surrounded by fat and connective tissue with an adrenal gland on top of each one
  - Right kidney is lower than the left (level of the 12th rib)
  - Capsule – covers the kidney, acts as shock absorber
  - Hilus – entry site of renal artery/nerves, exit site for renal vein / ureter (medial side)
  - Parenchyma – kidney tissue, cortex – outer layer, medulla – inner layer
- Microstructure
  - Nephron – functional unit of the kidney
    - Glomerulus
    - Bowman's capsule
    - Tubular system
      - Proximal and distal convoluted tubule
      - Loop of Henle
      - Collecting tubules
- Blood supply
  - 1200 ml/min 20-25% of cardiac output
  - Aorta →hilus →renal artery →divide into two branches → more branches →afferent arteriole → capillary network (glomerulus) → efferent arteriole →capillary network (peritubular capillaries) →venous system →renal vein → inferior vena cava
- Glomerular function
  - Semipermeable membrane where blood is filtered and urine formation begins
  - Hydrostatic pressure of blood in glomerular capillaries → filtered across membrane → Bowman's capsule → tubule → makes ultrafiltrate (similar composition to blood)
  - Glomerular filtration rate (GFR) – amount of blood filtered each minute
    - Normal = 125 ml/min
- Tubular function
  - Reabsorbs essential materials and excretes nonessentials
    - Reabsorption: substance → lumen of the tubules →tubule cells → capillaries
      - Active and passive transport
      - Proximal convoluted tubules reabsorbs - 80% of electrolytes, glucose, amino acids, small proteins
      - Loop of Henle – water, sodium, urea, chloride ions and other solutes
    - Secretion: substance → capillaries →tubular cells →lumen of the tubules
      - Hydrogen ions and creatinine
  - Changes the composition of the glomerular filtrate
- Functions of Segments of Nephron (table 45-1)
  - The basic function of the nephron is to cleanse blood plasma of unnecessary substances

- **Golmerulus** – selective filtration
- **Proximal Tubule** – Reabsorption of 80% of electrolytes and water; reabsorption of all glucose and amino acids; reabsorption of HCO3-; secretion of H+ and creatinine
- **Loop of Henle** – Reabsorption of Na+ and Cl- in ascending limb; reabsorption of water in descending loop; concentration of filtrate
- **Distal Tubule** – Secretion of K+, H+, ammonia; reabsorption of water (regulated by ADH); reabsorption of HCO3-; regulation of Ca+ and PO4- by parathyroid hormone, regulation of Na+ and K+ by aldosterone
- **Collecting Duct** – Reabsorption of water (ADH required)
  - **ADH** allows water to be reabsorbed into circulation by making the tubules and collecting ducts permeable to water

- Other functions of the kidneys
  - RBC production
    - Kidneys produce erythropoietin hormone → secreted in response to hypoxia and decreased renal blood flow (the kidney assumes if it is not getting blood the whole body must not be getting blood)
    - Kidney failure → decrease erythropoietin production → anemia
  - Reduction of SVR and BP regulation
    - Renin is produces and secreted by the kidneys (increases BP)
      - Decreased renal perfusion decreased arterial blood pressure, decreased ECF, decreased serum Na+ concentration and increased urinary Na+ → renin release →Angiotensin I activation → ACE converts to Angiotensin II →aldosterone release → Na+ and water retention → increase in BP
    - Kidneys synthesis prostaglandins (PG) → vasodilation, Na+ secretion (counter angiotensin/aldosterone) → lower BP by lowering SVR
      - Renal failure decreases PG production leading to hypertension

- Ureters
  - Carry urine from the renal pelvis to the bladder
    - Ureteropelvic junction (UPJ) : where the ureter connects to the renal pelvis
      - Very narrow and often the site of obstruction
    - Sympathetic, parasympathetic, and vascular supply → stimulation → acute, severe pain called renal colic
    - Supposed to be one way, when reflux occurs it leads to infection

- Bladder
  - A distensible (able to ill at low pressures) organ positioned behind the symphysis pubis and anterior to the vagina and rectum
  - Primary functions:
    - Serve as a reservoir for urine
    - Eliminate waste products from the body
  - Normal output is 1500 ml/day (varies with intake)
  - Urinate more during the day than at night because of ADH secretion during the day
  - 200-250 ml of urine will cause moderate distention and urge to empty your bladder
  - 400-600 ml can cause severe discomfort
  - 600-1000 ml is the maximum capacity

- Urethra
  - Small muscular tube that leads from the bladder neck to the external meatus
  - Primary function: serve as a conduit for urine from the ladder to outside the body
  - Female is only 1-2 inches
  - Male 8 – 10 inches
    - Prostatic urethra – bladder neck to the urogenital diaphragm (through prostate)
    - Membranous urethra – through the urogenital diaphragm and is encircles by the rhabdosphincter
    - Penile urethra - beyond the urogenital diaphragm to the urinary meatus
- Urethrovesical unit
  - Bladder, urethra and pelvic floor muscles → allows for continence
  - Damaged by diabetes mellitus, MS, paraplegia, and tetraplegia
  - Drugs effecting nerve transmission can also cause poor bladder function
- Gerontologic considerations
  - 20-30% decrease in size 30-90 years (accelerated by atherosclerosis)
  - 30-50% loss of glomeruli function by 70
  - Decreased renal blood flow → decreased GFR
  - Alteration in hormone levels (AHD, aldosterone, and ANP) → inability to concentrate urine, excrete water sodium, potassium and acid
  - Bladder, urethra and pelvic floor lose elasticity leading to incontinence
  - Kidney specific changes
    - Decrease in renal tissues, number of nephrons, and blood vessles
    - Thickened basement membraneof Bowman's capsule and glomeruli
    - Decreased loop of Henle and tubules function
  - Assessment changes
    - Less palpable
    - Decrease creatinine clearance → increased serum BUN and Creatinine
    - Altered drug excretion, nocturia, less concentrated urine
  - Ureter, bladder and urethra specific changes
    - Decreased elasticity and muscle tone, weakened sphincter
    - Decreased capacity and sensory receptors
    - Increase in unstable bladder contractions
    - Prostatic enlargement / thin, dry vaginal tissue
    - Retention of urine and stress incontinence
    - Frequency, urgency, nocturia, overflow incontinence, overactive bladder, dyuria

ASSESSMENT OF THE URINARY SYSTEM

- Subjective data
  - Past health history
    - Renal or urologic diseases or problems
      - Hypertension, DM, gout, metabolic problems, connective tissue disorders, skin or upper airway infections (strept), lupus, TB, viral hepatitis, neurologic conditions and trauma
      - Cancer, frequent infections, BPH, and calculi