Renal Physiology

Functions of the Renal System

Components of the Renal System
   Kidneys, ureters, urinary bladder, urethra

Nephrons
   Juxtamedullary and cortical nephrons

Structure of nephron
   Tubular components
      Bowman’s capsule
      Proximal tubule
      Loop of Henle
      Distal tubule
      Collecting duct
   Path of filtrate flow through nephrons

Vascular components
   Renal artery
   Renal arterioles
   Glomerular & peritubular capillaries, vasa recta

Juxtaglomerular apparatus

3 “components” of urine production
   Glomerular filtration
   Tubular reabsorption
   Tubular secretion

Glomerular filtration
   Filtration membrane
   3 pressures

Control of GFR
   Renal Autoregulation
      Myogenic & tubuloglomerular feedback mechanisms
   Neural regulation
      Sympathetic Nervous System
   Hormones
      Angiotensin II, prostaglandins

Estimation of GFR – inulin clearance

Tubular reabsorption & secretion

Transepithelial & paracellular transport
   Proximal tubule
      Na+, HCO3-, glucose, amino acid, Cl-, urea & H2O reabsorption
      H+ secretion
      Role of Na+-K+ ATPase
      Transport maximum (Tm) & renal threshold
         Glycosuria
Loop of Henle
   Na+ reabsorption – descending limb
   H2O reabsorption – ascending limb
   Na+-K+ ATPase
   Na-K-Cl- cotransporter
Distal Tubule & Collecting Duct
   Na+ reabsorption
   Intercalated vs. principal cells
Hormonal control of tubular reabsorption & secretion
   ADH
      Stimuli for secretion
      Mechanism of reabsorption (principal cells)
   Aldosterone
      Stimuli for secretion
      Mechanism of reabsorption/secretion (principal cells)
   ANP
      Stimuli for secretion
      Mechanism of action
Water balance
   Role of kidneys
How can we produce urine of varying volume and concentration?
Dilute urine
Concentrated urine
   VOG in the medullary ISF
   Countercurrent multiplication & exchange
Control of micturition
   Micturition reflex
Renal failure
   Hemodialysis & peritoneal dialysis

Objectives:
1. What are the major functions of the renal system?
2. What does retroperitoneal mean?
3. What are the major components of the renal system? What are their functions?
4. What is a nephron? Know the structure (tubular & vascular components) of the nephron.
5. Identify the path of urine flow from the time the urine leaves the nephrons until it exits the body through the urethra.
6. Identify the major regions of the kidney. Where are the nephrons found? Describe the path of fluid flow through a nephron. While in the nephron, is the fluid called urine?
7. What are the two classes of nephrons? What is the difference between the two?
8. What is the juxtaglomerular apparatus? What are the specialized cells within the afferent arterioles? The ascending limb of the loop of Henle? What are the functions of these cells?
9. What are the three processes integral to urine formation?
10. What is the composition of the filtrate? Where does filtration take place?
11. What are the three pressures that determine glomerular filtration?
12. What are the barriers to filtration across the filtration membrane? How do they work?
13. What are the major determinants of GFR?
14. How do the autoregulatory mechanisms help maintain GFR? Be able to discuss both the myogenic mechanism and tubuloglomerular feedback in detail.
16. What is transepithelial transport? Paracellular transport?
17. Be able to explain the mechanism of reabsorption/secretion throughout the length of the nephron. What ions, ion channels, transporters, and cell types are involved at each level of the nephron?
18. What is the renal threshold of a substance, i.e. like glucose? Why might an individual that has Diabetes Mellitus have glucose in their urine? What is glycosuria?
19. Describe hormonal regulation of tubular reabsorption and secretion. Where does this regulation occur in the nephron (i.e. what cells are involved)? What stimuli increase or decrease hormone secretion? How specifically does ADH increase water reabsorption? How specifically does aldosterone increase sodium reabsorption and potassium secretion? How specifically does ANP reduce sodium and water reabsorption?
20. Where does secretion predominantly take place in the nephron? Where do substances are typically secreted? Where does reabsorption occur in the nephron?
21. What is the difference between an Aquaporin I and Aquaporin II water channel? Where are they found in the nephron?
22. Are the kidneys able to replace lost fluid volume?
23. Describe the mechanisms by which dilute and concentration urine are produced. How are these mechanisms affected by hormones like aldosterone, ADH, and ANP?
24. What is the vertical osmotic gradient (VOG)? How is it produced? Where is it located? How does it contribute to the production of concentrated urine? How does countercurrent exchange prevent the VOG from collapsing?
25. How does the osmolarity of the filtrate change as it moves down the length of the nephron and collecting duct?
26. What is micturition? Describe the micturition reflex. How can this reflex be modified with learning?
27. What is renal failure? How does dialysis work? What is the difference between hemodialysis and peritoneal dialysis?