Urinary System Anatomy and Physiology

1. Anatomy
    1. Gross Anatomy
        1. Location
            1. Note: large vessels; kidneys receive 20% of cardiac output (≈ 1.3 l/min)!
        2. Male
        3. Female
        4. Control
    2. Organ Level of Kidney
        1. Cortex
        2. Medulla
        3. Pelvis
    3. Microanatomy
        1. Nephron
            1. Bowman's Capsule
            2. Proximal Tubule
            3. Loop of Henle
                1. descending: thin
                2. ascending: thick
            4. Distal Convoluted Tubule
            5. Collecting Duct
            6. Two types: Cortical and Juxtamedullary
            7. JGA: "control center", will talk about under topic of local control
2. Urine Production- Proximal Tubule
    1. filtration
        1. blood pressure forces smaller molecules through capillary sieve
        2. collected by Bowman's Capsule (120 ml/min!)
            1. no large molecules like proteins
    2. water
        1. salts
        2. minerals
        3. glucose
        4. amino acids
    3. Reabsorbtion into second capillary bed
        1. driven by active transport of Na^+ out of brush border cells lining the proximal tubule
        2. also drags Cl^- and H_2O along into peritubular capillaries
        3. cotransport of Na^+ and glucose into cells in exchange for protons (80 ml/min!)
            1. 2/3 of water
            2. some salts, minerals, urea [used later to generate concentration gradient]
            3. amino acids
    4. secretion by active transport of:
        1. fatty acids
        2. uric acid
        3. prostaglandins
        4. drugs
            1. secretion declines with age, one reason elderly susceptible to drug overdoses
    5. figure
3. Urine Concentration (Loop of Henle)
    1. descending loop
        1. permeable to water and salts
    2. ascending loop
        1. impermeable to water
        2. active transport of Na^+ out
    3. interstitial fluid increases in concentration
    4. countercurrent multiplier creates gradient
        1. up to 4 X plasma concentration in humans
        2. 20 X in Kangaroo Rats, which have long loops of Henle
    5. Urea concentration achieved at bottom of collecting duct by making tube impermeable to urea between ascending loop and top of collecting duct.
    6. Urea follows water and high salt concentration gradient.
    7. Countercurrent exchange in circulatory system around tubules (vasa recta) prevents breakdown of gradient