Chapter 25: The Urinary System

Kidneys filter blood, excrete wastes and toxins, regulate blood volume and content, produce hormones (renin & erythropoietin), Vitamin D synthesis, gluconeogenesis when fasting.

I. KIDNEY ANATOMY

Retroperitoneal location.

Indented hilum leads to sinus- location of blood vessels, ureter, nerves, lymphatics. Surrounded by fascia, fat & capsule.

Internally: cortex, medulla, pelvis. Pyramids, columns, major & minor calyces.

Infection = pyelonephritis.


Renal corpuscle = glomerulus and Bowman’s capsule.

Bowman’s Capsule continues as proximal convoluted tubule (PCT) → loop of Henle → DCT → collecting duct (shared by many nephrons).

Bowman’s Capsule with parietal and visceral layers, inner formed by podocytes, which create filtration slits with pedicals.

Loop with thin segment (H2O permeable) and thick segment.

Most nephrons cortical, ~15% juxtamedullary.

Afferent and efferent arteriole on either end of glomerulus, lead into peritubular capillaries (vasa recta around juxtamedullary nephrons).

Juxtaglomerular Apparatus = JGA between afferent arteriole (JG cells) and macula densa of ascending loop.

Filtration Membrane = fenestrated endothelium of glomerular capillaries; basement membrane w/ proteoglycans; filtration slits between podocytes.
II. URINE FORMATION

Filtration; reabsorption; secretion; water conservation. >99% of filtrate reabsorbed.

(A) Filtration

180L of filtrate formed per day. Cells and most proteins don’t pass.
Net Filtration Pressure = NFP, based on glomerular hydrostatic P vs, COP of blood and Capsular P.

Glomerular Filtration Rate (GFR) = filtrate/ min/ both kidneys.

-1- Intrinsic Controls:

   a. myogenic mechanism – increasing BP decreases afferent arteriole diameter.
   b. Tubuloglomerular feedback – macula densa creates vasoconstriction of afferent arteriole when increased salt in filtrate

-2- Extrinsic Controls:

   a. sympathetic ANS constricts afferent arteriole
   b. Renin – angiotensin

results in systemic arteriole constriction, increased Na+ reabsorption, increased ADH levels, thirst, constriction of efferent arteriole, decreases GFR.

(B) Tubular Reabsorption

Transcellular vs. Paracellular transport.

Many mechanisms depend upon membrane proteins.

Applies to Na+; K+; Mg++; Ca++; H2O; urea; HCO3-; small proteins...

Transport maxima for most.

Obligatory water reabsorption not regulated.
(C) Tubular Secretion

Movement from peritubular capillaries into the tubule.
H⁺; K⁺; NH₄⁺; creatinine; drugs; urea; uric acid.

(D) Regulation of Urine Volume & Concentration (osmolarity)

Countercurrent mechanisms between limbs of loop of Henle and between portions of Vasa Recta.

Osmolarity of filtrate quadruples in medulla.

Descending limb is water permeable, but not solute permeable.
Ascending limb is the reverse.

Positive feedback: the saltier it gets, the saltier it gets.

Urea also contributes to osmolarity of medulla. Its reabsorption from the collecting duct stimulated by ADH.

Vasa Recta protect the high osmolarity of the medulla.

Control of water reabsorption largely ADH, increased formation of aquaporins in collecting duct walls.

Regulated = facultative water reabsorption.

Diuretics: alcohol inhibits ADH; caffeine and other drugs decrease Na⁺ reabsorption.

Renal Clearance: volume of plasma cleared of a substance per minute.
Helps determine GFR.
Use inulin – not reabsorbed or secreted. Also creatinine, but not as accurate.

Renal disease associated with diabetes, hypertension. Treatment = hemodialysis.

III. URINE

Yellow due to urochrome.
Examined for odor, pH, specific gravity, clarity, color.
Chemical composition evaluated with chemstrips.
~95% water. Urea, uric acid, creatinine, electrolytes....
IV. URETERS

Mucosa with transitional epithelium.
Renal calculi may cause blockages. Removed with lithotripsy (ultrasonic waves).

V. URINARY BLADDER

Trigone = base surrounded by uretral and urethral openings.
Detrusor muscle elsewhere.
Rugae expands with filling.
Maximum capacity ~ 800-1000ml.

VI. URETHRA

Internal and external (voluntary) sphincters.
Three regions in males: prostatic, membranous and spongy.
Female anatomy predisposes towards UTIs.

VII. MICTURITION

Loss of control = incontinence.
Urinary retention linked to BPH.

VIII. CONGENITAL ABNORMALITIES

Hypospadias – in males, orifice ventral in penis.
Polycystic Kidney Disease – fluid cysts, problems when aging.