The Kidney and Its Collecting System

1. Filtration
2. Reabsorption
3. Secretion
4. Excretion

Excretion = Filtration – Reabsorption + Secretion
Nephron

Remember

Functional Unit of Kidney

Glomerulus Microcirculation

Tubular Microcirculation
Anatomy of Kidney

- Note the positions of
- Glomerulus
- Loop of Henle
- PCT, DCT, CT
- Cortex, Medulla, Pelvis.
Diseases of the kidney are divided into those that affect the four basic morphologic components:

1. Glomeruli
2. Tubules
3. Interstitium: the space between cells in a tissue.
4. Blood vessels
• Glomerulonephritis – inflammation of the glomeruli
• rapid loss of renal function
  ☐ Nephros – kidney
  ☐ -itis – inflammation of
  ☐ Glomus – small round ball or knot
  ☐ Pathos – suffering or disease
  ☐ -osis – diseased condition
The Nephrotic Syndrome

- The nephrotic is a specific type of Glomerulonephritis; characterized by heavy proteinuria, hypoalbuminemia (albumin in blood serum are abnormally low), severe edema, hyperlipidemia (elevated levels of any or all lipids and/or lipoproteins in blood), and lipiduria (lipid in the urine).
Specific types of Glomerulonephritis: 
The Nephrotic Syndrome

- The nephrotic syndrome refers to a clinical complex that includes the following:

(1) massive proteinuria, with daily protein loss in the urine of 3.5 gm or more in adults.

(2) hypoalbuminemia, with plasma albumin levels less than 3 gm/dL (low plasma osmotic pressure)

(3) generalized edema, *anasarca* is a consequence of the drop in plasma colloid osmotic pressure as a result of hypoalbuminemia)

(4) hyperlipidemia and lipiduria (lipiduria: the presence of lipids, lipoproteins in the urine).

A 4mL sample of hyperlipidemic blood with lipids separated into the top fraction.
The Nephrotic Syndrome

• Podocyte injury is an underlying mechanism of proteinuria, and may be the result of nonimmune causes (as in minimal change disease and FSGS) or immune mechanisms (as in membranous nephropathy).

1. **Minimal-change disease** is the most frequent cause of nephrotic syndrome in children; it is manifested by proteinuria and effacement of glomerular foot processes without antibody deposits. The pathogenesis is unknown; the disease responds well to steroid therapy

2- **Focal and Segmental Glomerulosclerosis FSGN**: is a lesion characterized histologically by sclerosis affecting some but not all glomeruli (focal involvement) and involving only segments of each affected glomerulus.
Focal segmental glomerulosclerosis (FSGS) describes both a common lesion in progressive kidney disease, and a disease characterized by marked proteinuria and podocyte injury.
3. Membranous nephropathy is nephrotic syndrome caused by an autoimmune response against an unknown renal antigen.

The disease often is resistant to steroid therapy.
The Nephritic Syndrome

• The nephritic syndrome is a specific type of Glomerulonephritis; it is characterized by hematuria, azotemia, oliguria with, proteinuria, and hypertension.

• The most common cause is immunologically mediated glomerular injury; lesions are characterized by proliferative changes and leukocyte infiltration.

• Acute post infectious glomerulonephritis typically occurs after streptococcal infection in children and young adults but may occur following infection with many other organisms.
Tubulointerstitial Nephritis

• Consists of a group of inflammatory diseases primarily involving the tubules and interstitium.

• In most cases of TIN caused by bacterial infection, the renal pelvis is prominently involved—hence the more descriptive term pyelonephritis (from pyelo, "pelvis").

• Acute pyelonephritis is a bacterial infection caused either by ascending infection as a result of reflux, obstruction, or other abnormality of the urinary tract, or by hematogenous spread of bacteria; characterized by abscess formation.

• in the kidneys, sometimes with papillary necrosis
Pathways of renal infection. Hematogenous infection results from bacteremic spread (Bacteria using the blood to spread).

More common is ascending infection, which results from a combination of urinary bladder infection, vesicoureteral reflux, and intrarenal reflux.
Acute pyelonephritis

- The cortical surface is studded with focal pale abscesses, more numerous in the upper pole and middle region of the kidney; the lower pole is relatively unaffected.

- Between the abscesses there is dark congestion of the renal surface.
• Chronic pyelonephritis implies recurrent kidney infections, usually is associated with urinary obstruction or reflux; results in scarring of the involved kidney, and gradual renal insufficiency.
Chronic Pyelonephritis

- Figure 14-16 Typical coarse scars of chronic pyelonephritis associated with vesicoureteral reflux.

- The scars are usually located at the upper or lower poles of the kidney and are associated with underlying blunted calyces.
Acute Tubular Injury

- **Acute tubular** necrosis (ATN) is a medical condition involving the death of **tubular** epithelial cells that form the renal tubules of the kidneys.

It is the most common cause of acute kidney injury; its clinical manifestations are electrolyte abnormalities, acidosis, uremia, and signs of fluid overload, often with oliguria.
Vascular Diseases of the Kidney

- **Nephrosclerosis**: hardening of the kidney, usually associated with hypertension and disease of the renal arterioles.

- It is characterized as benign or malignant depending on the severity and rapidity of the hypertension and arteriolar changes.

- **Arteriolar nephrosclerosis** that involving chiefly the arterioles, with degeneration of the renal tubules and fibrotic thickening of the glomeruli.
• **1. Benign Arterionephrosclerosis**: is progressive renal impairment caused by chronic, poorly controlled hypertension. Characteristic features are hyaline arteriolosclerosis and narrowing of vascular lumens with resultant cortical atrophy.

• **2. Malignant nephrosclerosis**: Acute kidney injury associated with severe elevation of blood pressure.
Renal Stones: *Urolithiasis* is calculus formation (either calcium oxalate or calcium oxalate mixed with calcium phosphate) at any level in the urinary collecting system, but most often the calculi arise in the kidney.

Symptomatic urolithiasis is more common in men than in women. A familial tendency toward stone formation has long been recognized.
**summery:**

- **Obstructive uropathy** is a structural or functional hindrance of normal urine flow, sometimes leading to renal dysfunction (obstructive nephropathy).

- **Nephrolithiasis**
  Urinary stones are typically classified by their location in the kidney (*nephrolithiasis*), ureter (*ureterolithiasis*), or bladder (*cystolithiasis*)

Fig A kidney stone, 8 millimeters (0.31 in) in diameter
Cystic Diseases

Adult polycystic kidney disease is a genetic disorder in which abnormal cysts develop and grow in the kidneys. It is two types: 

- **autosomal dominant polycystic kidney disease** (ADPKD)
- **autosomal recessive polycystic kidney disease** (ARPKD),
PKD is a disease of autosomal dominant inheritance caused by mutations in three genes. It accounts for about 10% of cases of chronic renal failure; kidneys may be very large and contain many cysts.

2. Autosomal recessive (childhood) polycystic kidney disease is caused by mutations in certain gene. It is less common than the adult form and strongly associated with liver abnormalities; kidneys contain numerous small cysts.
kidney cancer

• The most common type of kidney cancer is called renal cell carcinoma.

• **Renal cell carcinoma (RCC)** is a kidney cancer that originates in the lining of the proximal convoluted tubule, a part of the very small tubes in the kidney that transport waste molecules from the blood to the urine.

• **Renal cell carcinomas** account for 2% to 3% of all cancers in adults responsible for approximately 90–95% of cases.
Renal Cell Carcinoma

Renal cell carcinomas are classified into three types:

1. Clear cell carcinomas

2. Papillary renal cell carcinomas

3. Chromophobe renal cell carcinomas
Clear cell renal cell carcinoma (CCRCC)

• Clear cell renal cell carcinoma (CCRCC) is a renal cortical tumor typically characterized by malignant epithelial cells with clear cytoplasm.

• Genetic changes underlying clear cell renal cell carcinoma are the most common tumors frequently invade the renal vein.

Typical gross presentation of clear cell renal cell carcinoma (lower left) with golden color due to intracellular lipid accumulation.
Papillary renal cell carcinomas

- Papillary renal cell carcinomas frequently are associated with mutations of gene; they tend to be bilateral and multiple and show variable papilla formation.
Chromophobe renal cell carcinomas are less common;
tumor cells are not as clear as in the other renal cell carcinomas.