

Kidney and Excretion

Basic Function

Excretion

- While excretory systems are diverse, nearly all produce urine by a two-step process.
 - First, body fluid (blood, coelomic fluid, or hemolymph) is collected.
 - Second, the composition of the collected fluid is adjusted by **selective reabsorption** or **secretion** of solutes.

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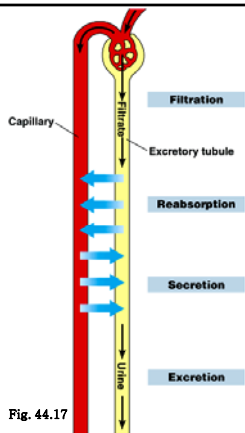


Fig. 44.17

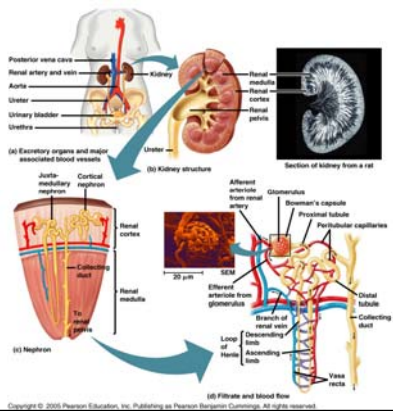
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Mammalian Kidney

- Mammals have a pair of bean-shaped kidneys.
 - These are supplied with blood by a **renal artery** and a **renal vein**.
 - In humans, the kidneys account for less than 1% of body weight, but they receive about 20% of resting cardiac output.

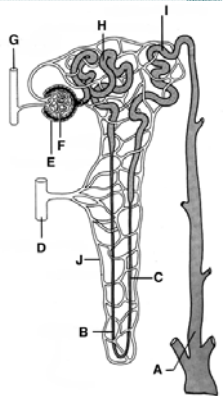
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Kidney



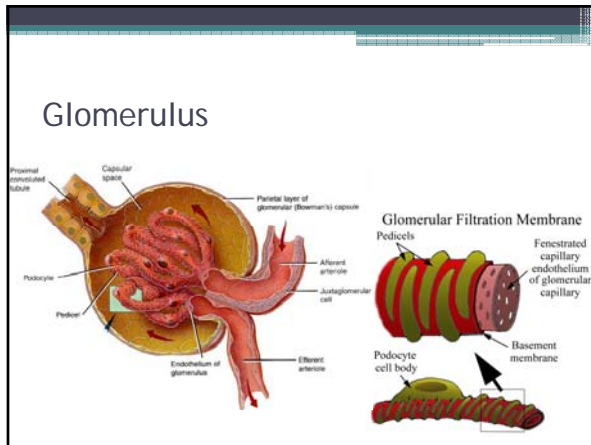
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Nephron Practice



- Filtration occurs as blood pressure forces fluid from the blood in the glomerulus into the lumen of Bowman's capsule.
 - The porous capillaries, along with specialized capsule cells called podocytes, are permeable to water and small solutes but not to blood cells or large molecules such as plasma proteins.
 - The filtrate in Bowman's capsule contains salt, glucose, vitamins, nitrogenous wastes, and other small molecules.

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- From Bowman's capsule, the filtrate passes through three regions of the nephron: the **proximal tubule**; the **loop of Henle**, a hairpin turn with a descending limb and an ascending limb; and the **distal tubule**.
 - The distal tubule empties into a **collecting duct**, which receives processed filtrate from many nephrons.
 - The many collecting ducts empty into the renal pelvis, which is drained by the ureter.

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- In the human kidney, about 80% of the nephrons, the **cortical nephrons**, have reduced loops of Henle and are almost entirely confined to the renal cortex.
 - The other 20%, the **juxtamedullary nephrons**, have well-developed loops that extend deeply into the renal medulla.
 - It is the juxtamedullary nephrons that enable mammals to produce urine that is hyperosmotic to body fluids, conserving water.

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- The nephron and the collecting duct are lined by a transport epithelium (Simple Cuboidal with Microvilli) that processes the filtrate to form the urine.
 - Their most important task is to reabsorb solutes and water (Osmoregulation)
 - The nephrons and collecting ducts reabsorb nearly all of the sugar, vitamins, and other organic nutrients from the initial filtrate and about 99% of the water.
 - This reduces 180 L of initial filtrate to about 1.5 L of urine to be voided.

Proximal Convoluted Tubule

- At this point in the nephron, the filtrate from the blood contains both waste molecules like urea and useful molecules like amino acids, glucose, and salt. The filtering process in the glomerulus is not selective (except by size) so the proximal convoluted tubule works to **actively transport** nutrients (glucose, amino acids, and salts) back into the blood capillaries so they are not lost in the urine. The tubule has a brush border with many villi to increase the surface area for this process of **selective reabsorption**. The cells of the tubule also contain many mitochondria that produce the ATP required for the large amount of active transport taking place throughout the length of the tubule.

Loop of Henle

- The Loop of Henle dips down into the hypertonic environment of the kidney medulla and is responsible for the **reabsorption of water** from the filtrate. Water **is drawn out of the descending limb of the loop**, by osmosis, into the hypertonic medulla of the kidney. This water can then move into the capillary network and back into circulation to maintain blood volume. The **ascending limb of the loop is impermeable to water and removes salt** into the **medulla** of the kidney adding to the hypertonicity

Distal Convolved Tubule

- The Distal Convolved Tubule is the site of **tubular secretion**. This process involves the active transport of materials from the blood directly into the tubule. Examples of molecules that are secreted by the distal convoluted tubule are creatinine, drugs like penicillin, and hydrogen ions. Tubular secretion of hydrogen ions along with the reabsorption of bicarbonate ions (a biological buffer) acts as a mechanism to control blood pH.

Diabetes and Nephron



- Filtrate from Bowman's capsule flows through the nephron and collecting ducts as it becomes urine.

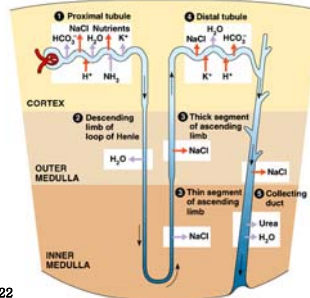


Fig. 44.22

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