Ultra-Structure of kidney

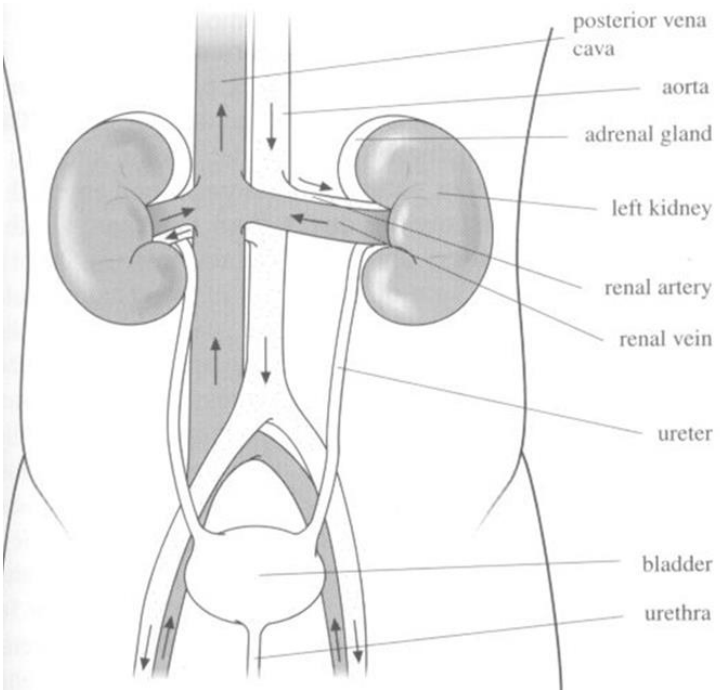
The excretory system is responsible for filtering wastes from the blood and both forming and secreting urine. These functions help to maintain the composition and volume of body fluids. Although it has far-reaching effects, the urinary system is relatively simple anatomically and consists of: Kidneys, Ureters, Bladder, and Urethra.

The main organs are the kidneys, which filter blood and produce urine. The other parts are simply accessory structures for the transport and storage of urine.

During the normal breakdown of protein and nucleic acids, nitrogen is released into the bloodstream. Some of this nitrogen is recycled to make new cellular products, but most of it is disposed of. The body has to have a way to rid itself of this unused nitrogen, as high levels in the blood can be toxic. Most of the nitrogen is bound with hydrogen as NH3 (ammonia), which is readily dissolved in water. For this reason, fish are able to excrete much of their nitrogen by simple diffusion into the surrounding water. Terrestrial animals have a different way of ridding their bodies of excess nitrogen. It is either excreted as uric acid or urea. Animals that are concerned about water loss, such as birds and reptiles, excrete the more concentrated uric acid as a pasty white material. Mammals, on the other hand, can excrete urea, along with more water. The mixture of urea, water, and other wastes is called 'urine.' Urine is still very concentrated in comparison to the blood, and the system that facilitates this concentration is the 'urinary system.

Kidneys

The kidneys of mammals are round or bean-shaped organs. They are located outside of the peritoneum – the membrane that encloses the organs of the abdominal cavity. Because of this position, they are referred to as retroperitoneal. They are surrounded by fat tissue known as perirenal fat. A fibrous capsule covers the kidney. The indentation of the bean shape is called the 'hilum.' The hilum is the site where the renal artery enters the kidney and both the renal vein and ureter exit.



Each kidney receives blood from a renal artery, and it is from this blood that urine is produced. Urine drains from each kidney through a ureter, which carries the urine to a urinary bladder. Urine passes out of the body through the urethra. Within the kidney, the mouth of the ureter flares open to form a funnel-like structure, the renal pelvis. The renal pelvis, in turn, has cup-shaped extensions that receive urine from the renal tissue. This tissue is divided into an outer renal cortex and an inner renal medulla. Together, these structures perform filtration, reabsorption, secretion, and excretion.

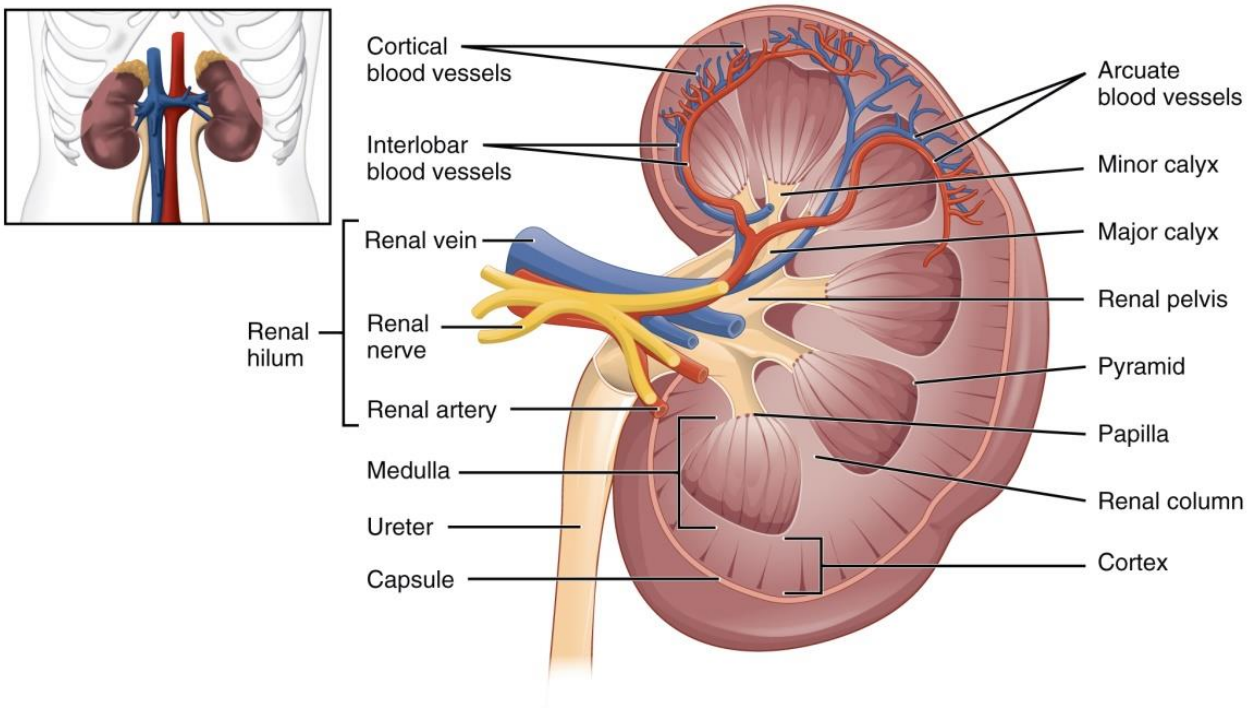
External Anatomy:

The left kidney is located at about the T12 to L3 vertebrae, whereas the right is lower due to slight displacement by the liver. Upper portions of the kidneys are somewhat protected by the eleventh and twelfth ribs. Each kidney weighs about 125–175 g in males and 115–155 g in females. They are about 11–14 cm in length, 6 cm wide, and 4 cm thick, and are directly covered by a fibrous capsule composed of dense, irregular connective tissue that helps to hold their shape and protect them. This capsule is covered by a shock-absorbing layer of adipose tissue called the renal fat pad, which in turn is encompassed by a tough renal fascia. The fascia and, to a lesser extent, the overlying peritoneum serve to firmly anchor the kidneys to the posterior abdominal wall in a retroperitoneal position.

On the superior aspect of each kidney is the adrenal gland. The adrenal cortex directly influences renal function through the production of the hormone aldosterone to stimulate sodium reabsorption.

Internal Anatomy:

A frontal section through the kidney reveals an outer region called the renal cortex and an inner region called the medulla. The renal columns are connective tissue extensions that radiate downward from the cortex through the medulla to separate the most characteristic features of the medulla, the renal pyramids and renal papillae. The papillae are bundles of collecting ducts that transport urine made by nephrons to the calyces of the kidney for excretion. The renal columns also serve to divide the kidney into 6–8 lobes and provide a supportive framework for vessels that enter and exit the cortex. The renal pyramids and renal columns taken together constitute the kidney lobes.



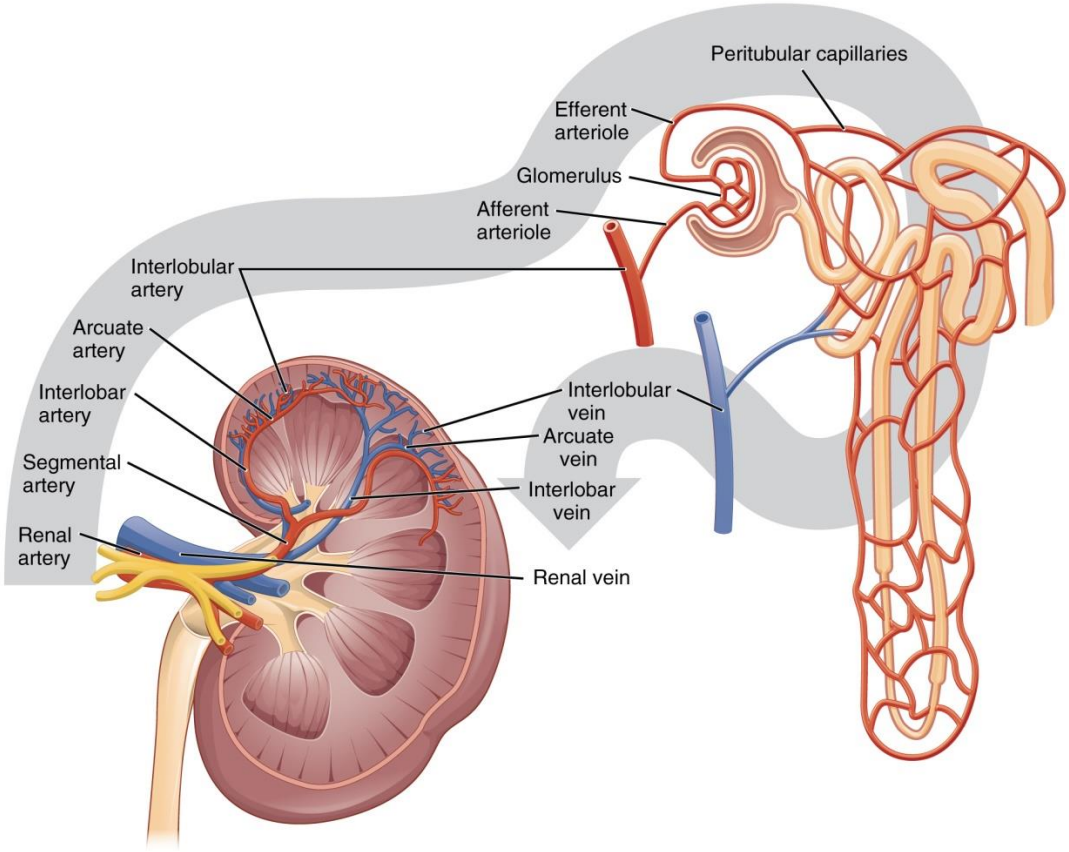
Renal Hilum:

The renal hilum is the entry and exit site for structures servicing the kidneys: vessels, nerves, lymphatics, and ureters. The medial-facing hila are tucked into the sweeping convex outline of the cortex. Emerging from the hilum is the renal pelvis, which is formed from the major and minor calyxes in the kidney. The smooth

muscle in the renal pelvis funnels urine via peristalsis into the ureter. The renal arteries form directly from the descending aorta, whereas the renal veins return cleansed blood directly to the inferior vena cava. The artery, vein, and renal pelvis are arranged in an anterior-to-posterior order.

Blood Vessels:

The renal artery first divides into segmental arteries, followed by further branching to form interlobar arteries that pass through the renal columns to reach the cortex. The interlobar arteries, in turn, branch into arcuate arteries, cortical radiate arteries, and then into afferent arterioles. The afferent arterioles service about 1.3 million nephrons in each kidney.



Nephrons:

The mammalian kidney is composed of roughly 1.3 million nephrons- the structural and functional unit of kidneys. Each of which is composed of four regions:

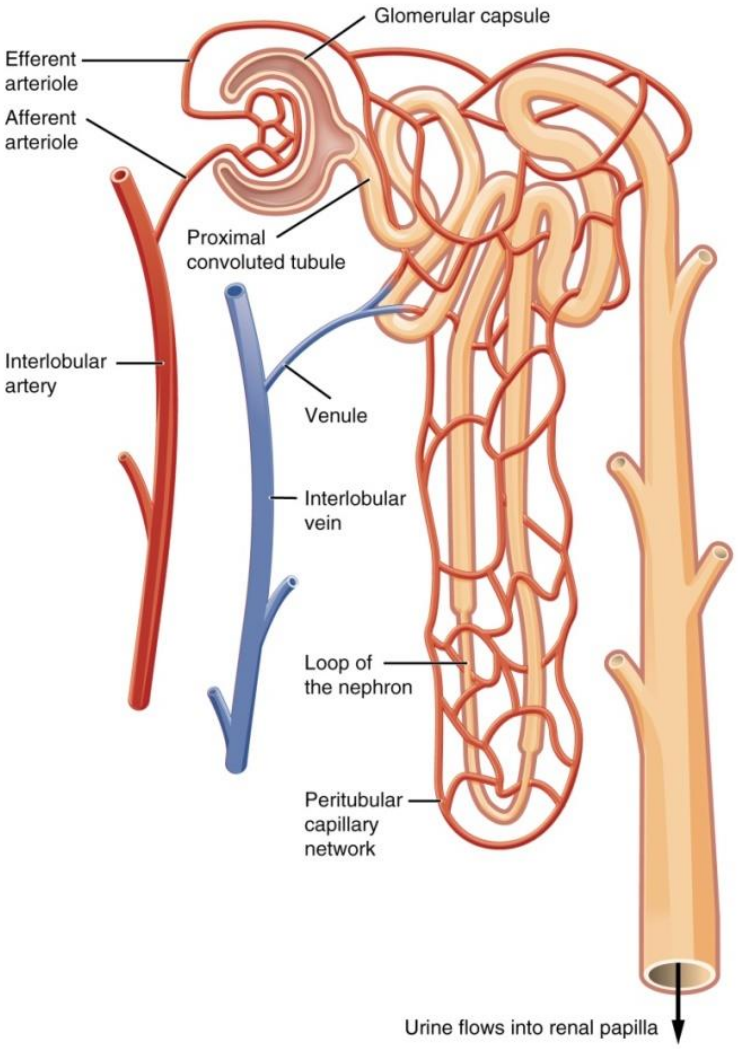
1**. Bowman's Capsule:** The filtration device at the top of each nephron is called a Bowman's capsule. Within each capsule an arteriole enters and splits into a fine network of vessels called a glomerulus. The walls of these capillaries act as a filtration device. Blood pressure forces fluid through the capillary walls. These walls withhold proteins and other large molecules in the blood, while passing water, small molecules, ions, and urea, the primary waste product of metabolism.

2**. Proximal tubule**: The Bowman's capsule empties into the proximal tubule, which reclaims most of the water (75%), as well as molecules useful to the body, such as glucose and a variety of ions.

3. **Renal tube:** The proximal tubule is connected to a long, narrow tube called a renal tubule, which is bent back on itself in its center. This long, hairpin loop, called the loop of Henle, is a reabsorption device. As the filtrate passes, the renal tubule extracts another 10% of water in the descending loop.

4. **Collecting duct:** The tube empties into a large collection tube called a collecting duct. The collecting duct operates as a water conservation device, reclaiming another 14% of water from the urine so that it is not lost from the body. Human urine is four times as concentrated as blood plasma—that is, the collecting ducts remove much of the water from the filtrate passing through the kidney.

The kidneys achieve this remarkable degree of water conservation by a simple but superbly designed mechanism: The duct bends back alongside the nephron tube, and the duct is permeable to urea. Urea passes out of the collecting duct by diffusion. This greatly increases the local salt (urea) concentration in the tissue surrounding the tube, causing water in urine to pass out of the tube by osmosis. The salty tissue sucks up water from the urine like blotting paper, passing it on to blood vessels that carry it out of the kidneys and back to the bloodstream.



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