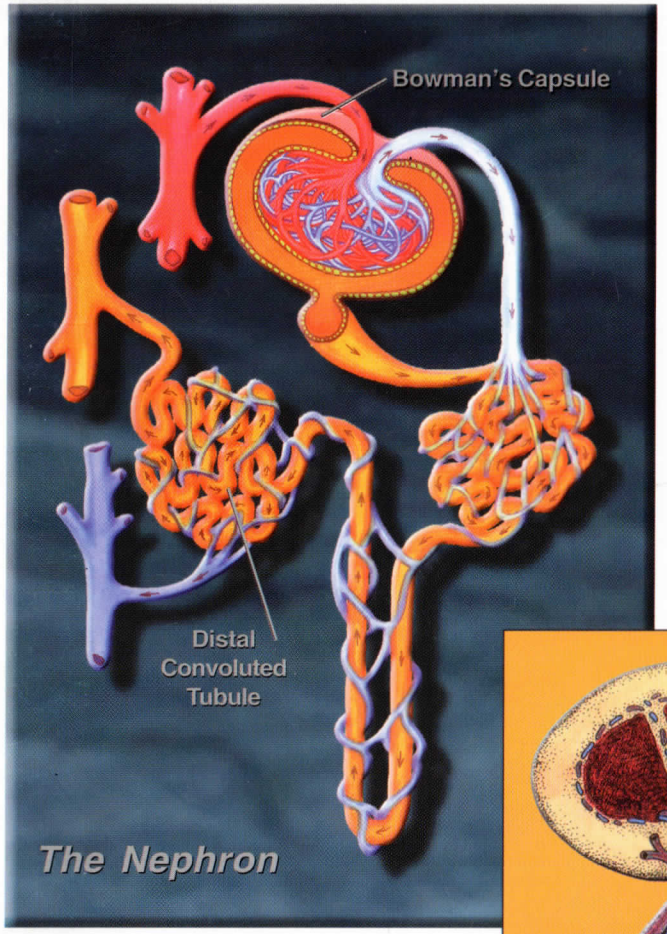
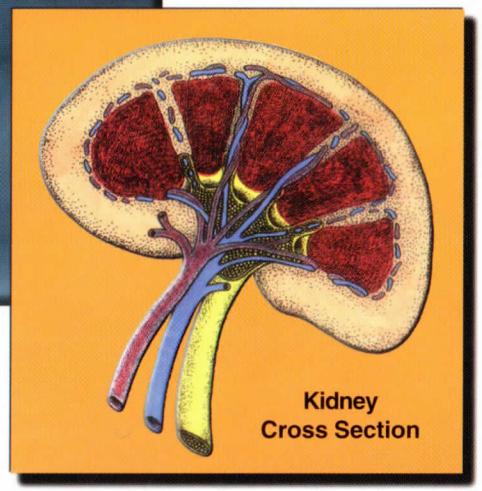
An Illustrated Dissection Guide To The... *Mammalian* *Kidney*





by David H. Hall

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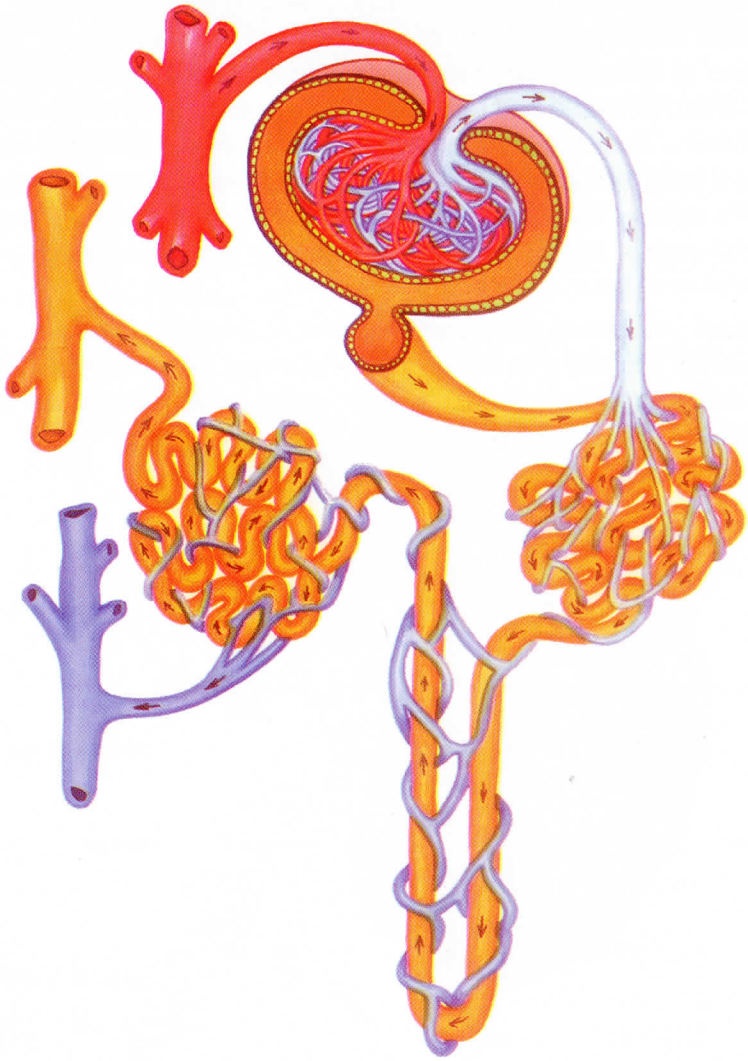

The Nephron

Introduction

Mammalian kidneys are marvelously complex organs that filter nitrogenous wastes from the bloodstream. This is accomplished by a filtration procedure where water, salts, and nutrients, that initially are removed from the blood, are returned. To explain the kidneys' mechanism of filtration and reclamation in detail is beyond the scope of this text. However, knowledge of general kidney anatomy will aid the students understanding of this process.

The kidney receives blood under high pressure from the **renal arteries**. These arteries are connected directly to the aorta. In humans all blood passes through the kidneys about twenty times per hour. Blood is filtered and returned to the bloodstream through the **renal vein**. Wastes generated by this procedure are collected as urine. Urine flows out of the kidney through the **ureters** which drain into the **urinary bladder**. The bladder stores urine until it becomes full at which point a sphincter muscle at the base of the bladder allows the release of urine.

Compare your sheep kidney with the one illustrated in *Figure 1.* Familiarize yourself with the structures outlined. The ***hilum*** is the indentation through which the arteries, veins, nerves, and ureter enter the kidney.

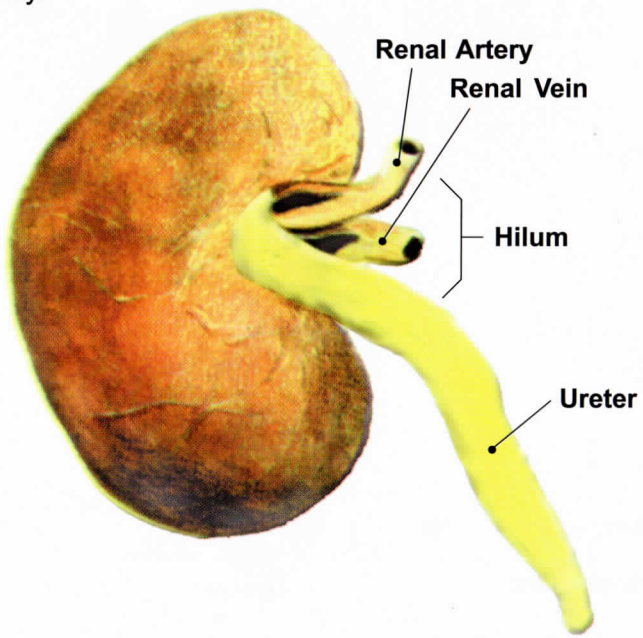

Figure 1. External anatomy of the sheep kidney.

Now with a large knife cut your kidney into two equal halves. Make your cut so your kidney looks like *Figure 2*. Compare your specimen with the one illustrated and find the features listed.

CORTEX—This is the outer region of the kidney where the glomerulus, Bowman's capsules and the convoluted tubules are located.

MEDULLA—This is the inner region that contains the collecting ducts and loops of Henle.

CALYX—These are sections of the kidney where major vessels enter the cortex and medulla regions of the kidney.

RENAL PELVIS—Region of the kidney where urine is collected before passing out through the ureter.

URETER—The tubule that carries urine from the kidney to the urinary bladder.

RENAL PYRAMIDS—Areas of the kidney medulla separated by the calyxes and the cortex.

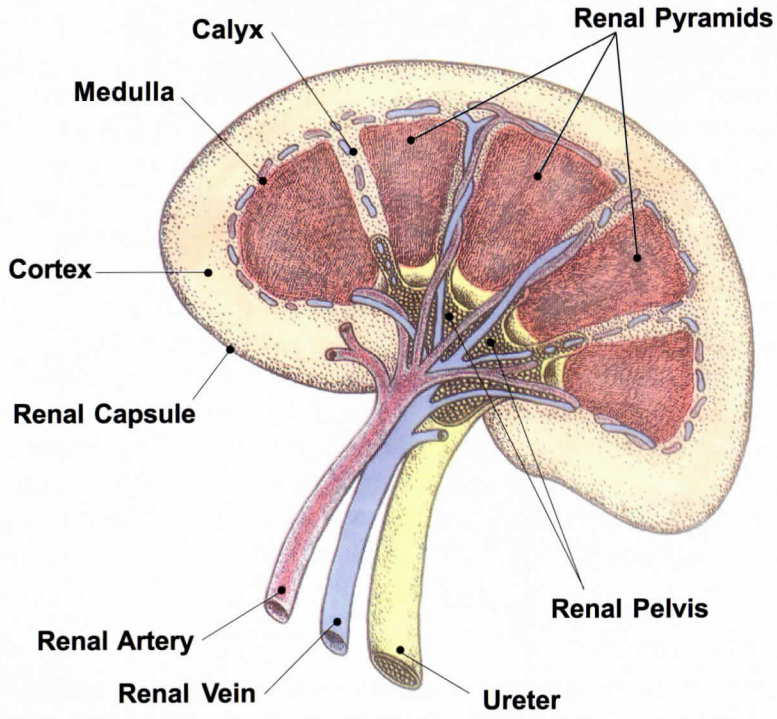

Figure 2. Cross section of the sheep kidney.

The ***nephron*** is the filtering unit of the kidney. It is a microscopic structure and there are over a million nephrons within a human kidney. The nephron is made up of four distinct sections: the glomerulus and Bowman's capsule, the proximal convoluted tubule, the loop of Henle, and the distal convoluted tubule. Refer to *Figure 3* throughout this discussion.

The glomerulus and Bowman's capsule assembly are located within the cortex of the kidney. The glomerulus is a tight knot or tuft of capillaries with an afferent arteriole leading into it and an efferent arteriole leading out of it. Wrapped tightly around the glomerular tuft is a collecting cup called Bowman's capsule. A single tubule leads away from the capsule. As blood under high pressure enters the glomerular capillaries, water, salts, sugars, urea, and other small molecules are forced through the capillary walls into the Bowman's capsule. Blood cells and large protein molecules cannot go through the capillary walls. The filtered blood exits the glomerulus at one fifth the volume it entered with. From here the filtered blood enters a bed of capillaries that surround the tubules whose function is explained below.

At this point the dilute urine contains water and nutrients the body needs to reclaim. This reclamation begins as soon as urine leaves the Bowman's capsule and enters the proximal convoluted tubule. This coiled and twisted tube is surrounded by capillaries that come from the glomerulus. The proximal convoluted tubule is also located within the cortex. From here the urine enters the long loop of Henle located within the medulla of the kidney. The loop of Henle travels down the medulla then back up into the cortex where it forms the distal convoluted tubule. After passing through this, the tubule empties into a collecting duct leading to the ureter. The entire length of the proximal convoluted tubule, the loop of Henle and the distal convoluted tubule are enclosed with a tight net of capillaries which originate from the glomerulus.

Urine Formation

Dilute urine exits the Bowman's capsule and immediately enters the proximal convoluted tubule. This tightly coiled and twisted tube is surrounded by a bed of blood capillaries carrying blood from the glomerulus. This is where blood reclaims much of the lost water

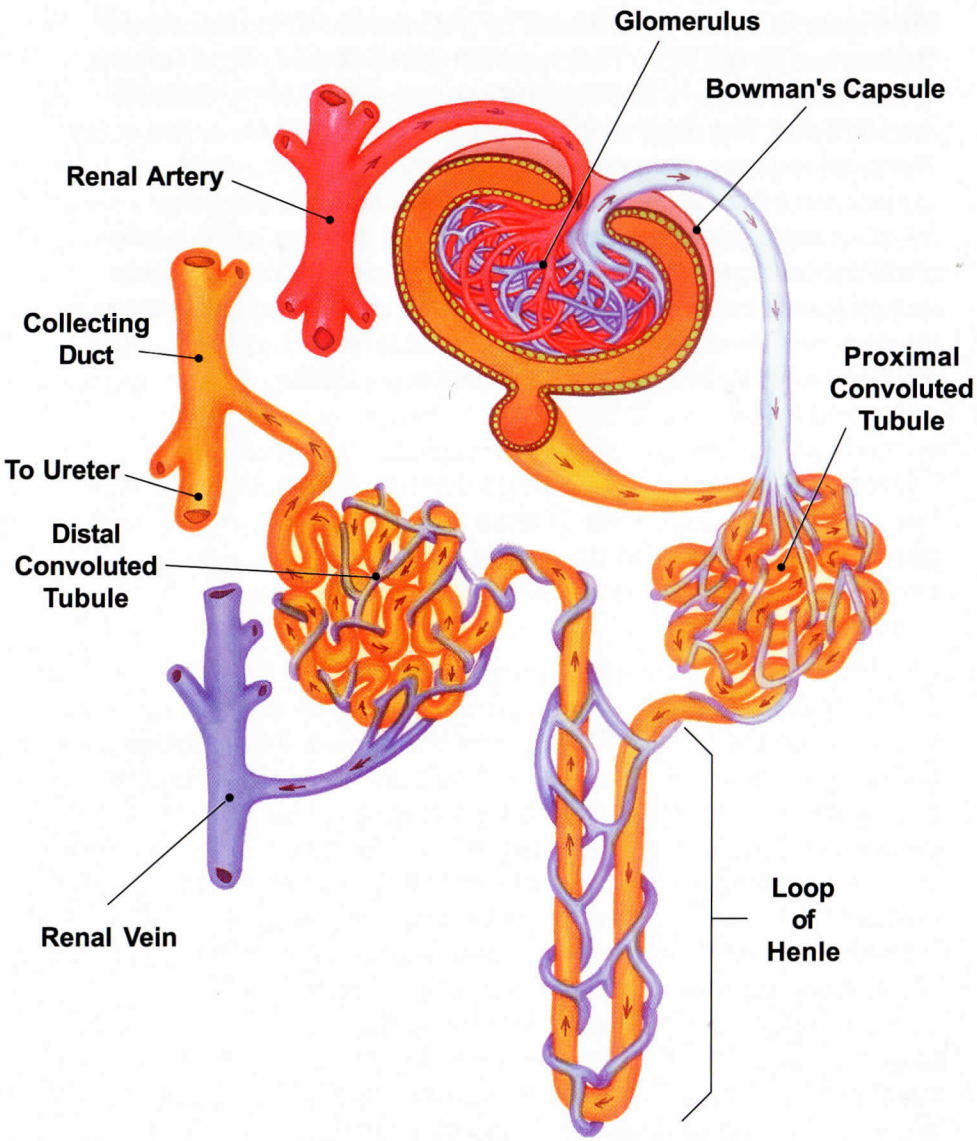

Figure 3. The Nephron.

and nutrients from the dilute urine. Sodium, glucose, and amino acids are removed from the dilute urine through active transport mechanisms. Water is reclaimed by osmosis and chloride ions are reabsorbed by diffusion. The descending limb of the Loop of Henle is where water, sodium, and chloride ions are reclaimed by osmosis and diffusion. The ascending limb of the Loop of Henle is where active transport reclaims more sodium and chloride ions. The distal convoluted tubule is under direct hormonal control determining whether more water and salts are reclaimed from the urine. Water reclamation is controlled by antidiuretic hormone (ADH) while salts are reclaimed under the influence of aldosterone. The effectiveness of reabsorption is demonstrated by the fact that only 1% of the glomerular filtrate is excreted out of the body as urine.

Notes