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DISTINCTIVE FEATURES OF THE HISTOLOGY OF URINARY ORGANS

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ABOUT ARTICLE

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Abstract: The kidneys are paired retroperitoneal organs of the urinary system. Their function is to filter blood and produce urine. Each kidney consists of a cortex, medulla and calyces. The nephron is the main functional unit of the kidney, in charge of removing metabolic waste and excess water from the blood. In this article we will explore the microanatomy of a nephron and learn how their function relates to their histological features.

INTRODUCTION

Learning about kidney histology doesn't have to be as painful as kidney stones! We have composed a simple step-by-step guide to help you master this complicated yet fascinating organ. If you need a little jump start, why not refresh your memory with our introduction to histology and gross anatomy of the kidney.

The kidney is a bean shaped organ, with a convex lateral surface, concave medial surface and superior and inferior poles. The medial surface features the hilum of the kidney, which is the passageway for the renal vessels and the ureter. A connective tissue capsule (renal capsule) and a layer of perinephric (perirenal) fat protect and cushion the kidney. The capsule contains a layer of contractile cells called myofibroblasts, which make the capsule able to adapt to the constant pressure changes within the kidney. The suprarenal (adrenal) gland sits on the kidney's superior pole, separated from it by the perinephric fat. Both the kidney and the suprarenal gland are covered by a layer of renal fascia.
The kidney parenchyma consists of two layers; an outer cortex and inner medulla. They comprise around one million urine-producing nephrons. Urine is collected into a system of renal calyces, which is a series of distinctive chambers within a kidney. Calyces gradually increase in size, starting with the minor calyces, which open into larger major calyces, which empty into the renal pelvis. From the renal pelvis, the urine passes into the ureter. The portion of the kidney which contains the calyces, renal pelvis, ureter and renal vessels is called the renal sinus.

Now let's take a closer look at the parenchyma layers. The renal cortex is the outer layer of the kidney tissue. It is darker than its underlying renal medulla because it receives over 90% of the kidney

blood supply. The cortex has a grainy appearance, as it mostly contains ovoid and coiled parts of the nephrons (renal corpuscles and convoluted tubules).

The renal medulla appears striped, as it contains vertical nephron structures (tubules, collecting ducts). It consists of renal (medullary) pyramids separated by projections of the renal cortex (renal columns). The apices of the pyramids project towards the renal pelvis and open into the minor calyces via perforated plates on their surfaces (area cribrosa). Each renal pyramid, with its surrounding cortical tissue, forms a renal lobe. Renal lobes are further divided into renal lobules. Each lobule consists of a group of nephrons emptying into one collecting duct. These structures can be observed in a coronal section of the kidney.

The nephron is the functional unit of the kidney. It produces concentrated urine by creating an ultrafiltrate from blood. A nephron consists of two main parts: a renal corpuscle and its associated renal tubule system.

Renal corpuscles are located in the renal cortex, while their tubular systems extend into the medulla. Depending on their distribution and morphology, there are two main types of nephrons in the kidney; cortical and juxtamedullary. Cortical nephrons have their corpuscles close to the kidney capsule. Their tubules are very short, extending only into the upper medulla. The corpuscles of the juxtamedullary nephrons are located close to the corticomedullary border. Their tubular systems are much longer, extending deep into the medulla.

Each nephron is surrounded by a network of capillaries. Branches from the renal interlobular arteries enter a nephron as the afferent arteriole, form a capillary tuft (glomerulus) then exit the nephron as the efferent arteriole. The capillary network then continues to surround the nephrons renal tubule system as peritubular capillaries, forming the vasa recta around the nephron loop. Did you know that these peritubular capillaries secrete erythropoietin (EPO)? A hormone that regulates red blood cell production.

The renal corpuscle is the filtration apparatus of the nephron. Each corpuscle consists of two main elements; the glomerulus and glomerular (Bowman's) capsule. The glomerulus is a network of capillaries formed by branches of the renal artery (afferent and efferent arterioles).

The glomerular capsule surrounds the glomerulus. It consists of two layers (parietal and visceral), which bound a cavity called the glomerular capsular space (Bowman’s / urinary space). The inner visceral layer is made of special cells called podocytes. Podocytes cover the walls of glomerular capillaries, interdigitating with each other and forming narrow slits between their projections. The outer parietal layer is made of simple squamous epithelium and is continuous with the nephron tubules. The afferent and efferent arterioles enter the renal corpuscle at the vascular pole, while the site where the glomerular capsule narrows and continues as the proximal thick segment of the nephron is called the urinary pole.

The proximal tubule is the first part of the tubular system. It consists of convoluted and straight segments. The proximal convoluted tubule is located within the renal cortex and is continuous with the capsular space.

The straight proximal tubule (or thick descending limb) extends down into the medulla. Both parts are composed of simple cuboidal epithelium, rich in mitochondria and microvilli (brush border). This morphology is adapted to the proximal tubule function of absorption and secretion. More than half of the previously filtered water and molecules are returned to the blood (reabsorption) by the proximal tubules.

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