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Histology of Urinary System

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ABSTRACT

The urinary system consists of the paired kidneys; paired ureters, which lead from the kidneys to the bladder; and the urethra, which leads from the bladder to the exterior of the body.[1] The kidneys conserve body fluid and electrolytes and remove metabolic waste Like the lungs and liver, the kidneys retrieve essential materials and dispose of wastes. They conserve water, essential electrolytes, and metabolites, and they remove certain waste products of metabolism from the body. The kidneys play an important role in regulating and maintaining the composition and volume of extracellular fluid. They also are essential in maintaining acid-base balance by excreting H+ when bodily fluids become too acidic or excreting bicarbonate when bodily fluids become too basic.[2] The kidneys are highly vascular organs; they receive approximately 25% of the cardiac output. The kidneys produce urine, initially an ultrafiltrate of the blood, which is then modified by selective resorption and specific secretion by the cells of the kidney. The final urine is conveyed by the ureters to the urinary bladder, where it is stored until discharged via the urethra. [3] The final urine contains water and electrolytes as well as waste products, such as urea, uric acid, and creatinine, and breakdown products of various substances.

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INTRODUCTION

The kidneys are large, reddish, bean-shaped organs located on either side of the spinal Column in the retroperitoneal space of the posterior abdominal cavity. They extend from the 12th thoracic to the 3rd lumbar vertebrae, with the right kidney positioned slightly lower. Each kidney measures approximately 10 cm long × 6.5 cm wide [from concave to convex border] × 3 Cm thick. On the upper pole of each kidney, embedded within the renal fascia and a thick protective layer of perirenal adipose tissue, lies an adrenal gland. The medial border of the kidney is concave and contains a deep vertical fissure, called the hilum, through which the renal vessels and nerves pass and through which the expanded, funnel-shaped origin of the ureter, called the renal pelvis, exits. A section through the kidney shows the relationship of these structures as they lie just within tile hilum of the kidney in a space called the renal sinus. Although not shown in the illustration, the space between and around these structures is filled largely with loose connective tissue and adipose tissue.

Explaing of capsule:

The kidney surface is covered by a connective tissue capsule. The capsule consists of two distinct layers: an outer layer of fibroblasts and collagen fibers, and an inner layer with a cellular component of myofibroblasts. The contractility of the my fibroblasts may aid in resisting volume and pressure variations that can accompany variations in kidney function. Its specific role, however, is not known. The capsule passes inward at the hilum, where it forms the connective tissue covering of the sinus and becomes continuous with the connective tissue forming the walls of the calyces and renal pelvis.

Cortex and Medulla Function:

Examination with the naked eye of the cut face of a fresh, hernisected kidney reveals that its substance can be divided into two distinct regions:

- Cortex, the outer reddish brown part
- Medulla, the much lighter-colored inner part

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The color seen in the cut surface of the unfixed kidney reflects the distribution of blood in the organ. Approximately 90 to 95% of the blood passing through the kidney is in the cortex; 5 to 10% is in the medulla [3].

The cortex is characterized by renal corpuscles and their associated tubules:

The cortex consists of renal corpuscles along with the convoluted and straight tubules of the nephron, the collecting tubules, collecting ducts, and an extensive vascular supply. The nephron is the basic functional unit of the kidney and is described below. The renal corpuscles are spherical structures, barely visible with the naked eye. They constitute the beginning segment of the nephron and contain a unique capillary network called a glomerulus [2].

Examination of a section cut through the cortex at an angle perpendicular to the surface of the kidney reveals a series of vertical striations that appear to emanate from the medulla These striations are the medullary rays [of Ferrein]. Their name reflects their appearance, as the striations seem to radiate from the medulla. Approximately 400 to 500 medullary rays project into the cortex from the medulla.

Each medullary ray is an aggregation of straight tubules and collecting ducts:

Each medullary ray contains straight tubules of the nephrons and collecting ducts. The regions between medullary rays contain the renal corpuscles, the convoluted tubules of the nephrons, and the collecting tubules.

Kidney Lobes and Lobules:

The number of lobes in a kidney equals the number of medullary pyramids:

Each medullary pyramid and the associated cortical tissue at its base and sides [one half of each adjacent renal column] constitutes a lobe of the kidney. The lobar organization of the kidney is conspicuous in the developing fetal kidney Each lobe is reflected as a convexity on the outer surface of the organ, but they usually disappear after birth. The surface convexities typical of the fetal kidney may persist, however, until the teenage years and, in some cases, into adulthood. Each human kidney contains 8 to t8 lobes. Kidneys of some animals possess only one pyramid; these kidneys are classified as unilobar, in contrast to the multilobar kidney of the human [3].

Describtion of Nephron and General organization of the Nephron:

The nephron is the structural and functional unit of the kidney:

The nephron is the fundamental structural and functional unit of the kidney. Each human kidney contains approximately 2 million nephrons. Nephrons are responsible for the production of urine and correspond to the secretory part of other glands. The collecting ducts are responsible for the final concentration of the urine and are analogous to the ducts of exocrine glands that modify tile concentration of the secretory product. Unlike the typical exocrine gland in which the secretory and duct portions arise from a single epithelial outgrowth, nephrons and their collecting tubules arise from separate primordia and only later become connected [2].

General Organization of the Nephron:

The nephron consists of the renal corpuscle and a tubule system:

As stated above, the renal corpuscle represents the beginning of the nephron. It consists of the glomerulus, a tuft of capillaries composed of 10 to 20 capillary loops, surrounded by a double-layered epithelial cup, the renal or Bowman's capsule. Bowman's capsule is the initial portion of the nephron where blood flowing through the glomerular capillaries undergoes filtration to produce the glomerular ultrafiltrate. The glomerular capillaries are supplied by an afferent arieriole and are drained by an efferent arteriole that then branches, forming a new capillary network to supply the kidney tubules. The site where the afferent and efferent arterioles penetrate and exit from the parietal layer of Bowman's capsule is called the vascular pole. Opposite this site is the urinary pole of the renal corpuscle, where the proximal convoluted tubule begins [3].

Continuing from Bowman's capsule, the remaining parts of the nephron [the tubular parts] are

- Proximal thick segment, consisting Of the proximal convoluted tubule [pars convoluta] and the proximal straight tubule [pars recta]
- Thin segment, which constitutes the thin part of the loop of Henle
- Distal thick segment, consisting of the distal straight tubule [pars recta] and the distal convoluted tubule [pars convolute]

The distal convoluted tubule connects to the collecting tubule, often through a connecting tubule, thus forming the uriniferous tubule, i.e., the nephron plus collecting tubule.

Conclusions:

1. The renal corpuscle is spherical and has an average diameter of 200 μm. It consists of the glomerular capillary tuft and the surrounding visceral and parietal epithelial layers of Bowman's capsule.

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2. The collecting tubules begin in the cortical labyrinth, as either connecting tubules or arched collecting tubules, and proceed to the medullary ray where they join the collecting ducts. The collecting duets within the cortex are referred to as cortical collecting ducts.
3. Visceral layer of Bowman's capsule, which contains specialized cells called podocytes or visceral epithelial cells. These cells extend processes around the glomerular capillaries.

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