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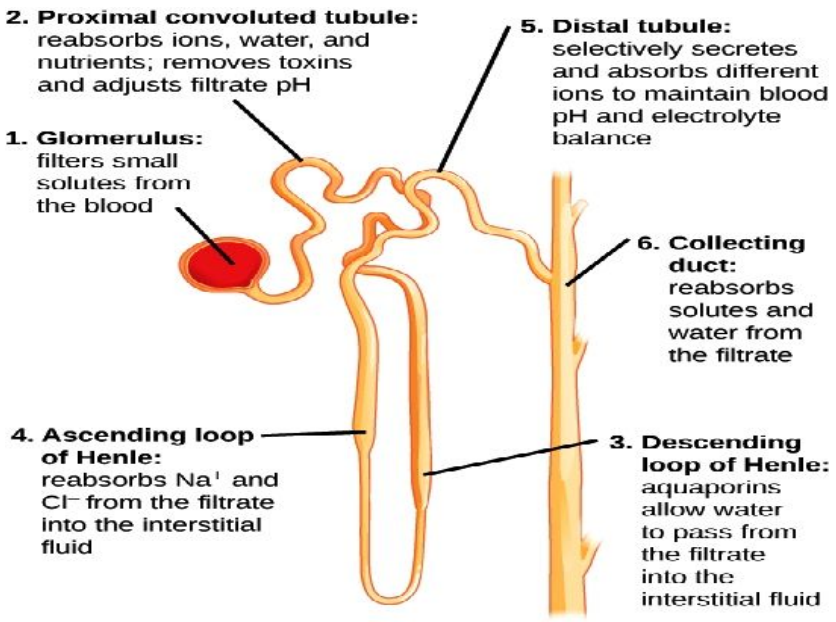
Class B.Sc 3rd yr. Paper 5, group-B 7908055676

Functional unit of kidney-P-1

Introduction

The kidney is a structurally complex organ essential for human survival since its embryonic development. Every cell in the renal parenchyma is highly specialized in maintaining electrolyte, volume, and waste homeostasis. Renal pathologies can be grossly categorized depending on the affected segment of the nephron: the glomerulus, tubules, interstitium, or blood supply. Each one differs in clinical manifestations, making it vital for the clinician to integrate differential diagnoses.

Here, we will cover renal histology, kidney function, and their correlation with clinical medicine. Structure macroscopically, the kidney divides into two sections: the renal cortex, the outer part of the kidney, and the medulla, the inner section. Both contain different structures of the nephron, the functional unit of the kidney.



It is crucial to comprehend the nephron's structure to understand the functioning of the kidney. The nephron is comprised of a glomerulus and a complex tubular system. The glomerulus and the first portion of the tubular system, known as the proximal convoluted tubule (PCT), are located in the renal cortex. Following the PCT, the loop of Henle, a hairpin-like structure, penetrates the medulla and returns to the cortex to connect with the distal convoluted tubule (DCT). Finally, the nephron drains into the collecting duct via connecting tubules. There are two types of nephrons: (1) superficial nephrons with their glomeruli located near the cortical surface and short loops of Henle, and (2) juxtamedullary nephrons, with glomeruli located near the cortico-medullary junction and long loops of Henle descending deeper into the renal medulla.

The glomerulus filters large amounts of blood, which the tubular system converts into urine through reabsorption and secretion of free water and solutes. The Glomerulus The glomerulus forms by a tuft of capillaries surrounded by an impervious capsule denominated Bowman's capsule. The glomerular capillaries are flanked by two resistance vessels, the afferent and efferent arterioles, regulating intraglomerular pressure. These capillaries have unique characteristics that allow them to filter large volumes of blood. The filtration barrier is composed of three structures that provide the support and selective properties needed for the formation of the primary glomerular filtrate, the ultrafiltrate. 1. Fenestrated endothelium of the glomerular capillaries: this layer confers size selectivity through fenestrae with diameters between 70 to 100 nm. 2. Glomerular basement membrane (GBM): this is a thick structure composed of extracellular proteins, including proteoglycans, laminin, fibronectin, and type IV collagen. These create a slit diaphragm through interdigitating long and thin foot processes. These cells serve to sustain the integrity of the capillary loops. Once blood is filtered, the ultrafiltrate resides between the visceral epithelium and Bowman's capsule. From here, the ultrafiltrate flows into the PCT.

The Proximal Convoluted Tubule Bowman's capsule gives rise to the PCT, which lies adjacent to the glomerulus in the renal cortex. The PCT forms from simple cuboidal epithelium dedicated to the absorption and transport of water, electrolytes, and other particles. These cells are characterized by a brush border of microvilli designed to increase the surface in contact with the glomerular ultrafiltrate, with abundant long, thin mitochondria lining the basal pole of the cell; and numerous vesicles involved in transcellular transport of 60 to 80% of the ultrafiltrate. The peritubular capillaries surround the PCT. This capillary network is responsible for the blood supply of the tubules as well as the recovery of the reabsorbed free water, ions, and other plasma constituents like amino acids and glucose.