

Kidney Structure and Function

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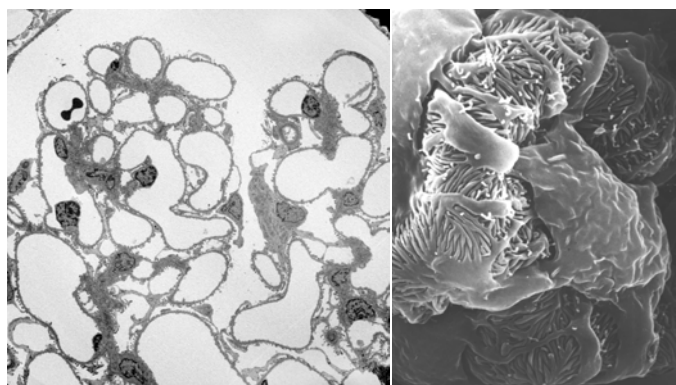
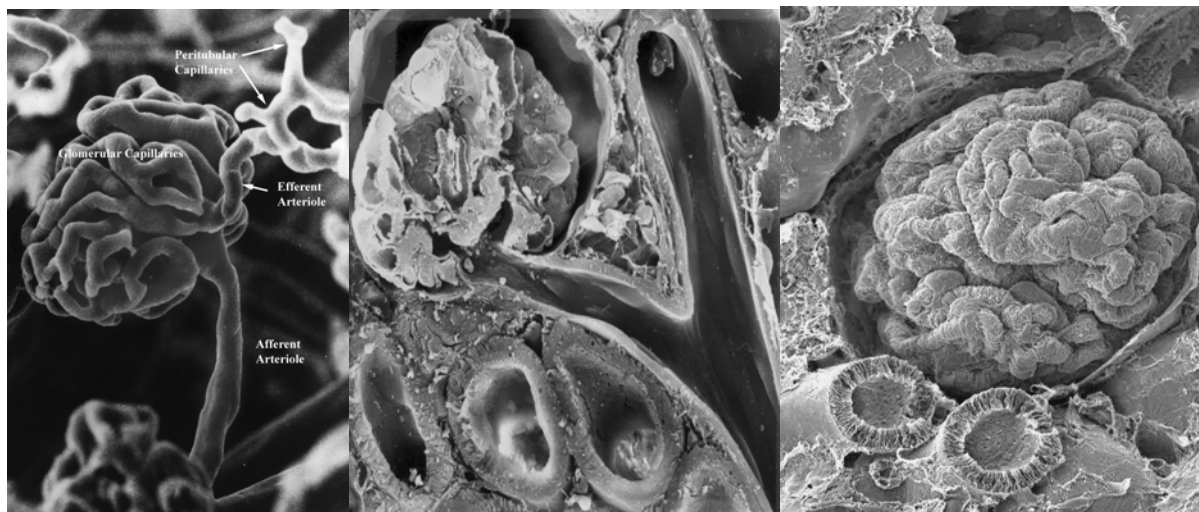
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The kidney is a multifunctional organ, not only getting rid of metabolic waste, but also regulating the internal milieu (electrolytes and water balance), secreting hormones and eliminating toxins. This process is dependent on obtaining high blood perfusion (about 20% of cardiac output), which passes through a filter (the glomerulus) and the filtrate is modified by a series of specialized tubules for the final production of urine.

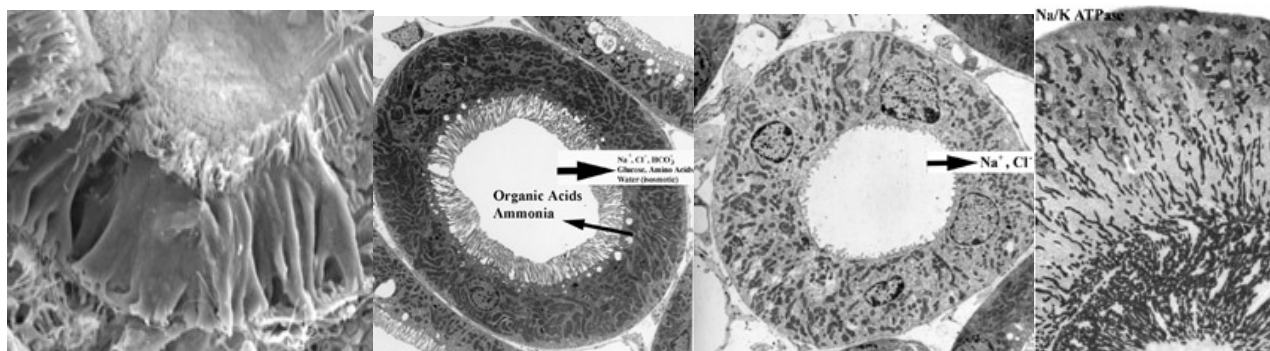
The glomerular epithelial cells – podocytes, have an intricate branching pattern of foot processes (pedicels) which interdigitate with the pedicels of neighboring cells. Between the pedicels is the filtration slit has a highly evolved intercellular junction that helps regulate the selectivity of the filtration process. [The current understanding of the structural and functional aspects of the glomerular filtration barrier](#), with its extensive [cell and molecular advances over the last decade](#), have provided insight into the pathogenesis of various diseases.

The structural, functional and [cell biology of renal epithelia](#) of the various tubule segments allows for a discreet set of activities. The proximal tubule is responsible for bulk fluid uptake from the filtrate along with ions, glucose, and amino acids. Proximal tubule also reabsorbs a number of toxic materials including heavy metals like Pb, Hg, Cd, and Pt as well as nephrotoxic antibiotics like gentamicin. Proximal tubules are [involved in various normal and pathological conditions](#) (i.e. acute tubular necrosis). The distal nephron (distal tubule and collecting duct) will provide the final adjustments to the composition of the urine. There are unique structural components of these tubule cells that facilitate their function such as the lush microvillous border of proximal tubules and the extensive basolateral infoldings of the proximal and distal tubule cells. Thick ascending limb of Henle's loop (distal straight) helps create a medullary concentration gradient necessary for concentrating urine (a counter current generator) and the thin tubules and vasa rectae function as countercurrent exchangers. [The juxtaglomerular apparatus](#) composed of the macula densa from the distal tubule and juxtaglomerular cells (renin secreting cells in the afferent arteriole) allow individual control of each glomerulus, (e.g. [tubuloglomerular feedback](#)). The vascularization of the kidney to provide the blood that will be filtered, is a critical step in renal function, as the vascular reabsorption of water, ions, and other material that are being retained by the body. The vascular arrangement with its two sets of capillaries, in series, are critical to renal function. The first capillary bed is in the glomerulus and the second set is the peritubular capillary network, within the interstitium in the cortex.

[Kidney development, incorporating branching morphogenesis and induction of mesenchyme to form epithelia and tubules](#), is critical to the development of this intricate structural / functional relationship.



Renal Glomerulus filters blood entering from the Afferent Arteriole. The glomerular capillary loops have a fenestrated endothelium internally with podocyte foot processes and filtration slits on the outer surface. Blood exits the glomerulus through the efferent arteriole and enters a second capillary system (i.e. peritubule capillaries).



Renal Tubules: Proximal tubules (left 2 figures) have basolateral plasma membrane folding and apical microvilli to expand the membrane area for reabsorption. Distal tubules reabsorb Na & Cl against a concentration gradient so they possess abundant Na-K ATPase (right figure).

Reference:

A standard nomenclature for structures of the kidney. *Am. J. Physiol.* 1988;254:F1-8.