Juxtaglomerular Apparatus

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FNTA SEM II

The **juxtaglomerular apparatus** (also known as the **juxtaglomerular complex**) is a structure in the kidney that regulates the function of each nephron, the functional units of the kidney. The juxtaglomerular apparatus is named because it is next to (juxta-[1]) the glomerulus.

The juxtaglomerular apparatus is a specialized structure formed by the distal convoluted tubule and the glomerular afferent arteriole. It is located near the vascular pole of the glomerulus and its main function is to regulate blood pressure and the filtration rate of the glomerulus. The **Macula densa** is a collection of specialized epithelial cells in the distal convoluted tubule that detect sodium concentration of the fluid in the tubule. In response to elevated sodium, the macula densa cells trigger contraction of the afferent arteriole, reducing flow of blood to the glomerulus and the glomerular filtration rate. The juxtaglomerular cells, derived from smooth muscle cells, of the afferent arteriole secrete Renin when blood pressure in the arteriole falls. Renin increases blood pressure via the Renin-angiotensin-aldosterone system. Lacis cells, also called extraglomerular mesangial cells, are flat and elongated cells located near the macula densa. Their function remains unclear.

The juxtaglomerular apparatus consists of three types of cells:

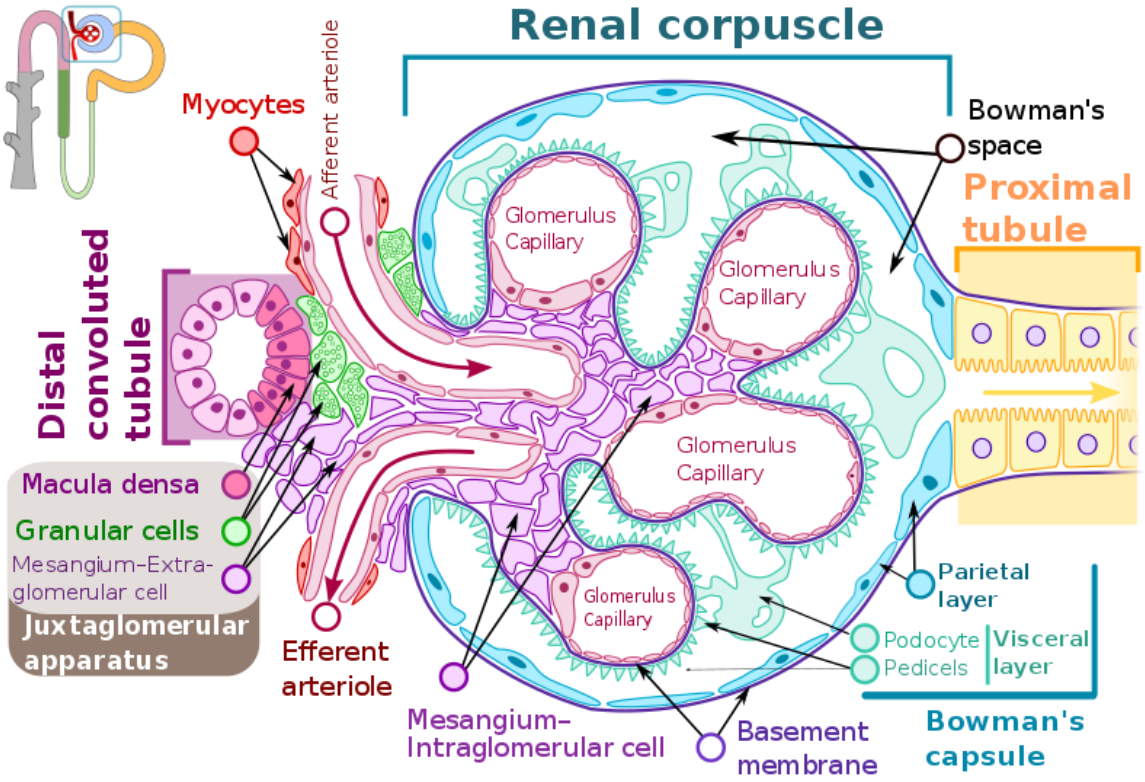
1. **The macula densa**, a part of the distal convoluted tubule of the same nephron
2. **Juxtaglomerular cells**, (also known as granular cells) which secrete Renin
3. **Extraglomerular mesangial cells**

Structure:

The juxtaglomerular apparatus comprises afferent and efferent arterioles, complemented by granular, Renin-secreting cells, the macula densa, a specialized group of distal tubular cells and **Lacis cells** (**Goormaghtigh cells or Polkissen cells, polar cushion, extraglomerular mesangial cells**). Lacis cells form a pyramid situated between the afferent and efferent arterioles and with its base on the macula densa and apex continuous with the glomerular mesangium. The juxtaglomerular apparatus can be considered as an anatomical unit important in tubuloglomerular feedback control of renal blood flow, glomerular filtration rate and possibly also tubular control of Renin secretion. Immunocytochemical study has confirmed that much of the Renin in the kidney is located in the outer media of the afferent arterioles, normally to a greater extent in superficial cortex than in juxtamedullary regions. Renin release occurs outwards into the extravascular space and into renal capillaries. Renin-secreting cells are also found in more proximal segments of the afferent arterioles and in interlobular arteries as well as in efferent arterioles

The juxtaglomerular apparatus, located in the glomerular hilum, consists of a vascular component (afferent and efferent arterioles and extraglomerular mesangium) and a tubular component (macula densa). Two types of contact between vascular and tubular components are observed: a) a complex type, involving distal tubule, extraglomerular mesangium, and proximal efferent arteriole, and b) a simple type, consisting of apposition of the basement membranes of the vascular and tubular components. Juxtaglomerular granular cells, the source of Renin, are present throughout the vascular component but are more numerous in the afferent arteriole. They can be considered as "myoendocrine" cells, since they contain myofibrils and attachment bodies, together with secretory granules and crystalline

protogranules. Macula densa cells differ from those elsewhere in the distal tubule in that their nuclei are closer to each other, the Golgi apparatus is basally located, and their basal membrane infoldings are less prominent. Adrenergic nerves are demonstrable by fluorescence histochemistry in the juxtaglomerular region. Electron microscopy reveals unmyelinated nerve fibers containing small dense-cored vesicles and capable, as shown by ultrastructural autoradiography, of incorporating exogenous tritiated norepinephrine. Neuroeffector junctions occur between nerves and cells of the vascular and, less frequently, the tubular component.



A renal corpuscle, showing the juxtaglomerular apparatus with Juxtaglomerular cells (granular cells), Macula densa cells and, extraglomerular mesangium

Function:

Macula densa

At the point where the afferent arterioles enter the glomerulus and the efferent arteriole leaves it, the tubule of nephron touches the arterioles of the glomerulus from which it rose. At this location, thick ascending limb of loop of Henle, there is a modified region of tubular epithelium called the Macula densa. Cells in the macula densa respond to changes in the sodium chloride levels in the distal tubule of the nephron via the tubuloglomerular feedback (TGF) loop.The macula densa's detection of elevated sodium chloride, which leads to an increase in GFR, is based on the concept of purinergic signaling. An increase in the salt concentration causes several cell signals to eventually cause the adjacent afferent arteriole to constrict. This decreases the amount of blood coming from the afferent arterioles to the glomerular capillaries, and therefore decreases the amount of fluid that goes from the glomerular capillaries into the Bowman's space (the glomerular filtration rate (GFR)).When there is a decrease in the sodium concentration, less sodium is reabsorbed in the macular densa cells. The cells increase the production of nitric oxide and Prostaglandins to vasodilate the afferent arterioles and increase Renin release.

Juxtaglomerular cells

The Renin–angiotensin system. It is activated when juxtaglomerular cells are poorly perfused.

Renin is produced by juxtaglomerular cells. These cells are similar to epithelium and are located in the tunica media of the afferent arterioles as they enter the glomeruli. The juxtaglomerular cells secrete Renin in response to:

- Stimulation of the beta-1 adrenergic receptor
- Decrease in renal perfusion pressure (detected directly by the granular cells)
- Decrease in NaCl concentration at the macula densa, often due to a decrease in glomerular filtration rate

Extraglomerular mesangial cells

Extraglomerular mesangial cells are located in the junction between the afferent and efferent arterioles, but their significance in this location is unknown. Renin is also found in these cells.