Chapter 2

NEPHRON

Nephron is functioning unit in formation of urine. There are one million nephrons in each kidney. Loops of zuxta medullary nephrons extend deep into medulla. They have different role in regulation of salt and water excretion.

GLOMERULUS

It is 150-200 micron in diameter and is filtering apparatus of nephron. There is intricate, spherical, convoluted, capillary network arising from afferent arteriole after it enters Bowman capsule. Walls of capillaries of this network form membrane across which process of filtration occurs.

Walls of glomerular capillaries have 3 layers. Endothelium is thin and attenuated and is traversed by multiple fenestrae with glycoprotein surface coat. Glomerular basement membrane is uninterrupted, highly convoluted membrane about 1200 A° thick, having central electron dense layer (lamina densa) and two electron lucent layers, lamina rara interna which is subendothelial in location and lamina rara externa which is subepithelial. Epithelium consists of large cells with extensive cytoplasmic projections. These sub-divide into foot processes which interdigitate with one another and are in direct contact with glomerular basement membrane. Between foot processes are filtration slits which are 240 A° in diameter. Covering epithelial cells and filling spaces between foot processes are glycoprotein cell coat upto 800 A° in thickness which is negatively charged. Fixed negative charge conferred by endothelial and epithelial cell coats helps in traversing of charged macromolecules across glomerular capillary wall. They restrict access of negatively charged molecules to urinary space and facilitate transit of those molecules which are positively charged.

Mesengial cells lie deep in central region of glomerulus and are separated from capillary lumina by overlying endothelial cells. Mesengial cells and intercellular material between them called matrix constitute mesangium.

Macromolecules which circulate through glomerular capillaries may enter mesangium through interface between endothelial and mesangial cells and migrate via intercellular channels towards zuxta glomerular region. Macromolecules may also be

phagocytosed by mesangial cells or by infiltrating phagocytes. Mesangium thus acts as component of reticuloendothelial system in glomerular circulation. Mesangial region is site of injury in diseases affecting glomeruli, responding sometimes in nonspecific ways (as with cellular and matrix proliferation) at other times with pathognomonic changes (eg intercapillary nodule formation in diabetic glomerulosclerosis).

BOWMAN CAPSULE

This sorrounds glomerulus. Its basement membrane is continuous with basement membrane of proximal convoluted tubule and is lined on inner aspect with parietal epithelial cells. Tubular portion of nephron begins at orifice in capsule situated opposite vascular pole.

TUBULES

Various portions are proximal convoluted tubule, loop of Henle, distal tubule and collecting duct. Tubular basement membrane provides uninterrupted framework for tubular epithelium.

Proximal convoluted tubule is situated in cortex. Its epithelium is cuboidal and one cell deep. Spherical nuclei are situated at basal surface of cell. Spaces between cells are channels through which solutes and water reabsorbed from lumen by cells pass to peritubular capillaries. Luminal brush border increases reabsorptive surface of cells. There is tight junction between cells in their luminal aspect. This is impermeable to solutes or water but back diffusion of reabsorbed solutes and water into tubular lumen occurs via these intercellular junctions. There are numerous mitochondria in cells of proximal convoluted tubule. Peritubular capillaries are next to basement membrane. Proximal convoluted tubule cells transport or reabsorb large quantity of water and solute from tubular lumen. They also participate in process of tubular secretion by which substances synthesized within cell or derived from circulation are added to luminal fluid.

Loop of Henle is continuation of proximal convoluted tubule. Nephrons with glomeruli situated in outer two third of cortex have short or absent loops. Those with glomeruli in inner third have longer loops which extend towards tip of papilla.

After descending into medulla loop turns back to ascend to cortex where it becomes distal tubule. Epithelium of descending limb is flat and squamous and tubular diameter is less than that of proximal convoluted tubule. This portion is called thin segment of loop. Luminal surface of cells of thin segment have short widely spaced microvilli and their cytoplasm has infrequent mitochondria.

Ascending limb has thicker epithelium and nuclei are situated near luminal surface. Numerous rod shaped mitochondria occupy basal half of these cells. Short microvilli arise from luminal surface. Cleft like infolding of basal plasma membrane of cells bring it into intimate contact with mitochondria.

Distal tubule has initial portion, pars recta which continues in straight course toward glomerulus. As distal tubule passes its glomerulus of origin it makes contact with afferent arteriole. This part of tubule is macula densa. Thereafter distal tubule becomes convoluted. Cells are cuboidal and have dense coarsely granular cytoplasm containing numerous mitochondria. Cell nucleus is apical. Luminal surface of cells has numerous short microvilli.

Collecting duct is formed by junction of 2 or more terminal segments of distal convoluted tubule and receives additional branches in its course to medullary papilla. It has cuboidal epithelium. This joins duct of Bellini through which urine from collecting ducts is discharged into minor calyx at papillary tip.

INTERSTITIUM

Interstitial space and number of cells increase as papilla is approached. Space is filled with flocculent material of low electron density.

Type 1 interstitial cells are most numerous. They resemble fibroblasts. They contain many lipid bodies and abundant granulated endoplasmic reticulum. Lipid droplets contain renal PGE2 and PGF2 alpha precursors.

Type 2 cells have some characteristics of mononuclear cells and may have phagocytic activity.

Type 3 pericyte is found adjacent to vasa recta.

Renal medulla is site for prostaglandin synthesis.

NERVE SUPPLY

Nerve fibres course along blood vessels. Some fibres innervate juxta glomerular efferent arterioles that give rise to vasa recta. Nerves play role in regulation of renal blood flow and glomerular filtration rate. Stimulation of renal sympathetic nerves cause reduction in cortical renal blood flow and leads to reduction in urinary excretion of sodium. Sympathetic blockers cause renal vasodilatation and mild natriuresis.

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