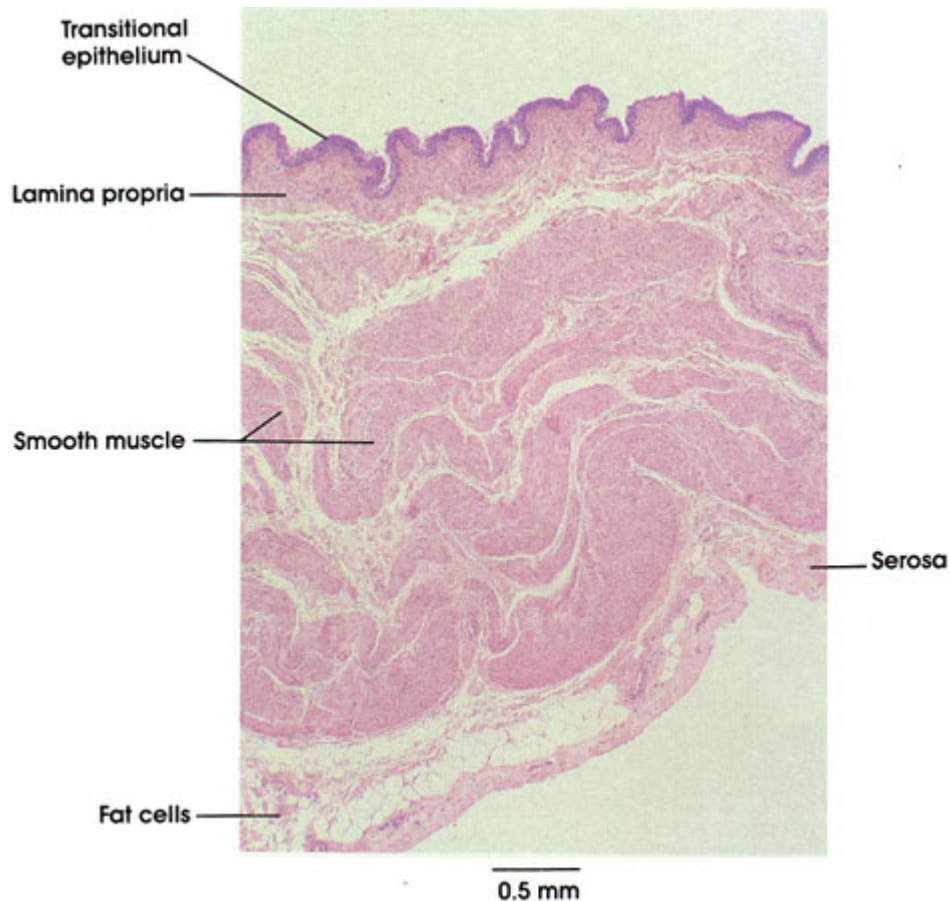


Plate 12.242 Urinary Bladder

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Peer Review Status: Externally Peer Reviewed

URINARY BLADDER



Human, 10% formalin, H. & E., 22 x

The component parts of the wall of the urinary bladder are shown at low power. The innermost layer, the mucosa, consists of transitional epithelium, underlaid by a prominent lamina propria. The folds in the mucosa are seen in three dimension to be extensive longitudinal ridges and represent one means by which the bladder wall accommodates to distention. The thickness of the epithelium is also reduced upon stretching, as is the height of the luminal epithelial cells (dome, or umbrella cells, see Plate 24 for details of the epithelium). Thus, the overall topography of sections of the bladder will always depend upon the state of distention and turgidity of the organ at the time of fixation. The muscular layer of the bladder is generally recognized as consisting of three layers: (1) inner longitudinal, (2) middle circular or spiral; and (3) outer longitudinal. The definition of these as discrete layers is rendered difficult by the intertwining of muscle bundles and

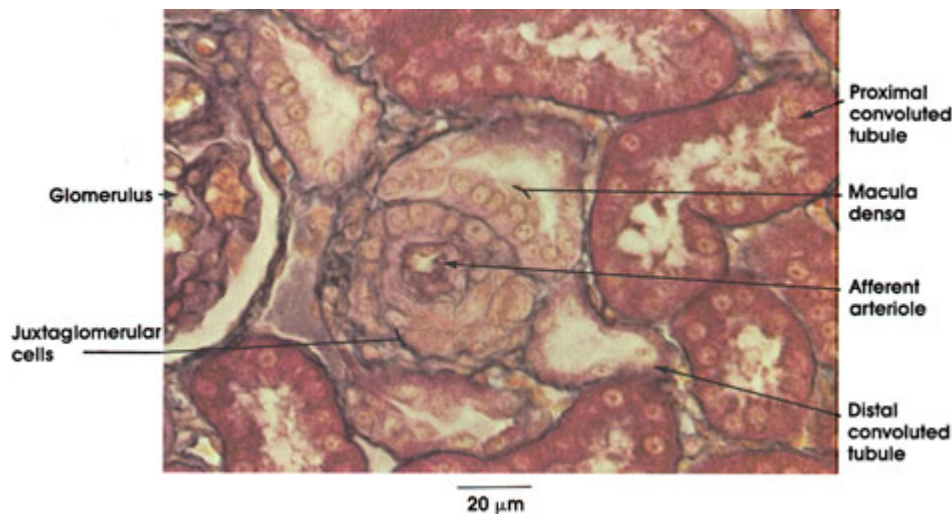
fascicles from adjacent layers, and by variation in the thickness of the respective layers in different parts of the organ (e.g., the formation of the internal sphincter by the internal longitudinal layer in the region of the trigone). This histological feature is in contradistinction to the well-defined muscle layers evident in preparations of the gastrointestinal tract. Such a muscular arrangement does, however, facilitate the occlusion of the bladder lumen upon voiding, and the avoidance of residual urine in the bladder, which is recognized as predisposing to bladder infections. The organ is covered by a connective tissue adventitia, except on its superior aspect, which bears a serosa of reflected peritoneum. Present within this layer are blood vessels, nerves, and underlying adipose tissue.

Plate 12.237 Kidney: Cortex

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Peer Review Status: Externally Peer Reviewed

KIDNEY Cortex



Rhesus monkey, Zenker's fluid, Mallory's stain, 612 x.

Afferent arteriole: Seen here in cross section. Its proximity to the glomerulus (not seen here), which it serves, is indicated by the presence of cells containing conspicuous granules, which replace smooth muscle fibers normally found in the wall of arterioles.

Juxtaglomerular cells: Rich in cytoplasmic granules containing renin. Renin secreted into the blood is known to play a role in the formation of a hypertensive substance known as angiotensin II.

Glomerulus: Tuft of capillaries having their origin from the afferent arteriole and surrounded by Bowman's capsule. The glomerulus, together with Bowman's capsule, constitutes the renal corpuscle.

Proximal convoluted tubule: Outlet of Bowman's capsule approximately 14 mm long with many small loops near the renal corpuscle. It ultimately straightens and runs toward the medulla in the medullary rays.

Distal convoluted tubule: This portion of the renal tubule has many short loops in close association with the proximal convoluted tubule and the glomerulus. It is about one third the length of the proximal tubule. The distal tubule is continuous with the collecting tubules.

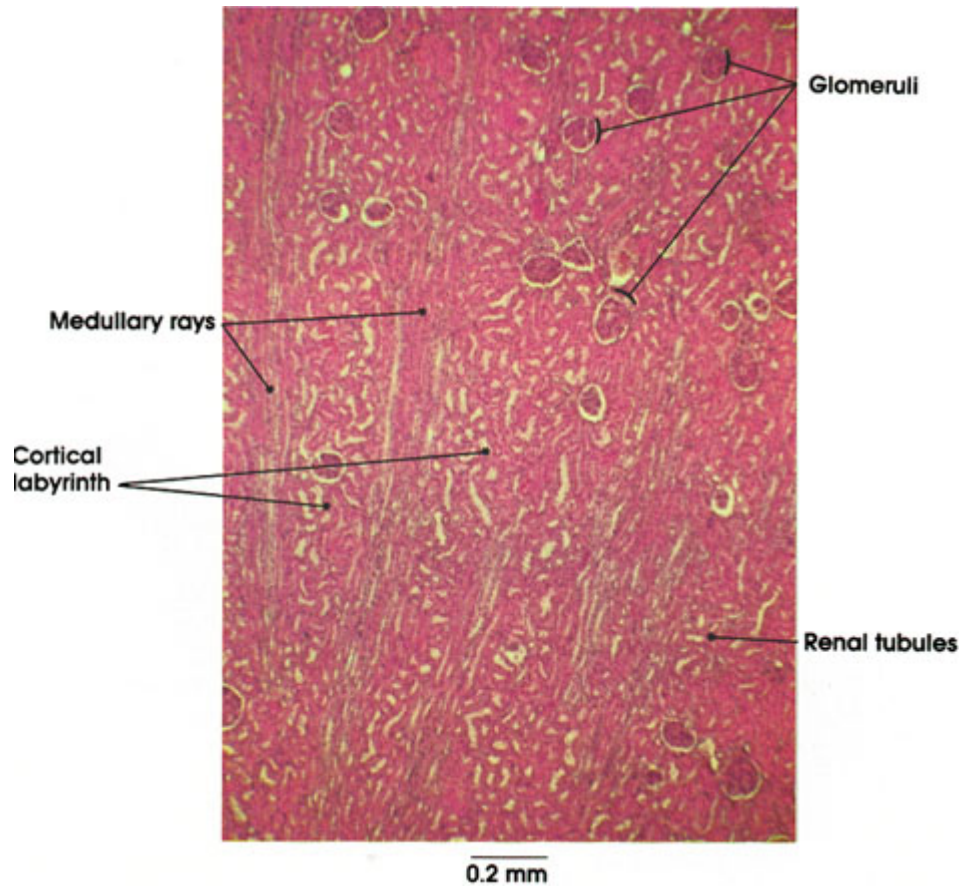
Macula densa: Specialized region of the distal convoluted tubule with tightly packed tubule cells in contact with the afferent arteriole. The bases of the cells of the macula densa are consistently found in intimate association with the juxtaglomerular cells in the wall of the afferent arteriole. Because this structural relationship suggests a functional relationship (supported experimentally), the macula densa and the juxtaglomerular cells together are referred to as the juxtaglomerular apparatus.

Plate 12.232 Kidney: Cortex

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Peer Review Status: Externally Peer Reviewed

KIDNEY Cortex



Rhesus monkey, 10% formalin, H. & E., 50 x.

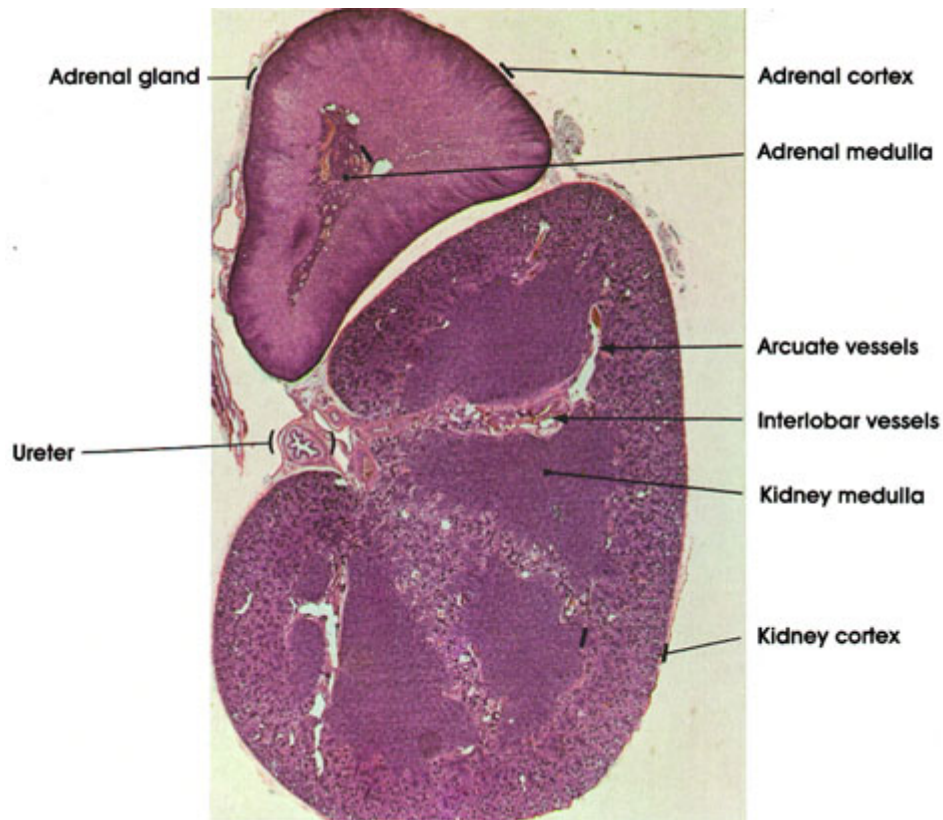
In this plate, the various constituents of kidney cortex are shown. The cortex is composed of radiating columns of straight renal tubules (medullary rays), alternating with regions containing glomeruli and convoluted renal tubules (cortical labyrinth). Other names for these two divisions are *pars radiata* or the processes of Ferrein* for the medullary rays, and the *pars convoluta* for the cortical labyrinth. The cortical labyrinths contain glomeruli, proximal and distal convoluted tubules, and the arched collecting tubules. The medullary rays contain the straight portions of proximal tubules (medullary segments), the thick segments of ascending arms of Henle's* loops, and the straight collecting tubules.

Plate 12.231 Kidney and Adrenal Gland

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Peer Review Status: Externally Peer Reviewed

KIDNEY AND ADRENAL GLAND
Fetal



Rhesus monkey, 10% formalin, H. & E., 6 x.

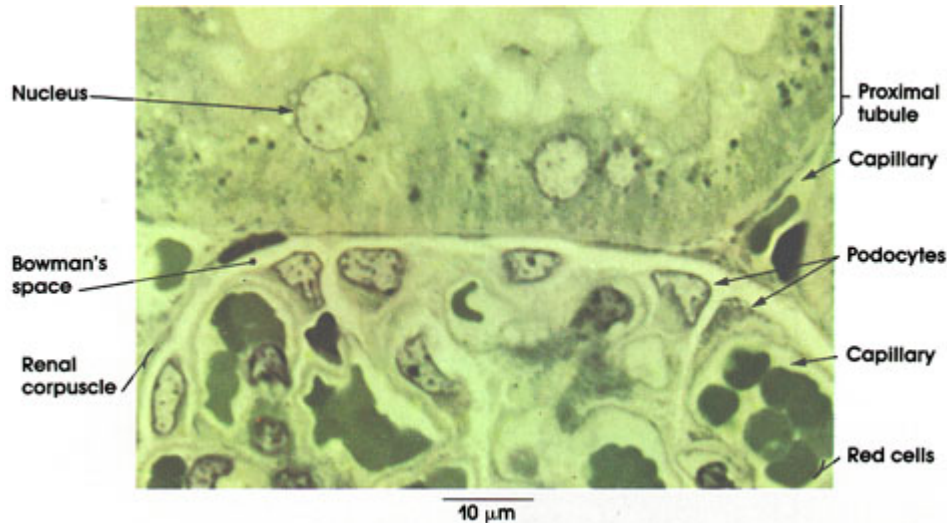
In this plate, the gross histologic features of the adrenal gland and the kidney are seen. Note the location of the adrenal gland, riding the superior pole of the kidney. Within the kidney, note the hilum where the ureter is seen in cross section and where vessels are seen entering and leaving the kidney. The divisions of the kidney into cortex and medulla are clearly seen. Note the peripheral location of the cortex and the cortical columns that dip between the medullary pyramids. The latter are pyramid-shaped medullary structures, with the base of the pyramid resting against the peripheral cortex and the apex toward the hilum. Between the pyramids, note the interlobar vessels. The interlobar artery is a branch of the renal artery. The interlobar veins form the renal vein. In the marginal zone, between the cortex and base of the pyramids, course the arcuate arteries and veins, which are tributaries of the interlobar vessels.

In the adrenal gland, note the subdivisions into cortex and medulla.

12.235 Kidney

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Peer Review Status: Externally Peer Reviewed



Cat, glutaraldehyde-osmium fixation, toluidine blue stain, 1416 x.

Proximal tubule: Single layer of cuboidal cells with irregular surface. Rounded nucleus. Granular cytoplasm (see also [Plate 16](#)).

Capillary: Within the renal corpuscle. Filled with red blood cells.

Podocytes: The name given to cells of the visceral epithelium of Bowman's capsule. They have many foot- like processes (podia) resting upon the basement membrane covering the capillaries.

Bowman's space: Space between the parietal and visceral layers of Bowman's capsule in continuity with the lumen of the proximal tubules. See also [Plate 234](#).

Renal corpuscle: Includes Bowman's capsule plus the glomerulus formed of capillaries. Also known as Malpighian body

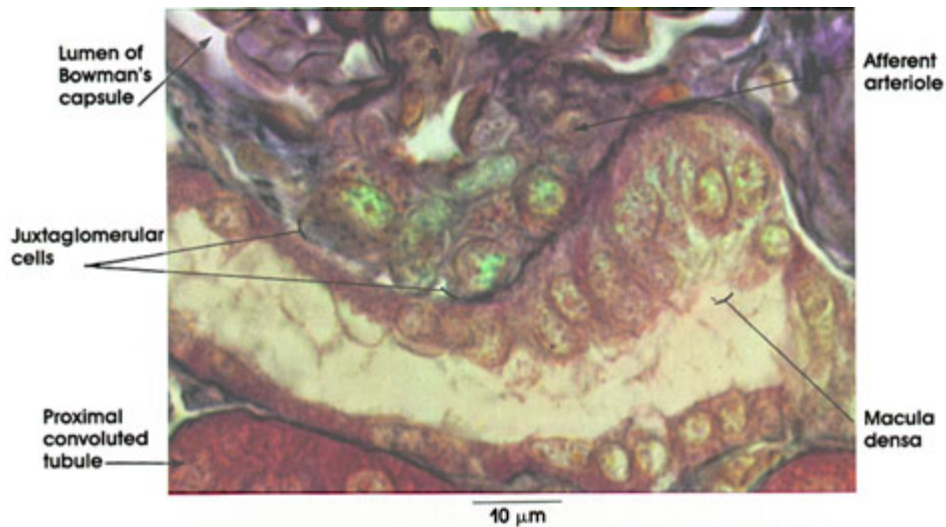
Plate 12.238 Kidney: Juxtaglomerular Cells

Ronald A. Bergman, Ph.D., Adel K. Afifi, M.D., Paul M. Heidger, Jr., Ph.D.

Peer Review Status: Externally Peer Reviewed

KIDNEY Juxtaglomerular cells

Urinary System



Rhesus monkey, Zenker's fluid, Mallory's stain, 1416 x.

Afferent arteriole: Terminal branch of the interlobular artery entering the glomerulus. The renal afferent arterioles are volume receptors and are sensitive to changes in perfusion (blood) pressure.

Juxtaglomerular cells: Granular variety of myoepithelioid cells in the wall of the afferent arteriole. Replace the typical smooth muscle cells of the tunica media of the artery. A decrease in afferent arterial volume secondary to low perfusion pressure results in the release of renin. Renin is an enzyme that is released into the blood and acts upon blood proteins to produce a potent vasoconstrictor, angiotensin, which can, under abnormal conditions, elevate blood pressure to dangerous levels. Hypertension of renal origin in humans can be cured by removal of the diseased or ischemic kidney. Renin also affects blood volume and osmolarity by initiating a chain of events leading to the release of the hormone aldosterone by the cells of the zona glomerulosa of the adrenal cortex. Aldosterone acts upon the renal tubules to enhance sodium reabsorption. A second system unrelated to the kidney (the hypothalamus of the brain and the posterior lobe of the pituitary, neurohypophysis), also regulates the volume and osmolarity of the extracellular fluid of the body. See [Plates 116](#) and [237](#).

Macula densa: A group of specialized cells of the straight portion of the distal tubule, in contact with the afferent arteriole and contiguous with the juxtaglomerular cells. The cells are taller, thinner, and tightly packed compared to other distal tubule cells. These cells are functionally related to the juxtaglomerular cells, although their exact role is undefined. The macula densa marks the origin of the convoluted portion of the distal tubule.

Lumen of Bowman's capsule: Located between the parietal and visceral epithelial layers. Receives the ultrafiltrate of blood plasma circulating through the glomerular capillaries. The glomerular filtrate traverses the glomerular endothelium, the basal lamina

Urinary System

(basement membrane), and the visceral epithelium to reach Bowman's space. Bowman's space is continuous with the lumen of the proximal convoluted tubule.

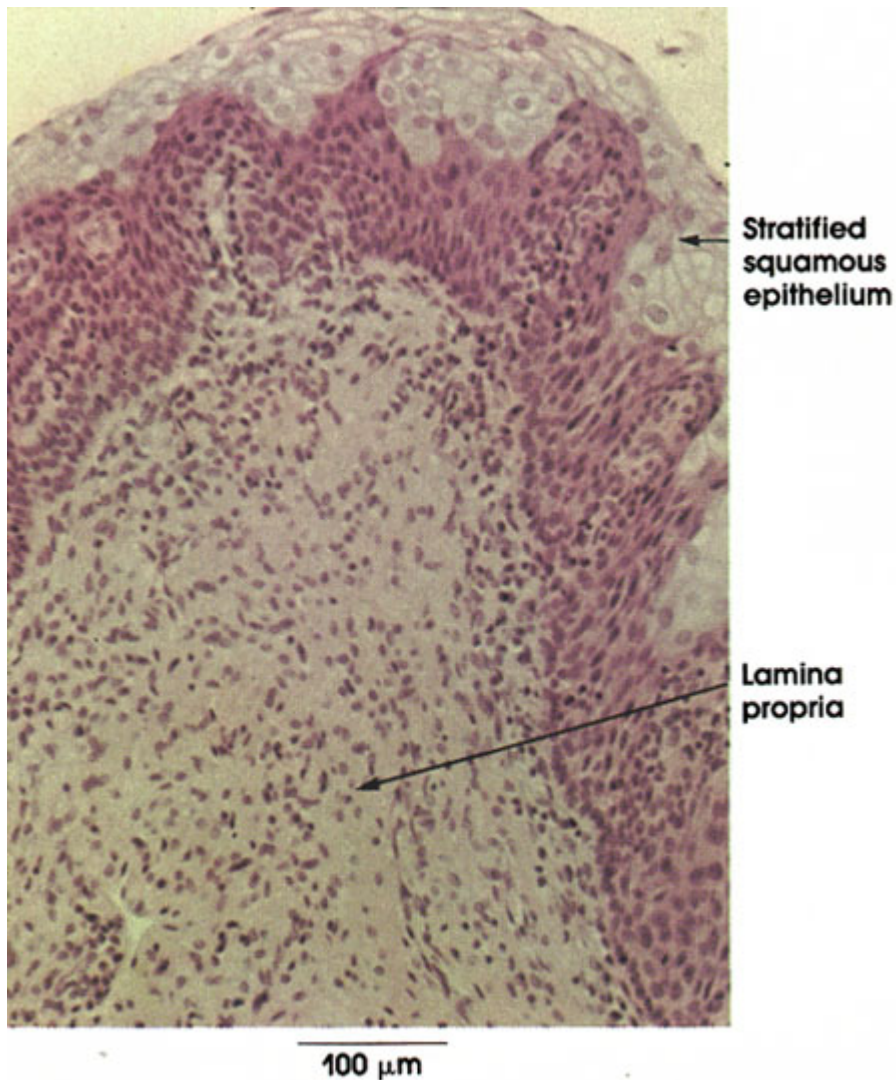
Proximal convoluted tubule: Deeply staining cuboidal cells surrounded by a thin basal lamina (basement membrane).

Plate 12.243 Urethra

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Peer Review Status: Externally Peer Reviewed

URETHRA Female



Human, 10% formalin, H. & E., 162 x.

This is a section of female urethra showing the mucosa. The lining epithelium here is stratified squamous. The type of epithelium lining the urethra is variable at different sites. It is transitional near the urinary bladder and stratified squamous throughout most of its extent except for interrupted segments of stratified columnar or pseudostratified epithelium. The lamina propria of loose connective tissue lacks papillae.

Plate 12.244 Urethra

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Peer Review Status: Externally Peer Reviewed

URETHRA Cavernous portion penis



Human, 10% formalin, H. & E., 162 x.

This plate shows the histology of the Cavernous portion of the male urethra. This portion of the urethra extends throughout the penis to open at the end of the glans. Note the stratified columnar epithelium mucosal lining intermixed with stratified squamous epithelium. The latter type of epithelium is found in interrupted areas throughout the extent of the urethra and is the only epithelial type found at the external opening of the urethra.

Note the deep recesses of the mucosal surface known as lacunae of Morgagni* Isolated intraepithelial mucous gland cells are seen interspersed between the stratified columnar cells lining the lacunae.

The lamina propria is made up of loose connective tissue rich in elastic fibers.

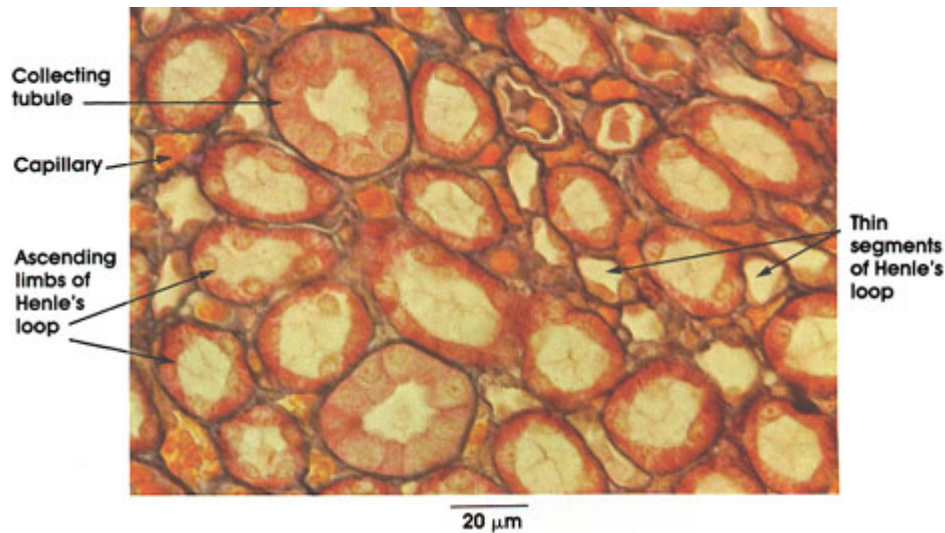
*Morgagni was an eighteenth-century Italian anatomist and pathologist.

Plate 12.239 Kidney: Medulla

Ronald A. Bergman, Ph.D., Adel K. Afifi, M.D., Paul M. Heidger, Jr., Ph.D.

Peer Review Status: Externally Peer Reviewed

KIDNEY Medulla



Rhesus monkey, Zenker's fluid, Mallory's stain, 612 x.

Collecting tubule: Cuboidal or columnar lining. Nuclei round and dark. Cytoplasm clear with distinct cell outlines.

Capillary: Filled with red cells.

Ascending limb of Henle's loop: Lined by cuboidal cells.

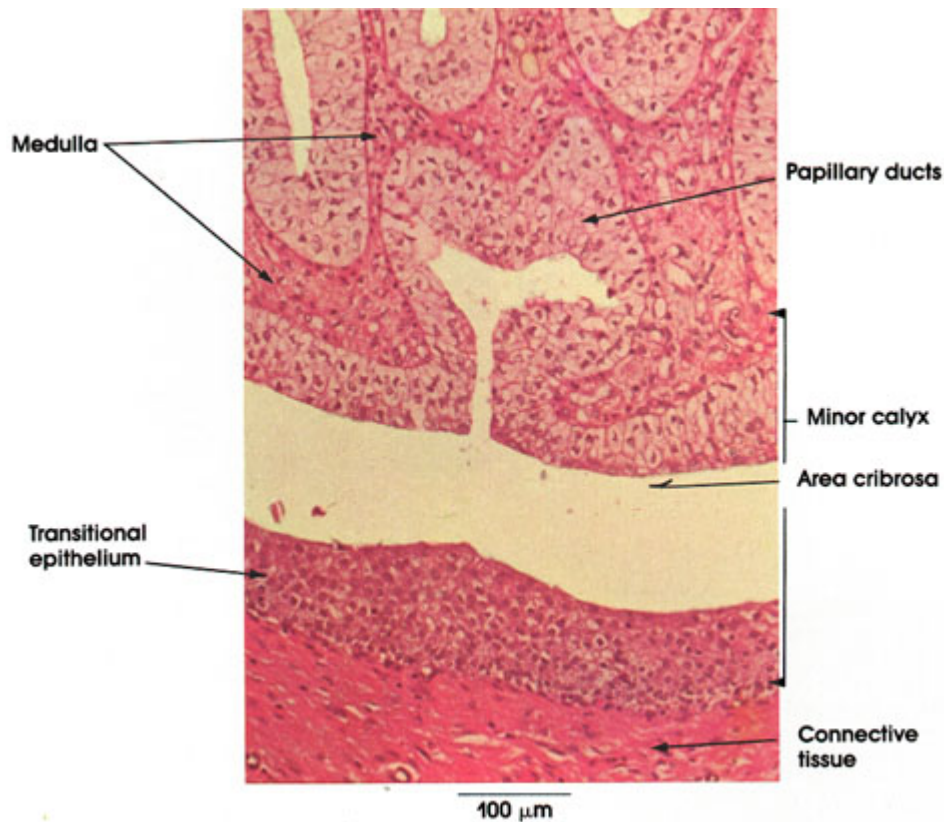
Thin segments of Henle's loop: Cells flattened, single layer, nuclei bulge into lumen.

Plate 12.240 Kidney

Ronald A. Bergman, Ph.D., Adel K. Afifi, M.D., Paul M. Heidger, Jr., Ph.D.

Peer Review Status: Externally Peer Reviewed

KIDNEY Papilla, area cribrosa, minor calyx



Rhesus monkey, Helly's fluid, H. & E., 162 x.

Papillary ducts (of Bellini): Named after Lorenz Bellini, the Italian anatomist, who described them in 1662. Arise by convergence of collecting tubules in the medulla near the pelvis. These ducts have large lumina and open at the area cribrosa at the apex of the papilla. Note the tall columnar epithelium lining the ducts. Cytoplasm of epithelial cells is clear; nuclei are dark and basally located. The tops of cells tend to bulge into the lumen.

Minor calyx: Subdivision of a major calyx in the pelvis of the kidney. The minor calyx is an infolded tube forming a double-walled cup. The inner wall of the calyx fits over the papilla of a pyramid. The transitional epithelium of the minor calyx is continuous with the columnar epithelium of the papillary ducts. The lamina propria is made up mostly of collagenous connective tissue and lacks papillae.

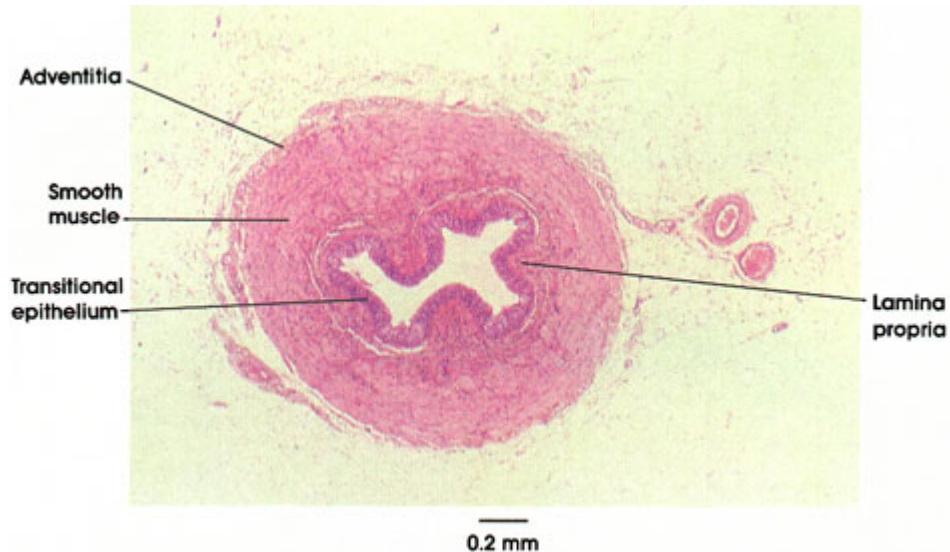
Area cribrosa: The sieve-like appearance of the papilla is produced by the large number of collecting tubules passing through it.

Plate 12.241 Ureter

Ronald A. Bergman, Ph.D., Adel K. Afifi, M.D., Paul M. Heidger, Jr., Ph.D.

Peer Review Status: Externally Peer Reviewed

URETER



Human, 10% formalin, H. & E., 35 x.

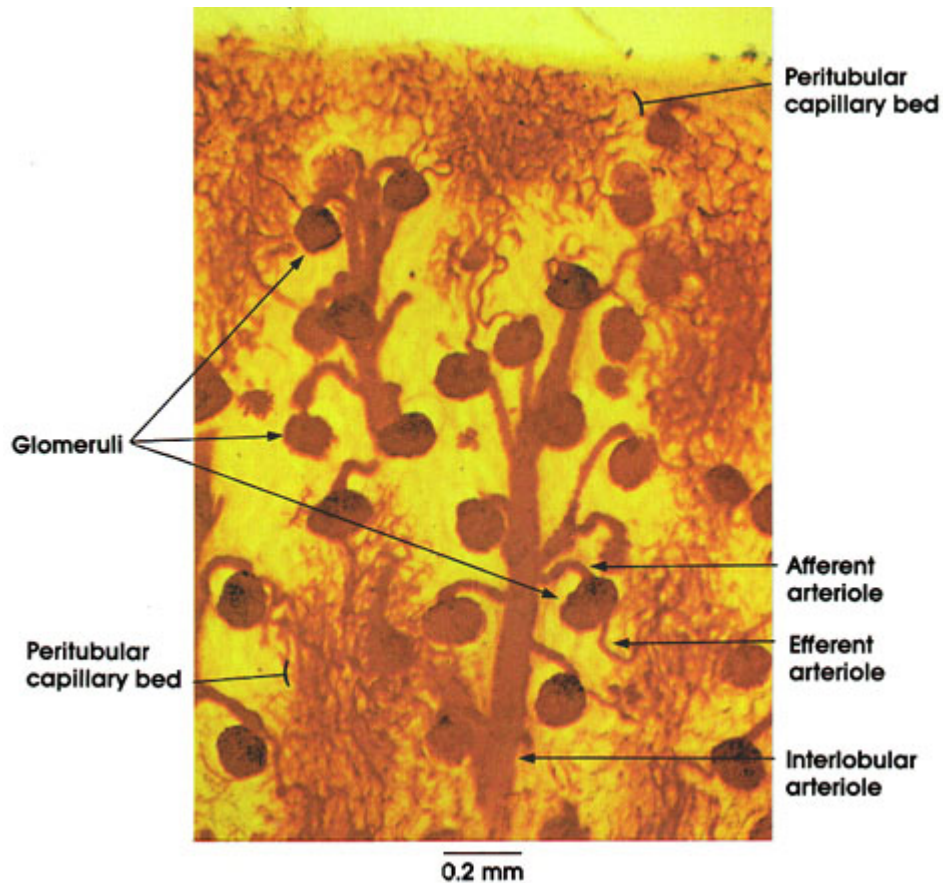
In cross section, the ureter typically exhibits a "festooned" appearance, reflecting contraction of the thick surrounding muscular layer and the consequent development of deep mucosal folds, consisting of the transitional epithelium and underlying lamina propria. There is no submucosa-the tissue of the lamina propria blends with the epimysial connective tissue of the muscularis. As in other urinary passages, the muscular layers are defined as inner longitudinal and outer circular (the converse of the gastrointestinal tract). However, these are not consistently clearly demarcated in histological section owing to incomplete separation of layers and intermingling of muscle fibers. The well-developed muscular layer generates the vigorous peristaltic wave, which propels urine from the renal pelvis to the urinary bladder. At the site of entry of the ureters into the bladder (the intramural portion of the ureter), the circular muscle layer disappears, and the ureters run an oblique course through the bladder wall. This anatomical arrangement, together with the closing of a fold of the bladder mucosa over the orifice of the ureter by hydrostatic backpressure of the bladder contents, provides an effective "physiological valve," which prevents backflow (reflux) of urine from the bladder to the ureter, and subsequently to the kidney pelvis. These anatomical features ensure against the kidney's being subject to hydrostatic pressure and tissue damage (hydronephrosis) upon voiding, and prevents reflux of bladder urine and transmission of infection to the upper urinary tract.

Plate 12.233 Kidney

Ronald A. Bergman, Ph.D., Adel K. Afifi, M.D., Paul M. Heidger, Jr., Ph.D.

Peer Review Status: Externally Peer Reviewed

KIDNEY
Vascular system cortex



Cat, vascular injection (gelatin), carmine, 50 x.

This is an injected specimen to demonstrate some aspects of vascular supply of the kidney. The interlobular arteries are branches of the arcuate arteries. The latter are located in the zone separating the cortex from the base of the medullary pyramids. The interlobular arteries ascend perpendicularly to the surface of the kidney and provide numerous short lateral branches (afferent arterioles) that enter one or more renal corpuscles (glomeruli). The interlobular arteries terminate at the periphery of the cortex as afferent arterioles, and each supplies a glomerulus. From every glomerulus, an efferent arteriole leaves and divides into a system of capillaries called the peritubular plexus around the tubules of the cortex. The injected carmine gelatin illustrates the larger size of the lumen of afferent arterioles. This relative size difference presumably increases the glomerular filtration pressure.