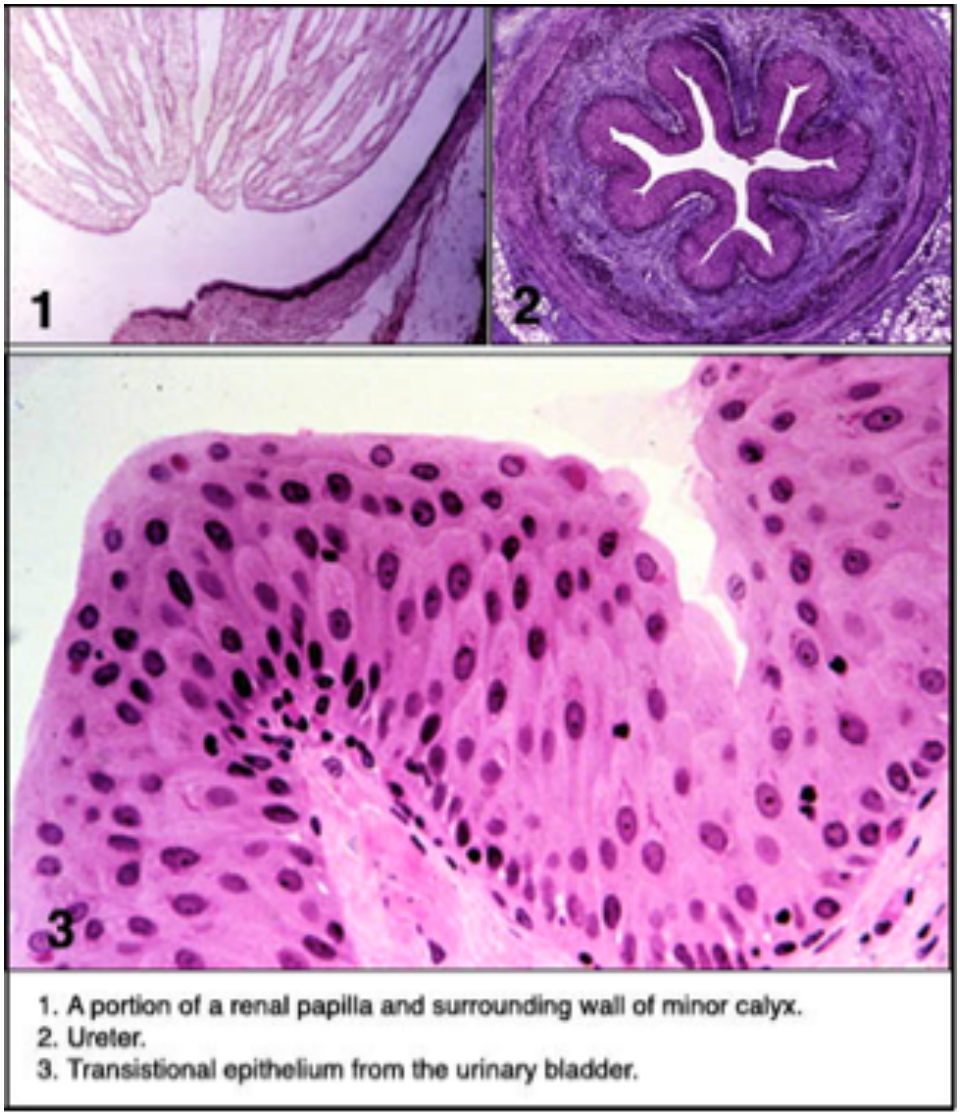
Extrarenal Passages



1. A portion of a renal papilla and surrounding wall of minor calyx.
2. Ureter.
3. Transistional epithelium from the urinary bladder.

The extrarenal passages consist of the minor and major calyces, renal pelvis, ureter, urinary bladder, and urethra. They convey urine to the outside of the body or, in the case of the bladder, store it temporarily. Except for the urethra, all have a similar basic structure with a mucosa, muscularis, and adventitia. The layers are thinnest in the minor calyces and increase in depth distally to reach their maximum development in the urinary bladder.

Calyces, Renal Pelvis, Ureters, and Urinary Bladder

The thickness of the wall of the extrarenal passages gradually increases from the upper to lower parts; except for this, all parts of the extrarenal passages show a similar histologic structure. The lumen is lined by a mucosa consisting of transitional epithelium that rests on a lamina propria. There is no submucosa, and the lamina propria blends with the connective tissue of the well-developed muscular coat. Transitional epithelium covers the external surfaces of the renal papillae and reflects onto the internal surfaces of the surrounding minor calyces. It also is continuous with the epithelium of the papillary ducts, thus providing a

complete epithelial lining that prevents escape of urine into the neighboring tissues. Transitional epithelium forms a barrier to the diffusion of salts and water into and out of the urine. In the major and minor calyces, the epithelium is two to three cells thick, increasing in the ureter to four or five layers and to six, eight, or more layers in the bladder. The surface cells are large and rounded and in the relaxed bladder have convex or dome-shaped borders that bulge into the lumen. The superficial cells sometimes contain large polyploid nuclei. The epithelium of the distended organ shows considerable changes in morphology. In the filled bladder, or as urine is propelled down the ureter, the epithelium is stretched and flattened and temporarily assumes the appearance of a thin stratified squamous epithelium. When the intraluminal pressure is relieved, the epithelium again assumes its nondistended appearance. In the relaxed bladder, the apical cytoplasm of the superficial cells contains fine filaments and fusiform vesicles that are limited by a membrane of the same thickness as the cell membrane. These vesicles are thought to represent reserve surface membrane for use during distension. Transitional epithelium lies on a very thin basement membrane that usually is not seen with the light microscope. The epithelium lies on a lamina propria that consists of a compact layer of fibroelastic connective tissue. Some diffuse lymphatic tissue also may be present. The muscularis of the urinary passageways consists of bundles of smooth muscle separated by abundant fibro connective tissue and begins in the minor calyces as two thin layers of smooth muscle. The inner, longitudinal layer begins at the attachment of the minor calyces to the renal papillae; the outer circular layer of muscle spirals around the renal papilla forming a thin coat. The walls of the minor calyces contract periodically around the renal papillae and aid in moving urine from the papillary ducts to the calyces and into the renal pelvis. The muscularis of the renal pelvis and upper two-thirds of the ureter consist of the same two layers and differ only in thickness. An additional outer, longitudinal layer of smooth muscle appears in the lower one-third of the ureter. The distal ends of the ureters, the intramural portions, pass obliquely through the wall of the bladder to empty into its lumen. The inner circular layer of smooth muscle disappears, and the contractions of the longitudinal layers help dilate the lumen of the distal ureter so that urine can enter the bladder. Peristaltic waves periodically pass along the ureter to convey urine to the bladder, into which it empties in small spurts. As the bladder fills, the pressure of its contents keeps the intramural portions of the ureters closed due to their oblique course in the bladder wall. The ureters open only when urine is forced through them. A valvelike flap of bladder mucosa that lies over the ureteral openings also prevents reflux of urine into the ureters. The muscularis of the urinary bladder is moderately thick and consists of inner longitudinal, middle circular, and outer longitudinal layers of smooth muscle. The middle layer is the most prominent and spirals around each ureteral opening. Around the internal urethral orifice, the muscle increases in thickness to form the internal sphincter of the bladder.

A coat of fibroelastic connective tissue, the adventitia, surrounds the muscularis and attaches the extrarenal passages to surrounding structures. In the renal pelvis it blends with the capsule of the kidney. On the superior surface of the bladder the fibroelastic coat is covered by peritoneum. The adventitia contains numerous blood vessels, lymphatics, and nerves. Blood vessels pierce the muscularis, provide it with capillaries, and then form a plexus of small vessels in the lamina propria. A rich capillary layer lies immediately beneath the epithelium. Nerve fibers and small ganglia also occur in the adventitia and represent the sympathetic and parasympathetic divisions of the autonomic nervous system. Parasympathetic fibers are important for control of micturition.

Male Urethra

In men, the urethra conveys urine from the bladder to the exterior and serves for the passage of seminal fluid during ejaculation. The male urethra is 18 to 20 cm long and has three segments. The first segment is 3 to 4 cm long and lies within the prostate, an accessory sex gland. This part forms the prostatic urethra (pars prostatica) and is lined by transitional epithelium similar to that of the bladder. The membranous urethra (pars membranacea) is very short (1.5 cm) and extends from the apex of the prostate to the root of the penis. The membranous urethra pierces the skeletal muscle of the urogenital diaphragm immediately before it enters the penis. Skeletal muscle surrounding this part of the urethra forms the external sphincter (sphincter urethrae) of the urethra and is under voluntary control during micturition. The third and longest segment, about 15 cm, is the penile urethra (pars cavernosa), which runs longitudinally through the corpus cavernosa urethrae to end at the tip of the glans penis. The membranous and penile parts of the urethra are lined by stratified or pseudostratified columnar epithelium. Stratified squamous epithelium often occurs in patches of the penile portion and also lines a distal enlargement, the fossa navicularis. The mucous membrane of the urethra shows small depressions or invaginations called the lacunae of Morgagni, which are continuous with the branched tubular glands of Littré. The epithelium lining these glands is the same as that found in the intraepithelial nests of clear, mucus-secreting cells within the urethral epithelium. The lamina propria beneath the urethral epithelium is a highly vascular, loose connective tissue rich in elastic fibers. Inner longitudinal and outer circular layers of smooth muscle bound the mucosa.

Female Urethra

The female urethra is shorter than the male (3 to 5 cm long) and is lined by stratified squamous epithelium, although patches of stratified or pseudostratified columnar may be found. Glands of Littré are present throughout its length. As in the male, the lamina propria is a vascular, fibroelastic connective tissue that contains numerous venous sinuses. The surrounding muscularis consists of an inner longitudinal layer of smooth muscle bundles and an outer circular layer. The female urethra is surrounded by skeletal muscle of the urogenital diaphragm that forms the sphincter urethrae near its orifice.